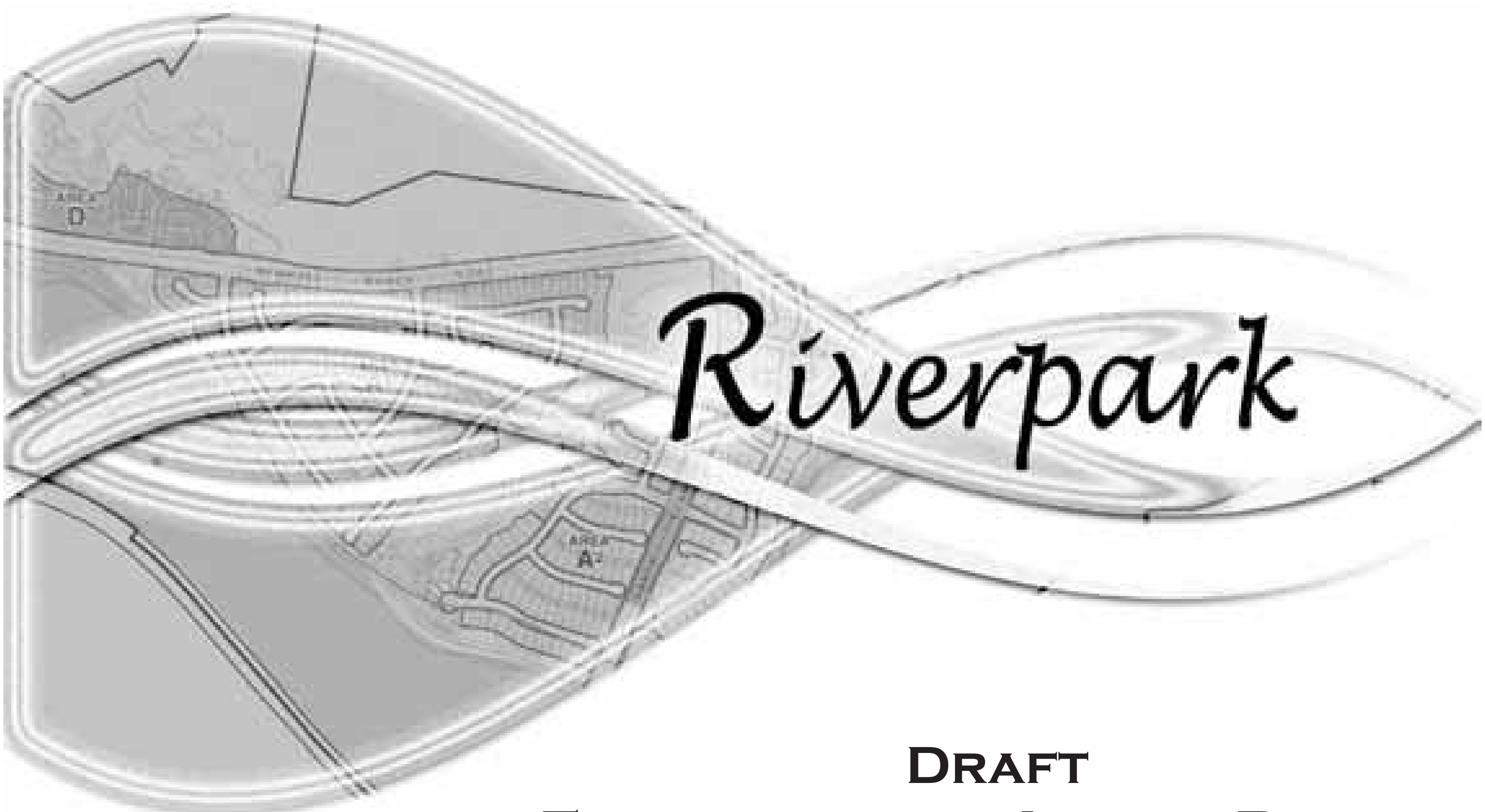

Draft Environmental Impact Report

SCH No. 2002091081

Volume IV – Appendices

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March 2004

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APPENDIX 4.8

Water Service Data

SB 610
WATER SUPPLY ASSESSMENT
for
THE RIVER PARK PROJECT

August 7, 2003

Prepared by:
Santa Clarita Water Division of
Castaic Lake Water Agency

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SB 610 WATER SUPPLY ASSESSMENT - The River Park Project

1.0 INTRODUCTION

This report is a Water Supply Assessment (Assessment) prepared at the request of the City of Santa Clarita for the proposed River Park project ("Project"). The Assessment has been drafted pursuant to the requirements of Senate Bill 610 (Costa; Chapter 643, Stats. 2001) ("SB 610") which requires the public water systems which may supply water to certain proposed development projects to prepare a water supply assessment for use by the planning agency in compliance with the California Environmental Quality Act (CEQA).[1]

This Assessment has been prepared by the Santa Clarita Water Division (SCWD)[2] of the Castaic Lake Water Agency (CLWA). SCWD will be the retail water supplier to the Project and is the operator of a "public water system" as defined by SB 610. As the operator of the public water system which may provide water to the proposed River Park development, SCWD is responsible for preparing an SB 610 Water Supply Assessment.[3]

An SB 610 Water Supply Assessment is required for any "project" that is subject to the California Environmental Quality Act (CEQA)[4] and proposes, *inter alia*, residential development of more than 500 dwelling units.[5] The River Park project is a qualifying project under this definition.

This Assessment will provide information to the City of Santa Clarita for its consideration in making a determination as to whether there is a sufficient water supply available to serve the River Park project.[6] The Assessment has been submitted to the city within 90-days of its request to the public water system.[7] The City of Santa Clarita requested this Assessment from SCWD on July 16, 2003.

No Assessment has been previously prepared for the River Park project that complies with the requirements of SB 610.[8]

[1] SB 610 amended section 21151.9 of the California Public Resources Code, and amended sections 10631, 10656, 10910, 10911, 10912, and 10915 of, repealed section 10913 of, and added and amended section 10657 of, the California Water Code.

[2] SCWD is the "public water system" for purposes of this Assessment as defined by Water Code § 10912 (b), (c). A public water system has 3,000 or more service connections and provides piped water to the public for human consumption.

[3] Water Code 10910(b).

[4] Public Resources Code § 21080.

[5] Water Code § 10912(a)(1). This section also includes other types of development which are defined as a "project" by this section of the code.

[6] Water Code § 10911(c) states that the lead agency shall determine, based on the entire record, whether projected water supplies will be sufficient to satisfy the demands of the project, in addition to existing and planned future uses.

[7] Water Code § 10910 (g)(1).

[8] Water Code § 10910(h) states that if a project has been the subject of a Water Supply Assessment that complies with the requirements of this part, no additional water supply Assessment shall be required for

1.1 River Park Project

The River Park project is a proposed residential development consisting of single and multi-family housing on a 695 acre site in the City of Santa Clarita. It includes 439 single-family dwellings, 744 apartments, 40,000 square feet of commercial building area, and a 29-acre passive park, of which a maximum of eight (8) acres would be landscaped and irrigated. The Project site is located at the terminus of Newhall Ranch Road, east of Bouquet Canyon Road between CLWA property and the Santa Clara River, north of Soledad Canyon Road. Home construction is anticipated to begin in 2006 and will continue until build-out in 2009. At build-out, total water demand for the project is estimated to be less than 700 acre-feet per year (afy) (Table 1.1).

1.2 Purpose of the Assessment

The purpose of the Assessment is to provide an analysis of whether the SCWD water system has sufficient projected water supplies to meet the projected demands of the Project.[9] Specifically this Assessment evaluates whether the total projected water *supply*, determined to be available for the Project during normal, single dry, and multiple dry water years over the next 20 years, will meet the projected water *demand* associated with the proposed Project, in addition to existing and planned future water uses, including agriculture and manufacturing uses.[10] If the water supply is anticipated to be insufficient, the Assessment must describe measures being taken to obtain an adequate supply.[11]

SB 610 requires this Assessment to be included in the Environmental Impact Report prepared for the River Park project pursuant to the California Environmental Quality Act (CEQA).[12] The relationship between the Assessment and other River Park environmental documents is discussed in more detail in the following paragraphs.

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subsequent projects that were part of a larger project for which a Water Supply Assessment was completed and that has complied with the requirements of this part and for which the public water system, or the city or county, has concluded that its water supplies are sufficient to meet the projected water demand associated with the proposed project, in addition to the existing and planned future uses, unless there has been substantial changes in the project or circumstances since approval of the Assessment.

[9] Water Code § 10910(c).
[10] Water Code § 10910 (c) (4).
[11] Water Code § 10911(a).
[12] Water Code § 10911(b), (c).

Table 1.1 – Estimated Water Demands

(Using SCWD Water Duty Factors From 2001)

LAND USE CATEGORY	AMOUNT	WATER DUTY FACTOR	WATER DEMAND (AFY)
Single Family Units	439 units	0.55 af/unit	241.45
Apartments	744 units	0.19 af/unit	141.36
Park	8 Acres	3 af per acre	24.0
Other Misc. Landscaping (irrigated common landscaping, pocket parks, etc.)	93 Acres	3 af per acre	279.0
Commercial (40,000 sq. ft.)	3 Acres	0.0289 af/ 100 sq ft	11.56
TOTAL PROJECT:			**697.37**

1.3 Castaic Lake Water Agency

The Castaic Lake Water Agency is a public water agency that serves an area of 195 square miles in Los Angeles and Ventura Counties. CLWA is a water wholesaler that provides about half of the water that Santa Clarita households and businesses use. CLWA, through the SCWD, also provides retail water service to the area previously served by the Santa Clarita Water Company. CLWA operates two potable water treatment plants, storage facilities and over 17 miles of transmission pipelines, and has initiated recycled water service. CLWA supplements local groundwater supplies with State Water Project (SWP) water from Northern California. This water is treated and delivered to the local water retailers, including the SCWD. The other three retail purveyors served by CLWA are: Los Angeles County Water District #36, Newhall County Water District, and Valencia Water Company.

1.4 Santa Clarita Water Division

In September 1999 CLWA acquired the Santa Clarita Water Company, an investor-owned retail water company serving the eastern part of the Santa Clarita Valley.[13] The former Santa Clarita Water Company was incorporated into CLWA's Santa Clarita Water Division, which continues to serve the same area with Santa Clarita Water Company's facilities. SCWD's service area includes portions of the City of Santa Clarita and unincorporated portions of Los Angeles County in the communities of Saugus, Canyon Country, and Newhall. SCWD supplies water from both groundwater wells and CLWA imported water. The SCWD is the retailer that will serve the River Park project. The project is located within the SCWD service area.

1.5 2000 Urban Water Management Plan

The water demand associated with the proposed River Park project is consistent with the projected future water demand figures in the most recent Urban Water Management Plan (UWMP) adopted by CLWA and the Santa Clarita Valley's retail purveyors: Los Angeles

[13] CLWA acquired 100% the capital stock in Santa Clarita Water Company by way of a judgment in eminent domain in Los Angeles County Superior Court case number BC 215065, entered on September 2, 1999. Subsequently, CLWA's authority to own the Santa Clarita Water Company and to provide retail water service through the former assets of the Company has been challenged in *Klajic v. Castaic Lake Water Agency* (California Court of Appeal, 2nd Dist, case number B161069). In addition, the public agency borrowing undertaken by CLWA to finance the acquisition of the Santa Clarita Water Company has been challenged in *Plambeck v. Stone and Youngberg* (LASC case no. BC249168). The cases are currently pending, but neither case seeks relief affecting the availability of water to Santa Clarita Water Company, SCWD or CLWA.

County Waterworks District # 36, Newhall County Water District, the Santa Clarita Water Company and the Valencia Water Company. The timing of the Project places it well within the timeframe for calculating "planned future uses" within the 2020 water supply projection included in the 2000 UWMP. Pertinent information from the UWMP, as well as other reports and analyses of water supply and demand, is considered in this Assessment. The final version of the Urban Water Management Plan was adopted by the CLWA Board of Directors on December 20, 2000 and submitted to the California Department of Water Resources.[14] Since adoption of the UWMP by the CLWA Board of Directors, additional documents, such as the State Water Project Delivery Reliability Report 2003, have been released that contain information and data that may update the UWMP. State law requires a revision of the UWMP by December 31, 2005, and any new information or data will be incorporated into that revision.

1.6 Reliance on the 2000 UWMP to Document Water Supply and Demand

SB 610 requires the Assessment to document the water demand for existing uses, planned future uses and the proposed development. Water Code §10910(c)(2) states that if the projected water demand associated with the proposed project was accounted for in the most recently adopted urban water management plan, the public water system may incorporate and consider the requested information from the urban water management plan in preparing the Assessment. The 2000 UWMP projections were based upon projected development based on the Los Angeles County Assessor's Land Use Codes (and General Plan documents) adopted by the City of Santa Clarita and by the County of Los Angeles, and did anticipate and take into account in its overall projections of demand, a level of development in the CLWA area consistent with that proposed by the River Park project. Pursuant to §10910(c)(2), this Assessment considers the data and findings included in the UWMP document in its determination of whether there is sufficient water supply to serve the River Park project because the Project's water demand is factored into the 20-year projection as a "planned future use."

The UWMP assumed that connections would increase by about 2,240 new connections per year. Connection data compiled and maintained by CLWA since 2000 (the year the UWMP was prepared) shows 2,249 new connections in 2000, 2,822 new connections in 2001 and 2,080 new connections in 2002. These actual numbers track closely with the assumptions from the UWMP.

[14] The validity and sufficiency of the UWMP were challenged in *County of Ventura v. Castaic Lake Water Agency*, (Kern County Superior Court case no. 245365-RJO). The trial court has ruled that UWMP meets the requirements of law. The Friends of the Santa Clara River have filed a notice of appeal from the Superior Court judgment, although the final judgment, including the award of costs, has not been filed. The County of Ventura has determined not to appeal the judgment.

1.7 Information Relied Upon in Preparation of this Assessment

Information from the following documentation has been relied upon in the preparation of this Assessment. The referenced documents are incorporated into this Assessment as if fully set forth herein. Copies of the referenced documents are available for review at the Castaic Lake Water Agency and copies can be obtained upon the payment of a fee to cover the cost of reproduction.

1.7.1 2000 Urban Water Management Plan, Castaic Lake Water Agency, Newhall County Water District, Santa Clarita Water Company and Valencia Water Company.

1.7.2 Santa Clarita Valley Water Report 2002, April 2003, CLWA, Los Angeles County Waterworks District #36, Newhall County Water District, and Valencia Water Company.

1.7.3 2001 Update Report, Hydrogeologic Conditions in the Alluvial and Saugus Formation Aquifer Systems, Richard C. Slade & Associates LLC (July 2002) ("Slade (2002)" herein).

1.7.4 Castaic Lake Water Agency, Capital Improvement Program, Kennedy-Jenks Consultants, 2003

1.7.5 The State Water Project Delivery Reliability Report, California Department of Water Resources, May 2003

1.7.6 Water Supply Contract Between the State of California Department of Water Resources and the Castaic Lake Water Agency, 1963 (plus amendments, including the "Monterey Amendment," 1995, and Amendment No. 18, 1999, the transfer of 41,000 acre-feet of Table A Amount from Kern

County Water Agency to Castaic Lake Water Agency)[15]

1.7.7 2002 Point of Delivery Agreement Among the Department of Water Resources of the State of California, Castaic Lake Water Agency and Kern County Water Agency (Semitropic Groundwater Storage Program).[16]

15 CLWA's contract rights to SWP water total 95,200 acre feet per year ("afy"), including a water transfer of 41,000 afy approved in 1999 from two water agencies in Kern County. CLWA's Environmental Impact Report prepared in connection with the 41,000 afy water transfer was challenged in *Friends of the Santa Clara River v. Castaic Lake Water Agency* (Los Angeles Superior Court Case No. PC 018110). The courts have required CLWA to re-certify the EIR but have held that CLWA may continue to utilize the 41,000 afy under the transfer.

16 Due to availability of SWP water during 2002, CLWA entered into a groundwater banking agreement in 2002. Twenty-four thousand acre feet of SWP water, contracted to CLWA, was stored within the Semitropic Groundwater Storage Program in Kern County so that CLWA may withdraw the water in future years of shortage. The Negative Declaration prepared by CLWA was challenged in *California Water Network v. Castaic Lake Water Agency* (Ventura County Superior Court case no. CIV 215327), which is pending.

2.0 WATER SUPPLY ASSESSMENT

Based on the information contained in the 2000 UWMP and other supporting information relied upon in the preparation of this Assessment SCWD concludes there will be a sufficient water supply available at the time the River Park project is ready for occupancy, to meet the needs of the project in addition to existing and other planned future uses.

CLWA has existing water entitlements, rights and contracts to meet future demand as needed over time, and has committed sufficient capital resources and planned investments in various water programs and facilities to serve all of its existing and planned customers, including SCWD's customers. SCWD water entitlements, rights and contracts for local supplies, in addition to imported supplies provided by CLWA are sufficient to serve all of its existing and planned customers. SCWD has also identified an operational strategy combined with a prudent and flexible management approach to ensuring water reliability.

SCWD's current service area-wide demands are approximately 27,000 afy[17]. As mentioned previously, the River Park project will require less than 700 afy at build-out. The conclusions of the SCWD as stated in the 2000 UWMP related to the requirements of the SB 610 Assessment for River Park are as follows:

2.1 Average/Normal Year Water Assessment

The UWMP indicates that no shortages are anticipated within the Agency's service area in an average/normal water year through 2020 if projected imported and local supplies are developed as estimated.[18] Total projected water demands for the CLWA through the year 2020 are compared with the supplies projected to be available to meet demands in this analysis. The following table summarizes the data from the UWMP.

"Future Planned Water Supply Programs" as listed below, are included in the UWMP to indicate examples of how CLWA would add reliability and flexibility to its water supply portfolio. Programs such as these will be analyzed by CLWA and contracts entered into as need and cost-effectiveness are determined through time. Future Water Supply Assessments will reflect these contractual agreements.

[17] This represents average year demand. Dry year demand is approximately 10% higher.
[18] Castaic Lake Water Agency, 2000 Urban Water Management Plan (December 2000) p.4-2.

Table 2.1 Average/Normal Water Year

SUPPLY AND DEMAND ASSESSMENT[19] (Acre-Feet Per Year)				
	Year 2005	Year 2010	Year 2015	Year 2020
EXISTING WATER SUPPLY PROGRAMS:				
Local Supplies				
Alluvial Aquifer	35,000	35,000	35,000	35,000
Saugus Formation	11,000	11,000	11,000	11,000
Recycled Water	1,700	1,700	1,700	1,700
Imported Supplies[20]				
SWP Table A Amount	56,073	56,073	56,073	56,073
TOTAL EXISTING SUPPLIES:	**103,773**	**103,773**	**103,773**	**103,773**
Total Estimated Demand	81,700	90,100	100,700	113,100
Difference Surplus/(Deficit)	22,073	13,673	3,073	(9,327)
FUTURE PLANNED WATER SUPPLY PROGRAMS:				
Local Supplies				
Recycled Water		9,000	14,000	17,000
Imported Supplies				
Water Transfers	5,200	5,200	5,200	5,200
TOTAL PLANNED SUPPLIES:	**5,200**	**14,200**	**19,200**	**22,200**

[19] Excerpted from Table 4-1 of the UWMP

[20] 56,073 af represents approximately 58.9% of CLWA's contractual Table A Amount. Normal year supply based on assumptions from the UWMP. The DWR SWP Delivery Reliability Report (2003) indicates greater reliability of Table A deliveries (72 to 76%) than was assumed for the 2000 UWMP

2.2 Single Dry Year Water Assessment

The UWMP evaluated the estimated dry-year demands and projected supplies for the year 2010 for the purpose of assessing a single dry year. This year was selected in order to show the results of local and imported water supply development over the next 10 years. In May 2003 DWR finalized its State Water Project Delivery Reliability Report. For the worst-case scenario single dry year (1977, with a one in 73 year probability of occurrence), DWR estimates that SWP deliveries to contractors would be approximately 20 percent of contract amounts. If projected imported and local supplies are developed as indicated, no shortages are anticipated within the Agency's service area for the extreme-case single dry-year scenario analyzed.

2.3 Multiple Dry Year Water Assessment

The UWMP estimated the minimum water supply available during each of the three water years, 2001, 2002, and 2003.[21] The surface and groundwater supplies included in this analysis are reflective of supplies available during the 1987-92 drought years, and in particular, 1990, 1991, and 1992. The supplies available from recycling projects are assumed to experience no reduction in a dry year but are also assumed not to be fully on-line at this early stage of the 20-year projection. Demand reductions of 10% based on short-term water conservation programs are assumed for these dry-year scenarios (this level of conservation was achieved during the 1987-1992 drought). If projected imported and local supplies are developed as indicated, no shortages are anticipated within the Agency's service area in the dry-year scenarios analyzed.[22] Years 1, 2 and 3 in Table 2.1 represent demand projections for 2003 through 2005. The single and multiple dry year water supply and demand assessments from the UWMP are summarized in the following table[23].

Information concerning "Future Planned Water Supply Programs" as listed below, from the UWMP and other sources was included to indicate examples of how CLWA would add reliability and flexibility to its water supply portfolio. Programs such as these will be analyzed by CLWA and contracts entered into as need and cost-effectiveness are determined through time. Future Water Supply Assessments will reflect these contractual agreements.

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[21] UWMP p. 4-3. Hot, dry weather may generate a 10 % increase above normal in both urban and agricultural water usage. This percentage was used to generate the dry-year demands in Table 2.2.
[22] UWMP p. 4-4.
[23] Excerpted from Table 4-2 of the UWMP

Table 2.2 Dry-Year and Multi-Dry Year Water

SUPPLY AND DEMAND ASSESSMENT (Acre-Feet Per Year)				
	Single Dry Year	**Multiple Dry Years Year 1**	**Year 2**	**Year 3**
EXISTING WATER SUPPLY PROGRAMS				
Local Supplies				
Alluvial Aquifer	35,000	32,500	32,500	32,500
Saugus Formation	13,000	13,000	13,000	13,000
Recycled Water	1,700	1,700	1,700	1,700
Imported Supplies[24]				
SWP Table A Amount	19,040	37,890	37,890	37,890
Semitropic Bank Account	7,200	7,200	7,200	7,200
Flexible Storage Account	4,684	1,561	1,561	1,561
TOTAL EXISTING SUPPLIES	**82,624**	**93,851**	**93,851**	**93,851**
Total Estimated Demand	90,900	82,000	83,300	84,600
Voluntary 10% Conservation	9,090	8,200	8,330	8,460
Difference Surplus/(Deficit)	814	11,851	10,551	9,251
FUTURE PLANNED WATER SUPPLY PROGRAMS (2010)[25]				
Local Supplies				

[24] 19,040 af represents 20% of CLWA's contractual Table A Amount. 37,890 af represents 39.8% of CLWA's contractual Table A Amount. Dry year supply based on assumptions from the UWMP.

[25] The UWMP assumed a total of 100,000 af in available future supplies by 2020. Therefore 50,000 af shown herein is assumed to be available by 2010.

Recycled Water	7,300
Saugus (New Wells)	20,000
Imported Supplies	
Water Transfers	3,500
Water Banking/Conjunctive Use	50,000
TOTAL FUTURE PLANNED SUPPLIES	**80,800**

3.0 IDENTIFICATION OF EXISTING WATER SUPPLY SOURCES

3.1 Annual Existing Water Supply Entitlements, Water Rights, or Water Service Contracts

The first substantive requirement of the SB 610 Assessment is the identification and description of the existing water supply sources in the public water system that will serve the Project. Water Code §10910(d) requires the Assessment to include an identification of any existing water supply entitlements, water rights, or water service contracts relevant to the identified water supply for the proposed project, and a description of the quantities of water received in prior years by the public water system. The identification of existing water supplies shall be demonstrated by providing information related to the following:

- Written contracts or other proof of entitlement to an identified water supply;
- Copies of a capital outlay program for financing the delivery of a water supply that has been adopted by the public water system;
- Federal, state, and local permits for construction of necessary infrastructure associated with delivering the water supply; and,
- Any necessary regulatory approvals that are required in order to be able to convey or deliver the water supply.

The current water supply for the Santa Clarita Valley is derived from four primary sources:

(1) Groundwater from the Alluvial Aquifer
(2) Groundwater from the Saugus Formation
(3) Imported SWP water
(4) Recycled Water

Recycled water is now available and currently being used to irrigate a golf course and several landscaped areas. The recycled water system can deliver 1,700 af, with plans to expand its use over the next 20 years.

Within the SCWD service area, these sources of water supply can be characterized as 1) *local supplies*, consisting of groundwater and recycled water, and 2) *imported supplies*, transported via the SWP, consisting of SWP Table A Amount.

Potential future water sources include additional recycled water, desalination, storm water runoff, increased Saugus pumping, and SWP reliability projects.[26]

Historically, local groundwater extracted from the Alluvial Aquifer and Saugus Formation has been the primary source of water in the SCWD's service area. However, since 1980, local groundwater supplies have been supplemented with imported water from the State Water Project.

3.2 Groundwater

Water Code §10910(f) requires this Assessment to include specific information describing groundwater resources if the water supply for a proposed project includes groundwater. Slade (2002) updates prior reports and includes a detailed review of the groundwater resources available to SCWD to supply the Project, including historic yields, estimated capacity and projected future yield capacity. Groundwater is drawn from two aquifer systems within the Santa Clara River Valley East Sub-basin, one of several sub-basins identified along the Santa Clara River in Los Angeles and Ventura counties by updated Bulletin 118 of the California Department of Water Resources. The shallow aquifer system is denominated the Alluvial Aquifer and the deeper aquifer is denominated the Saugus Formation. In addition to the SCWD, other large municipal and larger scale agriculture producers (including Newhall County Water District, Valencia Water Company, the Newhall Land and Farming Company and Wayside Honor Ranch) produce groundwater from the Alluvial Aquifer and Saugus Formation. Aggregate groundwater production by hundreds of other, small scale, water wells is estimated to account for less than 1% of total production from these aquifer systems.

The following sub-parts respond to specific requirements of Water Code §10910(f):

[26] UWMP p.1-11.

3.2.1 Water Code §10910(f)(1).

Review of relevant information contained in the urban water management plan.

Pages 2-2 through 2-6 of the 2000 UWMP provide an overview description of the local Alluvial and Saugus Formation aquifer systems, as well as historical and projected production.

3.2.2 Water Code §10910(f)(2).

Description of any groundwater basin or basins from which the proposed project will be supplied including information concerning adjudication and overdraft.

Slade (2002) Sections 2 through 5 describe two aquifer systems, the Alluvial Aquifer and the Saugus Formation, within the Santa Clara River Valley East Sub-basin ("Basin") and provides a detailed description of the groundwater basins. Slade (2002) also provides an assessment of the operational yield and other parameters of production capacity of the aquifer systems. The Basin is about 22 miles long east to west and about 13 miles wide. Slade (2002) estimates that about 200,000 acre feet of water is in storage in the Alluvial Aquifer and about 1.6 million acre feet is stored in the Saugus Formation. Neither aquifer system is in overdraft at the present time. The Basin has not been adjudicated and has not been identified as overdrafted or projected to be overdrafted by the Department of Water Resources.

3.2.3 Water Code §10910(f)(3)

Description and analysis of the amount and location of groundwater pumped by the public water system for the past five years from any groundwater basin from which the proposed project will be supplied.

Detailed information about the amount and location of groundwater pumped from both the Alluvial Aquifer and Saugus Formation is provided in Slade (2002) Sections 4 and 5, and in the 2002 Water Report. The most recent five year average production (1998-2002) by all producers from the Alluvial Aquifer is 39,000 afy (2002 Water Report). During the same period, total production from the Saugus Formation averaged 4,500 afy, with a low of 3,700 afy (1999) and a high of 5,555 afy (1998) (2002) Water Report, Table II-7).

3.2.4 Water Code §10910(f)(4)

Description and analysis of the amount and location of groundwater that is *projected* to be pumped by the public water system from any basin from which the proposed project will be supplied.

Slade (2002) does not provide detailed descriptions and analysis of locations or yields of specific new wells that may be constructed in the future. The report, however, anticipates that new capacity and replacement wells can be located, designed and operated within the Basin, both within the Alluvial Aquifer and the Saugus Formation, without creating undesirable conditions. Slade (2002), page 85. Groundwater supplies were reviewed in the UWMP and evaluated as to whether supply projections were realistic for average and dry conditions. The review made the following critical findings:[27]

1. Both the Alluvial Aquifer and the Saugus Formation are reasonable and sustainable sources at the yields represented in the 2000 UWMP.
2. The yields are not overstated and will not deplete or "dry up" the groundwater basin.
3. There is no need to reduce the yields for purposes of planning in the context of the UWMP.

Preliminary analyses and recent studies have concluded that additional pumping can be safely carried out in both aquifers.[28] Neither aquifer is in overdraft condition.

3.2.5 Water Code §10910(f) (5)

Analysis of the sufficiency of the groundwater from the basin or basins from which the proposed project will be supplied to meet the projected water demand associated with the proposed project.

Slade (2002) concludes that Alluvial Aquifer has storage capacity of about 200,000 af, with a sustainable operational yield ranging from 30,000 to 40,000 afy. Slade (2002) concludes that Alluvial Aquifer extractions should be reduced to 30,000 to 35,000 afy during dry periods.

[27] Luhdorff and Scalmanini, Consulting Engineers, Review of Ground-Water Components 2000 Urban Water Management Plan CLWA, NCWD, SCWC, and VWC (December 15, 2000). The review was based on information provided by Richard Slade & Associates. This review and baseline information is included in the appendices of the UWMP.

[28] UWMP p. 1-13 and Slade, 2001 Update Report Hydrogeologic Conditions in the Alluvial and Saugus Formation Aquifer Systems, (dated July 2002), Volume I, see Executive Summary.

Slade (2002) concludes that the Saugus Formation has storage capacity of 1.6 million acre-feet, with a sustainable operational yield of 7,500 to 15,000 afy. Slade (2002) concludes that Saugus Formation extraction can be increased, on an infrequent basis to the range of from 15,000 to 35,000 afy, without creating undesirable conditions. Recent extractions from the Saugus Formation averaged less than 6,000 afy, but averaged 10,500 afy during the 1989 to 1992 drought.

A small portion of the Saugus Formation is contaminated with ammonium perchlorate and four wells have been unavailable since 1997. In November 2002 one Alluvial well was also found to contain perchlorate. An Environmental Oversight Agreement has been signed by CLWA and the purveyors with the California Department of Toxic Substances Control, which includes a Remedial Action Workplan. Planning and development is underway to install treatment facilities to remove the perchlorate contamination and return the wells to service.

3.3 Recycled Water

Wastewater that has been highly treated and disinfected can be reused for landscape irrigation and other purposes. It is not suitable for use as potable water. In 1993, CLWA completed a *Reclaimed Water System Master Plan* to use recycled water as a reliable water source to meet some non-potable demand within the Santa Clarita Valley. The Master Plan is being updated, and the amount of recycled water expected to be produced in the future reaches approximately 17,000 acre-feet per year in 2020.[29]

CLWA is currently under contract for 1,700 acre-feet per year and that amount is now available.

3.4 State Water Project Water

Since 1980, local supplies in the Santa Clarita Valley have been supplemented with imported water from the State Water Project (SWP). This water obtained from the SWP through CLWA, is and will continue as the largest source of water for the Valley. The SWP contract amounts, depending on annual allocation, currently meet more than half of local demand. The reliability of SWP supplies is subject to both annual hydrology and planned improvements to the system.

CLWA's current SWP Table A Amount of 95,200 AFY is affected by, and can be reduced due to, a number of factors, including hydrologic conditions, the status of SWP facilities'

[29] UWMP p. 1-13.

construction and environmental requirements. Because of these factors, SWP supplies are subject to reduction, particularly during drought periods

In May 2003 the California Department of Water Resources completed its *State Water Project Delivery Reliability Report.* The report provides current information on the ability of the SWP to deliver water under existing and future levels of development, assuming historical levels of precipitation.

According to the report, the SWP will, on average, be able to deliver between 72-76 % of the maximum total contract amount of 4.1 million acre-feet per year, provided that an SWP contractor has the ability to utilize or store all of its Table A Amount made available for allocation. The level of deliveries drops to between 19% and 20% for an extraordinary dry year and approximately 40% for multiple dry years. This information will be used in and more fully analyzed in the discussion of CLWA's SWP supplies during the update of its Urban Water Management Plan in 2005.

Friends of the Santa Clara River v. Castaic Lake Water Agency

Filed 12/1/03 Friends of the Santa Clara River v. Castaic Lake Water Agency CA2/4

NOT TO BE PUBLISHED IN THE OFFICIAL REPORTS

IN THE COURT OF APPEAL OF THE STATE OF CALIFORNIA

SECOND APPELLATE DISTRICT

DIVISION FOUR

FRIENDS OF THE SANTA CLARA RIVER, Plaintiff and Appellant, v. CASTAIC LAKE WATER AGENCY, Defendant and Respondent.	B164027 (Los Angeles County Super. Ct. No. BS056954)

APPEAL from a judgment of the Superior Court of Los Angeles County, David P. Yaffe, Judge. Affirmed.

Law Office of Alyse M. Lazar and Alyse M. Lazar for Plaintiff and Appellant.

Rossmann and Moore, Antonio Rossmann and Roger B. Moore for Amici Curiae Planning and Conservation League and Citizens Planning Association of Santa Barbara County, Inc., in support of Plaintiff and Appellant.

Horvitz & Levy, Barry R. Levy, William N. Hancock; R. Bruce Tepper; and McCormick, Kidman & Behrens, Russell G. Behrens, H.L. (Mike) McCormick and David D. Boyer for Defendant and Respondent.

INTRODUCTION

This is the second time this case has been before us. On the first appeal we directed the trial court to issue a writ of mandate to set aside certification of respondent Castaic Lake Water Agency's Environmental Impact Report (EIR) because the EIR had been tiered upon a prior EIR that had been found to be infirm by an intervening appellate decision. Upon remand, respondent and appellant Friends of the Santa Clara River agreed a writ of mandate should issue to decertify the EIR but disagreed about whether the trial court should also enjoin the project pending certification of a new EIR. After consideration of documentary evidence and the presentation of written and oral arguments, the trial court rejected appellant's request for an injunction without prejudice to entertaining a renewed request founded on an adequate showing of entitlement to relief. This appeal follows entry of judgment in October 2002.

Appellant attacks the trial court's denial of its request for an injunction on two separate grounds. Appellant first contends the trial court's denial was in derogation of the directions contained in our earlier decision. The contention lacks merit. The clear and unambiguous dispositional language in our opinion granted the trial court the authority to deny in toto the request for an injunction. Appellant next contends the trial court erred on the merits in denying its request. Based upon the record, we find the trial court did not abuse its discretion in implicitly finding appellant had failed to carry its burden of establishing the predicates for injunctive relief. We therefore affirm the judgment.

FACTUAL AND PROCEDURAL BACKGROUND

Respondent purchased from the Kern County Water Agency entitlement to 41,000 acre-feet per year of water. The purchase followed consummation of the Monterey Agreement which changed the allocation between agricultural and urban contractors of entitlements to State Water Project (SWP) water. Respondent approved this purchase after first certifying an EIR. This EIR was "tiered" upon an earlier EIR approving the Monterey Agreement.[1] The Legislature favors tiering to streamline the regulatory process and to avoid unnecessary duplication of effort.

Appellant filed a petition for a writ of mandate in the superior court to compel respondent to set aside its certification of the EIR for the purchase of 41,000 acre-feet per year of SWP water. Appellant advanced various grounds in support of its petition. The superior court denied the petition. Appellant appealed the adverse judgment to this court.

While that appeal was pending, our colleagues in the Third Appellate District concluded the EIR prepared for the Monterey Agreement was inadequate and therefore ordered it decertified. (*Planning & Conservation League v. Department of Water Resources* (2000) 83 Cal.App.4th 892, review den. (*PCL*).)

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1 Tiering "means the coverage of general matters and environmental effects in an environmental impact report prepared for a policy, plan, program or ordinance followed by narrower or site-specific environmental impact reports which incorporate by reference the discussion in any prior environmental impact report and which concentrate on the environmental effects which (a) are capable of being mitigated, or (b) were not analyzed as significant effects on the environment in the prior environmental impact report." (Pub. Res. Code, § 21068.5.)

We therefore concluded that in the appeal presented to us *PCL* required decertification of respondent's EIR because it had been tiered on the now-decertified EIR for the Monterey Agreement. (*Friends of the Santa Clara River v. Castaic Lake Water Agency* (2002) 95 Cal.App.4th 1373, 1383-1388, review den. (*Friends I.*) We, however, rejected all of appellant's other challenges to respondent's EIR, finding "them to be *without merit*." (*Id.* at p. 1387.) We noted: "[R]espondent may be able to cure the *PCL* problem by awaiting action by the [Department of Water Resources] complying with the *PCL* decision, then issuing a subsequent EIR, supplement to EIR, or addendum to EIR [citations] tiering upon a newly certified Monterey Agreement EIR." (*Id.* at pp. 1387-1388.)

In regard to further action in the trial court we wrote: "[W]e leave to the trial court's discretion whether to enjoin all or portions of respondent's project pending completion of an adequate EIR. The trial court is in a better position than this court to determine factually the current status of the *PCL* litigation or of a new Monterey Agreement EIR." (*Id.* at p. 1388.)

The dispositional paragraph of our decision read, in relevant part: "The judgment is reversed. The trial court shall issue a writ of mandate vacating the certification of the EIR, shall retain jurisdiction until respondent certifies an EIR complying with CEQA consistent with the views expressed in this opinion, and shall consider such orders it deems appropriate under [Public Resources Code] section 21168.9." (*Id.* at p. 1388.)

Upon remand, the parties agreed the trial court was required to issue a writ of mandate to decertify respondent's EIR. The bone of contention was whether the trial court should also enjoin respondent from proceeding with the project, e.g., the transferring of the entitlement to the 41,000 acre-feet of water per year, pending completion of the new EIR.

Appellant argued: "To allow [respondent] to use any portion of its unstudied 41,000 afy [acre feet per year] entitlement before the EIR analysis is complete will result in **new permanent water connections** that will not be able to be reversed. Once houses are in and the faucets are on, there is no way to turn back. Without the proven need for this water to serve existing users, there is no equitable justification for allowing the use of any portion of the 41,000 afy entitlement in the face of its clear consistency with CEQA policies against pre-approved projects. A fair EIR process requires that project approval not be up and running as a foregone conclusion."

The evidentiary support for this argument is found in a declaration executed in August 2002 by appellant's counsel. The declaration sought to establish respondent would have sufficient water from other sources to supply its existing customers without use of the entitlement. From these factual allegations, appellant argued any use by respondent of the entitlement would necessarily be for new customers and therefore subject to being enjoined. The declaration referenced several attached documents and included allegations grounded upon information and belief. In pertinent part it averred:

> "I am informed that [respondent] has utilized at most 3674 af [acre feet] of the subject 41,000 afy [acre feet per year] water transfer during the past year. Attached is a true copy of CLWA Production Report for 2000, 2001, and half of 2002, and also a DWR Notice to State Water Project Contractors dated May 2002. The reports speak for themselves, and reflect CLWA's use of State Water Project entitlements to its various purveyors. The allocation of SWP water was 65% in the last year, and *petitioner is informed and believes that CLWA expects an even larger allocation in the coming fiscal year to as much as 90%.* The report shows that water use is measured yearly from June to June. It is undisputed that CLWA has a 54,200 afy entitlement to SWP water that is not under any legal cloud and clearly available for use, aside from the 41,000 afy that is the subject of this litigation. Based on a 65% delivery of SWP water, CLWA's

> allocation of its undisputed 54,200 afy totals 35,230 af. The report reflects use of 38,974 af from June 2001 until June 2002; which appears to be only 3674 af more than can be supplied from the 54,200 afy entitlement. It thus appears that CLWA *may have utilized* 3674 af of its allocation from the subject 41,000 af entitlement in the past year. If the SWP allocations increase to 75% or greater, *as is apparently expected,* by doing the math it appears that the 41,000 af water transfer is not needed for existing customers of the CLWA water purveyors while the supplemental environmental review is pending." (Italics added.)

Appellant therefore sought an order enjoining respondent "from any and all use of the 41,000 afy water transfer under the current approvals."

In addition, appellant's counsel averred she had communicated with counsel in the *PCL* case and that as of August 22, 2002, "the *PCL* case remand has not yet been settled or otherwise resolved, and that the Monterey Agreement Implementation Draft EIR to be prepared by the Department of Water Resources (DWR) as required by the *PCL* decision has not yet been published." As for the status of respondent's EIR, the declaration averred that respondent's attorney had informed her "that the agency has not yet published its Draft Supplemental EIR in response to [the Court of Appeal's decision], but that it intends to prepare the EIR itself rather than await the new DWR Monterey Agreement Implementation EIR."

In opposition, respondent asked the trial court to "**issue an order allowing the Transfer of Entitlement to remain intact pending completion of a new EIR.**" In particular, respondent urged that the entitlement was "necessary to satisfy current existing and projected near-term water demand"; that a "decision to set aside the Transfer of Entitlement would cause immediate irreparable harm to the Agency and the water consumers"; and that the Transfer "has been in effect for more than three years, and there is no evidence that the Transfer has resulted in any new or increased significant adverse environmental effects."

Respondent's opposition was supported by a detailed eight-page declaration from Dan Masnada, respondent's general manager. Masnada averred that respondent had already retained consultants to prepare a new EIR and they planned to complete the process by March 2003. A portion of Masnada's declaration directly refuted the allegations made by appellant's counsel about respondent's projected water supply. In pertinent part, Masnada averred:

> "[Counsel's] declaration states that 'CLWA expects an even larger allocation made by DWR in the coming fiscal year to as much as 90%.' . . . *There is no factual basis for this statement.* There have been no indications that CLWA's SWP allocation made by DWR in the coming year will be anywhere near 90%. To the contrary, based on discussions with DWR Operations Control Office Personnel it is likely that the initial 2003 SWP allocation on December 1, 2002 will be approximately 20%, as it was last year. If dry conditions occur next year, the final SWP allocation for 2003 could remain as low as 20%.
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> [Counsel's] Declaration also states that the CLWA Production Report 'shows that water use is measured yearly from June to June.' . . . This is incorrect. While annual water use can be measured from July to June, available SWP water supply is characterized on a calendar year basis because DWR allocates it on a calendar year basis. *[Her] accounting of water deliveries i[s] flawed.* She has utilized an approach that understates CLWA's current level of demand and projected deliveries to the retail purveyors during 2002. As discussed above, and shown in Exhibit A, CLWA's Final 2001 SWP allocation was 39%. Without the 41,000 AF in 2001, CLWA would have experienced a shortfall of 14,218 AF."

Appellant's reply to respondent's opposition did not include any additional declaration(s). Instead, its reply asserted respondent's "factual information" was "confusingly presented and misleading" and that a portion of Masnada's opinion about SWP allocations for 2003 was "complete conjecture and speculation."

After a hearing in which the parties presented argument and responded to questions from the bench, the trial court issued a writ of mandate ordering respondent to set aside its certification of the 1999 EIR and to certify a new EIR consistent with our opinion in *Friends I.* The trial court rejected appellant's request to enjoin any use of the water entitlement. It ruled: "Petitioner [appellant herein] requests that the Court also prohibit respondent from using any of the 41,000 acre feet of additional water allotted to it from the subject State Water Project. Petitioner contends that the said water will be used to approve new development that will not be able to be reversed if a Final Environmental Impact Report is not certified. Respondent contends that such a prohibition would prevent it from meeting the existing water needs in the area it services. *Both contentions appear to be speculative at this time. Respondent will not be prohibited from using the water to which it is entitled, but petitioner may renew its application for such prohibition based upon evidence of the actual use of such additional water for purposes it considers improper.*" (Italics added.)

This appeal follows.[2]

DISCUSSION

A. THE DIRECTIVE IN *FRIENDS I*

Appellant first contends the trial court misconstrued our directive in *Friends I.* Appellant's position is that our decision gave the trial court the power

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2 In July 2002, we denied respondent's motion to dismiss the appeal because denial of a *pendente lite* injunction is appealable pursuant to Code of Civil Procedure section 904.1, subdivision (a)(6).

to enjoin either all or part of the project pending certification of a new EIR but that it did not give it the power to decide, as it did in the proceedings it conducted following remand, not to enjoin any part of the project. Appellant relies upon the following language we now italicize from *Friends I*: "Like the court in *PCL, supra,* 83 Cal.App.4th at page 926 and footnote 16, we leave to the trial court's discretion whether to enjoin *all or portions* of respondent's project pending completion of an adequate EIR." (*Friends I, supra,* 95 Cal.App.4th 1373, 1388, italics added.) From that language, appellant argues "the Superior Court was not vested with the discretion to issue no injunction, but only with [the] discretion to issue a full or partial injunction."

Appellant's argument lacks merit because it ignores the clear dispositional language of our opinion which gave the trial court the authority to deny in toto a request for injunctive relief.

"Where a reviewing court has remanded a matter to the trial court with directions '. . . the trial court . . . is bound to specifically carry out the instructions of the reviewing court. . . . [A]ny material variance from the explicit directions of the reviewing court is unauthorized and void.'" (*Coffee-Rich, Inc. v. Fielder* (1975) 48 Cal.App.3d 990, 998.)

The appellate court's directions are determined by "look[ing] first to the dispositional language of the opinion--the language which constitutes the remittitur directions." (*Frankel v. Four Star International, Inc.* (1980) 104 Cal.App.3d 897, 902.) *Only if* the dispositional language is ambiguous and in need of interpretation will that language "be interpreted in light of the reasoning and holdings found in the body of the opinion. [Citations.]" (*Lesny Development Co. v. Kendall* (1985) 164 Cal.App.3d 1010, 1021.)

As set forth earlier, the pertinent portion of the dispositional language in *Friends I* read: "The judgment is reversed. The trial court shall issue a writ of mandate vacating the certification of the EIR, shall retain jurisdiction until respondent certifies an EIR complying with CEQA consistent with the views expressed in this opinion, *and shall consider such orders it deems appropriate under section 21168.9.*" (*Friends I, supra,* 95 Cal.App.4th 1373, 1388, italics added.) The statutory provision referenced--Public Resources Code section 21168.9--is lengthy and set forth in toto below in footnote 3.[3] The definitive

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3 The statute provides:

"(a) If a court finds, as a result of a trial, hearing, or remand from an appellate court, that any determination, finding, or decision of a public agency has been made without compliance with this division, the court shall enter an order that includes one or more of the following:

"(1) A mandate that the determination, finding, or decision be voided by the public agency, in whole or in part.

"(2) If the court finds that a specific project activity or activities will prejudice the consideration or implementation of particular mitigation measures or alternatives to the project, a mandate that the public agency and any real parties in interest suspend any or all specific project activity or activities, pursuant to the determination, finding, or decision, that could result in an adverse change or alteration to the physical environment, until the public agency has taken any actions that may be necessary to bring the determination, finding, or decision into compliance with this division.

"(3) A mandate that the public agency take specific action as may be necessary to bring the determination, finding, or decision into compliance with this division.

"(b) Any order pursuant to subdivision (a) shall include only those mandates which are necessary to achieve compliance with this division and only those specific project activities in noncompliance with this division. The order shall be made by the issuance of a peremptory writ of mandate specifying what action by the public agency is necessary to comply with this division. However, the order shall be limited to that portion of a determination, finding, or decision or the specific project activity or activities found to be in noncompliance only if a court finds that (1) the

(Fn. continued.)

construction of that statute is found in our Supreme Court's opinion in *Laurel Heights Improvement Assn. v. Regents of University of California* (1988) 47 Cal.3d 376. It concluded that the statute permits but does not require a court to enjoin a project while a new EIR is prepared. (*Id.* at pp. 423-425.) In deciding whether injunctive relief is appropriate, a court is to rely upon "traditional equitable principles." (*Id.* at p. 423.) Given this long-standing construction of section 21168.9,[4] it is clear our dispositional language granted the trial court the option to decline to grant any injunctive relief after it properly considered the pertinent equities. Appellant's argument that the trial court failed to follow our directions by declining to grant equitable relief is therefore without merit.

In any event, appellant engages in a crabbed interpretation of one phrase in our opinion to argue the trial court had no discretion to deny a request for

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portion or specific project activity or activities are severable, (2) severance will not prejudice complete and full compliance with this division, and (3) the court has not found the remainder of the project to be in noncompliance with this division. The trial court shall retain jurisdiction over the public agency's proceedings by way of a return to the peremptory writ until the court has determined that the public agency has complied with this division.

"(c) Nothing in this section authorizes a court to direct any public agency to exercise its discretion in any particular way. Except as expressly provided in this section, nothing in this section is intended to limit the equitable powers of the court."

4 See also *City of Santee v. County of San Diego* (1989) 214 Cal.App.3d 1438, 1456 ["Section 21168.9, as construed by the Supreme Court in *Laurel Heights,* merely grants a reviewing court the authority to stay all activity or use of a project until an agency certifies a proper EIR; it does not require it to do so. [Citation.] The court in *Laurel Heights* relied upon traditional equitable principles in deciding that injunctive relief there was not appropriate."].

injunctive relief. The sentence in which the phrase is found began with a specific reference to the *PCL* opinion: its dispositional language found at page 926, including footnote 16. That language included the same direction found in our dispositional language: the direction the trial court shall make any such orders it deems appropriate under section 21168.9. Footnote 16 read: "We earlier declined to stay implementation of the Monterey amendments and transfer of the Kern Fan Element. Consequently, the project was permitted to proceed pending disposition of this appeal. The record does not reflect the current status of the project and, in the absence of such information, we shall issue no orders concerning further implementation of the project. The trial court, acting under the authority provided by Public Resources Code section 21168.9, is the more appropriate forum to consider and rule upon requests *to enjoin all or portions of the project pending* the completion of administrative and judicial proceedings necessitated by our opinion." (*PCL, supra,* 83 Cal.App.4th 892, fn. 16 at p. 926, italics added.) Just as the *PCL* court did not intend to limit the trial court's authority by requiring it to enjoin at least a portion of the project, neither did we. We, as did the *PCL* court, were simply describing the types of requests that might be made, e.g., requests for a partial or full injunction. We did not intend to divest the trial court of its power to deny a request for injunctive relief if it either concluded that the moving party had failed to establish the predicates for relief or that, given the equities, relief was not required.

B. DENIAL OF INJUNCTIVE RELIEF

Appellant next contends: "The Superior Court's decision regarding injunctive relief was an abuse of discretion, because there is no factual basis to support the decision." (Bold omitted.) We disagree.

A decision to grant or deny a request for injunctive relief rests within the trial court's discretion. Its order will not be reversed on appeal unless an abuse of discretion is shown. It is, of course, the appellant's burden to establish an abuse of discretion. (*Cohen v. Board of Supervisors* (1985) 40 Cal.3d 277, 286.) "A trial court will be found to have abused its discretion only when it has exceeded the bounds of reason or contravened the uncontradicted evidence. [Citation.]" (*Lubavitch Congregation v. City of Long Beach* (1990) 217 Cal.App.3d 1388, 1391.)

It was appellant's burden as moving party in the trial court to establish the predicates for injunctive relief. In particular, Public Resources Code section 21168.9, subdivision (a)(2) requires the court to first find that a "specific project activity . . . will prejudice the consideration or implementation of particular mitigation measures or alternatives to the project" and that such activities "could result in an adverse change or alteration to the physical environment" before an injunction will issue. The trial court found appellant's claim of irreparable harm--new permanent water connections that will not be able to be reversed--to be speculative. In other words, it concluded appellant had failed to discharge its burden of proof.[5] However, it specifically left open the opportunity for appellant

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[5] To a certain extent, appellant relies upon four documents not presented to the trial court to support its contention of abuse of discretion. Three of those documents were prepared after the trial court entered judgment in October 2002. Each document is a portion of a report prepared for respondent. Prior to the submission of briefing, we granted appellant's request to take judicial notice of these documents.

Appellant wants to use this information to show respondent is improperly representing to third parties it is entitled to the 41,000 acre-feet per year of water. Appellant argues this is proof of the irreparable harm it is suffering because the trial court declined to enjoin respondent.

Our prior grant of appellant's motion for judicial notice does not require us to consider these documents. "Although a reviewing court may take judicial notice of

(Fn. continued.)

to renew its claim "based upon evidence of the actual use of such additional water for purposes it considers improper."

Distilled to its essence, appellant's present position is nothing more than an argument the trial court was required to credit the allegations in its counsel's declaration which allegedly supported its request for injunctive relief. That is, appellant would have us find that no reasonable judge could have found its evidentiary showing insufficient. We cannot make that finding.

The evidence on this issue was conflicting. As set forth above, Masnada's declaration directly contradicted some of the allegations made by appellant's counsel. Given the (purported) deficiencies Masnada pointed out in counsel's declaration, the fact that much of counsel's declaration was based upon information and belief, and appellant's failure to file a reply declaration addressing those points with its reply memorandum, the trial court was well within its discretion to conclude that *at that point in time* appellant had failed to make the requisite showing.

Appellant argues such a conclusion is insupportable because the trial court also found respondent's trial court contention to be speculative. Not so. Appellant

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matters not before the trial court, . . . the reviewing court need not give effect to such evidence. 'Having taken judicial notice of such a matter, the reviewing court may or may not apply it in the particular case on appeal. The effect to be given to matters judicially noticed on appeal, where the question has not been raised below, depends on factors that are not evidentiary in character.' [Citation.]" (*Doers v. Golden Gate Bridge etc. Dist.* (1979) 23 Cal.3d 180, 184, fn. 1.)

In this instance, given that (1) these documents essentially constitute "new evidence" in support of appellant's request for injunctive relief and (2) the trial court explicitly anticipated appellant would renew its request before it, we decline to consider the documents on this appeal.

If appellant wishes to renew a request for injunctive relief, it can bring these documents to the trial court's attention.

is conflating two distinct points respondent made in the trial court. First, based upon a claim of irreparable harm, respondent had affirmatively sought an order that the transfer of entitlement remain in effect until the new EIR was completed. Second, respondent refuted the factual allegations about its water sources contained in the declaration executed by appellant's counsel. The trial court's finding of speculation was directed at the first point: respondent's claim it would suffer irreparable harm if the trial court denied its request for an order that the transfer remain in effect until the EIR was completed. The finding of speculation was not directed at the second point: respondent's discrete refutations of appellant's allegations. The trial court could reasonably find respondent had failed to meet its burden to establish the predicate for the relief it sought but could also reasonably find that the portions of Masnada's declaration set forth above were sufficient to show appellant's claim for relief was likewise subject to serious question and therefore grounded in speculation. We therefore reject appellant's claim that "[r]espondent's entire argument that there was no abuse of discretion is incorrectly based on evidence that the lower court determined was mere speculation, not fact."[6] (Fn. omitted.)

Lastly, we address an argument raised in the amici brief jointly filed by the Planning and Conservation League and the Citizens Planning Association of Santa

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6 Appellant cites to various comments the court made as well as questions it posed during the hearing as proof that the court grounded its decision either in facts unsupported by the evidence or on legal principles inapplicable to the case. This approach is in error. A contextual reading of the transcript of the hearing indicates the court's questions and comments were intended to gather information, to focus the parties' arguments, and to test the strength of the parties' respective positions. The "bottom line" is whether the trial court abused its discretion in finding appellant had failed to discharge its burden to establish the predicates for injunctive relief. As explained above, the court did not so abuse its discretion.

Barbara County, Inc. in support of appellant. Amici are two of the environmental organizations that were the prevailing parties in *PCL, supra,* 83 Cal.App.4th 892.

Amici first inform us that in May 2003--seven months after the trial court entered judgment in this matter--the superior court in Sacramento approved a settlement agreement entered into by the parties in the *PCL* case. Pursuant to that agreement, work has commenced on a new EIR in regard to the Monterey Agreement and related issues. The settlement agreement recognizes that the transfer underlying this lawsuit is "'subject to pending litigation in the Los Angeles Superior Court following remand from the Second District Court of Appeal'"; that "'jurisdiction with respect to that litigation should remain in the [Los Angeles Superior Court]'"; and that "'nothing in this settlement agreement is intended to predispose the remedies or other actions that may occur in that pending litigation.'"

Amici argue the trial court abused its discretion in denying appellant's request for injunctive relief because the court ignored "the specific directions of *Friends I*" that its determination on interim relief should be based upon the status of the *PCL* litigation and the new statewide EIR to be prepared for the Monterey Agreement.[7] As support for that proposition, Amici cites us to the last two paragraphs of our opinion in *Friends I.* There, after concluding that other than the *PCL*/tiering issue all of appellant's complaints about the EIR were meritless, we wrote: "This suggests that respondent may be able to cure the *PCL* problem by awaiting action by the DWR complying with the *PCL* decision, then issuing a subsequent EIR, supplement to EIR, or addendum to EIR [citations] tiering upon a newly certified Monterey Agreement EIR. Appellant itself so suggests. [¶] Like the court in *PCL, supra,* 83 Cal.App.4th at page 926 and footnote 16, we leave to

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7 Appellant raised this point in the trial court and its opening brief.

the trial court's discretion whether to enjoin all or portions of respondent's project pending completion of an adequate EIR. The trial court is in a better position than this court to determine factually the current status of the *PCL* litigation or of a new Monterey Agreement EIR." (*Friends I, supra,* 95 Cal.App.4th 1373, 1387-1388.)

Amici misapprehend our directions to the trial court. As explained above, those directions are found in the dispositional language of our opinion. That language directed the trial court, inter alia, to "consider such orders it deems appropriate under [Public Resources Code] section 21168.9." (*Ibid.*) That section grants the trial court broad powers to fashion equitable relief. (See fn. 3, *ante*, and accompanying text at pp. 10-12.) Amici's argument that the exercise of said discretion was to be based upon the status of either the *PCL* litigation or the new EIR for the Monterey Agreement is at odds with the clear dispositional language we employed. The two paragraphs in our opinion upon which amici rely were merely suggestions as to how respondent could proceed and a statement that in exercising its discretion whether to grant equitable relief pending completion of a new EIR for this project, the trial court could ascertain, and if it so chose, rely upon the status of the *PCL* litigation and new Monterey Agreement EIR.

In any event, the parties' papers in the trial court informed it of what was then the current status of both the *PCL* litigation and the new Monterey Agreement EIR and the issue was discussed at the hearing. Nothing in the record suggests the court did not consider those facts in rendering its decision, a decision that was properly framed by the specific prayers for relief each party advanced in the trial court. To a large extent, amici's position is nothing more than an attempt to reargue the motion and to do so based upon events that occurred after judgment was rendered. Because the *PCL* litigation settled *after* the trial court entered its judgment, that settlement and the status of the preparation of the new Monterey Agreement EIR are matters that can be brought to the attention of the trial court if appellant seeks to renew its request for injunctive relief. Lastly, in order to forestall any unnecessary future litigation, we hasten to add that nothing stated in this opinion is to be construed to be an indication as to how the trial court should rule in any further proceeding(s) on any specific issue(s).

DISPOSITION

The judgment is affirmed.

NOT TO BE PUBLISHED IN THE OFFICIAL REPORTS

VOGEL (C.S.), P.J.

We concur:

HASTINGS, J.

CURRY, J.

Toxicological Benchmarks for Screening of Potential Contaminants of Concern for Effects on Aquatic Biota

ES/ER/TM-96/R2

Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota:

1996 Revision

ES/ER/TM-96/R2

Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision

G. W. Suter II
C. L. Tsao

Date Issued—June 1996

Prepared by
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Prepared for the
U.S. Department of Energy
Office of Environmental Management
under budget and reporting code EW 20

LOCKHEED MARTIN ENERGY SYSTEMS, INC.
managing the
Environmental Management Activities at the
Oak Ridge K-25 Site   Paducah Gaseous Diffusion Plant
Oak Ridge Y-12 Plant   Portsmouth Gaseous Diffusion Plant
Oak Ridge National Laboratory
under contract DE-AC05-84OR21400
for the
U.S. DEPARTMENT OF ENERGY

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PREFACE

The purpose of this report is to present and analyze alternate toxicological benchmarks for screening chemicals for aquatic ecological effects. This work was performed under Work Breakdown Structure 1.4.12.2.3.04.05.04 (Activity Data Sheet 8304, "Technical Integration—Risk Assessment"). Publication of this document meets a milestone for the Environmental Restoration (ER) Risk Assessment Program. Since the prior edition of this report (Suter and Mabrey 1994), both the U.S. Environmental Protection Agency Office of Solid Waste and Emergency Response and EPA Region IV have developed sets of screening benchmarks for water. This report includes those values and updates the other benchmarks that were presented in the last edition.

CONTENTS

TABLES

ACRONYMS

ACRs	acute chronic ratios
ARARs	applicable or relevant and appropriate requirements
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CV	Chronic Value
EC50	median effective concentration
EPA	U.S. Environmental Protection Agency
ETs	Ecotox Thresholds
FACR	Final Acute-Chronic Ratio
FAV	Final Acute Value
FCV	final chronic value
GLWQI	Great Lakes Water Quality Initiative
GMAV	genus mean acute value
LC50	median lethal concentration
LOEC	Lowest Observed Effect Co
MATC	Maximum Acceptable Toxicant Concentration
NAWQC	National Ambient Water Quality Criteria
NOEC	No Observed Effect Concentration
OSWER	Office of Solid Waste and Emergency Response
RI	Remedial Investigation
SACR	secondary acute chronic ratio
SAV	Secondary Acute Values
SCV	Secondary Chronic Value
SS	sensitive species
SVs	screening values

EXECUTIVE SUMMARY

One of the initial stages in ecological risk assessment of hazardous waste sites is the screening of contaminants to determine which, if any, of them are worthy of further consideration; this process is termed contaminant screening. Screening is performed by comparing concentrations in ambient media to benchmark concentrations that are either indicative of a high likelihood of significant effects (upper screening benchmarks) or of a very low likelihood of significant effects (lower screening benchmarks). Exceedance of an upper screening benchmark indicates that the chemical in question is clearly of concern and remedial actions are likely to be needed. Exceedance of a lower screening benchmark indicates that a contaminant is of concern unless other information indicates that the data are unreliable or the comparison is inappropriate. Chemicals with concentrations below the lower benchmark are not of concern if the ambient data are judged to be adequate.

This report presents potential screening benchmarks for protection of aquatic life from contaminants in water. Because there is no guidance for screening benchmarks, a set of alternative benchmarks is presented herein. The alternative benchmarks are based on different conceptual approaches to estimating concentrations causing significant effects. For the upper screening benchmark, there are the acute National Ambient Water Quality Criteria (NAWQC) and the Secondary Acute Values (SAV). The SAV concentrations are values estimated with 80% confidence not to exceed the unknown acute NAWQC for those chemicals with no NAWQC. The alternative chronic benchmarks are the chronic NAWQC, the Secondary Chronic Value (SCV), the lowest chronic values for fish and daphnids, the lowest EC20 for fish and daphnids from chronic toxicity tests, the estimated EC20 for a sensitive species, and the concentration estimated to cause a 20% reduction in the recruit abundance of largemouth bass. It is recommended that ambient chemical concentrations be compared to all of these benchmarks. If NAWQC are exceeded, the chemicals must be contaminants of concern because the NAWQC are applicable or relevant and appropriate requirements (ARARs). If NAWQC are not exceeded, but other benchmarks are, contaminants should be selected on the basis of the number of benchmarks exceeded and the conservatism of the particular benchmark values, as discussed in the text.

To the extent that toxicity data are available, this report presents the alternative benchmarks for chemicals that have been detected on the Oak Ridge Reservation. It also presents the data used to calculate the benchmarks and the sources of the data. It compares the benchmarks and discusses their relative conservatism and utility.

This report supersedes a prior aquatic benchmarks report (Suter and Mabrey 1994). It adds two new types of benchmarks. It also updates the benchmark values where appropriate, adds some new benchmark values, replaces secondary sources with primary sources, and provides more complete documentation of the sources and derivation of all values.

1. INTRODUCTION

An important early step in the assessment of ecological risks posed by a contaminated site is the screening of contaminants. In many cases, concentrations in water will be reported for more than 100 chemicals, most of which will be reported as undetected at some defined limit of detection. The assessor must decide which of the detected chemicals constitute an ecological hazard and which of the undetected chemicals may pose a hazard at concentrations below the reported detection limits. This screening is done by comparing the reported concentrations to toxicological benchmarks. If concentrations of a chemical exceed its benchmark for a particular medium, then it is worthy of further measurement and assessment. If not, it can be ignored (assuming that the analytical data are adequate).

In practice, a series of benchmarks of differing conservatism may be used. Exceedance of an upper screening benchmark would suggest a severe hazard and a need for urgent action. Nonexceedance of all lower screening benchmarks would suggest no hazard. Exceedance of an increasing number of benchmarks would constitute increasing evidence of the need for measurement and assessment. In addition to providing a better indication of the magnitude of the hazard, the use of multiple benchmarks provides information about the nature of the hazard which can be used in development of the conceptual model and in planning the Remedial Investigation (RI). For example, is the chemical at concentrations that are toxic to only daphnids, to daphnids and fish, to fish and aquatic plants, etc.? Are they at concentrations that have been demonstrated to be toxic or do they exceed only benchmarks that include conservative factors?

The purpose of this report is to present and analyze alternate toxicological benchmarks for screening chemicals for aquatic ecological effects. Since the prior edition of this report (Suter and Mabrey 1994), both the U.S. Environmental Protection Agency (EPA) Office of Solid Waste and Emergency Response (OSWER) and EPA Region IV have developed sets of screening benchmarks for water. This report includes those values and updates the other benchmarks that were presented in the last edition.

This compilation is limited to chemicals that have been detected on the Oak Ridge Reservation and to benchmarks derived from studies of toxic effects on fresh water organisms. The list of chemicals detected on the Oak Ridge Reservation includes 45 metals and 105 industrial chemicals. Only four pesticides occur on the list, and those are persistent and wide-spread (chlordane, DDT, heptachlor, and lindane).

2. METHODS FOR DERIVING BENCHMARKS

2.1 TYPES OF BENCHMARKS

The simplest screening benchmarks are toxicity test endpoints. A test endpoint is a statistically derived numeric summary of the results of a toxicity test. Test endpoints can be calculated in two ways. First, a level of effect can be estimated by fitting a function such as the probit or logit to the concentration-response data to derive a concentration-response model. Then by inverse regression, a concentration can be estimated that causes a particular level of effect such as the median lethal concentration (LC50). Second, hypothesis testing statistics can be used to determine whether each of the tested concentrations caused an effect that was statistically significantly different from the controls. The lowest concentration causing such an effect is termed the Lowest Observed Effect Concentration

(LOEC); the highest concentration for which there were no such effects is termed the No Observed Effect Concentration (NOEC). The geometric mean of the LOEC and NOEC is termed the Chronic Value (CV) and was formerly termed the Maximum Acceptable Toxicant Concentration (MATC).

Toxicity tests are conventionally divided into acute and chronic tests. Standard acute aquatic toxicity tests are 48 or 96 hours in duration and use juvenile or adult organisms; the test endpoints are the median lethal concentration (LC50) or median effective concentration (EC50) for death or some equivalent effect (e.g., immobilization). Standard chronic tests include all or most of the lifecycle of the test organisms, and they include observations of growth, deformities, and reproductive success as well as lethality. The standard endpoint for chronic tests is the CV.

Another important distinction is between response-specific and integrative endpoints. Conventionally, NOECs and LOECs are calculated for each response parameter, and the results for the most statistically sensitive parameter are reported. Because effects on populations and ecosystems are a result of the integrated effects of the toxicant on all life stages, it is more sensible to integrate the responses in the test when calculating the test endpoint. Integrative endpoints may be simple arithmetic combinations of effects such as the proportional mortality across all tested life stages or population parameters derived from simple models such as the intrinsic rate of natural increase, r.

Benchmarks may be combinations of multiple test endpoints. An example is the chronic NAWQC, which are derived from at least eight LC50s and three CVs.

Finally, benchmarks may be derived by using mathematical models to simulate an assessment endpoint, a specific environmental characteristic that is valued and is at risk due to the contamination or disturbance that is being assessed (Suter 1989). For example, in this study we present concentrations estimated to correspond to a 20% reduction in recruit abundance for largemouth bass (*Micropterus salmoides*) because production of fish, particularly game fish, is an assessment endpoint for Oak Ridge Reservation ecological risk assessments (Suter et al. 1992).

Conventional aquatic benchmarks, which are based on regulatory criteria or standard test endpoints used to derive criteria, are listed in Table 1. Unconventional aquatic benchmarks, which are based on levels of effects on integrative endpoints, are listed in Table 2.

2.2 WATER QUALITY CRITERIA

The National Ambient Water Quality Criteria (NAWQC) are applicable or relevant and appropriate requirements (ARARs); therefore, they provide the basis for the screening benchmarks for contaminants in water. The acute NAWQC are calculated by the EPA as half the Final Acute Value (FAV), which is the fifth percentile of the distribution of 48- to 96-hour LC50 values or equivalent median effective concentration (EC50) values for each criterion chemical (Stephan et al. 1985). The acute NAWQC are intended to correspond to concentrations that would cause less than 50% mortality in 5% of exposed populations in a brief exposure. They may be used as a reasonable upper screening benchmark because waste site assessments are concerned with sublethal effects and largely with continuous exposures, rather than the lethal effects and episodic exposures to which the acute NAWQC are applied. The chronic NAWQC are the FAVs divided by the Final Acute- Chronic Ratio (FACR), which is the geometric mean of quotients of at least three LC50/CV

Table 1. Summary of conventional benchmarks for priority contaminants in fresh water (all values in micrograms per liter)

Chemical	NAWQ Criteria		Tier II Values		Lowest Chronic Value for:				
	Acute	Chronic	Secondary Acute Value	Secondary Chronic Value	Fish	Daphnids	Non-Daphnid Inverte-brates	Aquatic Plants	All Organ-isms
Aluminum	750	87			3,288	1,900		460	460
Ammonia	pH and temperature dependent				1.7	630		2,400	1.7
Antimony			180[i]	30[i]	1,600	5,400		610	610
Arsenic III	360	190			2,962	914.1		2,320	914.1
Arsenic V			66	3.1	892	*450		48	48
Barium			110	4.0					
Beryllium			35	0.66	*57	5.3		100,000	5.3
Boron			30	1.6		8,830			8,830
Cadmium	3.9+	1.1+			1.7	0.15		2	0.15
Calcium						116,000			116,000
Chromium III	1,700+	210+			68.63	<44		397	<44
Chromium VI	16	11			73.18	6.132		2	2
Cobalt			1500	23	290	5.1			5.1
Copper	18+	12+			3.8	0.23	6.066	1	0.23
Cyanide	22	5.2			7.8		18.33	30	7.8
Iron		1,000			1,300	158			158
Lead	82+	3.2+			18.88	12.26	25.46	500	12.26
Lithium			260	14					
Magnesium						82,000			82,000
Manganese			2,300	120	1780	<1,100			<1,100
Mercury, inorganic or total	2.4			1.30[a]	<0.23	0.96		5	<0.23
Mercury, methyl			0.099	0.0028	0.52	<0.04		0.8-4.0	<0.04
Molybdenum			16,000	370		880			880

Table 1. (continued)

Chemical	NAWQ Criteria		Tier II Values		Lowest Chronic Value for:				
	Acute	Chronic	Secondary Acute Value	Secondary Chronic Value	Fish	Daphnids	Non-Daphnid Inverte-brates	Aquatic Plants	All Organ-isms
Nickel	1,400+	160+			<35	<5	128.4	5	<5
Potassium						53,000			53,000
Selenium	20	5			88.32	91.65		100	88.32
Silver	4.1+			0.36	0.12	2.6		30	0.12
Sodium						680,000			680,000
Strontium			15,000	1,500		42,000			42,000
Thallium			110	12	57	130		100	57
Tin			2,700	73		350			350
Uranium			46	2.6	*142				*142
Vanadium			280	20	80	1,900			80
Zinc	120+	110+			36.41	46.73	>5,243	30	30
Zirconium			310	17	*548				*548
Organics									
Acenaphthene	80[e]	23[e]			74	*6,646	227	520	74
Acetone			28,000	1,500	*507,640	1,560			*507,640
Anthracene			13	0.73	*0.09	<2.1			*0.09
Benzene			2,300	130		>98,000		525,000	525,000
Benzidene			70	3.9	*134				*134
Benzo(a)anthracene			0.49	0.027		*0.65			*0.65
Benzo(a)pyrene			0.24	0.014		*0.30			*0.30
Benzoic acid			740	42	*12,976				*12,976
Benzyl alcohol			150	8.6	*589				*589
BHC (lindane)	2	0.08			14.6	14.5	3.3	500	3.3

Table 1. (continued)

Chemical	NAWQ Criteria		Tier II Values		Lowest Chronic Value for:				
	Acute	Chronic	Secondary Acute Value	Secondary Chronic Value	Fish	Daphnids	Non-Daphnid Inverte-brates	Aquatic Plants	All Organ-isms
BHC (other)			39	2.2		*95			*95
Biphenyl				14[f]					
Bis(2-ethylhexyl)phthalate			27	3.0		912			912
4-Bromophenyl phenyl ether				1.5[f]					
Butylbenzyl phthalate				19[f]					
2-Butanone			240,000	14,000	*282,170	*1,394,927			*282,170
Carbon disulfide			17	0.92	*9,538	*244			*244
Carbon tetrachloride			180	9.8	1,970	*5,580			1,970
Chlordane	2.4	0.17[a]			1.6	16	1.09		1.09
Chlorobenzene			1,100	64	*1,203	*15,042		224,000	*1203
Chloroform			490	28	1,240	*4,483			1,240
DDD p,p'			0.19	0.011	*1.69				*1.69
DDT	1.1			0.013[bf]	0.73[c]	*0.016		0.3	0.3
Decane			880	49		*7,874			*7,874
Di-n-butyl phthalate			190	35	717[d]	697			697
Diazinon			0.17[g]	0.043[g]					
Dibenzofuran			66	3.7		*1,003			*1,003
1,2-Dichlorobenzene			260[f]	14[f]					
1,3-Dichlorobenzene			630[f]	71[f]					
1,4-Dichlorobenzene			180[f]	15[f]					
1,1-Dichloroethane			830	47	*14,680				*14,680
1,2-Dichloroethane			8,800	910	41,364	15,200			15,200
1,1-Dichloroethene			450	25	>2,800	*4,720		>798,000	>2,800

Table 1. (continued)

Chemical	NAWQ Criteria		Tier II Values		Lowest Chronic Value for:				
	Acute	Chronic	Secondary Acute Value	Secondary Chronic Value	Fish	Daphnids	Non-Daphnid Inverte-brates	Aquatic Plants	All Organ-isms
1,2-Dichloroethene			1,100	590	*9,538				*9,538
1,3-Dichloropropene			0.99	0.055	244	*805		4,950	244
Dieldrin	**0.18[e]**	**0.062[e]**							
Diethyl phthalate			1,800	210				85,600	85,600
Di-n-octyl phthalate					3,822	708			708
Endosulfan, all isomers				0.051[f]					
Endrin	0.095[e]	0.061[e]							
Ethyl benzene			130	7.3	>440	*12,922		>438,000	>440
Fluoranthene	33.6[e]	6.16[e]			30	15		54400	15
Fluorene			70[f]	3.9[f]					
Heptachlor			0.125[g,h]	0.0069[b,g]	1.26	*3.18		26.7	1.26
Hexachloroethane			210[e]	12[f]					
Hexane			10	0.58	*65,712				*65,712
2-Hexanone			1,800	99	*32,783				*32,783
Methoxychlor				0.019[f]					
1-Methylnaphthalene			37	2.1	*526				*526
4-Methyl-2-pentanone			2,200	170	77,400				77,400
2-Methylphenol			230	13	*489	*1,316			*489
Methylene chloride			26,000	2,200	108,000	*42,667			*42,667
Naphthalene			190	12	620	*1,163		33,000	620
4-Nitrophenol			1,200	300	*481	7,100		4190	*481
N-Nitrosodiphenylamine			3,800	210	*332	*1,042			*332
2-Octanone			150	8.3					

Table 1. (continued)

Chemical	NAWQ Criteria		Tier II Values		Lowest Chronic Value for:				
	Acute	Chronic	Secondary Acute Value	Secondary Chronic Value	Fish	Daphnids	Non-Daphnid Inverte-brates	Aquatic Plants	All Organ-isms
PCBs total	2.0			0.14[b]	0.2	2.1	0.8	0.144	0.1
Aroclor® 1221			5.0	0.28	*60				*60
Aroclor® 1232			10	0.58	*124			—	*124
Aroclor® 1242			1.2	0.053	9.00		4.9	300	4.9
Aroclor® 1248			1.4	0.081				—	
Aroclor® 1254			0.60	0.033		2.9		0.1	0.1
Aroclor® 1260			1,700	94	<1.3			—	2.3
Pentachlorobenzene			8.4[f]	0.47[f]					
1-Pentanol			2,000	110	*30,493				*30,493
Phenanthrene	30[e]	6.3[e]				200			200
Phenol	3,600[g]	110[g]			<200	*2,005		20,000	<200
2-Propanol			130	7.5	*590				*590
1,1,2,2 Tetrachloroethane			2,100	610	2,400	9,900		136,000	2,400
Tetrachloroethene			830	98	840	750		>816,000	750
Tetrachloromethane			4,400[f]	240[f]					
Toluene			120	9.8	*1,269	*25,229		245,000	*1,269
Tribromomethane			2,300[f]	320[f]					
1,2,4-Trichlorobenzene			700[f]	110[f]					
1,1,1-Trichloroethane			200	11	*3,493			>669,000	*3,493
1,1,2-Trichloroethane			5,200	1,200	9,400	18,400			9,400
Trichloroethene			440	47	11,100	*7,257			*7,257
Vinyl acetate			280	16	*810				*810
Xylene			230	13	*62,308				*62,308
m-Xylene			32[f]	1.8[f]					

Table 1. (continued)

Notes:

+ Hardness dependent criterion normalized to 100 mg/L

* Numbers preceded by * are estimates. Methods of estimation are described in the text.

[a] The chronic NAWQC for chlordane (0.0043 µg/L) and mercury (0.012 µg/L), are based on the final residue values. FCVs are used as benchmarks to protect aquatic life.

[b] The chronic NAWQC for DDT (0.001 µg/L), total PCBs (0.014 µg/L), and heptachlor (0.0038 µg/l) are is based on the final residue values; for benchmarks to protect aquatic life, we use SCVs.

[c] The CV for DDT in Jarvinen et al. 1977 of 0.9 µg/l is the arithmetic mean of the NOEC and LOEC. We used the geometric mean which is 0.73.

[d] For fish di-n-butyl phthalate lowest CV, the geometric mean of the measured concentrations for the NOEC and LOEC rather than the nominal concentrations used by the authors (McCarthy and Whitmore 1985) was used herein.

[e] These numbers are Final Acute Values and Final Chronic Values calculated by the EPA for use in the derivation of sediment quality criteria (EPA 1993b).

[f] Values calculated for OSWER (1996).

[g] Values calculated by the Great Lakes Water Quality Initiative (EPA 1993d).

[h] SAV was calculated by the Great Lakes Water Quality Initiative because some data used to derive FAV were questionable (EPA 1992)

[I] These values are draft FAV and FCV values (EPA 1988b).

Table 2. Summary of alternative benchmarks for priority contaminants in fresh water based on levels of chronic effects (all values in micrograms per liter)

Chemical	Lowest Test EC_{20} for: Fish	Lowest Test EC_{20} for: Daphnids	Sensitive Species Test EC_{20}	Population EC_{20}
Aluminum	4,700	540	75	
Antimony	2,310	1,900		79
Arsenic III	2,130	633	55	1,995
Arsenic V	1,500	>932		185
Barium				
Beryllium	*148	3.8		21
Boron		7,000		
Cadmium	1.8	0.75	0.013[a]	4.3
Calcium				
Chromium III	89		8.44	126
Chromium VI	51	0.5	0.266	316
Cobalt	810	<4.4		3.98
Copper	5	0.205	0.26	8.6
Cyanide	5.3		1.17	11
Fluorine	*5,336	3,706		1,080
Iron		16		
Lead	22		0.35	71
Magnesium				
Manganese	1,270	<1,100		112
Mercury, inorganic	0.87	0.87	0.18	0.32
Mercury, methyl	<0.03	0.87		0.28
Molybdenum		360		
Nickel	62	45	11[a]	215
Potassium				
Selenium	40	25	2.60	
Silver	0.20	<0.56	0.14[a]	0.32
Sodium				
Strontium				
Thallium	81	64		67

Table 2. (continued)

Chemical	Lowest Test EC_{20} for:		Sensitive Species Test EC_{20}	Population EC_{20}
	Fish	Daphnids		
Tin				
Uranium	*455			27
Vanadium	41	430		32
Zinc	47		21	80
Zirconium	*2,396			251
Organics				
Acenaphthene	<197			
Acetone	*161,867			23,714
Anthracene	*0.35	>8.2		
Benzene	21			229
Benzidene	*158			68
Benzo(a)anthracene				
Benzo(a)pyrene	>2.99			
Benzoic acid	*7,409			1,259
Benzyl alcohol	*550			375
BHC (lindane)	<1.1	11	0.11	
BHC (other)				
Bis(2-ethylhexyl)phthalate	>54	<3		50
2-Butanone	*98,772			17,783
Carbon disulfide	*5719			1,000
Carbon tetrachloride	65			224
Chlordane	<0.25	12.1	0.50	0.71
Chlorobenzene	1,002			165
Chloroethane				
Chloroform	8,400			562
DDD p,p'	*3.99			0.61
DDT	0.35		0.008	
Decane				

Table 2. (continued)

Chemical	Lowest Test EC_{20} for:		Sensitive Species Test EC_{20}	Population EC_{20}
	Fish	Daphnids		
Di-n-butyl phthalate	270	500		251
Dibenzofuran				
1,1-Dichloroethane	*8,219			1,585
1,2-Dichloroethane	29,000	<11,000		1,259
1,1-Dichloroethene				447
1,2-Dichloroethenes	*5,719			
1,3-Dichloropropene	*350			40
Diethyl phthalate				1,000
Di-n-octyl phthalate	<100	310		1,995
Ethyl benzene				398
Fluoranthene				32
Heptachlor	0.86		0.004	0.1
Hexane	*28,995			
2-Hexanone	*16,155			1,259
1-Methylnaphthalene	*500			31.62
4-Methyl-2-pentanone				1,585
2-Methylphenol	*470			74
Methylene chloride	410			1,259
Naphthalene	450	>600		1,000
4-Nitrophenols	*464	5,000		60
N-Nitrosodiphenylamine	*339			40
3-Octanone	*3571			
PCBs total	0.4	1.2		0.63
Aroclor® 1221	*80			10
Aroclor® 1232	*148			16
Aroclor® 1242	<2.9			1.58
Aroclor® 1248	0.4	2.5		1.26
Aroclor® 1254	0.52	1.2		0.63
Aroclor® 1260	2.1			316
1-Pentanol	*15,200			3,548

Table 2. (continued)

Chemical	Lowest Test EC_{20} for:		Sensitive Species Test EC_{20}	Population EC_{20}
	Fish	Daphnids		
Phenanthrene		110		
Phenol	<230			4,467
2-Propanol	*35,381			3,162
1,1,2,2-Tetrachloroethane	1,400	<420		1,585
Tetrachloroethene	500	510		50
Toluene	<26			200
1,1,1-Trichloroethane	*2,457	1,300		251
1,1,2-Trichloroethane	14,800	13,000		15,849
Trichloroethene	5758			232
Vinyl acetate	*718			108
Xylene	2680			

Notes:
* Numbers preceded by * are estimates. Methods of estimation are described in the text.
[a] Study LC50's were used rather than species mean LC50s so water hardness would correspond to EC20 values.

ratios from tests of different families of aquatic organisms (Stephan et al. 1985). It is intended to prevent significant toxic effects in chronic exposures and is used in this assessment as one possible lower screening benchmark. The NAWQC are listed in Table 1.

NAWQC for several metals are functions of water hardness; the criteria are lower for lower hardness levels. The criteria for 100 mg/L hardness as reported by the EPA are presented in this report. That hardness is near the lower end of the range of hardness values reported for the Oak Ridge Reservation, so it is moderately conservative. For sites with different water hardnesses, site-specific criteria should be calculated. The formulas for hardness correction are listed in the discussions of individual chemicals.

Many readers will note that the EPA's compilations of NAWQC contain values for many chemicals that have no NAWQC listed herein (EPA 1986b); the EPA lists lowest CVs for those chemicals for which there is not enough data to calculate a criterion but for which there is at least one CV. Lowest CVs are treated as a separate category of benchmarks in this compilation.

Some chronic NAWQC are based on protection of humans or other piscivorous organisms rather than protection of aquatic organisms. Those criteria are not included herein because screening for risks to wildlife or humans is performed by other methods. However, if sufficient data were available to calculate a final chronic value (FCV) for those chemicals, then the FCV are presented in place of the chronic NAWQC in Table 1, and its derivation is noted.

For particular chemicals, the lower screening benchmark could be lower than the chronic NAWQC for any one of the following reasons. First, the chronic NAWQC are based on a threshold for statistical significance rather than biological significance. In some chronic tests, because of highly variable results, the statistical threshold corresponds to greater than 50% effect on a response parameter (Stephan and Rogers 1985, Suter et al. 1987). Second, not all important responses are included in the subchronic toxicity tests that are used to calculate many chronic NAWQC. In particular, effects on fecundity, which is the most sensitive response parameter on average in fish toxicity tests (Suter et al. 1987), are often not included. Third, the chronic NAWQC are based on the most statistically sensitive of the measured response parameters in each chronic or subchronic test. Therefore, cumulative effects over the lifecycle of fish and invertebrates are not considered. Fourth, the NAWQC are set at a level that protects "most species most of the time." Finally, many of the NAWQC have not been revised since 1980 so they do not incorporate recent data that are included in the calculation of other benchmarks. These concerns are supported by the recent finding that nickel concentrations (on the Oak Ridge Reservation) that are below chronic NAWQC are nonetheless toxic to daphnids (Kszos et al. 1992).

2.3 TIER II VALUES

If NAWQC were not available for a chemical, the Tier II method described in the EPA's *Proposed Water Quality Guidance for the Great Lakes System* was applied (EPA 1993a). Tier II values were developed so that aquatic benchmarks could be established with fewer data than are required for the NAWQC. The Tier II values are concentrations that would be expected to be higher than NAWQC in no more than 20% of cases. Tier II values calculated by the EPA are listed in Table 1, and the sources are cited. Other Tier II values are derived as described in the following text.

The Tier II values equivalent to the FAV and FCV are the Secondary Acute Values (SAVs) and Secondary Chronic Values (SCVs), respectively. The sources of data for the Tier II values are listed in Appendix A, and the procedure and factors used to calculate the SACs and SCVs are in Appendix B. The methods described herein differ from EPA's (1993a) in one respect. The Great Lakes SAVs require an LC50 for a daphnid, but that requirement would severely restrict the number of benchmarks that could be calculated. The EPA has provided factors for calculating SAVs when no daphnid LC50s are available, and these factors are used herein (Stephan 1991).

Some of the SAVs and SCVs presented in this report differ from those presented in the prior edition (Suter and Mabrey 1994) for three reasons. First, in the previous report we included all data that occurred in EPA water quality criteria documents. However, much of the data included in criteria documents issued prior to 1985 are no longer considered acceptable by the EPA. Second, some data from the EPA's AQUIRE data set were used by Suter and Mabrey (1994) that appeared to be acceptable based on the information provided in the data base and the EPA's rating of the data. It has become clear that much of that data would not be acceptable to the EPA for calculating criteria. Therefore, we obtained all original publications and independently reviewed them against the criteria in Stephan et al. (1985). Those criteria are summarized in Appendix B. Finally, some new data have been found and incorporated.

Only high quality standard data are used in this document if such values are available for a chemical. That is, if even one test that meets the criteria in Stephan et al (1985) was found, all nonconforming tests were excluded. However, when no such values are available, nonstandard or lower quality test results which were judged by the authors to be reliable were used. Values derived using data that did not meet the Stephan et al. (1985) criteria are noted.

2.4 LOWEST CHRONIC VALUES

The lowest chronic values for fish and invertebrates reported in the literature are potential lower benchmarks. Chronic values are used to calculate the chronic NAWQC, but the lowest chronic value may be lower than the chronic NAWQC. Because of the short generation time of algae and the relative lack of standard chronic tests for aquatic plants, EPA guidelines are followed in using any algal test of at least 96-hour duration and any biologically meaningful response for the plant values.

2.5 ESTIMATED LOWEST CHRONIC VALUES

Estimated lowest chronic values for fish and invertebrates are another set of potential lower benchmarks. Estimated chronic values were extrapolated from 96-hour LC50s using equations from Suter et al. (1987) and Suter (1993). The equations are as follows where LC50 equals the lowest species mean 96-hour LC50 for fish and 48-hour EC50 for daphnids, and CV equals the estimated chronic value for that taxon. The 95% prediction interval at the mean is log CV ± the PI value (95% prediction intervals contain 95% of observations versus 95% confidence intervals which contain the mean with 95% confidence).

Fish CV for a metallic contaminant: (1)

$$\log CV = 0.73 \log LC50 - 0.70$$
$$PI = 1.2$$

Fish CV for a nonmetallic contaminant: (2)

$$\log CV = 1.07 \log LC50 - 1.51$$
$$PI = 1.5$$

Daphnid CV for a metallic contaminant: (3)

$$\log CV = 0.96 \log LC50 - 1.08$$
$$PI = 1.56$$

Daphnid CV for a nonmetallic contaminant: (4)

$$\log CV = 1.11 \log LC50 - 1.30$$
$$PI = 1.35$$

2.6 TEST EC20s

Another potential lower benchmark is the test EC20 for fish, which is defined as the highest tested concentration causing less than 20% reduction in (1) the weight of young fish per initial female fish in a lifecycle or partial life-cycle test or (2) the weight of young per egg in an early life-stage test. A similar potential lower benchmark is the test EC20 for daphnids, which is the highest tested concentration causing less than 20% reduction in the product of growth, fecundity, and survivorship in a chronic test with a daphnid species. (Daphnids include members of the genera *Daphnia, Ceriodaphnia,* and *Simocephalus.*) These benchmarks are intended to be indices of population production. They are equivalent to chronic values in that they are simply a summary of the results of chronic toxicity tests, and in most cases the same test supplied the lowest chronic value and the lowest test EC20. However, the test EC20s are based on a level of biological effect rather than a level of statistical significance, and they integrate all of the stages of the toxicity test rather than treating each response independently. The 20% figure was chosen as approximately the mean level of effect on individual response parameters observed at CVs and as a minimum detectable difference in population characteristics in the field (Suter et al. 1987, 1992). These values are listed in Table 2.

2.7 ESTIMATED TEST EC20s

The estimated test EC20 is another potential benchmark. The estimated values were extrapolated from 96-hour LC50 values using equations from Suter (1992). The equation for the lowest fish test EC20 is as follows where LC50 equals the lowest species mean 96-hour LC50 for fish, and the EC25 for weight of juveniles per egg is used as an estimate of the test EC20 value. (The difference between 20% and 25% effect is trivial given the uncertainties in these estimates and the steepness of the concentration-response curves.) The log-scaled 95% prediction interval at the mean is log EC25 ± the PI value:

$$\log EC25 = 0.90 \log LC50 - 0.86 \quad (5)$$
$$PI = 1.6$$

These values are listed in Table 2 for those chemicals that have no empirical test EC20.

2.8 SENSITIVE SPECIES TEST EC20s

The sixth potential benchmark is the EC20, adjusted to approximate the fifth percentile of the species sensitivity distribution. It is calculated in the same way as the chronic NAWQC except that the test EC20s are used in place of CVs, and salt water species were not included. The FAV for each of the criterion chemicals was divided by the geometric mean of ratios of LC50s to EC20s. These benchmarks are referred to as sensitive species (SS) test EC20s, and are listed in Table 2.

2.9 POPULATION EC25s

The last potential benchmark is an estimate of the continuous concentration that would cause a 20% reduction in the recruit abundance of largemouth bass. The method used was described by Barnthouse et al. (1990) and is briefly summarized herein. The recruit abundance estimates are generated by a matrix model of a reservoir largemouth bass population (Bartell 1990). The fecundity, hatching success, larval survival, and post-larval survival of the model population are each decremented by a value generated from statistical extrapolation models. For each life stage for which a concentration-response relationship could be calculated, that relationship was adjusted for the relative sensitivity of the test species and the bass. For those life stages with no concentration-response relationship, the relationship was estimated using life stage to life stage extrapolation models, and the taxonomic adjustment was made. However, if the authors of the study reported that life stage was unaffected, the decrement for that life stage was set to zero. If no chronic test data were available, extrapolations from LC50s to chronic responses of each life stage were performed. Uncertainties in all of these extrapolations were propagated through the models to generate estimates of uncertainty. For each chemical, each available freshwater fish chronic test was used to parameterize a model run. If no chronic test data were available, each available freshwater fish LC50 was used to parameterize a model run. The results are presented in Appendix C. The geometric mean of all population EC25 estimates for each chemical is reported in Table 2.

2.10 ECOTOX THRESHOLDS

The EPA's OSWER has published Ecotox Thresholds (ETs) which are intended to be used for screening contaminants at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites (OSWER 1996); these values are available for 20 metals and 47 organics in fresh water and for 10 metals and 7 organics in marine waters. The fresh water values are presented in Table 3. Their derivation is briefly explained in the following text.

In general, chronic NAWQC values are preferred as aqueous ETs. However, as with the benchmarks in Table 1, criteria that are based on fish consumption rather than aquatic toxic effects (DDT, heptachlor, and toxaphene) are not used. Tier II values are presented in their place. For diazinon, the FCV calculated by the Great Lakes Water Quality Initiative (GLWQI) was used as a criterion value (EPA 1992).

OSWER recommends the use of dissolved concentrations of metals. Therefore, the method described in Prothro (1993) is used to correct for dissolved phase concentrations, which causes some of the metals criteria values used as ETs to differ slightly from the criteria listed in Table 1 or in the Region IV values.

SCVs are used when NAWQCs are not available. Four of these SCVs are from the GLWQI (EPA 1992), 34 are from the prior edition of this document (Suter and Mabrey 1994), and 18 were calculated by OSWER (1996). Three chemicals with OSWER-derived SCVs (endosulfan, methoxyclor, and malathion) had NAWQCs, but the criteria were judged to be old and unreliable. Tier II values were not derived if no daphnia acute values were available.

2.11 REGION IV SCREENING VALUES

EPA Region IV has published acute and chronic ecological screening values (SVs) for fresh surface water (Waste Management Division 1995); they are presented in Table 3. The acute SVs consist of acute NAWQCs or, for chemicals with no acute NAWQC, of lowest acute LC50 or EC50 values divided by 10. The chronic SVs consist of chronic NAWQCs or, for chemicals with no chronic NAWQC, of lowest CVs divided by 10. If there were no CVs, the acute SV is divided by 10 to obtain the chronic SV. These divisions by 10 serve the same purpose as the models used to calculate Tier II values, but without the scientific or statistical basis and without using the full available data set. For some chemicals, the SVs are based on effects on fish eaters or irrigated plants rather than aquatic life. Region IV acknowledges that other values have greater ecological relevance (Waste Management Division 1995). As explained previously, there are separate benchmarks to address effects on plants and wildlife and an entirely separate set of risk assessment methods to protect humans who eat fish. Finally, the hardness dependent criteria are adjusted to 50 mg/L which is unrealistically low for the Oak Ridge Reservation and most other sites.

2.12 BACKGROUND CONCENTRATIONS

Background water concentrations should be used as a check for these benchmarks. That is, because some of these benchmarks are quite conservative and because the measured concentrations in ambient water may include forms that are not bioavailable, benchmark concentrations may be lower than background water concentrations. If the background concentrations are valid and represent an uncontaminated state and if exposed site does not contain forms of the chemicals that are more bioavailable or toxic than the forms at background sites, then screening benchmarks lower than th e background concentration should not be used.

Table 3. Summary of OSWER threshold values for aquatic life (EPA 1996) and Region IV screening values for freshwater surface water (Region IV 1995) (All values are µg/L)

Chemical	OSWER Values		Region IV Values[3]	
	NAWQC or FCV[1]	Tier II[2]	Acute Screening Values	Chronic Screening Values
Metals				
Aluminum			750	87
Antimony			1300 (2s)	160 (2s)
Arsenic III	190		360	190
Arsenic V		8.1 *		
Barium		3.9 *		
Beryllium		5.1 *	16 (6s)	053 (1s)
Boron			--	750[4]
Cadmium	1.0 h		1.79 h	0.66 h
Chromium III	180 h		984.32 h	117.32 h
Chromium VI	10		16	11
Cobalt		3.0 *		
Copper	11 h		9.22 h	6.54 h
Iron	1000		--	1000
Lead	2.5 h		33.78	1.32
Manganese		80 *		
Mercury			2.40	0.0123
Mercury, inorganic	1.3			
Mercury, methyl		0.003 *		
Molybdenum		240 *		
Nickel	160 h		789.00 h	87.71 h
Selenium	5.0		20.00	5.00
Silver			1.23 h	0.012 (1s)
Thallium			140.00(3s)	4.00 (2s)

Table 3. (continued)

Chemical	OSWER Values		Region IV Values[3]	
	NAWQC or FCV[1]	Tier II[2]	Acute Screening Values	Chronic Screening Values
Vanadium		19 *		
Zinc	100 h		65.04 h	58.91 h
Organic Compounds				
Acenaphthene	23 S		170 (2s)	17
Acrolein			6.8 (3s)	2.1 (1s)
Acrylonitrile			755 (4s)	75.5
Aldrin			3	0.3
Benzene		46 *	530 (7s)	53
Benzidine			250 (4s)	25
Benzo(a)pyrene		0.014 *		
a-BHC			--	500[6]
b-BHC			--	5000[6]
g-BHC (Lindane)	0.08		2	0.08
Biphenyl		14 #		
Bis(2-chloroethyl) ether			23800 (1s)	2380
Bis(2-ethylhexyl)phthalate		32 *	1110 (2s)	<0.3 (2s)
Bromoform			2930 (2s)	293
4-Bromophenylphenyl ether		1.5 #		
4- Bromophenylphenyl phthalate			36 (2s)	12.2 (1s)
Butylbenzyl phthalate		19 #	330 (4s)	22 (2s)
Carbon tetrachloride			3520 (3s)	352
Chlordane			2.4	0.0043[5]
Chlorobenzene		130 *	1950 (5s)	195
2-Chloroethylvinyl ether			35400 (1s)	3540
Chloroform			2890 (3s)	289
2-Chlorophenol			438 (5s)	43.8
Chloropyrifos			0.083	0.041

Table 3. (continued)

Chemical	OSWER Values		Region IV Values[3]	
	NAWQC or FCV[1]	Tier II[2]	Acute Screening Values	Chronic Screening Values
4,4'-DDT		0.013 +	1.1	0.001
4,4'-DDE			105 (1s)	10.5
4,4'-DDD			0.064 (8s)	0.0064
Demeton			--	0.1
Diazinon	0.043 F			
Dibenzofuran		20 *		
1,2-Dichlorobenzene		14 #	158 (4s)	15.8 (3s)
1,3-Dichlorobenzene		71 #	502 (3s)	50.2
1,4-Dichlorobenzene		15 #	112 (5s)	11.2
1,1-Dichloroethane		47 *		
1,2-Dichloroethane			11800 (3s)	2000 (1s)
1,1-Dichloroethylene			3030 (3s)	303
2,4-Dichlorophenol			202 (3s)	36.5 (1s)
1,2-Dichloropropane			5250 (3s)	525
Dichloropropylene (cis and trans)			606 (2s)	24.4 (1s)
Dieldrin	0.062 S		2.5	0.0019[5]
Diethyl phthalate		220 *	5210 (2s)	521
2,4-Dimethylphenol			212 (3s)	21.2
Dimethyl phthalate			3300 (2s)	330
Di-n-butyl phthalate		33 *	94 (6s)	9.4
2,4-Dinitrophenol			62 (3s)	6.2
2,4-Dinitrotoluene			3100 (2s)	310
Dioxin (2,3,7,8-TCDD)			0.1	0.00001[5]
1,2-Diphenylhydrazine			27 (2s)	2.7
Endosulfan, mixed isomers		0.051 #		
Endosulfan, alpha		0.051 #	0.22	0.056
Endosulfan, beta		0.051 #	0.22	0.056

Table 3. (continued)

Chemical	OSWER Values		Region IV Values[3]	
	NAWQC or FCV[1]	Tier II[2]	Acute Screening Values	Chronic Screening Values
Endrin	0.061 S		0.18	0.0023[5]
Ethylbenzene		290 *	4530 (5s)	453
Fluoranthene	8.1 S		398 (2s)	39.8
Fluorene		3.9 #		
Guthion			--	0.01
Heptachlor		0.0069 +	0.52	0.0038[5]
Heptachlor epoxide			0.52	0.0038[5]
Hexachlorobutadiene			9 (5s)	0.93 (1s)
Hexachlorocyclopentadiene			0.7 (4s)	0.07
Hexachloroethane		12 #	98 (5s)	9.8
Isophorone			11700 (2s)	1170
Lindane (see g-BHC)				
Malathion		0.097	--	0.01
Methoxychlor		0.019 #	--	0.03
Methyl bromide			1100 (1s)	110
Methyl chloride			55000 (1s)	5500
3-Methyl-4-chlorophenol (p-Chloro-m-cresol)			3 (1s)	0.3
2-Methyl-4, 6-dinitrophenol (4,6- Dinitro-o-cresol)			23 (4s)	2.3
Methylene chloride			19300 (3s)	1930
Mirex			--	0.001
Naphthalene		24 *	230 (4s)	62 (1s)
Nitrobenzene			2700 (2s)	270
2-Nitrophenol			--	3500
4-Nitrophenol			828 (3s)	82.8
n-Nitrosodiphenylamine			585 (2s)	58.5
Parathion			0.065	0.013

Table 3. (continued)

Chemical	OSWER Values		Region IV Values[3]	
	NAWQC or FCV[1]	Tier II[2]	Acute Screening Values	Chronic Screening Values
PCB (total polychlorinated biphenyls)		0.19 *		
PCB-1242			0.2 (7s)	0.014
PCB-1254			0.2 (7s)	0.014
PCB-1221			0.2 (7s)	0.014
PCB-1232			0.2 (7s)	0.014
PCB-1248			0.2 (7s)	0.014
PCB-1260			0.2 (7s)	0.014
PCB-1016			0.2 (7s)	0.014
Pentachlorobenzene		0.47 #	250	50
Pentachlorophenol	13 pH		20 pH	13 pH
Phenol			1020 (16s)	256 (1s)
Polynuclear aromatic hydrocarbons				
Phenanthrene	6.3 S			
1,2,4,5-Tetrachlorobenzene			250	50
1,1,2,2-Tetrachloroethane		420 *	932 (3s)	240 (1s)
Tetrachloroethylene		120 *	528 (5s)	84 (1s)
Tetrachloromethane		240 #		
Toluene		130 *	1750 (5s)	175
Toxaphene		0.011 #	0.73	0.00025
1,2-Trans-Dichloroethylene,			13500 (1s)	1350
Tribromomethane		320 #		
Tributyltin			--	0.026
1,2,4-Trichlorobenzene		110 #	150 (4s)	44.9 (1s)
1,1,1-Trichloroethane		62 *	5280 (2s)	528
1,1,2-Trichloroethane			3600 (3s)	940 (1s)
Trichloroethylene		350 *		

Table 3. (continued)

Chemical	OSWER Values: NAWQC or FCV[1]	OSWER Values: Tier II[2]	Region IV Values[3]: Acute Screening Values	Region IV Values[3]: Chronic Screening Values
2,4,6-Trichlorophenol			32 (3s)	3.2
m-Xylene		1.8 #		
Other				
Chloride			860,000	230,000
Chlorine (total residual - TRC)			19	11
Cyanide	5.2		22	5.2
pH				-2.5
Oil and Grease			--	0.01 (Low LC_{50})
Sulfide (S_2-, HS-)			--	2

Notes:
[1] EPA derived NAWQC or final chronic values (FCVs).
[2] Values calculated using the GLWQI Tier II methodology.
[3] Based on EPA Region IV Water Management Division, Water Quality Standards Unit's Screening List. Those followed by (*n*s) are derived by Region IV using safety factors.
[4] For long-term irrigation of sensitive crops (minimum standard).
[5] Based on the marketability of fish. The use of other values which may have greater ecological significance may be considered.
[6] Lowest plant value reported.
(*n*s) = number of species
h = hardness-dependent ambient water quality criterion (100 mg/L as $CaCO_3$ used for OSWER thresholds and 50 mg/L for Region IV values).
pH = pH-dependent ambient water quality criterion (7.8 pH used for OSWER thresholds and 6.0 for Region IV values).
S = FCV derived for EPA Sediment Quality Criteria documents.
F = FCV calculated using GLWQI Tier 1 methodology.
t = value is for total of all chemical forms.
* = value as calculated in Suter and Mabrey (1994).
+ = Value with EPA support documents.
# = value calculated by OSWER.

3. CHEMICAL-SPECIFIC INFORMATION

This section describes the sources of information and procedures that are specific to individua l elements. Except where noted, the sourc es of data for estimating chronic values and test EC20s for fish are the same. All data used to calculate Tier II values and estimated chronic values and EC20s ar e presented in Appendix A.

3.1 INORGANICS

Aluminum. There are NAWQC for aluminum. The toxicity of aluminum has been shown to vary widely with water hardness and pH (Ingersoll et al., 1990a 1990b; Woodward et al., 1989; Sadler and Lynam, 1988; and Cleveland et al. 1986; and others). The benchmarks were calculated using only tests in circumneutral water. Lowest chronic and test EC20 values for fish are from 28-day embryo-larval tests with *Pimephales promelas*. Kimball (n.d.) presented a CV of 5800 µg/L, however, after further analysis of Kimball's data, the EPA (1988a) offered another value of 3288 µg/L as the CV for aluminum. Lowest chronic and test EC20 values for daphnids are from McCauley et al. (1986). The EPA (1988a) gives a 4-day test EC50 for *Selenastrum capricornutum* which is used as the plant chronic value.

Ammonia. The test EC20 value for fish is from an embryo-larval test with fathead minnows (Thurston et al. 1986). The chronic value for fish is from an early life stage test with pink salmon, *Oncorhynchus gorbuscha* (Rice and Bailey 1980). The chronic value for daphnids is from EPA (1985a). Chronic values were determined using *Daphnia magna* in life-cycle tests. EPA (1985a) provided the chronic value for aquatic plants, in which *Chlorella vulgaris* experienced growth inhibition (EC50). The NAWQC for ammonia are functions of temperature (T) and pH. The acute NAWQC for ammonia is 0.52/FT/FPH/2, and the chronic NAWQC for ammonia is 0.80/FT/FPH/Ratio, where:

$$FT = \begin{cases} 10^{0.03(20-TCAP)}; & TCAP \le T \le 30 \\ 10^{0.03(20-T)}; & 0 \le T \le TCAP \end{cases}$$

$$FPH = \begin{cases} 1; & 8 \le pH \le 9 \\ \dfrac{1 + 10^{7.4-pH}}{1.25}; & 6.5 \le pH \le 8 \end{cases}$$

$$Ratio = \begin{cases} 16; & 7.7 \le pH \le 9 \\ (24)\dfrac{10^{7.7-pH}}{1 + 10^{7.4-pH}}; & 6.5 \le pH \le 7.7 \end{cases}$$

TCAP = 20° C for acute criteria and 15° C for chronic criteria when Salmonids or other sensitive cold water species are present

= 25° C for acute criteria and 20° C for chronic criteria when Salmonids and other sensitive coldwater species are absent

These criteria are presented in greater detail in EPA (1985a and 1986b).

Antimony. Chronic and test EC20 values for antimony are from Kimball (n.d.). The chronic tests of *Pimephales promelas* were embryo-larval, and 28-day life-cycle tests were used for *Daphnia magna*. The EPA (1978) gives a 4-day EC50 for chlorophyll A inhibition in *Selenastrum capricornutum* which is used as the plant value. The SAV and SCV listed in this report are draft FAV and FCV values (EPA 1988b).

Arsenic III. NAWQC are listed for arsenic III. The lowest chronic values for fish and daphnids are given by Call et al. (1983) and Lima et al. (1984). Early life stage tests were used on *Pimephales promelas* and life-cycle tests were used on *Daphnia magna*. Cowell (1965) provides the lowest chronic value for the algae *Spirogyra*, *Cladophora*, and *Zygnema* which is a concentration that produced a

100% kill in 2 weeks. The test EC20 value is derived from Lima et al. (1984) for fish and from Call et al. (1983) and Lima et al. (1984) for daphnids.

Arsenic V. The chronic and test EC20 values for fish are from an early life stage test with *Pimephales promelas* (DeFoe 1982), and the test EC20 for daphnids is from Spehar et al. (1980). The estimated chronic value for daphnids was calculated with a *Daphnia magna* LC50 from EPA (1985b) using Equation (3). Vocke (1980) provides the plant value from a 14-day EC50 test with *Scenedesmus obliquus*. The SAV and SCV listed in this report are lower than the acute and chronic LOEL values listed in the Water Quality Criteria Summary (EPA 1986b).

Barium. The chronic value for daphnids is from a 21-day test on *Daphnia magna* by Biesinger and Christensen (1972) which resulted in 16% reproductive impairment.

Beryllium. The chronic and test EC20 values for *Daphnia magna* are from a life-cycle test in Kimball (n.d.). Karlander and Krauss (1972) provide the plant value for *Chlorella vannieli*, a 10 to 20% reduction in autotrophic growth rates. The estimated chronic and test EC20 values for fish were derived using data for *Pimephales promelas* from EPA (1980f) in Equations (1) and (5). The derived SAV and SCV listed in this report are lower than the lowest CV listed in the Water Quality Criteria Summary (EPA 1986b) and the acute and chronic LOEL values listed in the Water Quality Criteria Summary (EPA 1986b).

Boron. The EC20 value for daphnids was based on a 21-day test on *Daphnia magna* by Gerisch (1984). A 21-day test of *Daphnia magna* by Lewis and Valentine (1981) provided the lowest daphnid chronic value.

Cadmium. The NAWQC for cadmium are functions of water hardness. The equations for these are $e^{(0.7852[\ln(\text{hardness})]-3.490}$ for the chronic value and $e^{(1.128[\ln(\text{hardness})]-3.828)}$ for the acute value (EPA 1986b). The lowest chronic value for fish is from Sauter et al. (1976) and Chapman et al. (n.d.) for daphnids. Early life stage tests were performed on brook trout, and life-cycle tests were performed on *Daphnia magna*. The test EC20 value is from Carlson et al. (1982) for fish and Elnabarawy et al. (1986) for daphnids. The value for aquatic plants is from Conway (1977). A relatively low cadmium concentration reduced the population growth rate of *Asterionella formosa* by an order of magnitude.

Calcium. The chronic value for daphnids is a concentration causing a 16% reduction in reproduction of *Daphnia magna* exposed to $CaCl_2 \cdot 2H_2O$ (Biesinger and Christensen 1972). Because the highly conservative secondary values were below commonly occurring ambient concentrations of this macronutrient, they were judged to be inappropriate and are not presented.

Chromium III. The NAWQC for chromium III are functions of water hardness. The equations are $e^{(0.8190[\ln(\text{hardness})]+1.5161)}$ for the chronic value and $e^{(0.8190[\ln(\text{hardness})]+3.688)}$ for the acute value. The lowest chronic value for fish is from an early life stage test by Stevens and Chapman (1984) on rainbow trout. Chapman et al. (n.d.) provide a chronic value from a life-cycle test of *Daphnia magna*. The plant value for chromium III is from a 4-day chronic test in which there was a 50% inhibition of growth of *Selenastrum capricornutum* (EPA 1985c). Stevens and Chapman (1984) also provided data for the test EC20 value for fish.

Chromium VI. There are NAWQC for chromium VI. The chronic and test EC20 values for fish are from Sauter et al. (1976). An early life stage test produced the chronic value for rainbow trout. For daphnids, a life-cycle chronic test was run by Mount (1982) on *Daphnia magna*, and the test EC20 is from Elnabarawy et al. (1986). *Microcystis aeruginosa*, used for the aquatic plant value, showed incipient inhibition in tests reported by the EPA (1985c).

Cobalt. The chronic and test EC20 values for cobalt are from Kimball (n.d.). *Daphnia magna* were used in 28-day life-cycle tests, and *Pimephales promelas* were used in embryo-larval tests.

Copper. The NAWQC for copper are functions of water hardness. The equations are $e^{(0.8545[\ln(\text{hardness})]-1.465)}$ for the chronic value and $e^{(0.9422[\ln(\text{hardness})]-1.464)}$ for the acute value. The chronic and test EC20 values for fish are from an early life stage test with brook trout by Sauter et al. (1976). The daphnid chronic value is from Chapman (n.d.). The test EC20 value for daphnids is derived from Dave (1984a). A 21-day test LC50 on *Daphnia magna* provided the chronic value for daphnids. Arthur and Leonard (1970) provided a chronic value through 6-week tests on the amphipod, *Gammarus pseudolimnaeus*. Steeman-Nielsen and Wium-Anderson (1970) provide a plant value based on a lag in growth of the alga, *Chlorella pyrenoidosa*.

Cyanide. There are NAWQC for cyanide. The chronic and test EC20 values for fish were both from a brook trout life-cycle test by Koenst et al. (1977). Oseid and Smith (1979) provide full life-cycle test on *Gammarus pseudolimnaeus*, an amphipod. The alga, *Scenedesmus quadricauda*, showed incipient inhibition in chronic tests by the EPA (1985e).

Iron. The NAWQC for iron is based on a field study at a site receiving acid mine drainage and is not consistent with the current method for deriving criteria. The lowest chronic value for daphnids (158 µg/L) is a threshold for reproductive effects from a 21-day test of $FeCl_2$ with *Daphnia magna* (Dave 1984c). It is considerably lower than the 4380 µg/L concentration causing 16% reproductive decrement in another test of $FeCl_2$ with *D. magna* (Biesinger and Christensen 1972). Dave (1984c) argued that his result was more applicable to a situation in which "an acidic iron-containing waste water is discharged into a lake or a river" where it is neutralized, but Biesinger and Christensen's (1972) result "is probably more close to the steady-state situation in natural freshwater without any point source of iron." The lowest chronic value for fish is a concentration that caused 100% larval mortality in an embryo-larval test with rainbow trout exposed to dissolved iron salts (Amelung 1981).

Lead. The NAWQC for lead are functions of water hardness. The equations are $e^{(1.273[\ln(\text{hardness})]-4.705)}$ for the chronic value and $e^{(1.273[\ln(\text{hardness})]-1.460)}$ for the acute value. The lowest chronic value for fish was provided by an early life stage test on rainbow trout by Davies et al. (1976). *Daphnia magna* were used in 21-day tests to determine lowest chronic toxicity by Chapman et al. (manuscript). Borgmann et al. (1978) provided a chronic value for a life-cycle test on *Lymnaea palastris*, a snail. *Chlorella vulgaris*, *Scenedesmus quadricauda*, and *Selenastrum capricornutum* experienced 53%, 35%, and 52% growth inhibition, respectively, at the plant chronic value (EPA 1985f). The test EC20 value for fish is from Sauter et al. (1976). The acute-EC20 ratio from which the SS test EC20 was calculated had to be obtained using a species mean acute value for *Salmo gairdneri* (EPA 1985f) since no acute value was reported by Sauter et al. (1976).

Magnesium. The chronic value for daphnids is a concentration causing a 16% reduction in reproduction of *Daphnia magna* exposed to $MgCl_2 \cdot 6H_2O$ (Biesinger and Christensen 1972). Because the highly conservative secondary values were below commonly occurring ambient concentrations of this nutrient element, they were judged to be inappropriate and are not presented.

Manganese. All chronic and test EC20 values for manganese are from Kimball (n.d.). The fish chronic value is from a 28-day early life-stage test with *Pimephales promelas*.

Mercury, inorganic, or total. Mercury has NAWQC. However, the chronic criterion for mercury is based on the final residue value derived from a methyl mercury bioconcentration factor. To protect aquatic life, the secondary values were derived from the EPA's (1985f) final acute and chronic values.

The chronic and test EC20 values for fish are from Call et al. (1983), and those for daphnids are from Biesinger et al. (1982). The chronic tests for fish were run on *Pimephales promeles* throughout their embryo-larval stage. *Daphnia magna* were used in flow through life-cycle tests. The plant value is for incipient inhibition of *Microcystis aeruginosa* in an 8-day test (EPA 1985f). The acute-EC20 ratio used to calculate the SS test EC_{20} value had to be derived using a species mean acute value (EPA 1985g) since no acute value was reported in Biesinger et al. (1982).

Mercury, methyl. The chronic and test EC20 values for fish are from McKim et al. (1976). Brook trout were used in three generation life-cycle tests. The test EC20 value for daphnids is from Biesinger et al. (1982). The alga, *Chlorella vulgaris*, was used in 15-day EC50 (growth) tests by Rai et al. (1981) to determine chronic toxicity values for aquatic plants.

Molybdenum. The chronic and test EC20 values for daphnids are from Kimball (n.d.). *Daphnia magna* were used in a 28-day life-cycle test to determine the chronic value.

Nickel. The NAWQC for nickel are functions of water hardness. The equation for these are $e^{(0.8460[\ln(hardness)]+1.1645)}$ for the chronic value and $e^{(0.8460[\ln(hardness)]+3.3612)}$ for the acute value. However, nickel concentrations of 10 µg/L in Oak Ridge Reservation stream water (considerably below the chronic NAWQC for nickel but similar to the lowest of the alternate benchmarks) reduced 7-day *Ceriodaphnia dubia* survivorship to 60% (Kszos et al. 1992). The chronic and test EC20 values for fish are from Nebeker et al. (1985). The chronic value for fish was determined through an early life stage test on rainbow trout. For daphnids, the chronic value was from Lazareva (1985) and the test EC20 was from Münzinger (1990). *Daphnia magna* were used in a life-cycle test to determine the chronic value. The caddisfly, *Clistoronia magnifica*, was used in life-cycle tests by Nebeker et al. (1984) to determine the chronic value. The plant chronic toxicity values were provided by the EPA (1986a) for *Microcystis aeruginosa*, which showed incipient inhibition.

Potassium. The chronic value for daphnids is a concentration causing a 16% reduction in reproduction of *Daphnia magna* exposed to KCl (Biesinger and Christensen 1972). Because the highly conservative secondary values were below commonly occurring ambient concentrations of this macronutrient, they were judged to be inappropriate and are not presented.

Selenium. NAWQC are listed for selenium. The chronic and test EC20 values for fish are from Goettl and Davies (1976). Their tests were during the early life stage of rainbow trout. The chronic value for daphnids is from Kimball (n.d.), and the test EC20 is from Johnston (1987). These tests were run for 28 days on *Daphnia magna*. The green alga, *Scenedesmus obliquus*, exhibited reduced growth in the 14-day chronic toxicity tests (Vocke et al. 1980). The acute-EC20 ratio used in calculation of the SS EC20 value had to be derived using a species mean acute value for *Daphnia magna* (EPA 1987a) because no acute value was reported by Johnston.

Silver. The acute NAWQC for silver, which is a function of water hardness, is given by the equation $e^{(1.72[\ln(hardness)]-6.52)}$. The SCV was estimated from the FAV and acute-chronic ratios for three species. Although questions about two of these ratios prompted the EPA to refrain from calculating a final chronic value, we judged them to be better than the default value. The lowest chronic value for fish is based on an early life stage test on rainbow trout by Davies et al. (1978). The lowest chronic value for daphnids and the test EC20 for fish are from Nebeker et al. (1983). The daphnid CV is from a test with *Daphnia magna*. The test EC20 for daphnids is from Elnabarawy et al. (1986). The plant value is for growth inhibition in *Chlorella vulgaris* (EPA 1980y).

Sodium. The chronic value for daphnids is a concentration causing a 16% reduction in reproduction of *Daphnia magna* exposed to NaCl (Biesinger and Christensen 1972). Because the highly conservative secondary values were below commonly occurring ambient concentrations of this macronutrient, they were judged to be inappropriate and are not presented.

Strontium. The chronic value for daphnids is from 21-day tests on *Daphnia magna* by Biesinger and Christensen (1972) which resulted in 16% reproductive impairment.

Thallium. Chronic and test EC20 values are from Kimball (n.d.). Embryo-larval tests were run on *Pimephales promelas*, and 28-day chronic tests were run on *Daphnia magna*. The aquatic plant value is a 4-day EC50 which reduced the cell numbers of the alga, *Selenastrum capricornutum* (EPA 1978).

Tin. The chronic value is from Biesinger and Christensen (1972). It caused 16% reproductive impairment in *Daphnia magna* in 21 days.

Uranium. The chronic value for fish is an estimate based on a fathead minnow LC50 from Cushman et al. (1977) used in Equation (1). The test EC20 is an estimate based on the same data; however, Equation (5) was used.

Vanadium. The lowest chronic and test EC20 values for fish are from Holdway and Sprague (1979) and for daphnids from Kimball (n.d.).

Zinc. The NAWQC for zinc are functions of water hardness. The equations are $e^{(0.8473[\ln(\text{hardness})]+0.7614)}$ for the chronic value and $e^{(0.8473[\ln(\text{hardness})]+0.8604)}$ for the acute value. The chronic and test EC20 values for fish are from Spehar (1976), and the chronic value for daphnids is from Chapman et al. (n.d.). Life-cycle tests were run on *Jordanella floridae* and *Daphnia magna*. Nebeker et al. (1984) provided chronic values from life-cycle tests on the caddisfly, *Clistoronia magnifica*. Bartlett et al. (1974) ran 7-day tests on *Selenastrum capricornutum*. These aquatic plants showed incipient inhibition of growth.

Zirconium. The chronic and test EC20 values for fish are estimates based on an LC50 for *Pimephales promelas* from Cushman et al. (1977). These values were calculated using Equations (1) and (5).

3.2 ORGANICS

Acenaphthene. Although the full data requirements are not met for acenaphthene, the EPA has presented final acute and chronic values for derivation of sediment quality criteria which are presented in the criteria columns (EPA 1993b). The fish chronic value is from an early life-stage test with *Pimephales promelas*, and the non-daphnid chronic value is from a life-cycle test with a midge *Paratanytarsus sp*. (EPA 1993b). The plant value is from EPA (1978). *Selenastrum capricornutum* were used in 96-hour EC50 (50% reduction in cell numbers).

Acetone. The test EC20 value for fish is an estimate based on an LC50 for rainbow trout. The chronic value for Daphnia magna is a 28-day life-cycle test from LeBlanc and Surprenant (1983).

Anthracene. The chronic value for daphnids (*Daphnia magna*) was estimated using an EC50 from Holst and Giesy (1989). The chronic and test EC20 values for fish are an estimate based on an LC50 for bluegill from Oris and Giesy (1985). Calcu lations were performed using Equations (2), (4), and (5).

Benzene. The lowest chronic value for daphnids is given by EPA (1978). *Daphnia magna* were used in life-cycle tests. The lowest chronic value for aquatic plants is given by Kauss and Hutchinson (1975), which was a 48-hour test EC50 on *Chlorella vulgaris*. The chronic value for fish is an estimate based on data for the rainbow trout from EPA (1980d) and Equation (2). The test EC20 value for fish is derived from Black and Birge (1982). The reade r should note that Black and Birge conducted a series of screening tests for a large number of chem icals on several freshwater organisms. Larval fish survival was recorded to only 4 days post-hatch, and LOECs and NOECs were not determined. These tests, then, did not generate standard chronic values and are not equivalent to the other chronic tests cited in thi s report. The test EC20 values based on tests by Black and Birge may be high relative to those fro m conventional chronic tests.

Benzidene. The chronic and EC20 value for fish are an estimate based on data for red shiner from EPA (1980c). Calculations were performed using Equations (2) and (5).

Benzo(a)anthracene. The chronic value for daphnids is an estimate based on data for *Daphnia magna* from Trucco et al. (1983) used in Equation (4).

Benzo(a)pyrene. The test EC20 for fish is derived from Hannah et al. (1982). The chronic value for daphnids is an estimate based on data for *Daphnia magna* from Trucco et al. (1985) used in Equation (4).

Benzoic Acid. The chronic value for fish is an estimate based on data for the mosquitofish from AQUIRE used in Equation (2). The estimated test EC20 for fish is b ased on the same data, but Equation (5) was used.

Benzyl Alcohol. The chronic and test EC20 values for fish are estimates based on data for bluegill from Dawson et al. (1977). The calculations were performed using Equations (2) and (5) .

BHC (lindane). There are NAWQC for lindane. The chronic values for daphnids, fish, and non-daphnid invertebrates are all from Macek et al. (1976a). The test EC20 values for daphnids and fish are also from Macek et al. (1976a). The chronic values were derived from life-cycle tests run on *Pimephales promelas*, *Daphnia magna*, and the midge *Chironimus tentans*. The chronic value for aquatic plants is from Krishnakumari (1977); *Scenedesmus acutus* exhibited 20% growth inhibition in 5 days. The acute-EC20 ratio from which the SS EC20 wa s calculated was derived using a species mean acute value for *Salvelinus fontinalis* (EPA 1980s) since no acute data were reported by Macek et al. (1976a).

BHC (other). The chronic value for daphnids was estimated using a *Daphnia magna* EC50 from AQUIRE in Equation (4).

Bis(2-ethylhexyl)phthalate. The chronic and test EC20 values for fish are from a rainbow trout early life-stage test (Mehrle and Mayer 1976). A much lower value was reported in the previous edition of this report, but the results of that study are now believed to be incorrect (Knowles et al. 1987). The new value is supported by a CV of 912 μg/L from Adams and Heidolph (1985). That study is used in the derivation of the SCV because, unlike the K nowles et al. (1987) study, it has an accompanying acute value (48-hr EC50). No test EC20 for daphnids was calculate d because insufficient detail was presented by Adams and Heidolph (1985) and Knowles et al. (1987).

2-Butanone. The chronic values for fish and daphnids are estimates based on data from Veith et al. (1983) and Randall and Knopp (1980), respectively. Equation (4) was applied to the data fo r *Daphnia magna*, and Equation (2) was applied to the data for *Pimephales promelas*. The test EC20 value for fish is also an estimate using Equation (5) and an LC50 from Veith et al. (1983).

Carbon disulfide. The chronic and test EC20 values for fish are estimates based on data fo r mosquitofish from AQUIRE using equation s (2) and (5). The chronic value for daphnids is an estimate for *Daphnia magna* using data from Van Leeuwen (1985) in Equation (4).

Carbon tetrachloride. The chronic value for fish is a rainbow trout embryo-larval LC50 (Black and Birge 1982); therefore, it may be too high. However, it is lower than values presented by Kimball et al. (n.d.) and EPA (1980h) for fathead minnows. The same test was used to derive the test EC20 for fish (see the comments on benzene). The chronic value for daphnids is from a 7-day reproduction test with *Daphnia magna* (Kimball et al. n.d.). None of the subchronic tests could be used in the calculation of the SCV.

Chlordane. The chronic NAWQC for chlordane is based on the final residue value. For a criterion to protect aquatic life rather than its use, the FCV is reported. The lowest chronic and test EC20 values are derived from *Daphnia magna*, bluegill, and *Chironomus tentans* life-cycle tests (Cardwell et al. 1977).

Chlorobenzene. The chronic values for fish and daphnids are estimates based on data for bluegill and *Daphnia magna* from EPA (1980j). The values were calculated using Equations (2) and (4). The plant value is a 96-hour EC50 for cell number with *Selenastrum capricornutum* (EPA 1980j).

Chloroform. The test EC20 value for fish is from Black and Birge (1982). (Refer to the section on benzene). The chronic value is a 27-day LC50 for rainbow trout (embryo-larval) from EPA (1980l). The EPA (1986b) gives this value as a lowest observed effect value in lieu of a NAWQC. The chronic value for daphnids is an estimate based on data for *Daphnia magna* from EPA (1980l) and calculated from Equation (4).

DDD. The chronic and EC20 values for fish are estimates based on data for largemouth bass from Mayer and Ellersieck (1986) and are calculated using Equations (2) and (5).

DDT. The acute NAWQC for DDT is used. The chronic NAWQC, however, is not used because it is based on the final residue value. T o protect aquatic life, an SCV is presented. The test EC20 value for fish is derived from Jarvinen et al. (1977). The fish chronic value is from a *Pimephales promelas* life-cycle test (EPA 1980m). The chronic value for daphnids is an estimate based on data for *Daphnia pulex* from EPA (1980m) and calculated with Equation (4). The aquatic plant chronic value is fro m Sodergreen (1968). *Chlorella vulgaris* was affected in growth and morphology.

Decane. The chronic value for daphnids is an estimate based on data for *Daphnia magna* from LeBlanc (1980) used in Equation (4).

Di-n-butyl phthalate. All chronic and test EC20 values are from McCarthy and Whitmore (1985). The chronic value for daphnids is based on the geometric means of the observed concentration of fresh solutions and aged solutions. *Daphnia magna* were used in life-cycle tests, and *Pimephales promelas* were used in early life stage tests.

Dibenzofuran. The chronic value for daphnids is an estimate based on data for *Daphnia magna* from LeBlanc (1980) and used in Equation (4).

1,1-Dichloroethane. The chronic and test EC20 values for fish are estimates based on an LC50 for guppy from Koneman (1981) and calculated using Equations (2) and (5).

1,2-Dichloroethane. The chronic value for fish is from Ahmad et al. (1984). Early life stage tests were conducted on *Pimephales promelas.* The test EC20 value for fish is from Benoit et al. (1982). The chronic and test EC20 values for daphnids are from *Daphnia magna* 28-day life-cycle tests (Richter et al. 1983).

1,1-Dichloroethene. The chronic values for fish and aquatic plants are from EPA (1978). *Pimephales promelas* were used in embryo-larval tests. The alga, *Selenastrum capricornutum*, was used in a 96-hour EC50 where it exhibited loss of chlorophyll A and cell numbers. The chronic value for daphnids is an estimate based on data for *Daphnia magna* from EPA (1980n) used in Equation (4).

1,2-Dichloroethene. The chronic and test EC20 values for fish are estimates based on data for bluegill from EPA (1980n). These values were derived using Equations (2) and (5).

1,3-Dichloropropene. The test EC20 for fish was estimated using an LC50 for bluegill from EPA (1980o) in Equation (5). The chronic values for fish and aquatic plants are from EPA (1978). *Pimephales promelas* were used in an embryo-larval test, and *Selenastrum capricornutum* were used in a 96-hour EC50. The alga showed chlorophyll A and cell loss. The chronic value for daphnids was estimated using an EC50 for *Daphnia magna* from EPA (1980o) in Equation (4).

Diethyl phthalate. The plant value is a 96-hour EC50 for *Selenastrum capricornutum* (EPA 1978).

Di-n-octyl phthalate. All chronic and test EC20 values are from McCarthy and Whitmore (1985). Chronic values were based on *Pimephales promelas* in early life stage tests and *Daphnia magna* in life-cycle tests. There are no Tier II values for di-n-octyl phthalate because LC50s were not available.

Ethyl benzene. The chronic value for aquatic plants is from EPA (1978). *Selenastrum capricornutum* displayed chlorophyll A inhibition in 96-hour EC50. The chronic value for daphnids was estimated using an EC50 for *Daphnia magna* from EPA (1980p) in Equation (4).

Fluoranthene. Although the full data requirements are not met for fluoranthene, the EPA (1993c) has derived an FAV and FCV as a part of the derivation of sediment quality criteria which are presented in Table 1. The fish CV is from an early life-stage test with *Pimephales promelas*, and the daphnid CV is from a life-cycle test with *Daphnia magna* EPA (1993c).

Heptachlor. The acute NAWQC for heptachlor is used. Because the chronic NAWQC is based on the final residue value, an SCV is reported herein. The chronic and test EC20 values for fish are from Macek et al. (1976b). *Pimephales promelas* were used in life-cycle tests to determine the chronic value for fish. The SS test EC20 value was calculated using an acute-EC20 ratio that was derived from a species mean acute value for *Pimephales promelas* (EPA 1980r) because no acute data are available from Macek et al. (1976b). The chronic value for aquatic plants is from EPA (1980r). Growth inhibition was exhibited by *Selenastrum capricornutum* in 96-hour EC50. The chronic value for daphnids is an estimate based on data for *Daphnia pulex* from EPA (1980r) using Equation (4).

Hexane. The chronic value and test EC20 value for fish are estimates based on LC50s for golden orfe from AQUIRE and calculated using Equations (2) and (5).

2-Hexanone. The chronic value and test EC20 value are estimates based on an LC50 for *Pimephales promelas* from Geiger et al. (1986) and calculated using Equations (2) and (5).

1-Methylnaphthalene. The chronic and test EC20 values for fish are estimates based on data for *Pimephales promelas* from Mattson (1976). The values were calculated with Equations (2) and (5).

4-Methyl-2-pentanone. The chronic value for fish is from Call et al. (1985). *Pimephales promelas* embryos, larva, and juveniles were exposed for 31 to 33 days.

2-Methylphenol. The chronic value for daphnids is an estimate based on data for *Daphnia magna* from Adema (1978) and Canton and Adema (1978). The value was calculated using Equation (4). The chronic and test EC20 values for fish were estimated using an LC50 for rainbow trout from DeGraeve et al. (1980) in Equations (2) and (5).

Methylene chloride. The chronic value for fish is from Dill et al. (1987). *Pimephales promelas* were used in 32-day embryo-larval tests. The chronic value for daphnids is an estimate based on data for *Daphnia magna* from LeBlanc (1980) used in Equation (4). The test EC20 value for fish is from Black and Birge (1982). (Refer to the section on benzene concerning data from this source.)

Naphthalene. The chronic and test EC20 values for fish are from DeGraeve et al. (1982), and the test EC20 value for daphnids is from Geiger and Buikema (1982). *Pimphales promelas* were used in embryo-larval tests to determine chronic toxicity. The chronic value for aquatic plants is from EPA (1980t). The alga, *Chlorella vulgaris*, exhibited inhibited cell numbers in 48-hour EC50. The chronic value for daphnids is an estimate based on data for *Daphnia magna* from EPA (1980t) used in Equation (4).

4-Nitrophenol. The chronic and test EC20 values for daphnids are from Francis et al. (1986). The chronic and test EC20 values for fish are estimates based on data for bluegill from Buccafusco et al. (1981) and used with Equations (2) and (5). The EPA (1978) is the source for the chronic value for aquatic plants. *Selenastrum capricornutum* exhibited chlorophyll A reduction in 96-hour EC50.

N-nitrosodiphenylamine. The source for the estimated fish and daphnid chronic values are Buccafusco et al. (1981) and LeBlanc (1980), respectively. Equation (2) was used to calculate the estimated fish (bluegill) value, and Equation (4) was used for the estimated daphnid (*Daphnia magna*) value. The test EC20 value for fish is also an estimate. Buccafusco et al. (1981) provided the LC50 for bluegill used with Equation (5) to estimate the EC20.

PCBs: Total. There are NAWQC for PCBs, but the chronic criterion is based on the final residue value. Since that value is intended to protect the use of aquatic life, an SCV is calculated to protect the aquatic life itself. The fish lowest chronic value and test EC20 are from a full life-cycle test of fathead minnows by DeFoe (1978). The lowest chronic value and test EC20 for daphnids are from a 2-week continuous flow test with *Daphnia magna* (Nebeker and Puglisi 1974). The lowest chronic value for non-daphnid invertebrates is from a 3-week LC50 for *Tanytarsis dissimilis* by Nedeker and Puglisi (1974). The lowest plant value is for reduction in carbon fixation by *Scenedesmus quadricaudata* in a 24-hour test (Laird 1973).

PCBs: Aroclor® 1221. The chronic and test EC20 fish values are estimates based on data for cutthroat trout by Stalling and Mayer (1972). Equations (2) and (5) were used to determine the EC20 value for fish. The chronic value for aquatic plants is a 48-hour LC50 for *Euglena gracilis* (Ewald et al. 1976).

PCBs: Aroclor® 1232. The chronic and test EC20 fish values are estimates based on data for cutthroat trout by Stalling and Mayer (1972) and AQUIRE. The geometric mean was derived from these two values and then placed into Equations (2) and (5).

PCBs: Aroclor® 1242. The chronic and test EC20 values for fish are from Nebeker et al. (1974). *Pimephales promelas* were used in full life-cycle tests. The chronic values for non-daphnid invertebrates are from Nebeker and Puglisi (1974). *Gammarus pseudolimnaeus* were exposed to PCBs for 2 months in a continuous-flow system. The chronic value for aquatic plants is a 24-hour test in which *Scenedesmus obtusiusculus* showed growth inhibition (Larsson and Tillberg 1975).

PCBs: Aroclor® 1248. The chronic and test EC20 values for fish are from DeFoe et al. (1978), and the chronic and test EC20 values for daphnids are from Nebeker and Puglisi (1974). The chronic values for fish were full life-cycle tests carried out on *Pimephales promelas*. The chronic value for daphnids was determined through 3-week exposures that created a 16% reproductive impairment in *Daphnia magna*. The chronic value for a non-daphnid invertebrate is from Nebeker and Puglisi (1974). *Gammarus pseudolimnaeus* was exposed for 2 months.

PCBs: Aroclor® 1254. The chronic value for fish is from a brook trout life-cycle test (Mauck et al. 1978), and the test EC20 value is from a fathead minnow life-cycle test (Nebeker et al. 1974). The chronic and test EC20 values for daphnids are from Nebeker and Puglisi (1974). *Daphnia magna* were exposed for 2 weeks in a continuous-flow environment. The lowest chronic value for nondaphnid invertebrates is from a 3-week LC50 for *Tanytarsis dissimilis* by Nedeker and Puglisi (1974). The lowest plant value is for reduction in carbon fixation by *Scenedesmus quadricaudata* in a 24-hour test (Laird 1973).

PCBs: Aroclor® 1260. The chronic and test EC20 values for fish are from DeFoe et al. (1978). The chronic value is ambiguous because significant effects occurred at the lowest concentration tested in a 30-day fathead minnow larval test at the lowest concentrations tested (1.3 µg/L) but not in a 240-day lifecycle at the highest concentration tested (2.1 µg/L).

1-Pentanol. The chronic and test EC20 values for fish are estimates based on data for rainbow trout from AQUIRE and calculated using Equations (2) and (5).

Phenanthrene. The chronic and test EC20 values for daphnids are from Geiger and Buikema (1982). The chronic value was determined using *Daphnia pulex* in full life-cycle tests.

Phenol. The chronic and test EC20 values for fish are from fathead minnow embryo-larval tests (DeGraeve et al. 1980). The chronic value for daphnids is an estimate based on data for *Daphnia longispina* from EPA (1980v) and calculated using Equation (4). The chronic value for aquatic plants is from Reynolds (1975). *Selenastrum capricornutum* exhibited 60% reduction in cell numbers and 12% growth inhibition.

2-Propanol. The chronic and test EC20 values for fish are estimates based on data for *Pimephales promelas* from AQUIRE and Veith et al. (1983). The geometric mean of these LC50s was used in Equations (2) and (4).

1,1,2,2-Tetrachloroethane. The chronic and test EC20 values for fish are from Ahmad et al. (1984), and the values for daphnids are from Richter et al. (1983). The chronic values for fish were derived from embryo-larval tests on *Pimephales promelas*. The chronic values for daphnids were derived from 28-day tests run on *Daphnia magna*. The chronic value for aquatic plants is from EPA (1978). *Selenastrum capricornutum* exhibited chlorophyll A inhibition in 96-hour EC50.

Tetrachloroethene. The chronic value for fish is an embryo-larval test on fathead minnows (EPA 1980aa). The test EC20 value for fish is from Ahmad et al. (1984). The chronic and test EC20 values for daphnids are from Richter et al. (1983). These were 28-day tests on *Daphnia magna*. The plant value is from EPA (1978). *Selenastrum capricornutum* decreased in cell number and chlorophyll A during the 96-hour EC50.

Toluene. The chronic value is an estimate based on data for *Daphnia magna* from EPA (1980cc) and calculated using Equation (4). The chronic value from *Pimephales promelas* is from Devlin et al. (1982). The test EC20 value for fish is from Black and Birge (1982). (Refer to the section on benzene.) *Chlorella vulgaris* was used in 10-day tests by Kauss and Hutchinson (1975) to determine the chronic value for aquatic plants.

1,1,1-Trichloroethane. The chronic value and test EC20 value for daphnids are from Thompson and Carmichael (1989). *Daphnia magna* were used in 17-day chronic tests. The chronic value and test EC20 for fish were estimated based on data for *Pimephales promelas* from Alexander et al. (1978) and calculated using Equation (2). The chronic value for aquatic plants is from EPA (1978). *Selenastrum capricornutum* decreased in chlorophyll A and cell numbers in the 96-hour EC50.

1,1,2-Trichloroethane. The chronic value and test EC20 values for fish are from Ahmad et al. (1984) and the chronic and test EC20 values for daphnids are from Richter et al. (1983). The chronic value for fish is based on 32-day embryo-larval tests on *Pimephales promelas*, while the chronic value for daphnids is based on 28-day tests on *Daphnia magna*.

Trichloroethene. The chronic and test EC20 values for fish are from Smith et al. (1991). *Jordanella floridae*, the flagfish, was used in 28-day embryo-larval tests. The chronic value for daphnids is an estimate based on data for *Daphnia pulex* from EPA (1980dd) and calculated using Equation (4).

Vinyl acetate. The chronic and test EC20 values for fish are estimates based on an LC50 for *Pimephales promelas* from AQUIRE calculated using Equations (2) and (5).

Xylene. The chronic value for fish is an estimate based on an LC50 for common carp from AQUIRE and calculated using Equation (2). The test EC20 value for fish is from Black and Birge (1982). (Refer to the section on benzene.)

4. APPLICATION OF BENCHMARKS

Use of these aquatic screening benchmarks requires that the assessor choose which benchmarks to employ and which water concentrations to apply them to. The choice of benchmarks depends on the interpretation of the benchmarks, their regulatory standing, and their degree of conservatism.

Each of the alternative benchmarks has a different interpretation. Exceedances of NAWQC create a regulatory imperative for action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) because they are ARARS. Exceedance of a Tier II value implies a greater than 20% chance that the NAWQC, if their value were known, would be exceeded. Exceedance of a CV indicates that the field concentration is greater than a concentration dividing statistically insignificant from significant effects in a chronic toxicity test. Exceedance of a test EC20 indicates that biologically significant effects levels were exceeded in a chronic toxicity test. Exceedance of the SS test EC20 indicates that a biologically significant effect level may be exceeded in a sensitive species. Exceedance of a population EC20 indicates that a significant reduction in a largemouth bass population could occur. Therefore, exceedance of either the acute or chronic NAWQC indicates a need for action. Exceedance of an SCV implies a low risk. Exceedance of any of the other benchmarks indicates a risk of real effects that should lead to additional data collection and assessment. However, these inferences all depend on comparison of the benchmarks to appropriate water concentrations.

Contaminant screening is not a regulatory process, but managers at some sites prefer to use only values that have regulatory standing. The NAWQC are clearly regulatory values in that they are ARARS and have been adopted by Tennessee and most other states as water quality standards. Lowest chronic values (the last column in Table 1) have been presented by the EPA in place of NAWQC (EPA 1986b), but they are not criteria. They merely indicate that the EPA believes toxic effects may occur at that concentration. The Tier II values (SAV and SCV) are proposed by the EPA as values that could be used for regulatory enforcement in the Great Lakes (EPA 1993a). They are more conceptually consistent with the NAWQC than lowest chronic values and may come to have the same standing as NAWQC, but currently they are only proposed by the EPA.

OSWER's Ecotox Thresholds and Region IV's screening values (or values proposed by other regions) are alternative benchmark sets derived by the EPA. Both are based on NAWQC values; however, Region IV uses values adjusted to 50 ppm hardness which is unrealistically conservative for most sites, while OSWER adjusts to dissolved-phase concentrations which are not available for most screening assessments. In addition, Region IV uses NAWQCs based on fish marketability which is not relevant to protecting aquatic life. Therefore, the standard EPA Office of Water NAWQC values and FCVs in Table 1 will be more useful in most cases. When NAWQCs are not available, the ETs correspond to SCVs, but some of the SCVs have been superseded by values presented in Table 1 of this document. When NAWQCs are not available, the SVs are based on divisions of lowest toxic values by 10 or 100 which is equivalent to derivation of SAVs and SCVs but is not as scientifically defensible. Therefore, for the Oak Ridge Reservation and many other sites, the NAWQCs and Tier II values listed in Table 1 are generally preferable to either the ETs or SVs.

As discussed in the introduction, the chronic benchmarks are to be used as lower screening benchmarks. The acute NAWQC and SAVs are to be used as upper screening benchmarks. However, because of their conservatism, exceedance of the SAV cannot be taken to indicate that severe effects are likely to be occurring. If an SAV is exceeded, the assessor should examine the acute values used to generate the Tier II values (Appendix A) and judge whether in fact severe effects are likely.

All of these benchmarks are based on toxicity tests conducted in the laboratory. Therefore, they should be compared to water concentrations that are as equivalent as possible to concentrations in test water which is nearly all dissolved. The EPA Office of Water has decided that for metals the appropriate comparison is to concentrations in 0.1 to 0.45 µm filtered ambient water (HECD 1992, Prothro 1993). Acid soluble or even total recoverable concentrations, rather than dissolved concentrations, are often reported because they are required for human health risk assessments. In addition, Region IV and most other EPA regional offices require use of acid soluble concentrations in ecological risk assessments for the sake of conservatism. However, acid soluble concentrations of metals typically include 30 to 95% particle bound material (HECD 1992). Therefore, acid soluble concentrations should be used for aquatic ecological risk assessments to satisfy the regional regulators, but dissolved concentrations should also be used if possible for a realistic screening of the chemicals and to make realistic estimates of risk.

The NAWQC for hardness dependent metals are based on a hardness of 100 mg/L, which is appropriately conservative for ambient waters on the Oak Ridge Reservation. If these benchmarks are applied to a site with hard or soft water, the NAWQC for those metals should be recalculated as recommended by the EPA.

5. REFERENCES

Adams, W. J. and B. B. Heidolph. 1985. Short-cut chronic toxicity estimates using *Daphnia magna*. pp. 87–102. in R. D. Cardwell, R. Purdy, and R. C. Bahner (eds.), *Aquatic Toxicity and Hazard Assessment*, Seventh Symposium. ASTM, Philadelphia, PA.

Adams, W. J., G. R. Biddinger, K. A. Robillard. 1995. A summary of the acute toxicity of 14 phthalate esters to representative aquatic organisms. *Environ. Toxicol. Chem.* 14:1569–1574.

Adelman, I. R., L. L. Smith, and G. D. Siesennop. 1976. Chronic toxicity of Guthion to the fathead minnow (*Pimephales promelas* Rafinesque). *Bull. Environ. Contam. Toxicol.* 15:726–733.

Adema, D. M. M. 1978. *Daphnia magna* as a test animal in acute and chronic toxicity tests. *Hydrobiologia*. 59:125–134.

Adema, D. M. M. and I. G. J. Vink. 1981. A comparative study of the toxicity of 1,1,2-trichloroethane, dieldrin, pentachlorophenol and 3,4 dichloroaniline for marine and fresh water organisms. *Chemosphere*. 10:533–554.

Adema, D. M. M., J. H. Canton, W. Slooff, and A. O. Hanstveit. 1981. *Research for a useful combination of test methods to determine the aquatic toxicity of environmentally dangerous chemicals.* Rep. No. CL81/100, Natl. Inst. Public Health Environ. Hyg., the Netherlands.

Ahmad, N. et al. 1984. *Aquatic toxicity tests to characterize the hazard of volatile organic chemicals in water: A toxicity data summary—Parts I and II.* EPA-600/3-84-009. U.S. Environmental Protection Agency, Duluth, Minn.

Alexander, H. C., W. M. McCarthy, and E. A. Bartlett. 1978. Toxicity of perchloroethylene, trichloroethylene, 1,1,1-trichloroethane, and methylene chloride to fathead minnows. *Bull. Environ. Contam. Toxicol.* 20:344–352.

Allison, D. T. and R. O. Hermanutz. 1977. *Toxicity of diazinon to brook trout and fathead minnows*. EPA-600/3-77-060. U.S. Environmental Protection Agency, Duluth, Minn.

Amelung, M. 1981. Auswirkungen gelöster Eisenverbindungen auf die Ei- und Larvalentwicklung von *Salmo gairdneri* (Richardson). *Arch. Fisch Wiss.* 32:77–87.

Anderson, D. R. and E. B. Lusty. 1980. *Acute toxicity and bioaccumulation of chloroform to four species of freshwater fish.* PNL-3046. NUREG/CR-0893. Report No. CR-0893, U.S. Nuclear Reg. Comm., Washington, D. C.

Arthur, J. W. and E. N. Leonard. 1970. Effects of copper on *Gammarus pseudolimnaeus*, *Physa integra*, and *Campeloma decisum* in soft water. *J. Fish. Res. Bd. Canada.* 27:1277–1283.

Arthur, J. W. and J. G. Eaton. 1970. Effects of copper on *Gammarus pseudolimnaeus* and the fathead minnow (*Pimephales promelas*). *J. Fish. Res. Board Canada.* 28:1841–1845.

Bailey, H. C., D. H. W. Liu, and H. A. Javitz. 1985. Time/toxicity relationships in short-term static, dynamic, and plug-flow bioassays. in R. C. Bahner and D. J. Hansen (eds.), *Aquatic Toxicology and Hazard Assessment*, Eighth Symposium, ASTM STP 891, Philadelphia, PA.

Barnthouse, L. W., G. W. Suter II, and A. E. Rosen. 1990. Risks of toxic contaminants to exploited fish populations: influence of life history, data uncertainty and exploitation intensity. *Environ. Toxicol. Chem.* 9:297–311.

Bartell, S. M. 1990. Ecosystem context for estimating stress-induced reductions in fish populations, pp. 167–182, in *American Fisheries Society Special Symposium 8*. Bethesda, MD.

Bartlett, L. and F. W. Rabe. 1974. Effects of copper, zinc, and cadmium on *Selenastrum capricornutum*. *Water Res.* 8:179–185.

Benoit, D. A. 1975. Chronic effects of copper on survival, growth, and reproduction of the bluegill (*Lepomis macrochirus*). *Trans. Am. Fish. Soc.* 104:353–358.

Benoit, D. A., and G. W. Holcombe. 1978. Toxic effects of zinc on fathead minnows *Pimephales promelas* in soft water. *J. Fish Biol.* 13:701–708.

Benoit, D. A., F. A. Puglisi, and D. L. Olson. 1982. A fathead minnow *Pimephales promelas* early life stage toxicity test method evaluation and exposure to four organic chemicals. *Environ. Pollut. Ser. A Ecol. Biol.* 28:189–197.

Biesinger, K. E., L. E. Anderson, and J. G. Eaton. 1982. Chronic effects of inorganic and organic mercury on *Daphnia magna*: toxicity, accumulation, and loss. *Arch. Environm. Contam. Toxicol.* 11:769–774.

Biesinger, K. E. and G. M. Christensen. 1972. Effects of various metals on survival, growth, reproduction, and metabolism of *Daphnia magna*. *J. Fish. Res. Bd. Canada.* 29:1691–1700.

Birge, W. J., J. A. Black, and A. G. Westerman. 1978. *Effects of polychlorinated biphenyl compounds and proposed PCB-replacement products on embryo-larval stages of fish and amphibians*. Res. Rep. No. 118, University of Kentucky, Water Resour. Res. Inst., Lexington, KY.

Black, J. A. and W. J. Birge. 1982. *The aquatic toxicity of organic compounds to embryo-larval stages of fish and amphibians*. University of Kentucky, Water Resources Research Institute, Lexington, Kentucky.

Bluzat, R., O. Junot, G. Lespinasse, and J. Seuge. 1979. Chronic toxicity of acetone in the fresh water snail *Lymnea stagnalis*. *Toxicology*. 14:179–190.

Borgmann, U., O. Kramar, and C. Loveridge. 1978. Rates of mortality, growth, and biomass production of *Lymnaia palustris* during chronic exposure to lead. *J. Fish. Res. Board Can*. 35:1109–1115.

Brooke, L. T., D. J. Call, D. L. Geiger, and C. E. Northcott. 1984. *Acute toxicities of organic chemicals to fathead minnows (Pimephales promelas)*, Vol. 1. Center for Lake Superior Environmental Studies, University of Wisconsin, Superior, WI.

Brungs, W. A. 1969. Chronic toxicity of zinc to the fathead minnow *Pimephales promelas* Rafinesque. *Trans. Am. Fish. Soc*. 98:272–279.

Buccafusco, R. J., S. J. Ells, and G. A. LeBlanc. 1981. Acute toxicity of priority pollutants to bluegill (*Lepomis macrochirus*). *Bull. environ. Contam. Toxicol.* 26:446–452.

Buhl, K. J. and S. J. Hamilton. 1990. Comparative toxicity of inorganic contaminants released by placer mining to early life stages of Salmonids. *Ecotoxicol. Enviorn. Saf.* 20:325–342.

Buikema, A. L. Jr., J. Cairns, Jr., and G. W. Sullivan. 1974. Evaluation of *Philodina acuticornis* (Rotifera) as bioassay organisms for heavy metals. Water Resour. Bull. Am. Water Res. Assoc. 10:648–661.

Cairns, J. Jr and A. Scheier. 1968. A comparison of the toxicity of some common industrial waste components tested individually and combined. *Prog. Fish-Cult.* 30:3–8

Call, D. J., L. T. Brook, N. Ahmad, and J. E. Richter. 1983. *Toxicity and metabolism studies with EPA priority pollutants and related chemicals in freshwater organisms*. EPA-600/3-83-095. U.S. Environmental Protection Agency, Duluth, Minn.

Call, D. J., L. T. Brook, M.L. Knuth, S. H. Poirer, and M.D. Hoglund. 1985. Fish subchronic toxicity prediction model for industrial organic chemicals that produce narcosis. *Environ. Toxic. and Chem*. 4:335–341.

Call, D. J., L. T. Brooke, S. L. Harting, S. H. Poirier and D. J. McCauley. 1986. *Toxicity of phenanthrene to several freshwater species.* Report to Battelle Memorial Research Institute, Columbus, OH, Subcontract No. F-4114 (8834)-411, Work Assignment No. 45. Center for Lake Superior Environmental Studies, University of Wisconsin-Superior, Superior, WI.

Canton, J. H. and D. M. M. Adema. 1978. Reproducibility of short-term and reproduction toxicity experiments with *Daphnia magna* and comparison of the sensitivity of *Daphnia magna* with *Daphnia pulex* and *Daphnia cucullata* in short-term experiments. *Hydrobiologia* 59:135–140.

Canton, J. H., P. A. Greve, W. Slooff, and G. J. Van Esch. 1975. Toxicity, accumulation and elimination studies of alpha-hexachlorocyclohexane (alpha-HCH) with freshwater organisms of different trophic levels. *Water Res.* 9:1163–1169.

Cardwell, R. D., D. G. Foreman, T. R. Payne, and D. J. Wilbur. 1976. *Acute toxicity of selected toxicants to six species of fish*. EPA-600/3-76-008, U.S. EPA, Duluth, MN.

Cardwell, R. D., D. G. Foreman, T. R. Payne, and D. J. Wilbur. 1977. *Acute and chronic toxicity of chlordane to fish and invertebrates*, EPA-600/3-77-019. U.S. Environmental Protection Agency, Duluth, Minn.

Carlson, A. R. and P. A. Kosian. 1987. Toxicity of chlorinated benzenes to fathead minnow s (*Pimephales promelas*). *Arch. Environ. Contam. Toxicol.* 16:129–135.

Carlson, A. R. et al. 1982. *Cadmium and endrin toxicity to fish in waters containing mineral fibers*, EPA-600/3-82-053. U.S. Environmental Protection Agency, Duluth, Minn.

Chandler, J. H. Jr., and L. L. Marking. 1979. Toxicity of fishery chemicals to the Asiatic clam , *Corbicula manilensis*. *Prog. Fish-Cult.* 41:148–151.

Chapman, G. A., S. Ota, and F. Recht. n.d. *Effects of water hardness on the toxicity of metals to Daphnia magna*. U.S. Environmental Protection Agency, Corvallis, Oregon.

Cleveland, L., E. E. Little, S. J. Hamilton, D. R. Buckler, and J. B. Hunn. 1986. Interactive toxicity of aluminum and acidity to early life stages of brook trout. *Trans. Amer. Fish. Soc.* 115:610–620.

Conway, H. L. 1977. Sorption of arsenic and cadmium and their effects on growth, micronutrien t utilization, and photosynthetic pigment composition of *Asterionella formosa*. *J. Fish. Res. Board Can.* 35:26–294.

Couture, P., C. Blaise, D. Cluis, and C. Bastien. 1989. Zirconium toxicity assessment using bacteria, algae and fish assays. *Water Air Soil Pollut.* 47:87–100.

Cowell, B. C. 1965. The effects of sodium arsenite and sile x on the plankton populations in farm ponds. *Trans. Am. Fish. Soc.* 94:371–377.

Cowgill, U. M., I. T. Takahashi, and S. L. Applegath. 1985. A comparison of the effect of fou r benchmark chemicals on *Daphnia magna* and *Ceriodaphnia dubia affinis* tested at two different temperatures. *Environ. Toxicol. Chem.* 4:415–422.

Cowgill, U. M. and D. P. Milazzo. 1991. The sensitivity of *Ceriodaphnia dubia* and *Daphnia magna* to seven chemicals utilizing the three-bood test. *Arch. Environ. Contam. Toxicol.* 20:211–217.

Cushman, R. M., S. G. Hildebrand, R. H. Strand, and R. M. Anderson. 1977. *The toxicity of 35 trace elements in coal to freshwater biota: a data base with automated retrieval capabilities*. ORNL/TM-5793. Oak Ridge National Laboratory.

Dave, G. 1984a. Effects of copper on growth, reproduction, survival and haemoglobin in *Daphnia magna*. *Comp. Biochem. Physiol.* 78C:439–443.

Dave, G. 1984b. Effects of fluorid e on growth, reproduction, and survival in *Daphnia magna*. *Comp. Biochem. Physiol.* 78C:425–431.

Dave, G. 1984c. Effects of waterborne iron on growth, reproduction, survival and haemoglobin i n *Daphnia magna*. *Comp. Biochem. Physiol.* 78C:433–438.

Davies, P. H., J. P. Goettl, Jr., and J. R. Sinley. 1978. Toxicity of silver to rainbow trout (*Salmo gairdneri*). *Water Res.* 12:113–117.

Davies, P. H., J. P. Goettl, Jr., J. R. Sinley, and Smith. 1976. Acute and chronic toxicity of lead t o rainbow trout *Salmo gairdneri*, in hard and soft water. *Water Res.* 10:199–206.

Dawson, G. W., A. L. Jennings, D. Drozdowski, and E. Rider. 1977. The Acute toxicity of 47 Indistrial chemicals to fresh and saltwater fishes. *J. Hazard. Mater.* 1:303–318.

DeFoe, D. L., G. D. Veith, and R. L. Carlson. 1978. Effects of Aroclor 1248 and 1260 on the fathead minnow (*Pimephales promelas*). *J. Fish. Res. Board Can.* 7:997–1002.

DeFoe, D. L. 1982. *Arsenic (V) Test Results.* U.S. EPA, Duluth, MN (Memo to R. L. Spehar, U.S. EPA, Duluth, MN).

DeGraeve, G. M., D. L. Geiger, J. S. Meyer, and H. L. Bergman. 1980. Acute and embryo-larva l toxicity of phenolic compounds to aquatic biota. *Arch. Environ. Contam. Toxicol.* 9:557–568.

DeGraeve, G. M., R. G.Elder, D. C.Woods, and H.L.Bergman. 1982. Effects of naphthalene an d benzene on fathead minnows and rainbow trout. *Arch. Environ. Contam. Toxicol.* 11:487–490.

Devlin, E. W., J. D. Brammer, and R. L. Puyear. 1982. Acute toxicity of toluene to three age groups of fathead minnows (*Pimephales promelas*). *Bull. Enviorn. Contam. Toxicol.* 29:12–17.

Dill, D. C., W. M. McCarthy, H. C. Alexander, and E. A. Bartlett. 1980. *Toxicity of 1,1-Dichloroethylene (Vinylidene chloride) to aquatic organisms.* Ecol. Res. Ser., EPA-600/3-80-057, Environ. Res. Lab., U.S. EPA, Duluth, MN.

Dill, D. C., P. G. Murphy, and M. A. Mayes. 1987. Toxicity of methylene chloride to life stages of the fathead minnow, *Pimephales promelas* Rafinesque. *Bull. Environ. Contam. Toxicol.* 39:869–876.

Ding, S. R. 1980. Acute Toxicities of vanadium, nickel, and cobalt to several species of aquati c organisms. *Environ. Qual.* 1:17–21.

Dominguez, S. E. and G. A. Chapman. 1984. Effect of pentachlorophenol on the growth and mortality of embryonic and juvenile steelhead trout. *Arch. Environ. Contam. Toxicol.* 13:739–743.

Dwyer, W. P., F. L. Mayer, J. L. Allen, and D. R. Buckler. 1978. Chronic and simulated use-patter n exposures of brook trout (*Salvelinus fontinalis*) to 3-trifluoromethyl-4-nitrophenol (TFM). *Investigations in Fish Control.* 84:1–6.

Eaton, J. G. 1974. Chronic cadmium toxicity to the bluegill (*Lepomis macrochirus* Rafinesque). *Trans. Am. Fish. Soc.* 103:729–735.

Elnabarawy, M. T., A. N. Welter, and R. R. Robideau. 1986. Relative sensitivity of three daphni d species to selected organic and inorganic chemicals. *Environ. Toxicol. Chem.* 5:393–398.

EPA. (n.d.). AQUIRE: Aquatic Information Retrieval Toxicity Data Base. National Technical Information Service, Springfield, Va.

EPA. 1978. *In-depth studies on health and environmental impacts of selected water pollutants.* Contract No. 68-01-4646, U. S. EPA, Duluth, MN (also known as C. E. Stephan's Table of Data).

EPA. 1980a. *Ambient water quality criteria for acenaphthene.* EPA 440/5-80-015. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980b. *Ambient water quality criteria for antimony.* EPA 440/5-80-020. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980c. *Ambient water quality criteria for benzidene.* EPA 440/5-80-023. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980d. *Ambient water quality criteria for benzene.* EPA 440/5-80-018. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980e. *Ambient water quality criteria for benzidene.* EPA 440/5-80-023. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980f. *Ambient water quality criteria for beryllium.* EPA 440/5-80-024. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980g. *Ambient water quality criteria for cadmium.* EPA 440/5-80-025. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980h. *Ambient water quality criteria for carbon tetrachloride.* EPA 440/5-80-026. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980i. *Ambient water quality criteria for chlordane.* EPA 440/5-80-027. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980j. *Ambient water quality criteria for chlorinated benzenes.* EPA 440/5-80-028. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980k. *Ambient water quality criteria for chlorinated ethanes.* EPA 440/5-80-029. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980l. *Ambient water quality criteria for chloroform.* EPA 440/5-80-033. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980m. *Ambient water quality criteria for DDT.* EPA 440/5-80-038. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980n. *Ambient water quality criteria for dichloroethylenes.* EPA 440/5-80-041. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980o. *Ambient water quality criteria for dichloropropane and dichloropropene.* EPA 440/5-80-043. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980p. *Ambient water quality criteria for ethylbenzene*. EPA 440/5-80-048. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980q. *Ambient water quality criteria for fluoranthene*. EPA 440/5-80-049. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980r. *Ambient water quality criteria for heptachlor*. EPA 440/5-80-052. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980s. *Ambient water quality criteria for hexachlorocyclohexane*. EPA 440/5-80-054. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980t. *Ambient water quality criteria for naphthalene*. EPA 440/5-80-059. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980u. *Ambient water quality criteria for nitrophenols*. EPA 440/5-80-063. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980v. *Ambient water quality criteria for phenol*. EPA 440/5-80-066. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980w. *Ambient water quality criteria for phthalate esters*. EPA 440/5-80-067. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980x. *Ambient water quality criteria for polychlorinated biphenyls*. EPA 440/5-80-068. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980y. *Ambient water quality criteria for silver*. EPA 440/5-80-071. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980z. *Ambient water quality criteria for beryllium*. NTIS, Springfield, Virginia.

EPA. 1980aa. *Ambient water quality criteria for tetrachloroethylene*. EPA 440/5-80-073. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980bb. *Ambient water quality criteria for thallium*. EPA 440/5-80-074. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980cc. *Ambient water quality criteria for toluene*. EPA 440/5-80-075. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980dd. *Ambient water quality criteria for trichloroethylene*. EPA 440/5-80-077. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1980ee. *Ambient water quality criteria for nitrosamines*. EPA 440/5-80-064. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1984a. *Ambient water quality criteria for cadmium - 1984*. EPA 440/5-84-032. U.S. Environmental Protection Agency, Washington , D. C.

EPA. 1985a. *Ambient water quality criteria for ammonia - 1984.* EPA 440/5-85-001. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1985b. *Ambient water quality criteria for arsenic - 1984.* EPA 440/5-84-033. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1985c. *Ambient water quality criteria for chromium - 1984.* EPA 440/5-84-029. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1985d. *Ambient water quality criteria for copper - 1984.* EPA 440/5-84-031. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1985e. *Ambient water quality criteria for cyanide - 1984.* EPA 440/5-84-030. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1985f. *Ambient water quality criteria for lead - 1984.* EPA 440/5-84-027. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1985g. *Ambient water quality criteria for mercury - 1984.* EPA 440/5-84-026. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1986a. *Ambient water quality criteria for nickel - 1986.* EPA 440/5-86-004. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1986b. *Quality criteria for water.* EPA 440/5-86-001. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1987a. *Ambient water quality criteria for selenium, 1987.* EPA 440/5-87-006. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1987b. *Ambient water quality criteria for zinc, 1987.* EPA 440/5-87-003. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1988a. *Ambient water quality criteria for aluminum - 1988.* EPA 440/5-86-008. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1988b. *Ambient water quality criteria for antimony(III).* Draft. August 30th, 1988. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1992. *Great Lakes Water Quality Initiative Tier II water quality values for protection of aquatic life in ambient water. Support documents.* November 23, 1992.

EPA. 1993a. Water quality guidance for the Great Lakes System and correction; Proposed rules . *Federal Register.* 58(72):20802-21047.

EPA. 1993b. *Sediment quality criteria for the protection of benthic organisms - acenaphthene.* EPA-822-R-93-013. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1993c. *Sediment quality criteria for the protection of benthic organisms - fluoranthene.* EPA-822-R-93-012. U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1993d. *Great Lakes Water Quality Initiative Criteria documents for the protection of aquatic life in ambient water (February 1993 Draft).* PB93-154656. National Technical Information Service. Springfield, VA.

Erben, R. and Z. Pisl. 1993. Acute toxicity for some evaporating aromatic hydrocarbons for freshwater snails and crustacenas. *Int. Rev. Gesamten Hydrobiol.* 78:161–167.

Ernst, W. R. and E. T. Garside. 1987. Lethal effects of vanadium to two life stages of brook trout *Salvelinus fontinalis*. *Can. J. Zool.* 65:628–634.

Ewald, W. G., J. E. French, and M. A. Champ. 1976. Toxicity of Polychlorinated Biphenyls (PCBs) to *Euglena gracilis*: Cell Population Growth, Carbon Fixation, Chlorophyll Level, Oxygen Consumption, and Protein and Nucleic Acid Synthesis. *Bull. Environ. Contam. Toxicol.* 16:71–80.

Ewell, W. S., J. W. Gorsuch, R. O. kringle, K. A. Robillard, and R. C. Spiegel. 1986. Simultaneous evaluation of the acute effects of chemicals on seven aquatic speices. *Environ. Toxicol. Chem.* 5:831–840.

Fargasova, A. 1994. Toxicity of metals on *Daphnia magna* and *Tubifex tubifex*. *Ecotoxicol. Environ. Saf.* 27:210–213.

Finlayson, B. J., and K. M. Verrue. 1985. Toxicities of butoxyethanol ester and propylene glycol butyl ether ester formulations of 2,4-dichlorophenoxy acetic acid (2,4-D) to juvenile salmonids. *Arch. Environ. Contam. Toxicol.* 14:153–160.

Francis, P. C., D. W. Grothe, and J. C. Scheuring. 1986. Chronic toxicity of 4-nitrophenol to *Daphnia magna Straus* under static-renewal and flow-through conditions. *Bull. Environ. Contam. Toxicol.* 36:730–737.

Geiger, J. G. and A. I. Buikema, Jr. 1982. Hydrocarbons depress growth and reproduction of *Daphnia pulex* (Cladocera). *Can. J. Fish. Aquati. Sci.* 39:830–836.

Geiger, D. L., C. E. Northcott, D. J. Call, and L. T. Brooke. 1985. *Acute toxicities of organic chemicals to fathead minnows* (*Pimephales promelas*), Vol. 2. Center for Lake Superior Environmental Studies, University of Wisconsin, Superior, WI.

Geiger, D. L., D. J. Call, and L. T. Brooke. 1988. *Acute toxicities of organic chemicals to fathead minnows* (*Pimephales promelas*), Vol. 4. Center for Lake Superior Environmental Studies, University of Wisconsin, Superior, WI.

Geiger, D. L., L. T. Brooke, and D. J. Call. 1990. *Acute toxicities of organic chemicals to fathead minnows* (*Pimephales promelas*), Vol. 5. Center for Lake Superior Environmental Studies, University of Wisconsin, Superior, WI.

Geiger, D. L., S. H. Poirier, L. T. Brooke, and D. J. Call. 1986. *Acute toxicities of organic chemicals to fathead minnows* (*Pimephales promelas*), Vol. 3. Center for Lake Superior Environmental Studies, University of Wisconsin, Superior, WI.

Gersich, F. M. 1984. Evaluation of a static renewal chronic toxicity test method for *Daphnia magna* straus using boric acid. *Environ. Toxicol. Chem.* 3:89–94.

Glassi, S., M. Mingazzini, L. Vigano, D. Cesareo, and M. L. Tosato. 1988. Approaches to modelin g toxic responses of aquatic organisms to aromatic hydrocarbond. *Ecotoxicol. Enviornn. Saf.* 16:158–169.

Goettl, J. P., Jr. and P. H. Davies. 1976. Water pollution studies. Federal Aid Project F-33-R-11 . Department of Natural Resources, Colorado Division of Wildlife.

Hamelink, J. L., D. R. Buckler, f. L. Mayer, D. U. Palawski, and H. O. Sanders. 1986. Toxicity o f fluoridone to aquatic invertebrates and fish. *Environ. Toxicol. Chem.* 5:97–94.

Hamilton, S. J. 1995. Hazard assessment of inorganics to three endangered fish in the Green River , Utah. *Ecotoxicol. Environ. Saf.* 30:134–142.

Hamilton. S. J. and K. J. Buhl. 1990. Safety assessment of selected inorganic elements to fry of chinook salmon (*Oncorhynchus tshawytscha*). *Ecotoxicol. Enviorn. Saf.* 20:307–324.

Hannah, J. B., J. E. Hose, M. L. Landolt, B. S. Miller, S. P. Felton, and W. T. Iwaoko. 1982 . Benzo(a)pyrene-induced morphologic and developmental abnormalities in rainbow trout. *Arch. Environ. Contam. Toxicol.* 11:727–734.

Hazel, C. R. and S. J. Meith. 1970. Bioassay of king salmon eggs and sac fry in copper solutions. *Calif. Fish Game.* 2:121–124.

HECD (Health and Criteria Division). 1992. *Interim guidance on interpretation and implementation of aquatic life criteria for metals.* U.S. Environmental Protection Agency, Washington, D.C.

Hermanutz, R. O., R. H. Mueller, and K. D. Kempfer. 1973. Captan toxicity to fathead minnow s (*Pimephales promelas*), bluegills (*Lepomis macrochirus*), and brook trout (*Salvelinus fontinalis*). *J. Fish. Res. Board Can.* 30:1811–1817.

Hodson, P. V., R. Parisella, B. Blunt, B. Gray, K. L. E. Kaiser. 1991. *Quantitative structure-activity relationships for chronic toxicity of phneol, p-chlorophenol, 2,4-dichlorophenol, pentachlorophenol, p-nitrophenol, and 1,2,4-trichlorobenzene to early life stages of rainbow trout* (*Oncorhynchus mykiss*). Can. Tech. Rep. Fish. Aquat. Sci. 1784.

Hodson, P. V., D. G. Dixon, and K. L. E. Kaiser. 1984. Measurement of median lethal dose as a rapid indication of contaminant toxicity to fish. *Environ. Toxicol. Chem.* 3:243–254.

Holcombe, G. W., D. A. Benoit, E. N. Leonard, and J. M. McKim. 1976. Long term effects of lea d exposure on three generations of brook trout (*Salvelinus fontinalis*). *J. Fish. Res. Board Can.* 33:1731–1741.

Holcombe, G. W., G. L. Phipps, and J. T. Fiandt. 1982. Effects of phenol, 2,4-dimethylphenol,2,4 - dichlorophenol, and pentachlorophenol on embryo, larval, and early-juvenile fathead minnow s (*Pimephales promelas*). *Arch. Environ. Contam. Toxicol.* 11(1):73–78.

Holcombe, G. W., G. L. Phipps, and J. T. Fiandt. 1983. Toxicity of selected priority pollutants t o various aquatic organisms. *Ecotoxicol. Environ. Saf.* 7400–7409.

Holcombe, G. W., G. L. Phipps, M. L. Knuth, and T. Felhaber. 1984. The acute toxicity of selected substituted phenols, benzenes and benzoic acid esters to fathead minnows *Pimephales promelas*. *Environ. Pollut. Ser. A Ecol. Biol.* 35:367–381.

Holdway, D. A. and J. B. Sprague. 1979. Chronic toxicity of vanadium to flagfish. *Water Res.* 13:905–910.

Holman, W. F., and K. J. Macek. 1980. An aquatic safety assessment of linear alkylbenzsulfonate (LAS): chronic effects on fathead minnows. *Trans. Am. Fish. Soc.* 109:122–131.

Holst, L. L. and J. P. Giesy. 1989. Chronic effects of the photoenhanced toxicity of anthracene on *Daphnia magna* reproduction. *Environ. Toxicol. Chem.* 8:933–942.

Howe, G. E., L. L. marking, T. D. Bills, J. J. Rach, and F. L. Mayer, Jr. 1994. Effects of water temperature and pH on toxicity of terbufos, trichlorfon, 4-nitrophenol and 2,4-dinitrophenol to the amphipod *Gammarus pseudolimnaeus* and rainbow trout (*Onchorhynchus mykiss*). *Environ. Toxicol. Chem.* 13:51–56.

Ingersoll, C. G. et al. 1990a. Aluminum and acid toxicity to two strains of brook trout (*Salvelinus fontinalis*). *Can. J. Fish. Aquat. Sci.* 47:1641–1648.

Ingersoll, C. G. et al. 1990b. Effects of pH, aluminum, and calcium on survival and growth of eggs and fry of brook trout (*Salvelinus fontinalis*). *Can. J. Fish. Aquat. Sci.* 47:1580–1592.

Jarvinen, A. W., M. J. Hoffman, and T. W. Thorslund. 1977. Long-term toxic effects of DDT food and water exposure on fathead minnows (*Pimephales promelas*). *J. Fish. Res. Board Can.* 34:2089–2103.

Jarvinen, A. W., B. R. Nordling, and M. E. Henry. 1983. Chronic toxicity of dursban (chlorpyrifos) to the fathead minnow (*Pimephales promelas*) and the resultant acetylcholinesterase inhibition. *Ecotoxicol. Environ. Safety*. 7:423–434.

Johnson, W. W. and M. T. Finley. 1980. *Handbook of acute toxicity of chemicals to fish and aquatic invertebrates*. Resour. Publ. 137, Fish Wildl. Serv., U.S. D.I., Washington, D.C.

Johnston, P. A. 1987. Acute toxicity of inorganic selenium to *Daphnia magna* (Straus) and the effect of sub-acute exposure upon growth and reproduction. *Aquat. Toxicol.* 10:335–352.

Karlander, E. P. and R. W. Krauss. 1972. Absorption and toxicity of beryllium and lithium in *Chlorella vannielii* Shihira and Krauss. *Chesapeake Science*. 13:245–253.

Kauss, P. B. and T. C. Hutchinson. 1975. The effects of water-soluble petroleum components on the growth of *Chlorella vulgaris* Beijerinck. *Environ. Pollut.* 9:157–174.

Keen, R., and C. R. Baillod. 1985. Toxicity to *Daphnia* of the end products of wet oxidation of phenol and substituted phenol. *Water Res.* 19:767–772.

Khangarot, B. S. 1991. Toxicity of metals to a freshwater tubificid worm, *Tubifex tubifex*. *Bull. Environ. Contam. Toxicol.* 46:906–912.

Khangarot, B. S., A. Sehgal, and M. K. Bhasin. 1985. Man and biosphere--Studies on the Sikki m Himalayas. Part 5: Acute toxicity of selected heavy metals on the tadpoles of *Rana hexadactyla*. *Acta Hydrochim. Hydrobiol.* 13:259–263.

Kimball, G. n.d. The effects of lesser known metals and one organic to fathead minnows [*Pimephales promelas*] and *Daphnia magna*. U.S. Environmental Protection Agency, Duluth, MN.

Kleiner, C. F., R. L. Anderson, and D. K. Tanner. 1984. Toxicity of fenitrothion to fathead minnow s (*Pimephales promelas*) and alternate exposure duration studies with fenitrothion and endosulfan. *Arch. Environ. Contam. Toxicol.* 13:573–578.

Koenst, W. M., L. L. Smith, Jr., and S. J. Broderius. 1977. Effect of chronic exposure of brook trout to sublethal concentrations of hydrogen cyanide. *Environmental Science and Technology* 11:883–886.

Könemann, H. 1981. Quantitative structure-activity relationships in fish toxicity studies. Part 1 : Relationship for 50 industrial pollutants. *Toxicology.* 19:209–221.

Kouyoumjian, H. H. and R. F. Uglow. 1974. Some aspects of the toxicity of p,p'-DDT, p,p'-DDE and p,p'-DDD to the freshwater planarian *Polycelis felina* (Tricladida). *Environ. Pollut.* 7:103–109.

Krishnakumari, M. K. 1977. Sensitivity of the alga *Scenedesmus acutus* to some pesticides. *Life Sciences*. 20:1525–1532.

Kszos, L. A., A. J. Stewart, and P. A. Taylor. 1992. An evaluation of nickel toxicity to *Ceriodaphnia dubia* and *Daphnia magna* in a contaminated stream and in laboratory tests. *Environ. Toxicol. Chem.* 11:1001–1012.

Kühn, R., M. Pattard, K. Pernak, and A. winter. 1989. Results of the harmful effects of selected water pollutants (anilines, phenol, aliphatic compounds) to *Daphnia magna*. *Water Res.* 23:495–499.

Kühn, R., M. Pattard, K. Pernak, and A. Winter. 1989 . Results of the harmful effects of water pollutants to *Daphnia magna* in the 21 day reproduction test. *Water Res.* 23:501–510.

Larsson, L. and J. Tillberg. 1975. Effects of the Commercia l Polychlorinated Biphenyl Mixture Aroclor 1242 on Growth, Viability, Phosphate Uptake, Res piration and Oxygen Evolution in *Scenedesmus*. *Physiol. Plant* 33:256–260.

Lazareva, L. P. 1985. Changes in biological characteristics of *Daphnia magna* from chronic action of copper and nickel at low concentrations. *Hydrobiol. J.* 21(5):59–62.

LeBlanc, G. A. 1980. Acute toxicity of priority pollutants to water flea (*Daphnia magna*). *Bull. Environ. Contam. Toxicol.* 24:684–691.

LeBlanc, G. A. and D. C. Surprenant. 1983. The acute and chronic toxicity of acetone, dimethy l formamide, and triethylene glycol to *Daphnia magna* (Straus). *Arch. Environ. Contam. Toxicol.* 12:305–310.

LeBlanc, G. A., J. D. Mastone, A. P. Paradice, B. F. Wilson, H. B. Lockhart, Jr., and K. A. Robillard. 1984. The influence of speciation on the toxicity of silver to fathead minnow (*Pimephales promelas*). *Environ. Toxicol. Chem.* 3:37–46.

Leduc, G. 1978. Deleterious effects of cyanide on early life stages of atlantic salmon (*Salmo salar*). *J. Fish. Res. Board Can.* 35:166–174.

Lewis, M. A. and L. C. Valentine. 1981. Acute and chronic toxicities of boric acid to *Daphnia magna* Straus. *Bull. Environ. Contam. Toxicol.* 27:309–315.

Lima, A. R. et al. 1984. Acute and chronic toxicities of arsenic (III) to fathead minnows, flagfish, daphnids, and an amphipod. *Arch. Environ. Contam. Toxicol.* 13:595–601.

Lind, D., K. Alto, and S. Chatterton. 1978. *Regional copper-nickel study; aquatic toxicology study.* Minnesota Environmental Quality Board.

Lock, R. A. C. and A. P. van Overbeeke. 1981. Effects of mercuric chloride and methylmercuric chloride on mucus secretion in rainbow trout, *Salmo gairdneri* Richardson. *Comp. Biochem. Physiol.* 69C:67–74.

Luard, E. J. 1973. Sensitivity of *Dunaliella* and *Scenedesmus* (*Chlorphyceae*) to Chlorinated hydrocarbons. *Phycologia* 12:29–33.

Macek, K. J., K. S. Buxton, S. K. Derr, J. W. Dean, and S. Sauter. 1976a. *Chronic toxicity of lindane to selected aquatic invertebrates and fish.* EPA-600/3-76-046. U.S. Environmental Protection Agency, Duluth, Minn.

Macek, K. J., M. A. Lindberg, S. Sauter, K. Buxton, and P. A. Costa. 1976b. *Toxicity of four pesticides to water fleas and fathead minnows.* EPA-600/3-76-099. U.S. Environmental Protection Agency, Duluth, Minn.

McCarthy, J. F. and D. K. Whitmore. 1985. Chronic toxicity of di-n-butyl and di-n-octyl phthalate to *Daphnia magna* and the fathead minnow. *Environ. Toxicol. Chem.* 4:167–179.

McCauley, D. J., L. T. Brooke, D. J. Call, and C. A. Lindberg. 1986. *Acute and chronic toxicity of aluminum to* <u>Ceriodaphnia dubia</u> *at various pH's.* Center for Lake Superior Environmental Studies, University of Wisconsin-Superior, Superior, Wis.

McKim, J. M., and D. A. Benoit. 1971. Effects of long-term exposures to copper on survival, growth, and reproduction of brook trout (*Salvelinus fontinalis*). *J. Fish. Res. Board Can.* 28:655–662.

McKim, J. M., G. F. Olson, G. W. Holcombe, and E. P. Hunt. 1976. Long-term effects of methylmercuric chloride on three generations of brook trout (*Salvelinus fontinalis*): toxicity, accumulation, distribution, and elimination. *J. Fish. Res. Board Can.* 33:2726–2739.

Martin, T. R. and D. M. Holdich. 1986. The Acute lethal toxicity of heavy metals to peracarid crustaceans (with particular reference to fresh-water Asellids and Gammarids). *Water Res.* 20:1137–1147.

Mattson, V. R., J. W. Arthur, and C. T. Walbridge. 1976. *Acute toxicity of selected organic compounds to fathead minnows*. Ecol. Res. Ser. EPA-600/3-76-097, Environ. Res. Lab., U.S. EPA, Duluth, MN.

Mauck, W. L., P. M. Mehrle, and F. L. Mayer. 1978. Effects of the polychlorinated biphenyl Aroclor ® 1254 on growth, survival, and bone development in brook trout (*Salvelinus fontinalis*). *J. Fish. Res. Board Can.* 35:1084–1088.

Mayer, F. L., Jr., P. M. Mehrle, Jr., and W. P. Dwyer. 1975. *Toxaphene effects on reproduction, growth and mortality of brook trout.* EPA-600/3-75-013. U. S. Environmental Protection Agency, Duluth, Minn.

Mayer, F. L., Jr., P. M. Mehrle, H. O. Sanders. 1977. Residue dynamics and biological effects of polychlorinated biphenyls in aquatic organisms. *Arch. Environ. Contam. Toxicol.* 5:501–511.

Mayer, F. L., Jr., and H. O. Sanders. 1973. Toxicology of phthalic acid esters in aquatic organisms. *Environmental Health Perspectives* 5:153–157.

Mayer, F. L., Jr. and M. R. Ellersieck. 1986. *Manual of acute toxicity: interpretation and data base for 410 chemicals and 66 species of freshwater organisms*. Resource Publication 160. U.S. Fish and Wildlife Service, Washington, D.C.

Mayes, M. A., H. C. Alexander, D. L. Hopkins, P. B. Latvaitis. 1986. Acute and chronic toxicity of ammonia to freshwater fish: a site-specific study. *Environ. Toxicol. Chem.* 5:437–442.

Mehrle, P. M., and F. L. Mayer. 1976. Di-2-ethylhexyl phthalate: residue dynamics and biological effects in rainbow trout and fathead minnows. *Trace Subst. Env. Health* 10:519–524.

Millemann, R. E., W. J. birge, J. A. Black, R. M. Cushman, K. L. Daniels, P. J. Franco, J. M. Giddings, J. F. McCarthy, and A. J. Stewart. 1984. Comparative acute toxicity to aquatic organisms of components of coal-derived synthetic fuels. *Trans. Am. Fish. Soc.* 113:74–85.

Moles, A., S. D. Rice, and S. Korn. 1979. Sensitivity of Alaskan freshwater and anadromous fishes to Prudhoe Bay crude oil and benzene. *Trans. Am. Fish. Soc.* 108:408–414.

Mount, D. I. 1968. Chronic toxicity of copper to fathead minnows (*Pimephales promelas* Rafinesque). *Water Res.* 2:215–223.

Mount, D. I. 1982. Memorandum to Charles E. Spehar. U.S. Environmental Protection Agency, Duluth, Minn. June 7.

Mount, D. I., and C. E. Stephan. 1969. Chronic toxicity of copper to the fathead minnow (*Pimephales promelas*) in soft water. *J. Fish. Res. Board Can.* 26:2449–2457.

Munoz, M. J. and J. V. Tarazona. 1993. Synergistic effect of two- and four-component combinations of the polycyclic aromatic hydrocarbons: Phenanthrene, anthracene, naphthalene and acenapthene on *Daphnia magna*. *Bull. Enviorn. Contam. Toxicol.* 50:363–368.

Münzinger, A. 1990. Effects of nickel on *Daphnia magna* during chronic exposure and alterations in the toxicity to generations pre-exposed to nickel. *Wat. Res.* 24:845–852.

Nebeker, A. V., C. K. McAuliffe, R. Mshar, and D. G. Stevens. 1983. Toxicity of silver to steelhead and rainbow trout, fathead minnows, and *Daphnia magna*. *Environ. Toxicol. Chem.* 2:95–104.

Nebeker, A. V., C. Savonen, R. J. Baker, J. K. McCrady. 1984. Effects of copper, nickel, and zinc on the life cycle of the caddisfly *Clistoronia magnifica* (Limnephilidae). *Environ. Toxicol. Chem.* 3:645–649.

Nebeker, A. V., C. Savonen, and D. G. Stevens. 1985. Sensitivity of rainbow trout early life stages to nickel chloride. *Environ. Toxicol. Chem.* 4:233–239.

Nebeker, A. V., and F. A. Puglisi. 1974. Effect of polychlorinated biphenyls (PCBs) on survival and reproduction of *Daphnia*, *Gammarus*, and *Tanytarsus*. *Trans. Am. Fish. Soc.* 103:722–728.

Nebeker, A. V., F. A. Puglisi, and D. L. DeFoe. 1974. Effect of polychlorinated biphenyl compounds on survival and reproduction of the fathead minnow and flagfish. *Trans. Am. Fish. Soc.* 103:562–568.

Oris, J. T., J. P. Giesy Jr. 1985. The pho toenhanced toxicity of anthracene to juvenile sunfish (*Lepomis* sp.). *Aquat. Toxicol.* 6:133–146.

Oseid, D. M., L. L. Smith Jr. 1979. The effects of hydrogen cyanide on *Asellus communis* and *Gammarus pseudolimnaeus* and changes in their competitive response when expose d simultaneously. *Bull. Environ. Contam. Toxicol.* 21:439–447.

OSWER (Office of Solid Waste and Emergency Response). 1996. Ecotox thresholds. *ECO Update* 3 (2):1–12.

Palawski, D., J. B. Hunn, and F. J. Dwyer. 1985. Sensitivity of young striped bass to organic an d inorganic contaminants in fresh and saline waters. *Trans. Am. Fish. Soc.* 114:748–753.

Parkhurst, B. R., R. G. Elder, J. S. Meyer, D. A. Sanchez, R. W. Pennak, and W. T. Waller. 1984. An environmental hazard evaluation of uranium in a R ocky Mountain stream. *Environ. Toxicol. Chem.* 3:113–124.

Passino, D. R. M. and A. J. Novak. 1984. Toxicity of Arsenate and DDT to the Cladoceran *Bosmina logirostris*. *Bull. Environ. contam. Toxicol.* 33:325–329.

Passino, D. R. M. and J. M. Kramer. 1980. Toxicity of arsenic and PCBs to fry of deepwater ciscoes (Coregonus). *Bull. Environ. Contam. Toxicol.* 24:527–534.

Passino, D. R. M and S. B. Smith. 1987. Acute bioassays and hazard evaluation of representativ e contaminants detected in Great Lakes fish. *Enviorn. Toxicol. Chem.* 6:901–907.

Phipps, G. L., G. W. Holcombe, and J. T. Fiandt. 1981. Acute toxicity of phenol and substituted phenols to the fathead minnow. *Bull. Environ. Contam. Toxicol.* 26:585–593.

Pickering, Q. H. 1974. Chronic toxicity of nickel to the fathead minnow and flagfish. *Trans. Am. Fish. Soc.* 103:562–568.

Pickering, Q. H. 1980. Chronic toxicity of hexavalent chromium to the fathead minnow (*Pimephales promelas*). *Arch. Environ. Contam. Toxicol.* 9:405–413.

Pickering, Q. H. and C. Henderson. 1966. Acute toxicity of some important petrochemicals to fish. *J. Water Pollut. Control Fed.* 38:1419–1429.

Pickering, Q. H. and M. H. Gast. 1972. Acute and chronic toxicity of cadmium to the fathead minnow (*Pimephales promelas*). *J. Fish. Res. Board Can.* 29:1099–1106.

Pickering, Q. H. and W. T. Gilliam. 1982. Toxicity of aldicarb and fonofos to the early life-stage of the fathead minnow. *Arch. Environ. Contam. Toxicol.* 11:699–702.

Pickering, Q. H., and T. O. Thatcher. 1970. The chronic toxicity of linear allcylate sulfonate (LAS) to *Pimephales promelas*, Rafinesque. *J. Water Pollut. Control Fed.* 42:243–254.

Prothro, M. G. 1993. Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria. Memorandum to Water Management Division Directors and Environmental Services Division Directors, Regions I-X, October 1, 1993.

Rai, L. C., J. P. Gaur, H. D. Kumar. 1981. Protective effects of certain environmental factors on the toxicity of zinc, mercury, and methylmercury to *Chlorella vulgaris*. *Environ. Res.* 25:250–259.

Randall, T. L. and P. V. Knopp. 1980. Detoxification of specific organic substances by wet oxidation. *J. Water Pollut. Control Fed.* 52:2117–2130.

Region IV. 1995. Ecological screening values. Ecological Risk Assessment Bulletin No. 2. Waste Management Division, U.S. Environmental Protection Agency Region IV, Atlanta, GA.

Reynolds, J. H., E. J. Middlebrooks, D. B. Porcella, W. J. Grenney. 1975. Effects of temperature on oil refinery waste toxicity. *J. Water Poll. Control Fed.* 47:2674–2693.

Rhodes, J. E, W. J. Adams, G. R. Biddinger. 1995. Chronic toxicity of 14 phthalate esters to *Daphnia magna* and rainbow trout (*Oncorhynchus mykiss*). *Environ. Toxicol. Chem.* 14:1967–1976.

Richter, J. E., S. F. Peterson, and C. F. Kleiner. 1983. Acute and chronic toxicity of some chlorinated benzenes, chlorinated ethanes, and tetrachloroethylene to *Daphnia magna*. *Arch. Environ. Contam. Toxicol.* 12:679–684.

Roghair, C. J., A. Buijze, E. S. E. Yedema, and J. L. M. hermens. 1994. A QSAR for base-line toxicity to the midge *Chironomus riparius*. *Chemosphere* 28:989–997.

Sanders, H. O., 1970. Pesticide toxicities to tadpoles of the western chorus frog *Peseudacris triseriata* and flowler's toad *Bufo woodhousii fowleri*. *Copeia* 2:246–251.

Sanders, H. O. 1969. *Toxicity of pesticides to the crustacean Gammarus lacustris.* Tech. Paper No. 25, Bur. Sports Fish. Wildl., Fish Wildl. Serv., U.S.D.I.

Sanders, H. O. 1972. *Toxicity of some insecticides to four species of malacostracan crustaceans.* Tech. Paper No. 66, Bur. Sports Fish. Wildl., Fish Wildl. Serv., U.S.D.I.

Sanders, H. O., F. L. Mayer, Jr., and D. F. Walsh. 1973. Toxicity, residue dynamics, and reproductive effects of phthalate esters in aquatic invertebrates. *Environ. Res.* 6:84–90.

Sanders, H. O. and O. B. Cope. 1968. The relative toxicities of several pesticides to naiads of three species of stoneflies. *Limnol. Oceanogr.* 13:112–117.

Sadler, K. and S. Lynam. 1988. The influence of calcium on aluminum-induced changes in the growth rate and mortality of brown trout, *Salmo trutta L. J. Fish Biol.* 33:171–179.

Sauter, S., K. S. Buxton, K. J. Macek, and S. R. Petrocelli. 1976. *Effects exposure to heavy metals on selected freshwater fish.* EPA-600/3-76-105. U.S. Environmental Protection Agency, Duluth, Minn.

Seim, W. K., L. R. Curtis, S. W. Blenn, and G. A. Chapman. 1984. Growth and survival of developing steelhead trout (*Salmo gairdneri*) continuously or intermittently exposed to copper. *Can. J. Fish. Aquat. Sci.* 41:433–438.

Shubat, P. J., S. H. Poirier, M. L. knuth, and L. T. Brooke. 1982. Acute toxicity of tetrachloroethylene and tetrachloroethylene with dimethylformamide to rainbow tro ut (*Salmo gairdneri*). *Bull. Environ. Contam. Toxicol.* 28:7–10.

Sinley, J. R., J. P. Goettl, Jr., and P. H. Davies. 1974. The effects of zinc on rainbow trout (*Salmo gairdneri*) in hard and soft water. *Bull. Environ. Contam. Toxicol.* 12:193–201.

Sloff, W. 1983. Benthic macroinvertebrates and water quality assessment: Some toxicologica l considerations. *Aquat. Toxicol.* 4:73–82.

Slonim, A. R. and E. E. Ray. 1975. Acute toxicity of beryllium sulfate to salamander larvae (*Ambystoma* sp.). *Bull. Enviorn. Contam. Toxicol.* 13:307–312.

Slonim, C. B. and A. R. Slonim. 1973. Effect of water hardness on the tolerance of the guppy t o beryllium sulfate. *Bull. Environ. Contam. Toxicol.* 10:295–301.

Smith, A. D., A. Bharath, C. Mallard, D. Orr, K. Smith, J. A. S utton, J. Vukmanich, L. S. McCarthy, and G. W. Ozburn. 1991. The acute and chronic toxicity of ten chlorinated organic compounds to the American flagfish (*Jordanella floridae*). *Arch. Enviorn. Contam. Toxicol.* 20:94–102.

Smith, L. L., S. J. Broderius, D. M. Oseid, G. L. Kimball, W. M. Koenst, and D. T. Lind. 1979. *Acute and chronic toxicity of HCN to fish and invertebrates.* EPA-600/3-79-009. U.S. Environmental Protection Agency.

Smith, L. R., T. M. Holsen, N. C. Ibay, R. M. Block, and A. B. de Leon. 1985. Studies on the acute toxicity of fluoride ion to stickleback, fathead minnow, and rainbow trout. *Chemosphere* 14(9):1383–1389.

Smith, S. B., J. F. Savino, and M. A. Blouin. 1988. Acute toxicity to *Daphnia pulex* of six classes of chemical compounds potentially hazardous to Great Lakes aquatic biota. *J. Great Lakes Res.* 14:394–404.

Snarski, V. M., and G. F. Olson, 1982. Chronic tox icity and bioaccumulation of mercuric chloride in the fathead minnow (*Pimephales promelas*). *Aquat. Toxicol.* 2:143–156.

Spehar, R. L. 1976. Cadmium and zinc toxicity to flagfish, *Jordanella floridae*. *J. Fish. Res. Board Can.* 33:1939–1945.

Spehar, R. L., J. T. Fiandt, R. L. Anderson, and D. L. DeFoe. 1980. Comparative toxicity of arsenic compounds and their accumulation in invertebrates and fish. *Arch. Environ. Contam. Toxicol.* 9:53–63.

Spehar, R. L., D. K. Tanner, and B. R. Nordling. 1983. Toxici ty of the synthetic pyrethroids, permethrin, and AC 222,705 and their accumulation in early life stages of fathead minnows and snails. *Aquat. Toxicol.* 3:171–182.

Stalling, D. L. and F. L. Mayer, Jr. 1972. Toxicities of PCBs to fish and environmental residues . *Environ. Health Perspect.* 1:159–164.

Steeman-Nielsen, E. and S. Wium-Andersen. 1970. Copper ions as poison in the sea and freshwater . *Marine Biology*. 6:93–97.

Stephan, C. E. 1991. Letter to Mr. Jim Grant. Michigan Department of Natural Resources.

Stephan, C. E., D. I. Mount, D. J. Hansen, J. H. Gentile, G. A. Chapman, and W. A. Brungs. 1985 . *Guidelines for deriving numerical national water quality criteria for the protection of aquatic organisms and their uses.* PB85-227049. National Technical Information Service, Springfield, Va.

Stephan, C. E., and J. R. Rogers. 1985. Advantages of using regression analysis to calculate results of chronic toxicity tests, pp. 328-339 in *Aquatic Toxicology and Hazard Assessment: Eighth Symposium*, R. C. Bahner and D. J. Hansen (eds.), American Society for Testing and Materials , Philadelphia.

Stephan, E. E. and R. J. Erickson. n.d. *Guidelines for deriving an aquatic life pesticide concentration*. U.S. Environmental Protection Agency, Environmental Research Laboratory, Duluth, MN , unpublished document.

Stevens, D. G. and G. A. Chapman. 1984. Toxicity of trivalent chromium to early life stages o f steelhead trout. *Environ. Toxicol. Chem.* 3:125–133.

Streufert, J. M., J. R. Jones, and H. O. Sa nders. 1980. Toxicity and biological effects of phthalate esters on midges (*Chironomus plumosus*). *Trans. Mo. Acad. Sci.* 14:33–40.

Suter, G. W. II. 1989. Ecological endpoints, pp. 2-1–2-28, in *Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference Document.* EPA 600/3-89/013. W. Warren-Hicks, B. R. Parkhurst, and S. S. Baker, Jr. (eds.). Corvallis Environmental Research Laboratory, Oregon.

Suter, G. W., II, M. A. Futrell, G. A. Kerchner. 1992. *Toxicological benchmarks for screening of potential contaminants of concern for effects on aquatic biota on the Oak Ridge Reservation, Oak Ridge, Tennessee.* ORNL/ER-139. Oak Ridge National Laboratory.

Suter, G. W., II, A. E. Rosen, E. Linder, and D. F. Parkhurst. 1987. End points for responses of fish to chronic toxic exposures. *Environ. Toxicol. Chem.* 6:793–809.

Suter, G. W., II. 1992. *Ecological Risk Assessment.* Lewis Publishers, Chelsea, MI.

Suter, G. W., II, A. Redfearn, R. K. White, and R. A. Shaw. 1992. *Approach and strategy for performing ecological risk assessments for the Department of Energy Oak Ridge Field Office Environmental Restoration Program.* ES/ER/TM-33. Environmental Restoration Division, Oak Ridge National Laboratory, Oak Ridge, TN.

Thompson, R. S., and N. G. Carmichael. 1989. 1,1,1-Trichloroethane: medium-term toxicity to carp, daphnids, and higher plants. *Ecotox. Environ. Safety* 17:172–182.

Thurston, R.V., R. C. Russo, E. L. Meyn, and R. K. Zajdel. 1986. Chronic toxicity of ammonia t o fathead minnows. *Trans. Amer. Fish. Soc.* 115:196–207.

Trucco, R. G., F. R. Engelhardt, an d B. Stacey. 1983. Toxicity, accumulation and clearance of aromatic hydrocarbons in *Daphnia pulex. Environ. Pollut. Ser. A. Ecol. Biol.* 31:191–202.

van den Dikkenberg, R. P., H. H. Canton, L. A. M. Mathijssen-Spiekman, and C. J. Roghair. 1989. *The usefulness of gasterosteus aculeatus-the three-spined stickleback-as a test organism in routine toxicity testing.* Rep. No. 718625003, Natl. Inst. Public Health Environ. Protection, Bilthoven, the Netherlands.

Van der Schalie, W. H. 1983. *The acute and chronic toxicity of 3,5-dinitroaniline, 1,3-dinitrobenzene, and 1,3,5-trinitrobenzene to freshwater aquatic organisms.* Technical Report 8305. U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, Frederick, MD.

Van Leeuwen, C. J. and H. Maas. 1985. The aquatic toxicity of 2,6-dichlorobenzamide (BAM), a degradation product of the herbicide dichlobenil. *Environ. Pollut. Ser. A.* 37:105–115.

Van Leeuwen, C. J., J. L. Maas-Diepeveen, G. Niebeek, W. H A. Vergouw, P. S. Griffioen, and M. W. Luijken. 1985. Aquatic toxicological aspects of dithiocarbamates and related compounds. I. Short-term toxicity tests. *Aquat. Toxicol.* 7:145–164.

Vareille-Morel, C. and J. Debord. 1990. Sensibil ité du Mollusque prosobranche *Potamopyrgus jenkinsi* Smith à l'action de chlorures métalliques ($ZnCl_2$, $BaCl_2$, $CuCl_2$)et d'un molluscicide de synthèse, la N-tributyl-morpholine. *Ann Rech. Vét.* 21:111-118.

Veith, G. D., D. J. Call, L. T. Brooke. 1983. Estimating the acute toxicity of narcotic industria l chemicals to fathead minnows, pp. 90-97, in *Aquatic Toxicol. and Hazard Assessment: Sixth Symposium.* W. E. Bishop, R. D. Cardwell, and B. B. Heidolph (eds.), ASTM STP 802 , Philadelphia.

Veith, G. D., D. J. Call, and L. T. Brooke. 1983. Structur e-toxicity relationships for the fathead minnow, *Pimephales promelas*: narcotic industrial chemicals. *Can. J. Fish. Aquat. Sci.* 40:743–748.

Villar, D., M. H. Li, and D. J. Schaeffer. 1993. Toxicity of organophosphorus pesticides to *Dugesia dorotocephala. Bull. Environ. Contam. Toxicol.* 51:80–87.

Vincent, M., J. Debord, and B. Penicaut. 1986. Comparative studies on the toxicity of metal chlorides and of a synthetic organic molluscicide, N-trityl-Morpholine, upon two aquatic amphipods: *Gammarus pulex* and *Echinogammarus berilloni*. *Ann. Rech. Vét.* 17:441–446.

Vocke, R. W., K. L. Sears, J. J. O'Toole, R. B. Wildham. 1980. Growth responses of selected freshwater algae to trace elements and scrubber ash slurry generated by coal-fired power plants. *Water Res.* 14:141–150.

Walbridge, C. T., J. T. Fiandt, G. L. Phipps, and G. W. Holcombe. 1983. Acute toxicity of ten chlorinated aliphatic hydrocarbons to the fathead minnow (*Pimephales promelas*). *Arch. Environ. Contam. Toxicol.* 12:661–666.

Wallen, I. E., W. C. Greer, and R. Lasater. 1957. Toxicity to *Gambusia affinis* of certain pure chemicals in trubid waters. *Sewage Ind. Wastes* 29:695–711.

Ward, T. J., and R. L. Boeri. 1991a. *Early Life Stage Toxicity of Di-n-Butyl Phthalate (DnBP) to the rainbow Trout (Oncorhynchus mykiss) Under Flow-Through Conditions*. 9102-CMA. Chemical Manufacturers Association, Washington, D.C.

Waste Management Division. 1995. Ecological screening values, Ecological Risk Assessment Bulletin No. 2. U.S. Environmental Protection Agency Region IV. Atlanta, Georgia.

Williams, P.L. and D.B.Dusenbery. 1990. Aquatic toxicity testing using the nematode, *Caenorhabditis elegans*. *Environ. Toxicol. Chem.* 9:1285–1290

Woodward, D. F., A. M. Farag, M. E. Mueller, E. E. Little, F. A. Vertucci. 1989. *Sensitivity of endemic Snake River cutthroat trout to acidity and elevated aluminum. Trans. Amer. Fish. Soc.* 118:630–643.

Ziegenfuss, P. S., W. J. Renaudette, and W. J. Adams. 1986. Methodology for assessing the acute toxicity of chemicals sorbed to sediments: Testing the equilibrium partitioning theory. in T. M. Poston and R. Purdy (eds.), *Aquatic Toxicology and Environmental Fate, Ninth Volume.* ASTM, Philadelphia, PA.

Appendix A

DATA USED FOR TIER II CALCULATIONS

Table A.1. Data and calculated results for derivation of Tier II values (all values in µg/l). Requirements are listed in App. B.2; other terms are defined in the text

Compound	Genus/species	Requirement[a]	Endpoint	Concentration	GMAV[b]	A-C Ratio[c]	Reference
			INORGANICS				
Arsenic V							
	Bosmina longirostris	4	EC50	850	850		Passino and Novak, 1984
	Daphnia pulex	4	LC50	3,600	3,600		Jurewicz and Buikema, 1980
	Gambusia affinis	2,3	LC50	49,000	49,000		Jurewicz and Buikema, 1980
	Morone saxatilis	2,3	LC50	40,500			Palawski et al., 1985
	Morone saxatilis	2,3	LC50	30,500	35,150		Palawski et al., 1985
	Oncorhynchus kisutch	1	LC50	43,600			Buhl and Hamilton, 1990
	Oncorhynchus kisutch	1	LC50	58,500			Buhl and Hamilton, 1990
	Oncorhynchus mykiss	1	LC50	28,000			Palawski et al., 1985
	Oncorhynchus mykiss	1	LC50	67,500	46,860		Buhl and Hamilton, 1990
	Pimephales promelas	2,3	LC50	42,000			Palawski et al., 1985
	Pimephales promelas	2,3	LC50	25,600	32,790		DeFoe, 1982
	Pimephales promelas		CV	892		28.7	DeFoe, 1982
	Thymallus arcticus	1	LC50	5,020			Buhl and Hamilton, 1990
	Thymallus arcticus	1	LC50	5,500	5,255		Buhl and Hamilton, 1990
	Tubifex tubifex	7,8	LC50	127,360	127,360		Fargasova, 1994

Tier II Parameters	Tier II Values
FAVF	12.9
SAV	65.89
SACR	20.95
SCV	3.1

[a] The eight acute data requirements.
[b] Genus Mean Acute Value.
[c] Acute-Chronic Ratio.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Barium							
	Daphnia magna	4	LC50	410,000	410,000		LeBlanc, 1980
	Daphnia magna		EC16	5,800		70.69[a]	Biesinger and Christensen, 1972
	Echinogammarus berilloni	5	LC50	122,000	122,000		Vincent et al., 1986
	Gammarus pulex	5	LC50	238,000	238,000		Vincent et al., 1986
	Potamopyrgus jenkinsi	7,8	LC50	1,700			Vareille-Morel, 1990
	Potamopyrgus jenkinsi	7,8	LC50	930			Vareille-Morel, 1990
	Potamopyrgus jenkinsi	7,8	LC50	1,800			Vareille-Morel, 1990
	Potamopyrgus jenkinsi	7,8	LC50	1,400			Vareille-Morel, 1990
	Potamopyrgus jenkinsi	7,8	LC50	1,100			Vareille-Morel, 1990
	Potamopyrgus jenkinsi	7,8	LC50	440			Vareille-Morel, 1990
	Potamopyrgus jenkinsi	7,8	LC50	330			Vareille-Morel, 1990
	Potamopyrgus jenkinsi	7,8	LC50	1,300	976.6		Vareille-Morel, 1990

Tier II Parameters	Tier II Values
FAVF	8.6
SAV	113.6
SACR	28.29
SCV	4.0

[a] In the absence of any experimental value, EC16 is used to calculate an A-C ratio.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Beryllium	*Asellus intermedius*	5	LC50	10,000	10,000		Ewell et al., 1986
	Dugesia tigrina	7,8	LC50	10,000	10,000		Ewell et al., 1986
	Gammarus fasciatus	5	LC50	700	700		Ewell et al., 1986
	Helisoma trivolvis	7,8	LC50	10,000	10,000		Ewell et al., 1986
	Lumbriculus variegatus	7,8	LC50	10,000	10,000		Ewell et al., 1986
	Pimephales promelas	2,3	LC50	10,000	10,000		Ewell et al., 1986
	Ambystoma maculatum	2,3	LC50	3,150			Slonim and Ray, 1975
	Ambystoma maculatum	2,3	LC50	18,200			Slonim and Ray, 1975
	Ambystoma maculatum	2,3	LC50	8,020			Slonim and Ray, 1975
	Ambystoma maculatum	2,3	LC50	8,320			Slonim and Ray, 1975
	Ambystoma opacum	2,3	LC50	3,150	4,977		Slonim and Ray, 1975
	Caenorhabditis elegans	7,8	LC50	140	140		Williams and Dunsenbery, 1990
	Carassius auratus	2,3	LC50	55,900	55,900		Cardwell et al., 1976
	Daphnia magna	4	EC50	2,410			Kimball n.d.
	Daphnia magna	4	EC50	2,450	2,430		Kimball n.d.
	Daphnia magna		CV	5.267		461.4	Kimball n.d.
	Jordanella floridae	2,3	LC50	46,300			Cardwell et al., 1976
	Jordanella floridae	2,3	LC50	41,100			Cardwell et al., 1976
	Jordanella floridae	2,3	LC50	41,100	42,760		Cardwell et al., 1976
	Pimephales promelas	2,3	LC50	37,900			Cardwell et al., 1976
	Pimephales promelas	2,3	LC50	17,900			Kimball n.d.
	Pimephales promelas	2,3	LC50	17,500	22,810		Kimball n.d.
	Poecilia reticulata	2,3	LC50	1,330			Slonim and Slonim, 1973
	Poecilia reticulata	2,3	LC50	160			Slonim and Slonim, 1973
	Poecilia reticulata	2,3	LC50	190			Slonim and Slonim, 1973

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
	Poecilia reticulata	2,3	LC50	1,330	343.2		Slonim and Slonim, 1973
	Tubifex tubifex	7,8	EC50	10,250	10,250		Khangarot, 1991

Tier II Parameters	Tier II Values
FAVF	4.0
SAV	35
SACR	52.88
SCV	0.66

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Boron							
	Daphnia magna	4	LC50	133,000			Gersich, 1984
	Daphnia magna		CV	9,330			Gersich, 1984
	Daphnia magna	4	LC50	226,000	173,400		Lewis and Valentine, 1981
	Daphnia magna		CV	8,832		19.10[a]	Lewis and Valentine, 1981
	Ptychocheilus lucius	2,3	LC50	279			Hamilton, 1995
	Ptychocheilus lucius	2,3	LC50	>100			Hamilton, 1995
	Ptychocheilus lucius	2,3	LC50	527	383.4		Hamilton, 1995
	Xyrauchen texanus	2,3	LC50	>100			Hamilton, 1995
	Xyrauchen texanus	2,3	LC50	233			Hamilton, 1995
	Xyrauchen texanus	2,3	LC50	279	255.0		Hamilton, 1995
	Gila elegans	2,3	LC50	>100			Hamilton, 1995
	Gila elegans	2,3	LC50	280			Hamilton, 1995
	Gila elegans	2,3	LC50	552	393.1		Hamilton, 1995

Tier II Parameters	Tier II Values
FAVF	8.6
SAV	29.65
SACR	18.29
SCV	1.6

[a] The A-C Ratio for *D. magna* is the geometric mean of A-C Ratios from Gersich, 1987 and Lewis and Valentine, 1981.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Cobalt[a]							
	Asellus intermedius	5	LC50	>100,000			Ewell et al., 1986
	Carassius auratus	2,3	LC50	66,800	66,800		Ding, 1980
	Cyprinus carpio	2,3	LC50	82,700	82,700		Ding, 1980
	Daphnia magna	4	EC50	6,830			Kimball, 1978
	Daphnia magna	4	EC50	5,150	5,931		Kimball, 1978
	Daphnia magna		CV	5.103		1,162	Kimball, 1978
	Dugesia tigrina	7,8	LC50	25,000	25,000		Ewell et al., 1986
	Gammarus fasciatus	5	LC50	>100,000			Ewell et al., 1986
	Helisoma trivolvis	7,8	LC50	>100,000			Ewell et al., 1986
	Lumbriculus variegatus	7,8	LC50	>100,000			Ewell et al., 1986
	Philodina acuticornis	7,8	EC50	59,000	59,000		Buikema et al., 1974
	Pimephales promelas	2,3	LC50	22,000			Ewell et al., 1986
	Pimephales promelas	2,3	LC50	3,750			Kimball, 1978
	Pimephales promelas	2,3	LC50	3,460	6,584		Kimball, 1978
	Pimephales promelas		CV	286.2		12.59	Kimball, 1978
	Rana hexadactyla	3	LC50	17,590	17,590		Khangarot et al., 1985
	Tubifex tubifex	7,8	EC50	139,320	139,320		Khangarot, 1991

Tier II Parameters	Tier II Values
FAVF	4.0
SAV	1,483
SACR	63.98
SCV	23

[a] All data are for cobalt II.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Lithium							
	Ptychocheilus lucius	2,3	LC50	28,000			Hamilton, 1995
	Ptychocheilus lucius	2,3	LC50	41,000	33,880		Hamilton, 1995
	Xyrauchen texanus	2,3	LC50	53,000			Hamilton, 1995
	Xyrauchen texanus	2,3	LC50	186,000	99,290		Hamilton, 1995
	Gila elegans	2,3	LC50	62,000			Hamilton, 1995
	Gila elegans	2,3	LC50	65,000	63,480		Hamilton, 1995
	Tubifex tufifex	7,8	EC50	9,340	9,340		Khangarto, 1991

Tier II Parameters	Tier II Values
FAVF	36.2
SAV	258.0
SACR	17.9
SCV	14

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Manganese[a]							
	Asellus aquaticus	5	EC50	333,000	333,000		Martin and Holdich, 1986
	Crangonyx pseudogracilis	5	EC50	694,000	694,000		Martin and Holdich, 1986
	Daphnia magna	4	EC50	19,500			Kimball n.d.
	Daphnia magna	4	EC50	19,200	19,350		Kimball n.d.
	Pimephales promelas	2,3	LC50	30,600			Kimball n.d.
	Pimephales promelas	2,3	LC50	36,900	33,600		Kimball n.d.
	Pimephales promelas		CV	1,775		18.93	Kimball n.d.

Tier II Parameters	Tier II Values
FAVF	8.6
SAV	2,250
SACR	18.24
SCV	120

[a] All data are for manganese II.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Mercury, methyl							
	Oncorhynchus mykiss	1	LC50	24	24		Lock and van Overbeeke, 1981
	Salvelinus fontinalis	1	LC50	65			McKim et al., 1976
	Salvelinus fontinalis	1	LC50	84	74		McKim et al., 1976
	Salvelinus fontinalis		CV	0.5193		142.3	McKim et al., 1976

Tier II Parameters	Tier II Values
FAVF	242
SAV	0.09917
SACR	35.72
SCV	0.0028

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Molybdenum[a]							
	Daphnia magna	4	LC50	203,200			Kimball n.d.
	Daphnia magna	4	LC50	210,300	206,700		Kimball n.d.
	Daphnia magna		CV	877.8		235.5	Kimball n.d.
	Pimephales promelas	2,3	LC50	628,000	628,000		Kimball n.d.

Tier II Parameters	Tier II Values
FAVF	13.2
SAV	15,660
SACR	42.26
SCV	370

[a] All tests are for molybdenum VI.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Strontium							
	Daphnia magna	4	LC50	125,000	125,000		Biesinger and Christensen, 1972
	Daphnia magna		EC16	42,000		2.98[a]	Biesinger and Christensen, 1972
	Tubifex tubifex	7,8	EC50	240,800	240,800		Khangarot, 1991
	Caenorhabditis elegans	7,8	LC50	465,000	465,000		Williams and Dusenbery, 1990

Tier II Parameters	Tier II Values
FAVF	8.6
SAV	14,530
SACR	9.85
SCV	1,500

[a] In the absence of any experimental chronic values, EC16 is used to calculate an A-C Ratio.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Thallium[a]							
	Daphnia magna	4	EC50	880			Kimball, n.d.
	Daphnia magna	4	EC50	930	905.0		Kimball, n.d.
	Daphnia magna		CV	134.5		6.724	Kimball, n.d.
	Cyprinodon variegatus		LC50	20,900[b]			EPA, 1978
	Cyprinodon variegatus		CV	6,010		3.478	EPA, 1978
	Lepomis macrochirus	2,3	LC50	120,000			Buccafusco et al., 1981
	Lepomis macrochirus	2,3	LC50	132,000	125,900		Dawson et al., 1977
	Pimephales promelas	2,3	LC50	1,810			Kimball, n.d.
	Pimephales promelas	2,3	LC50	1,780	1,795		Kimball, n.d.
	Pimephales promelas		CV	56.92		31.53	Kimball, n.d.

Tier II Parameters	Tier II Values
FAVF	8.6
SAV	105.2
SACR	9.034
SCV	12

[a] All data are for thallium I.

[b] Acute value of *C. variegatus*, a saltwater species, is used for SACR calculation only.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Tin[a]							
	Daphnia magna	4	LC50	55,000	55,000		Biesinger and Christensen, 1972
	Daphnia magna		EC16[b]	350		157.1	Biesinger and Christensen, 1972

Tier II Parameters	Tier II Values
FAVF	20.5
SAV	2,683
SACR	36.93
SCV	73

[a] All data are for tin II.

[b] In the absence of any experimental chronic values, EC16 is used to calculate an A-C Ratio.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Uranium							
	Salvelinus fontinalis	1	LC50	5,500			Parkhurst et al., 1984
	Salvelinus fontinalis	1	LC50	23,000	11,250		Parkhurst et al., 1984

Tier II Parameters	Tier II Values
FAVF	242
SAV	46.48
SACR	17.9
SCV	2.6

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Vanadium[a]							
	Daphnia magna	4	EC50	1,580			Kimball, n.d.
	Daphnia magna	4	EC50	1,460			Kimball, n.d.
	Daphnia magna	4	EC50	3,800			Bensen &Neven, 1987
	Daphnia magna	4	EC50	2,900			Bensen &Neven, 1987
	Daphnia magna	4	EC50	3,900			Bensen &Neven, 1987
	Daphnia magna	4	EC50	3,600			Bensen &Neven, 1987
	Daphnia magna	4	EC50	3,300	2,746		Bensen &Neven, 1987
	Daphnia magna		CV	1900		2[b]	Bensen &Neven, 1987
	Gala elegans	2,3	LC50	8,800			Hamilton, 1995
	Gala elegans	2,3	LC50	4,000			Hamilton, 1995
	Gala elegans	2,3	LC50	3,000	4,727		Hamilton, 1995
	Jordanella floridae	2,3	LC50	11,200	11,200		Holdway and Sprague, 1979
	Jordanella floridae		CV	83.49		134.1	Holdway and Sprague, 1979
	Oncorhynchus tshawytscha	1	LC50	16,500	16,500		Hamilton and Buhl, 1990
	Pimephales promelas	2,3	LC50	1,800			Kimball, n.d.
	Pimephales promelas	2,3	LC50	1,900	1,850		Kimball, n.d.
	Pimephales promelas		CV	169.7		10.90	Kimball, n.d.
	Ptychocheilus lucius	2,3	LC50	7,800			Hamilton, 1995
	Ptychocheilus lucius	2,3	LC50	3,800			Hamilton, 1995
	Ptychocheilus lucius	2,3	LC50	4,300	5,032		Hamilton, 1995
	Salvelinus fontinalis	1	LC50	7,000			Ernst and Garside, 1987
	Salvelinus fontinalis	1	LC50	15,000	10,250		Ernst and Garside, 1987
	Xyrauchen texanus	2,3	LC50	5,300			Hamilton, 1995

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
	Xyrauchen texanus	2,3	LC50	2,200			Hamilton, 1995
	Xyrauchen texanus	2,3	LC50	4,600	3,770		Hamilton, 1995

Tier II Parameters	Tier II Values
FAVF	6.5
SAV	284.6
SACR	14.29
SCV	20

[a] All data are for vanadium V.

[b] Since the experimental A-C Ratio is less than 2, the A-C Ratio of *D. magna* is et to 2 (Stephan et al., 1985).

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Zirconium							
	Oncorhynchus mykiss	1	LC50	20,000	20,000		Couture et al., 1989
	Tubifex tubifex	7,8	EC50	221,180	221,180		Khangarot, 1991

Tier II Parameters	Tier II Values
FAVF	64.8
SAV	308.6
SACR	17.9
SCV	17

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
			ORGANICS				
Acetone							
	Asellus intermedius	5	LC50	>100,000	>100,000		Ewell et al., 1986
	Ceriodaphnia dubia	4	LC50	8,098,000	8,098,000		Cowgill and Milazzo, 1991
	Chironomus tentans	6	LC50	46,900,000	46,900,000		Ziegenfuss et al., 1986
	Corbicula manilensis	7,8	LC50	20,000,000	20,000,000		Chandler and Marking, 1979
	Daphnia magna	4	EC50	13,500,000	13,500,000		Randall and Knopp, 1980
	Daphnia magna	4	LC50	30,640[a]			LeBlanc and Surprenant, 1983
	Daphnia magna		CV	1,556		19.69	LeBlanc and Surprenant, 1983
	Dugesia tigrina	7,8	LC50	>100,000	>100,000		Ewell et al., 1986
	Gammarus fasciatus	5	LC50	>100,000	>100,000		Ewell et al., 1986
	Helisoma trivolvis	7,8	LC50	>100,000	>100,000		Ewell et al., 1986
	Lepomis macrochirus	2,3	LC50	8,300,000	8,300,000		Cairns and Scheier, 1968
	Lumbriculus variegatus	7,8	LC50	>100,000	>100,000		Ewell et al., 1986
	Oncorhynchus mykiss	1	LC50	5,540,000	5,540,000		Johnson and Finley, 1980
	Pimephales promelas	2,3	EC50	7,280,000			Brooke et al., 1984
	Pimephales promelas	2,3	EC50	8,120,000			Brooke et al., 1984
	Pimephales promelas	2,3	EC50	6,210,000	7,160,000		Brooke et al., 1984

Tier II Parameters	Tier II Values
FAVF	3.6
SAV	27,780
SACR	18.48
SCV	1500

[a] Since the acute test was part of the same study as the chronic test, the acute value was used to derive an ACR for *D. magna*. The LC50 value was not used as part of GMAV because EC50 for immobilization is available.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Anthracene							
	Daphnia magna	4	EC50	95			Munoz and Tarazona, 1993
	Daphnia pulex	4	EC50	754	267.6		Smith et al., 1988

Tier II Parameters	Tier II Values
FAVF	20.5
SAV	13.06
SACR	17.9
SCV	0.73

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Benzene	*Asellus aquaticus*	5	LC50	254,000	254,000		Erben and Pisl, 1993
	Carassius auratus	2,3	LC50	34,420	34,420		Pickering and Henderson, 1966
	Chironomus thummi	6	LC50	100,000	100,000		Sloff, 1983
	Cottus cognatus	2,3	LC50	13,500	13,500		Moles et al., 1979
	Daphnia magna	4	LC50	200,000			LeBlanc, 1980
	Daphnia magna	4	LC50	400,000			Canton and Adema, 1978
	Daphnia magna	4	LC50	620,000			Canton and Adema, 1978
	Daphnia magna	4	LC50	412,000			Canton and Adema, 1978
	Daphnia magna	4	LC50	356,000			Canton and Adema, 1978
	Daphnia magna	4	LC50	412,000			Canton and Adema, 1978
	Daphnia magna	4	LC50	356,000	376,200		Canton and Adema, 1978
	Daphnia pulex	4	LC50	345,000			Canton and Adema, 1978
	Daphnia pulex	4	LC50	265,000	302,400		Canton and Adema, 1978
	Gasterosteus aculeatus	2,3	LC50	21,800	21,800		Moles et al., 1979
	Ictalurus punctatus	2,3	LC50	425,000	425,000		Johnson and Finley, 1980
	Lepomis macrochirus	2,3	LC50	22,490	22,490		Pickering and Henderson, 1966
	Oncorhynchus gorbuscha	1	LC50	4,630			Moles et al., 1979
	Oncorhynchus kisutch	1	LC50	12,350			Moles et al., 1979
	Oncorhynchus mykiss	2,3	LC50	5,300			DeGraeve et al., 1982
	Oncorhynchus mykiss	1	LC50	21,600			Hodson et al., 1984
	Oncorhynchus nerka	1	LC50	9,430			Moles et al., 1979
	Oncorhynchus tshawytscha	1	LC50	10,280	9,008		Moles et al., 1979
	Pimephales promelas	2,3	LC50	24,600			Geiger et al, 1990

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
	Pimephales promelas	2,3	LC50	12,600	17,600		Geiger et al, 1990
	Poecilia reticulata	2,3	LC50	36,600			Pickering and Henderson, 1966
	Poecilia reticulata	2,3	LC50	28,600	32,350		Galassi et al., 1988
	Salvelinus malma	2,3	LC50	10,430			Moles et al., 1979
	Salvelinus malma	2,3	LC50	10,480	10,450		Moles et al., 1979
	Thymallus arcticus	2,3	LC50	12,890	12,890		Moles et al., 1979

Tier II Parameters	Tier II Values
FAVF	4.0
SAV	2,252
SACR	17.9
SCV	130

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Benzidine							
	Daphnia magna	4	EC50	600	600		Kuhn et al., 1989
	Oncorhynchus mykiss	1	LC50	7,400	7,400[a]		EPA, 1980c
	Salmo trutta lacustris	1	LC50	4,350	4,350[a]		EPA, 1980c
	Notropis lutrensis	2,3	LC50	2,500	2,500[a]		EPA, 1980c

Tier II Parameters	Tier II Values
FAVF	8.6
SAV	69.77
SACR	17.9
SCV	3.9

[a] The EPA criteria document was cited because the data come from an EPA internal investigation, which was not available.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Benzo(a)anthracene							
	Daphnia pulex	4	LC50 MOR	10[a]	10		Trucco et al., 1983

Tier II Parameters	Tier II Values
FAVF	20.5
SAV	0.4878
SACR	17.9
SCV	0.027

[a] The test was based on a non-standard, but conservative, exposure of 96 hours. The standard exposure is 48 hr for daphnids. The length of the Daphnid is 1.9-2.1 mm; the age of the Daphnid species is not available.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Benzo(a)pyrene							
	Daphnia pulex	4	LC50 MOR	5[a]	5		Trucco et al., 1983

Tier II Parameters	Tier II Values
FAVF	20.5
SAV	0.2439
SACR	17.9
SCV	0.014

[a]The test was based on a non-standard, but conservative, exposure of 96 hours. The standard exposure is 48 hr for daphnids. The length of the Daphnid is 1.9-2.1 mm; the age of the Daphnid species is not available.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Benzoic acid							
	Gambusia affinis	2,3	LC50	180,000[a]	180,000		Wallen et al., 1957

Tier II Parameters	Tier II Values
FAVF	242
SAV	743.8
SACR	17.9
SCV	42

[a] Done in turbid water.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Benzyl alcohol							
	Lepomis macrochirus	2,3	LC50	10,000	10,000		Dawson et al., 1977
	Pimephales promelas	2,3	LC50	460,000	460,000		Mattson et al., 1976

Tier II Parameters	Tier II Values
FAVF	64.8
SAV	154.3
SACR	17.9
SCV	8.6

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
BHC (other than Lindane)							
	Daphnia magna	4	EC50	800	800		Canton et al., 1975

Tier II Parameters	Tier II Values
FAVF	20.5
SAV	39.02
SACR	17.9
SCV	2.2

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Bis(2-ethylhexyl) phthalate							
	Chironomus plumosus	6	EC50	>18,000			Streufert et al., 1980
	Daphnia pulex	4	EC50	133	133		LeBlanc, 1980
	Daphnia magna	4	LC50	2,000[a]			Adams & Heidolph, 1985
	Daphnia magna		CV	912		2.193	Adams & Heidolph, 1985
	Gammarus pseudolimnaeus	4	LC50	>32,000			Sanders et al., 1973
	Gasterosteus aculeatus	2,3	LC50	>300			van den Dikkenberg et al., 1989
	Ictalurus punctatus	2,3	LC50	>100,000			Johnson and Finley, 1980
	Jordanella floridae	2,3	LC50	>320			Adema et al., 1981
	Lepomis macrochirus	2,3	LC50	>770,000			Buccafusco et al., 1981
	Lepomis macrochirus	2,3	LC50	>100,000			Johnson and Finley, 1980
	Oncorhynchus kisutch	1	LC50	>100,000			Johnson and Finley, 1980
	Oncorhynchus mykiss	1	LC50	> 320			Adams et al., 1995
	Pimephales promelas	2,3	LC50	>670			Adams et al., 1995
	Pimephales promelas	2,3	LC50	>160			Adams et al., 1995
	Rana pipiens	3	LC50	4,440	4,440		Birge et al., 1978

Tier II Parameters	Tier II Values
FAVF	5.0
SAV	26.60
SACR	8.890
SCV	3.0

[a] This LC50 was used to calculate the A-C ratio, but not the GMAV because an EC50 was available.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
2-Butanone							
	Daphnia magna	4	EC50	5,091,000	5,091,000		Randall and Knopp, 1980
	Pimephales promelas	2,3	LC50	3,200,000	3,200,000		Veith et al, 1983

Tier II Parameters	Tier II Values
FAVF	13.2
SAV	242,400
SACR	17.9
SCV	14,000

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Carbon disfulfide[a]							
	Poecilia reticulata	2,3	LC50 MOR	4,000	4,000		Van Leeuwen et al., 1985

Tier II Parameters	Tier II Values
FAVF	242
SAV	16.53
SACR	17.9
SCV	0.92

[a] Although carbon disfulide is a volatile compound, static test was used because flow-through, measured tests are not available.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Carbon tetrachloride[a]							
	Pimephales promelas	2,3	LC50	41,400			Geiger et al., 1990
	Pimephales promelas	2,3	LC50	43,300			Kimball, n.d.
	Pimephales promelas	2,3	LC50	42,900	42,530		Kimball, n.d.

Tier II Parameters	Tier II Values
FAVF	242
SAV	175.7
SACR	17.9
SCV	9.8

[a] Because carbon tetrachloride is a volatile compound, only flow-through, measured tests were used.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C ratio	Reference
Chlorobenzene							
	Carassius auratus	2,3	LC50	51,620	51,620		Pickering and Henderson, 1966
	Ceriodaphnia dubia	4	LC50	7,900[a]			Cowgill et al., 1985
	Ceriodaphnia dubia	4	LC50	7,900[a]			Cowgill et al., 1985
	Ceriodaphnia dubia	4	LC50	11,400[a]	8,927		Cowgill et al., 1985
	Daphnia magna	4	LC50	86,000			LeBlanc, 1980
	Daphnia magna	4	LC50	13,000[a]			Cowgill et al., 1985
	Daphnia magna	4	LC50	10,700[a]			Cowgill et al., 1985
	Daphnia magna	4	LC50	15,400[a]	116,500		Cowgill et al., 1985
	Lepomis macrochirus	2,3	LC50	7,400	7,400		Bailey et al., 1985
	Oncorhynchus mykiss	1	LC50	7,460	7,460		Hodson et al., 1984
	Pimephales promelas	2,3	LC50	16,900	16,900		Geiger et al., 1990
	Poecilia reticulata	2,3	LC50	45,530	45,530		Pickering and Henderson, 1966

Tier II Parameters	Tier II Values
FAVF	6.5
SAV	1,138
SACR	17.9
SCV	64

[a] Author indicated both *D. magna* and *C. dubia/affinis* are less sensitive to chlorobenzene at 24°C than at 20°C; thus, tests with 20°C were used to established a conservative estimate of the effect of chlorobenzene.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Chloroform[a]	*Ictalurus punctatus*	2,3	LC50	75,000	75,000		Anderson and Lusty, 1980
	Lepomis macrochirus	2,3	LC50	16,200			Anderson and Lusty, 1980
	Lepomis macrochirus	2,3	LC50	22,300			Anderson and Lusty, 1980
	Lepomis macrochirus	2,3	LC50	13,300			Anderson and Lusty, 1980
	Lepomis macrochirus	2,3	LC50	18,300			Anderson and Lusty, 1980
	Lepomis macrochirus	2,3	LC50	20,800	17,880		Anderson and Lusty, 1980
	Micropterus salmoides	2,3	LC50	55,800			Anderson and Lusty, 1980
	Micropterus salmoides	2,3	LC50	52,500			Anderson and Lusty, 1980
	Micropterus salmoides	2,3	LC50	45,400	51,040		Anderson and Lusty, 1980
	Oncorhynchus mykiss	1	LC50	18,200			Anderson and Lusty, 1980
	Oncorhynchus mykiss	1	LC50	18,400			Anderson and Lusty, 1980
	Oncorhynchus mykiss	1	LC50	22,100			Anderson and Lusty, 1980
	Oncorhynchus mykiss	1	LC50	15,100			Anderson and Lusty, 1980
	Oncorhynchus mykiss	1	LC50	17,100	18,040		Anderson and Lusty, 1980
	Pimephales promelas	2,3	EC50	70,700	70,700		Geiger et al., 1990

Tier II Parameters	Tier II Values
FAVF	36.2
SAV	493.9
SACR	17.9
SCV	28

[a] Because chloroform is a volatile compound, only flow-through, measured tests were used.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
p,p'DDD							
	Asellus brevicaudus	5	LC50	10			Sanders, 1972
	Asellus brevicaudus	5	LC50	16	12.65		Mayer and Ellersieck, 1986
	Bufo woodhousei	3	LC50	140	140		Sanders, 1970
	Cypridopsis vidua	5	EC50	45	45		Mayer and Ellersieck, 1986
	Daphnia pulex	4	EC50	3.2	3.2		Mayer and Ellersieck, 1986
	Gammarus fasciatus	5	LC50	0.6			Sanders, 1972
	Gammarus fasciatus	5	LC50	0.86			Sanders, 1972
	Gammarus lacustris	5	LC50	0.64	0.68		Sanders, 1969
	Ictalurus punctatus	2,3	LC50	1,500	15,000		Mayer and Ellersieck, 1986
	Ischnura verticalis	6	LC50	34	34		Mayer and Ellersieck, 1986
	Micropterus salmoides	2,3	LC50	42	42		Mayer and Ellersieck, 1986
	Oncorhynchus mykiss	1	LC50	70	72		Mayer and Ellersieck, 1986
	Palaemonetes kadiakensis	5	LC50	0.68			Sanders, 1972
	Palaemonetes kadiakensis	5	LC50	2.4	1.3		Mayer and Ellersieck, 1986
	Pimephales promelas	2,3	LC50	4,400	4,400		Mayer and Ellersieck, 1986
	Polycelis felina	7,8	LC50	740	740		Kouyoumjian and Uglow, 1974
	Pseudacris triseriata	3	LC50	400	400		Sanders, 1970
	Pteronarcys californica	6	LC50	380	380		Sanders and Cope, 1968
	Simocephalus serrulatus	4	EC50	4.5	4.5		Mayer and Ellersieck, 1986
	Stizostedion vitreum	2,3	LC50	14	14		Mayer and Ellersieck, 1986

Tier II Parameters	Tier II Values
FAVF	3.6
SAV	0.1889
SACR	17.9
SCV	0.011

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Decane[a]							
	Daphnia magna	4	LC50	18,000	18,000		LeBlanc, 1980

Tier II Parameters	Tier II Values
FAVF	20.5
SAV	878.0
SACR	17.9
SCV	49

[a] Although decane is a volatile compound, static test was used because flow-through tests were not available.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C ratio	Reference
Di-n-butyl phthalate							
	Chironomus plumosus	6	EC50	760	760		Streufert et al., 1980
	Daphnia magna	4	EC50	5200	5200		McCarthy and Whitmore, 1985
	Daphnia magna		CV	1004		5.179	McCarthy and Whitmore, 1985
	Gammarus pseudolimnaeus	5	LC50	2100	2100		Johnson and Finley, 1980
	Ictalurus punctatus	2,3	LC50	2900	2900		Johnson and Finley, 1980
	Lepomis macrochirus	2,3	LC50	1200			Buccafusco et al., 1981
	Lepomis macrochirus	2,3	LC50	700	916.5		Johnson and Finley, 1980
	Oncorhynchus mykiss	1	LC50	1600	1600		Adams et al., 1995
	Oncorhynchus mykiss		CV	137.8[a]		11.61	Rodes et al., 1995
	Orconectes nais	5	LC50	10000[b]	10000		Johnson and Finley, 1980
	Pimephales promelas	2,3	LC50	1100			Geiger et al., 1985
	Pimephales promelas	2,3	LC50	850			Geiger et al., 1985
	Pimephales promelas	2,3	LC50	2020[c,d]			McCarthy and Whitmore, 1985
	Pimephales promelas	2,3	LC50	920	1148		Adams et al., 1995
	Pimephales promelas		CV	748.3		2.699	McCarthy and Whitmore, 1985

Tier II Parameters	Tier II Values
FAVF	4.0
SAV	190.0
SACR	5.455
SCV	35

[a] Length of the test is 60 d post-hatch (99 d exposure); the National Guidelines recommend 90 d post-hatch for salmonids.

Table A.1. (continued)

[b] Authors note toxicity is hardness(44-272 ppm) and pH(6.5-9.0) independent; no further data are available.

[c] Derived from range-finding test.

[d] ACR derived from acute test of larval fathead minnows is the only test available as part of the same study as the chronic test. The National Guidelines recommend using juvenile fish for deriving ACR.

[e] Because of an accident during the experiment, length of the test is 20 d post-hatch; the National Guidelines recommend 28-32 d post-hatch for fish other than salmonids. However, the authors note since a larger number of fish died at 1.0 mg/L, "no evidence that additional exposure time would have produced any meaningful result".

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Dibenzofuran							
	Daphnia magna	4	LC50	1,700	1,700		LeBlanc, 1980
	Pimephales promelas	2,3	EC50	780			Geiger et al., 1988
	Pimephales promelas	2,3	EC50	980	874.3		Geiger et al., 1988

Tier II Parameters	Tier II Values
FAVF	13.2
SAV	66.23
SACR	17.9
SCV	3.7

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
1,1-Dichloroethane[a]							
	Poecilia reticulata	2,3	LC50	202,000	202,000		Kõneman, 1981

Tier II Parameters	Tier II Values
FAVF	242
SAV	834.7
SACR	17.9
SCV	47

[a] Although 1,1-dichloroethane is a volatile compound, static test was used because flow-through test is not available.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C ratio	Reference
1,2-Dichloroethane[a]							
	Daphnia magna	4	EC50	160,000	160,000		Richter et al., 1983
	Pimephales promelas	2,3	LC50	116,000	116,000		Walbridge et al., 1983
	Pimephales promelas		CV	41,360		2.804	Benoit et al, 1985

Tier II Parameters	Tier II Values
FAVF	13.2
SAV	8,788
SACR	9.649
SCV	910

[a] Because 1,2-Dichloroethane is a volatile compound, only flow-through, measured tests were used (static, measured tests for Daphnids).

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
1,1-Dichlorolethene[a]							
	Pimephales promelas	2,3	LC50 MOR	108,000	108,000		Dill et al., 1980

Tier II Parameters	Tier II Values
FAVF	242
SAV	446.3
SACR	17.9
SCV	25

[a] Although 1,1-dichloroethene is a volatile compound, static test is used because flow-through, measured tests are not available.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
1,2-Dichloroethene[a]							
	Lepomis macrochirus	2,3	LC50	140,000	140,000		Buccafusco, 1981
	Daphnia magna	4	LC50	220,000	220,000		LeBlanc, 1980

Tier II Parameters	Tier II Values
FAVF	13.2
SAV	10,610
SACR	17.9
SCV	590

[a] Although 1,2-dichloroethene is a volatile compound, static tests were used because flow-through, measured tests are not available.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
1,3-Dichloropropene[a]							
	Pimephales promelas	2,3	EC50	239	239		Geiger et al., 1990

Tier II Parameters	Tier II Values
FAVF	242
SAV	0.9876
SACR	17.9
SCV	0.055

a Because 1,3-dichloropropene is a volatile compound, only flow-through measured test was used.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Diethyl phthalate							
	Daphnia magna	4	EC50	86,000	86,000		Adams et al., 1995
	Daphnia magna		CV	38,410		2.239	Rhodes et al., 1995
	Lepomis macrochirus	2,3	LC50	16,700	16,700		Adams et al., 1995
	Pimephales promelas	2,3	LC50	31,800			Geiger et al., 1985
	Pimephales promelas	2,3	LC50	17,000	23,250		Adams et al., 1995
	Oncorhynchus mykiss	1	LC50	12,000	12,000		Adams et al., 1995

Tier II Parameters	Tier II Values
FAVF	6.5
SAV	1,846
SACR	8.952
SCV	210

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Ethyl benzene[a]							
	Pimephales promelas	2,3	EC50	8,450	8,450		Geiger et al., 1990
	Poecilia reticulata	2,3	LC50	9,600	9,600		Galassi et al., 1988

Tier II Parameters	Tier II Values
FAVF	64.8
SAV	130.4
SACR	17.9
SCV	7.3

[a] Because ethyl benzene is a volatile compound, only flow-through, measured tests were used.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Hexane							
	Pimephales promelas	2,3	EC50	2,500	2,500		Geiger et al., 1990

Tier II Parameters	Tier II Values
FAVF	242
SAV	10.33
SACR	17.9
SCV	0.58

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
2-Hexanone							
	Pimephales promelas	2,3	LC50	428,000	428,000		Geiger et al., 1986

Tier II Parameters	Tier II Values
FAVF	242
SAV	1,769
SACR	17.9
SCV	99

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
1-Methylnaphthalene							
	Pimephales promelas	2,3	EC50	9,000	9,000		Mattson et al., 1976

Tier II Parameters	Tier II Values
FAVF	242
SAV	37.19
SACR	17.9
SCV	2.1

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
4-Methyl-2-pentanone							
	Pimephales promelas	2,3	LC50	540,000			Brooke et al., 1984
	Pimephales promelas	2,3	LC50	505,000	522,200		Veith et al., 1983a
	Pimephales promelas		CV	77,360		6.750	Call et al., 1985

Tier II Parameters	Tier II Values
FAVF	242
SAV	2,158
SACR	12.93
SCV	170

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
2-Methylphenol							
	Carassius auratus	2,3	LC50 MOR	23,250	23,250		Pickering and Henderson, 1966
	Lepomis macrochirus	2,3	LC50 MOR	20,780	20,780		Pickering and Henderson, 1966
	Oncorhynchus mykiss	1	LC50 MOR	8,400	8,400		DeGraeve et al., 1980
	Pimephales promelas	2,3	LC50	14,000			Geiger et al., 1990
	Pimephales promelas	2,3	LC50	18,200	15,960		DeGraeve et al., 1980
	Poecilia reticulata	2,3	LC50	18,850	18,850		Pickering and Henderson, 1966

Tier II Parameters	Tier II Values
FAVF	36.2
SAV	232.0
SACR	17.9
SCV	13

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Methylene chloride							
	Daphnia magna	4	LC50 MOR	220,000	220,000		LeBlanc, 1980
	Lepomis macrochirus	2,3	LC50 MOR	220,000	220,000		Buccafusco et al., 1981
	Pimephales promelas	2,3	EC50	330,000	330,000		Geiger, 1986
	Pimephales promelas		LC50 MOR	502,000[a]			Dill et al., 1987
	Pimephales promelas		CV	108,540		4.625	Dill et al., 1987

Tier II Parameters	Tier II Values
FAVF	8.6
SAV	25,580
SACR	11.40
SCV	2,200

[a] The LC50 value is used to calculate the ACR because it is part of the same study as the chronic test; but it is not used to determine the GMAV of *Pimephales* sp. because an EC50 is available.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C ratio	Reference
Napthalene							
	Daphnia magna	4	EC50	2,194			Munoz and Tarazona, 1993
	Daphnia pulex	4	EC50	4,663	3,199		Smith et al., 1988
	Oncorhynchus mykiss	1	LC50	1,600	1,600		DeGraeve et al., 1982
	Pimephales promelas	2,3	LC50	6,140			Geiger et al., 1985
	Pimephales promelas	2,3	LC50	7,900	6,965		DeGraeve et al., 1982
	Pimephales promelas		CV	619		12.77	DeGraeve et al., 1982

Tier II Parameters	Tier II Values
FAVF	8.6
SAV	186.0
SACR	15.96
SCV	12

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
4-Nitrophenol							
	Daphnia magna	4	EC50	7,680			Keen and Baillod, 1985
	Daphnia magna	4	EC50	4,700	6,008		Kuhn et al., 1989
	Daphnia magna		CV	7,071		2[a]	Kuhn et al., 1989
	Gammarus pseudolimnaeus	5	LC50	6,550	6,550		Howe et al., 1994
	Ictalurus punctatus	2,3	LC50	15,000	15,000		Holcombe et al., 1984
	Lepomis macrochirus	2,3	LC50	8,300	8,300		Buccafusco et al., 1981
	Oncorhynchus mykiss	1	LC50	7,900	7,900		Hodson et al., 1984
	Oncorhynchus mykiss		CV	989.1		7.987	Hodson et al., 1991
	Pimephales promelas	2,3	LC50	59,000			Phipps et al., 1981
	Pimephales promelas	2,3	LC50	62,000			Phipps et al., 1981
	Pimephales promelas	2,3	LC50	41,000			Holcombe et al., 1984
	Pimephales promelas	2,3	LC50	37,300			Geiger et al., 1985
	Pimephales promelas	2,3	LC50	41,000			Geiger et al., 1985
	Pimephales promelas	2,3	LC50	58,600	48,760		Geiger et al., 1985

Tier II Parameters	Tier II Values
FAVF	5.0
SAV	1,202
SACR	3.997
SCV	300

[a] Since the experimental A-C Ratio was less than 2, the A-C Ratio of *D. magna* is set to 2 (Stephan et al, 1985).

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
N-Nitrosodiphenylamine							
	Daphnia magna	4	LC50	7,800	7,800		LeBlanc, 1980

Tier II Parameters	Tier II Values
FAVF	20.5
SAV	3,805
SACR	17.9
SCV	210

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
2-Octanone[a]							
	Pimephales promelas	2,3	EC50	36,000	36,000		Brooke, 1984

Tier II Parameters	Tier II Values
FAVF	242
SAV	148.8
SACR	17.9
SCV	8.3

[a]Because 3-Octanone tests do not have standardard exposure, 2-Octanone tests, which have the standard exposure, were used.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
PCBs: total							
	Pimephales promelas					9.443	Nebeker et al., 1974

Tier I Parameters	Tier I Values	
FAV	2.0	EPA, 1980x

Tier II Parameters	Tier II Values
SACR	14.64
SCV	0.14

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
PCBs: Aroclor® 1221							
	Oncorhynchus clarki	1	LC50	1,200			Mayer et al., 1977

Tier II Parameters	Tier II Values
FAVF	242
SAV	4.959
SACR	17.9
SCV	0.28

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
PCBs: Aroclor® 1232							
	Oncorhynchus clarki	1	LC50	2,500			Johnson and Finley, 1980

Tier II Parameters	Tier II Values
FAVF	242
SAV	10.33
SACR	17.9
SCV	0.58

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
PCBs: Aroclor® 1242							
	Gammarus pseudolimnaeus	5	LC50	72			Nebeker and Puglisi, 1974
	Gammarus pseudolimnaeus	5	LC50	74	72.99		Nebeker and Puglisi, 1974
	Ictalurus punctatus	2,3	LC50	>100			Johnson and Finley, 1980
	Ischnura verticalis	7,8	LC50	400	400		Mayer et al., 1977
	Oncorhynchus clarki	1	LC50	5,400	5,400		Mayer et al., 1977
	Perca flavescens	2,3	LC50	>150			Johnson and Finley, 1980
	Pimephales promelas	2,3	LC50	15	15		Nebeker et al., 1974
	Pimephales promelas		LC50	300[a]			Nebeker et al., 1974
	Pimephales promelas		CV	9.000		33.33	Nebeker et al., 1974

Tier II Parameters	Tier II Values
FAVF	12.9
SAV	1.163
SACR	22.02
SCV	0.053

a Because this value is more than ten times of another life stage, it is not used in the GMAV calculation. However, since the preferred life stage in deriving the A-C Ratio is juvenile, it is used in A-C Ratio derivation.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
PCBs: Aroclor® 1248							
	Gammarus pseudolimnaeus	5	LC50 MOR	29	29		Nebeker and Puglisi, 1974
	Ictalurus punctatus	2,3	LC50 MOR	>100			Johnson and Finley, 1980
	Lepomis macrochirus	2,3	LC50 MOR	278			Stalling and Mayer, 1972
	Lepomis macrochirus	2,3	LC50	690	438.0		Johnson and Finley, 1980
	Oncorhynchus clarki	1	LC50	5,750	5,750		Johnson and Finley, 1980
	Perca flavescens	2,3	LC50	>100			Johnson and Finley, 1980

Tier II Parameters	Tier II Values
FAVF	20.1
SAV	1.443
SACR	17.9
SCV	0.081

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
PCBs: Aroclor® 1254							
	Coregonus hoyi	1	LC50	>10,000			Passino and Kramer, 1980
	Gammarus fasciatus	5	LC50	2,400	2,400		Johnson and Finley, 1980
	Ictalurus punctatus	2,3	LC50	>200			Johnson and Finley, 1980
	Ischnura verticalis	6	LC50	200	200		Mayer et al., 1977
	Lepomis macrochirus	2,3	LC50	2,740	2,740		Johnson and Finley, 1980
	Oncorhynchus clarki	1	LC50	42,500	42,500		Johnson and Finley, 1980
	Orconectes nais	5	LC50	100	100		Johnson and Finley, 1980
	Perca flavescens	2,3	LC50	>150			Johnson and Finley, 1980
	Pimephales promelas	2,3	LC50	7.7	7.7		Nebeker et al., 1974
	Pimephales promelas		CV	2.878		2.676	Nebeker et al., 1974

Tier II Parameters	Tier II Values
FAVF	12.9
SAV	0.5969
SACR	17.9
SCV	0.033

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
PCBs: Aroclor® 1260							
	Ictalurus punctatus	2,3	LC50	>400			Johnson and Finley, 1980
	Lepomis macrochirus	2,3	LC50	>400			Johnson and Finley, 1980
	Oncorhynchus clarki	1	LC50	61,000	61,000	-	Mayer et al., 1977
	Perca flavescens	2,3	LC50	>200			Johnson and Finley, 1980

Tier II Parameters	Tier II Values
FAVF	36.2
SAV	1,685
SACR	17.9
SCV	94

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C ratio	Reference
1-Pentanol[a]							
	Pimephales promelas	2,3	LC50	472,000	472,000		Geiger et al., 1986

Tier II Parameters	Tier II Values
FAVF	242
SAV	1950
SACR	17.9
SCV	110

[a]Because 1-pentanol is a volatile compound, only flow-through, measured test was used.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
2-Propanol							
	Chironomus riparius	7	LC50	12,500,000	12,500,000		Roghair et al., 1994
	Pimephales promelas	2,3	LC50	10,400			Veith et al., 1983
	Pimephales promelas	2,3	LC50	9,640			Veith et al., 1983
	Pimephales promelas	2,3	LC50	6,550	8,692		Brooke et al., 1984

Tier II Parameters	Tier II Values
FAVF	64.8
SAV	134.1
SACR	17.9
SCV	7.5

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
1,1,2,2-Tetrachloroethane[a]							
	Daphnia magna	4	EC50	23,000	23,000		Richter et al., 1983
	Daphnia magna		CV	9,829		2.34	Richter et al., 1983
	Jordanella floridae	2,3	LC50	18,480	18,480		Smith et al., 1991
	Jordanella floridae		CV	8,467		2.183	Smith et al., 1991
	Pimephales promelas	2,3	LC50	20,400			Walbridge et al., 1983
	Pimephales promelas	2,3	LC50	20,300	20,350		Geiger et al., 1985
	Pimephales promelas		CV	2,366		8.601	Ahmad et al., 1984

Tier II Parameters	Tier II Values
FAVF	8.6
SAV	2,149
SACR	3.529
SCV	610

[a] Because 1,1,2,2-tetrachloroethane is a volatile compound, only flow-through, measured tests were used.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Tetrachloroethene[a]							
	Daphnia magna	4	EC50	8,500	8,500		Richter et al., 1983
	Daphnia magna		CV	750.0		11.33	Richter et al., 1983
	Jordanella floridae	2,3	LC50	8,430	8,430		Smith et al., 1991
	Jordanella floridae		CV	3,107		2.714	Smith et al., 1991
	Oncorhynchus mykiss	1	LC50	5,840			Shubat et al., 1982
	Oncorhynchus mykiss	1	LC50	4,990	5,398		Shubat et al., 1982
	Pimephales promelas	2,3	LC50	13,400			Walbridge et al., 1983
	Pimephales promelas	2,3	LC50	20,300	16,490		Geiger et al., 1985
	Pimephales promelas		CV	836.7		19.71	Geiger et al., 1985

Tier II Parameters	Tier II Values
FAVF	6.5
SAV	830.5
SACR	8.463
SCV	98

[a] Because tetrachloroethene is a volatile compound, only flow-through, measured tests were used.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Toluene[a]							
	Pimephales promelas	23	LC50	31,700			Geiger et al., 1990
	Pimephales promelas	2,3	LC50	36,200			Geiger et al., 1986
	Pimephales promelas	2,3	LC50	30,000			Devlin et al., 1982
	Pimephales promelas	2,3	LC50	31,000			Devlin et al., 1982
	Pimephales promelas	2,3	LC50	26,000			Devlin et al., 1982
	Pimephales promelas	2,3	LC50	18,000	28,170		Devlin et al., 1982
	Pimephales promelas		CV	4,899		5.243	Devlin et al., 1982

Tier II Parameters	Tier II Values
FAVF	242
SAV	116.4
SACR	11.89
SCV	9.8

[a] Because toluene is a volatile compound, only flow-through, measured tests were used.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
1,1,1-Trichloroethane[a]							
	Pimephales promelas	2,3	LC50	52,900			Geiger et al., 1986
	Pimephales promelas	2,3	LC50	42,300	47,300		Geiger et al., 1986

Tier II Parameters	Tier II Values
FAVF	242
SAV	195.5
SACR	17.9
SCV	11

[a] Because 1,1,1-trichloroethane is a volatile compound, only flow-through, measured tests were used.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
1,1,2-Trichloroethane[a]							
	Daphnia magna	4	EC50	81,000	81,000		Richter et al., 1983
	Daphnia magna		CV	18,385		4.406	Richter et al., 1983
	Jordanella floridae	2,3	LC50	45,117	45,117		Smith et al., 1991
	Jordanella floridae		CV	46,609		2[b]	Smith et al., 1991
	Pimephales promelas	2,3	LC50	81,600	81,600		Ahmad et al., 1984
	Pimephales promelas		CV	9,423		8.659	Ahmad et al., 1984

Tier II Parameters	Tier II Values
FAVF	8.6
SAV	5,246
SACR	4.241
SCV	1200

[a] Because 1,1,2-trichloroethane is a volatile compound, only flow-through, measured tests were used.

[b] Since the experimental A-C Ratio is less than 2, the A-C Ratio of *J. floridae* is set to 2 (Stephan et al., 1985).

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Trichloroethene[a]							
	Jordanella floridae	2,3	LC50	28,280	28,280		Smith et al., 1991
	Jordanella floridae		CV	11,057		2.558	Smith et al., 1991
	Pimephales promelas	2,3	LC50	40,700			Alexander et al., 1978
	Pimephales promelas	2,3	LC50	45,000			Walbridge et al., 1983
	Pimephales promelas	2,3	LC50	44,100	43,230		Geiger et al., 1985

Tier II Parameters	Tier II Values
FAVF	64.8
SAV	436.4
SACR	9.358
SCV	47

[a] Because trichloroethene is a volatile compound, only flow-through, measured tests were used.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C Ratio	Reference
Vinyl acetate[a]							
	Carassius auratus	2,3	LC50	42,330	42,330		Pickering and Henderson, 1966
	Lepomis macrochirus	2,3	LC50	18,000	18,000		Pickering and Henderson, 1966
	Pimephales promelas	2,3	LC50	14,000			Pickering and Henderson, 1966
	Pimephales promelas	2,3	LC50	15,000			Pickering and Henderson, 1966
	Pimephales promelas	2,3	LC50	14,000			Pickering and Henderson, 1966
	Pimephales promelas	2,3	LC50	15,000			Pickering and Henderson, 1966
	Pimephales promelas	2,3	LC50	15,000			Pickering and Henderson, 1966
	Pimephales promelas	2,3	LC50	23,000			Pickering and Henderson, 1966
	Pimephales promelas	2,3	LC50	26,000			Pickering and Henderson, 1966
	Pimephales promelas	2,3	LC50	20,000			Pickering and Henderson, 1966
	Pimephales promelas	2,3	LC50	24,000[b]			Pickering and Henderson, 1966
	Pimephales promelas	2,3	LC50	19,730[b]	18,090		Pickering and Henderson, 1966
	Poecilia reticulata	2,3	LC50	31,080	31,080		Pickering and Henderson, 1966

Tier II Parameters	Tier II Values
FAVF	64.8
SAV	277.8
SACR	17.9
SCV	16

[a] Although vinyl acetate is a volatile compound, static tests were used because flow-through, measured tests are not available.
[b] Auther notes hardness influences toxicity; vinyl acetate is more toxic in soft water than hard water.

Table A.1. (continued)

Compound	Genus/species	Requirement	Endpoint	Concentration	GMAV	A-C ratio	Reference
Xylene[a]							
	Lepomis macrochirus	2,3	LC50	15,700	15,700		Bailey et al., 1985
	Pimephales promelas	2,3	EC50	15,300[b,d]			Geiger et al., 1990
	Pimephales promelas	2,3	EC50	14,800[c,d]	15,050		Geiger et al., 1990

Tier II Parameters	Tier II Values
FAVF	64.8
SAV	232.3
SACR	17.9
SCV	13

[a] Because xylene is a volatile compound, only flow-through, measured tests were used.
[b] o-xylene (99+% purity) was used.
[c] m-xylene (99% purity) was used.
[d] Because analytical procedures used at waste sites do not discriminate isomers, toxicity tests on individual and mixture of isomers are considered equivalent.

Appendix B

METHODS FOR DERIVATION OF TIER II VALUES

METHODS FOR DERIVATION OF TIER II VALUES

B.1 Method for data selection

The procedure used to select and aggregate test data was adopted from the guidelines for deriving National Ambient Water Quality Criteria (NAWQC) (Stephan et al. 1985). The selection criteria are summarized in the following text.

B.1.1 Chemical Considerations

Not all forms of inorganic chemicals require unique Tier II values. Metal salts with the same oxidation state at ambient conditions (e.g., $BeCl_2$ and $BeSO_4$) are expected to exhibit similar toxicity and are given a common Tier II value. Nonionizable, covalently bonded compounds of metals or metals of different oxidation states were considered different chemicals, for which separate Tier II values were derived.

For volatile compounds, only results of flow-through tests with measured chemical concentrations were used, if available. However, if flow-through measured tests were not available, the genus mean acute value (GMAV) was based on static and flow-through unmeasured tests.

Pesticides were screened for commercial formulations; wettable powder, emulsifiable concentrates, and formulated mixtures were eliminated. Only pesticides of technical grades or better were considered.

B.1.2 Dilution water considerations

Test results were rejected if unusual dilution water was used (e.g., TOC > 5 ppm, lack of appropriate salts, low dissolved oxygen), unless toxicity has been demonstrated to be independent of these factors. Tests in which dissolved oxygen fell below 40% saturation for static or 60% saturation for flow-through were eliminated.

B.1.3 Biological parameters

Tests of certain organisms were excluded from the Tier II value derivation. Single-celled organisms and brine shrimp (*Artemia* sp.) were not used. Fish were generally limited to species with wild North American populations. However, if none of the tests with North American fish were acceptable and values for other organisms were not available, non-resident fish were used.

Tests which did not refer to a standard procedure or indicate use of a control group were excluded. Acute tests in which organisms were fed were eliminated, unless feeding was demonstrated to be independent of toxicity.

For the acute tests, only daphnids and midges (*Chironomus* sp.) have a specified starting age. Daphnids must be less than 24 hours of age at the start of the test. Midges in second or third instar larvae were preferred, but midge tests starting at fourth instar were accepted. Although the starting age for all other organisms has not been specified, juvenile stages were preferred whenever they were available (unless another life stage is more sensitive to the chemical). All organisms should receive a 96-hour exposure period, except daphnids and midges, where 48 hours is the standard exposure period. The endpoint for daphnids and midges is the EC50 for immobilization. If this is not available, LC50 is used. For fish, the preferred endpoint is the EC50 for loss of equilibrium, immobilization, and/or mortality. If those are not available, LC50 is used.

In chronic tests, the starting age, exposure duration, and endpoints may be different for daphnids and fish and for salmonids and non-salmonids. Daphnids must be less than 24 hours old at the start of the test, and the test should last at least 21 days. Endpoints are based on mortality and number of young per female.

For a given fish species, preference is given to the following types of chronic tests in the order as follows: full life cycle, partial life cycle, and early life stage. The less desirable chronic test is not included in the calculation if a more desirable type is available.

B.1.4 Variation of Acute Values within the same genus

If the acute values within a species or among species in a genus differ by a factor of 10 or more, the higher values were excluded, and those that are within the factor of 10 range were used to attain a conservative estimate. If the acute concentrations of a given species differ by a factor of two or more among different life stages, the more sensitive life stage is used to protect the organisms in all life stages.

B.1.5 ACR Considerations

If the acute chronic ratios (ACRs) for a chemical differ by more than a factor of 10, the tests were carefully examined to determine whether outliers should be rejected. ACRs from saltwater species should be used along with the freshwater ACRs when less than three ACRs from freshwater species are available. If the lowest GMAV is from larvae of barnacles, bivalves, lobsters, crabs, shrimp, or abalones, the secondary acute chronic ratio (SACR) is assumed to be 2. If an ACR is less than 2, acclimation may have occurred. The ACR is then set to 2.

Preference was given to acute and chronic tests done in the same study. If these are not available, an acute value with water characteristics similar to the chronic value was used. If values from similar water are not available, the GMAV of the species is used with the chronic value to derive an ACR. If multiple chronic values for a species are available but none are part of the same study as an acute test, the geometric mean of the chronic values was calculated and used with the GMAV to derive an ACR for that species.

B.1.6 Acceptable exposure types and life stage used to derive ACR

For daphnids, renewal is required for chronic tests; while for acute tests, static exposure is acceptable. All chronic test concentrations should be measured. The life stage of daphnids has to be 24 hours or younger at the start of both acute and chronic tests.

For fish, both acute and chronic tests require flow-through measured tests. For acute fish tests, the life stage of the organism should be juvenile.

B.1.7 Other considerations

Concentrations above the solubility of chemicals and "greater than" values were used only when at least one definitive concentration was available.

B.2 Calculation method

Tier II values are derived if fewer than eight of the acute data requirements or three chronic data requirements presented in EPA (1993a) are met. The eight acute data requirements include:

1. The family *Salmonidae* in the class *Osteichthyes*
2. One other family (preferably a commercially, or recreationally important, warmwater species) in the class *Osteichthyes* (e.g., bluegill, channel catfish, etc.)
3. A third family in the phylum *Chordata* (e.g., fish, amphibian, etc.)
4. A planktonic crustacean (e.g., a cladocceran, copepod, etc.)
5. A benthic crustacean (e.g., ostracod, isopod, amphipod, crayfish, etc.)
6. An insect (e.g., mayfly, dragonfly, damselfly, stonefly, caddisfly, mosquito, midge, etc.)
7. A family in a phylum other than *Arthropoda* or *Chordata* (e.g., *Rotifera*, *Annelida*, *Mollusca*, etc.)
8. A family in any order of insect or any phylum not already represented

If all of these data requirements are not met, then an FAV is calculated. The FAV is a Tier I criterion, and its derivation is documented in Stephan et al. (1985) and in Appendix A of EPA (1993a). The FAV, however, is used in the derivation of the SCV if the chronic data requirements are not met.

Tier II values, as mentioned previously, are calculated when the data requirements are not met. The first calculation of the Tier II criteria is the SAV. The SAV is derived by taking the lowest genus mean acute value (GMAV) for any of the genera present and dividing it by a Final Acute Value Facto r (FAVF). The FAVF is selected from Table B.1 where n is the number of the eight acute dat a requirements that are satisfied. FAVFs are selected from the tw o columns depending on whether an acute value (LC50 or EC50) for a daphnid is included in the data set.

Once the SAV is calculated, the Secondary Acute-Chronic Ratio (SACR) is derived. If three o r more Acute-Chronic Ratios (AC Rs) are present, then the SACR is determined by finding the geometric mean of the ACRs. There must be at least three ACRs. If there are not three chronic values from the literature, then a default value of 17.9 (EPA 1991) is used until the total number of ACRs is three. If multiple ACRs are given for the same genus, then the geometric me an of those ACRs must be calculated. This genus mean ACR can then be used in the derivation of the SACR. Therefore, several members of the same genus can only present one valu e towards the mandatory three. If no ACRs are given, then the SACR is 17.9.

The final calculation for Tier II values is the derivation of an SCV. The SCV is calculated b y dividing the FAV or SAV by the SACR.

Table B.1. Factors for estimation of the Tier II values (EPA 1993 and Stephan 1991)

Number of GMAVs[a]	Factor for data sets that include an acute value for a daphnid[b]	Factors for data sets that do not include an acute value for a daphnid[b]
1	20.5	242
2	13.2	64.8
3	8.6	36.2
4	6.5	20.1
5	5.0	12.9
6	4.0	9.2
7	3.6	7.2

[a] GMAV is Genus Mean Acute Value
[b] Daphnids includes members of the genera *Daphnia, Ceriodaphnia,* and *Simocephalus*.

Appendix C

TABLE SHOWING CONCENTRATIONS ESTIMATED TO CAUSE A 20% REDUCTION IN THE RECRUIT ABUNDANCE OF LARGEMOUTH BASS, WITH UPPER AND LOWER 95% CONFIDENCE BOUNDS

Table C.1. Concentrations estimated to cause a 20% reduction in the recruit abundance of largemouth bass, with upper and lower 95% confidence bounds. All units are ug/L

Chemical	Test Species	Test Type	Lower 95% CL	Median	Upper 95%CL	Source
Ammonia	Fathead minnow	Chronic	3.98	100	1585	Mayes et al. 1986
	Fathead minnow	Chronic	3.98	32	200	Thurston et al. 1986
Antimony	Fathead minnow	Acute	5.01	79	501	EPA 1980b
Arsenic III	Fathead minnow	Chronic	100	1995	31623	Call et al. 1983
Arsenic V	Fathead minnow	Acute	20	159	1000	EPA 1985a
	Rainbow trout	Acute	10	100	501	EPA 1985a
	Mosquitofish	Acute	32	398	2512	EPA 1985a
Beryllium	Fathead minnow	Acute	0.35	7.08	40	EPA 1980f
	Bluegill	Acute	2.00	32	126	EPA 1980f
	Flagfish	Acute	2.00	32	126	EPA 1980f
	Guppy	Acute	1.58	25	126	EPA 1980f
Cadmium	Fathead minnow	Chronic	1	10	79	Pickering and Gast 1972
	Bluegill	Chronic	1.99	13	50	Eaton 1974
	Brook trout	Chronic	0.13	1.26	6.31	Benoit et al. 1976
	Brook trout	Chronic	0.32	3.16	25	Sauter et al. 1976
	Flagfish	Chronic	0.63	3.98	50	Carlson et al. 1982
	Flagfish	Chronic	0.79	3.16	7.94	Spehar 1976
Chromium III	Rainbow trout	Chronic	13	126	1000	Stevens and Chapman 1984
Chromium VI	Fathead minnow	Chronic	25	158	1260	Pickering 1980
	Rainbow trout	Chronic	100	631	5010	Sauter et al. 1976
Cobalt	Fathead minnow	Acute	0.16	3.98	32	Lind et al. 1978
Copper	Fathead minnow	Chronic	0.40	3.98	40	Mount 1968
	Fathead minnow	Chronic	0.32	3.16	16	Mount and Stephan 1969
	Bluegill	Chronic	1.995	13	50	Benoit 1975
	Brook trout	Chronic	1	3.98	16	McKim and Benoit 1971
	Brook trout	Chronic	1	5.01	40	Sauter et al. 1976
	Coho salmon	Chronic	3.16	32	316	Hazel and Meith 1970

Table C.1. (continued)

Chemical	Test Species	Test Type	Lower 95% CL	Median	Upper 95%CL	Source
	Rainbow trout	Chronic	3.98	32	200	Seim et al. 1984
Cyanide	Fathead minnow	Chronic	0.20	2.51	16	Smith et al. 1979
	Atlantic Salmon	Chronic	1.99	16	200	Leduc 1978
	Bluegill	Chronic	5.01	25	158	Smith et al. 1979
	Brook trout	Chronic	1.58	13	79	Smith et al. 1979
Lead	Brook trout	Chronic	13	50	316	Holcombe et al. 1976
	Rainbow trout	Chronic	13	100	631	Sauter et al. 1976
Manganese	Fathead minnow	Acute	11	112	794	Kimball n.d.
Mercury, inorganic	Fathead minnow	Chronic	0.04	0.79	13	Call et al. 1983
	Fathead minnow	Chronic	0.01	0.13	3.16	Snarski and Olson 1982
Mercury, methyl	Rainbow trout	Acute	0.004	0.16	1.26	EPA 1985e
	Brook trout	Acute	0.02	0.50	3.98	EPA 1985e
Nickel	Fathead minnow	Chronic	32	126	501	Pickering 1974
	Rainbow trout	Chronic	13	63	398	Nebeker et al. 1985
	Rainbow trout	Chronic	126	1260	15800	Nebeker et al. 1985
Silver	Fathead minnow	Chronic	0.01	0.1	1	Holcombe et al. 1983
	Rainbow trout	Chronic	0.1	1	7.94	Nebeker et al. 1983
Thallium	Fathead minnow	Acute	0.25	4.47	40	EPA 1980bb
	Bluegill	Acute	73	1000	6310	EPA 1980bb
Uranium	Fathead minnow	Acute	0.398	10	50	Cushman et al. 1977
	Fathead minnow	Acute	0.501	10	50	Cushman et al. 1977
	Fathead minnow	Acute	0.631	13	79	Cushman et al. 1977
	Fathead minnow	Acute	32	398	3980	Cushman et al. 1977
Vanadium	Fathead minnow	Acute	0.28	5.01	40	Kimball n.d.
	Brook trout	Acute	5.01	63	398	Ernst and Garside 1987
	Flagfish	Acute	10	100	501	Holdway and Sprague 1979
Zinc	Fathead minnow	Chronic	3.98	40	316	Benoit and Holcombe 1978

Table C.1. (continued)

Chemical	Test Species	Test Type	Lower 95% CL	Median	Upper 95%CL	Source
	Fathead minnow	Chronic	3.16	40	316	Brungs 1969
	Coho salmon	Chronic	16	126	794	Finlayson and Verrue 1980
	Flagfish	Chronic	6.31	32	126	Spehar 1976
	Rainbow trout	Chronic	40	501	5010	Sinley et al. 1974
Zirconium	Fathead minnow	Acute	3.16	50	316	Cushman et al. 1977
	Fathead minnow	Acute	3.16	50	398	Cushman et al. 1977
	Fathead minnow	Acute	32	398	3160	Cushman et al. 1977
	Fathead minnow	Acute	63	794	6310	Cushman et al. 1977
	Bluegill	Acute	10	126	501	Cushman et al. 1977
	Bluegill	Acute	200	2510	15800	Cushman et al. 1977
Organics						
AC 222,705	Fathead minnow	Chronic	0.0006	0.01	0.063	Spehar et al. 1983
Acetone	Fathead minnow	Acute	1780	19900	25100	AQUIRE[a]
	Bluegill	Acute	3160	50100	501000	AQUIRE[a]
	Rainbow trout	Acute	1260	31600	316000	AQUIRE[a]
	Mosquitofish	Acute	631	10000	100000	AQUIRE[a]
AG thiosulfate complex	Fathead minnow	Chronic	1000	10000	79400	LeBlanc et al. 1984
Aldicarb	Fathead minnow	Chronic	3.16	50	631	Pickering and Giliam 1982
Atrazine	Brook trout	Chronic	100	1000	12600	Macek et al. 1976b
Benzene	Fathead minnow	Acute	10	100	794	EPA 1980d
	Bluegill	Acute	13	158	1000	EPA 1980d
	Rainbow trout	Acute	3.16	40	316	EPA 1980d
	Mosquitofish	Acute	200	3160	25100	EPA 1980d
	Guppy	Acute	32	316	1580	EPA 1980d
Benzidene	Rainbow trout	Acute	5.01	63	398	EPA 1980c
	Lake trout	Acute	3.16	40	251	EPA 1980c
	Flagfish	Acute	10	126	794	EPA 1980c
Benzoic acid	Mosquitofish	Acute	126	1260	10000	AQUIRE[a]
Benzyl alcohol	Fathead minnow	Acute	16	1780	12600	AQUIRE[a]
	Bluegill	Acute	6.31	79	398	AQUIRE[a]
Bis(2-ethylhexyl)phthalate Rainbow trout	Acute	100	1000	7940		AQUIRE[a]
	Largemouth bass	Acute	25	316	1580	AQUIRE[a]

Table C.1. (continued)

Chemical	Test Species	Test Type	Lower 95% CL	Median	Upper 95%CL	Source
2-Butanone	Channel catfish	Acute	0.006	0.40	6.31	AQUIRE[a]
	Fathead minnow	Acute	501	10000	100000	AQUIRE[a]
	Mosquitofish	Acute	1990	31600	398000	AQUIRE[a]
Captan	Fathead minnow	Chronic	0.32	3.16	20	Hermanutz et al. 1973
Carbaryl	Fathead minnow	Chronic	3.16	32	1000	Carlson 1971
Carbon disulfide	Mosquitofish	Acute	100	1000	7940	AQUIRE[a]
Carbon tetrachloride	Fathead minnow	Acute	11	126	1260	EPA 1980h
	Bluegill	Acute	40	398	3160	EPA 1980h
Chloramine	Fathead minnow	Chronic	0.32	3.16	13	Arthur and Eaton 1971
Chlordane	Bluegill	Chronic	0.13	0.40	2.51	Cardwell et al. 1977
	Brook trout	Chronic	0.20	1.26	7.94	Cardwell et al. 1977
Chlorobenzene	Fathead minnow	Acute	11	112	794	EPA 1980j
	Bluegill	Acute	10	126	1000	EPA 1980j
	Guppy	Acute	32	316	2510	EPA 1980j
Chloroform	Bluegill	Acute	79	794	5010	EPA 1980l
	Rainbow trout	Acute	40	398	3160	EPA 1980l
p,p'DDD	Fathead minnow	Acute	0.79	13	100	AQUIRE[a]
	Bluegill	Acute	0.002	0.1	1	AQUIRE[a]
	Rainbow trout	Acute	0.02	0.40	3.16	AQUIRE[a]
	Largemouth bass	Acute	0.003	0.13	1	AQUIRE[a]
	Channel catfish	Acute	0.025	1.26	16	AQUIRE[a]
2,4-D Butoxyethanol ester	Coho salmon	Chronic	10	100	1260	Finlayson and Verrue 1985
Diazinon	Fathead minnow	Chronic	0.32	3.16	25	Allison and Hermanutz 1977
	Flagfish	Chronic	10	50	316	Allison and Hermanutz 1977
Di-n-butyl phthalate	Fathead minnow	Chronic	13	251	3980	McCarthyand Whitmore 1985
2,6-Dichlorobenzamide	Rainbow trout	Chronic	1260	12600	50100	Van Leeuwen and Maas 1985
1,3-Dichlorobenzene	Fathead minnow	Chronic	316	1585	15849	Ahmad et al. 1984

Table C.1. (continued)

Chemical	Test Species	Test Type	Lower 95% CL	Median	Upper 95%CL	Source
1,4-Dichlorobenzene	Fathead minnow	Chronic	32	398	6310	Ahmad et al. 1984
1,1-Dichloroethane	Guppy	Acute	158	1580	12600	AQUIRE[a]
1,2-Dichloroethane	Fathead minnow	Acute	40	398	3160	EPA 1980k
	Bluegill	Acute	316	3980	31600	EPA 1980k
1,1-Dichloroethene	Fathead minnow	Acute	40	398	3160	EPA 1980n
	Bluegill	Acute	50	501	3980	EPA 1980n
2,4-Dichlorophenol	Fathead minnow	Chronic	32	200	1580	Holcombe et al. 1982
1,2-Dichloropropane	Fathead minnow	Chronic	398	3980	39800	Benoit et al. 1982
1,3-Dichloropropane	Fathead minnow	Chronic	501	5010	50100	Benoit et al. 1982
1,3-Dichloropropene	Bluegill	Acute	3.16	40	251	EPA 1980o
Diethyl phthalate	Bluegill	Acute	79	1000	6310	AQUIRE[a]
2,4-Dimethylphenol	Fathead minnow	Chronic	100	1260	19900	Holcombe et al. 1982
Dimethyl phthalate	Rainbow trout	Chronic	0.004	0.04	0.40	Ward and Boeri 1991b
1,3-Dinitrobenzene	Rainbow trout	Chronic	100	1000	7940	Van Der Schalie 1983
	Rainbow trout	Chronic	63	794	6310	Van Der Schalie 1983
Dinoseb	Fathead minnow	Chronic	0.13	3.16	40	Call et al. 1983
Di-n-octyl phthalate	Fathead minnow	Chronic	200	1990	39800	McCarthy and Whitmore 1985
Diuron	Fathead minnow	Chronic	1	16	158	Call et al. 1983
Dursban	Fathead minnow	Chronic	0.002	0.032	0.20	Jarvinen et al. 1983
DNBP	Rainbow trout	Chronic	0.00004	0.0004	0.005	Ward and Boeri 1991a
Endrin	Fathead minnow	Chronic	0.005	0.13	1.58	Carlson et al. 1982
Endosulfan	Fathead minnow	Chronic	0.002	0.016	0.13	Macek et al. 1976b
Ethyl benzene	Fathead minnow	Acute	10	158	1000	EPA 1980p
	Bluegill	Acute	50	501	3980	EPA 1980p
	Guppy	Acute	79	794	5010	EPA 1980p
Fenitrothion	Fathead minnow	Chronic	0.1	126	1990	Kleiner et al. 1984

Table C.1. (continued)

Chemical	Test Species	Test Type	Lower 95% CL	Median	Upper 95%CL	Source
Fluoranthene	Bluegill	Acute	2.00	32	126	EPA 1980q
Fluridone	Fathead minnow	Chronic	32	398	10000	Hamelink et al. 1986
Fonofos	Fathead minnow	Chronic	3.16	20	158	Pickering and Giliam 1982
Guthion	Fathead minnow	Chronic	0.013	0.13	3.98	Adelman et al. 1976
Heptachlor	Fathead minnow	Chronic	0.01	0.1	0.63	Macek et al. 1976b
Hexachlorobutadiene	Fathead minnow	Chronic	0.32	3.98	63	Benoit et al. 1982
Hexachlorocyclohexane (lindane)	Bluegill Macek et al. 1976a	Chronic	0.16	1	6.31	
Hexachloroethane	Fathead minnow	Chronic	3.98	100	1580	Ahmad et al. 1984
2-Hexanone	Fathead minnow	Acute	100	1260	12600	AQUIRE[a]
Kelthane	Fathead minnow	Chronic	0.32	7.94	100	Spehar et al. 1982
LAS 11.2	Fathead minnow	Chronic	126	1580	25100	Holman et al. 1980
LAS 11.7	Fathead minnow	Chronic	13	200	2510	Holman et al. 1980
LAS Mixture	Fathead minnow	Chronic	20	316	1580	Pickering and Thatcher 1970
Malathion	Flagfish	Chronic	3.162	20	126	Hermanutz 1978
1-Methylnaphthalene	Fathead minnow	Acute	1.78	31.62	200	AQUIRE[a]
4-Methyl-2-pentanone	Fathead minnow	Acute	141	1580	15800	AQUIRE[a]
2-Methylphenol	Fathead minnow	Acute	3.98	40	398	AQUIRE[a]
	Bluegill	Acute	13	126	1000	AQUIRE[a]
	Rainbow trout	Acute	6.31	79	398	AQUIRE[a]
Methylene chloride	Fathead minnow	Acute	63.10	1000	10000	AQUIRE[a]
	Bluegill	Acute	158	1580	12600	AQUIRE[a]
Naphthalene	Fathead minnow	Chronic	73	1000	12600	DeGraeve et al. 1982
4-Nitrophenol	Fathead minnow	Acute	13	159	1260	AQUIRE[a]
	Bluegill	Acute	3.98	50	316	AQUIRE[a]
	Rainbow trout	Acute	6.31	79	398	AQUIRE[a]

Table C.1. (continued)

Chemical	Test Species	Test Type	Lower 95% CL	Median	Upper 95%CL	Source
	Channel catfish	Acute	0.79	20	200	AQUIRE[a]
N-nitrosodiphenylamine	Bluegill	Acute	3.16	40	251	AQUIRE[a]
PCBs: Aroclor 1221	Cutthroat trout	Acute	0.63	10	50	AQUIRE[a]
PCBs: Aroclor 1232	Cutthroat trout	Acute	1.26	16	126	AQUIRE[a]
PCBs: Aroclor 1242	Fathead minnow	Chronic	0.13	1.58	40	Nebeker et al. 1974
PCBs: Aroclor 1248	Flagfish	Chronic	0.13	1.26	7.94	Nebeker et al. 1974
PCBs: Aroclor 1254	Fathead minnow	Chronic	0.1	0.63	7.94	Nebeker et al. 1974
PCBs: Aroclor 1260	Cutthroat trout	Acute	32	316	2510	AQUIRE[a]
Pentachloroethane	Fathead minnow	Chronic	100	1260	19900	Ahmad et al. 1984
Pentachlorophenol	Fathead minnow	Chronic	1.58	32	501	Holcombe et al. 1982
	Fathead minnow	Chronic	0.32	1.99	20	Spehar et al. 1985
	Fathead minnow	Chronic	0.63	6.31	63	Spehar et al. 1985
	Fathead minnow	Chronic	1.26	13	126	Spehar et al. 1985
	Fathead minnow	Chronic	1.99	16	158	Spehar et al. 1985
	Rainbow trout	Chronic	1.58	10	50	DominguezandChapman 1984
1-Pentanol	Bluegill	Acute	398	5010	39800	AQUIRE[a]
	Rainbow trout	Acute	200	2510	19900	AQUIRE[a]
Permethrin	Fathead minnow	Chronic	0.02	0.40	5.01	Spehar et al. 1983
Phenol	Fathead minnow	Chronic	1000	12600	199000	Degraeve et al. 1980
	Rainbow trout	Chronic	126	1580	15800	Degraeve et al. 1980
Propanil	Fathead minnow	Chronic	0.01	0.1	0.63	Call et al. 1983
2-Propanol	Fathead minnow	Acute	200	3160	31600	AQUIRE[a]
Pydrin	Fathead minnow	Chronic	0.006	0.13	1.58	Spehar et al. 1982
1,1,2,2-Tetrachloroethane	Fathead minnow	Chronic	251	1580	50100	Ahmad et al. 1984
Tetrachloroethene	Fathead minnow	Acute	3.16	50	398	EPA 1980aa
	Bluegill	Acute	10	100	501	EPA 1980aa
	Rainbow trout	Acute	3.16	40	316	EPA 1980aa

Table C.1. (continued)

Chemical	Test Species	Test Type	Lower 95% CL	Median	Upper 95%CL	Source
Tetrachloroethylene	Fathead minnow	Chronic	40	1000	12600	Ahmad et al. 1984
Toluene	Fathead minnow	Acute	10	126	1000	EPA 1980cc
	Bluegill	Acute	13	126	1000	EPA 1980cc
	Guppy	Acute	50	501	3160	EPA 1980cc
Toxaphene	Brook trout	Chronic	0.01	0.063	0.40	Mayer et al. 1975
1,1,1-Trichloroethane	Fathead minnow	Acute	18	200	1580	AQUIRE[a]
	Bluegill	Acute	32	316	1580	AQUIRE[a]
1,1,2-Trichloroethane	Fathead minnow	Chronic	1000	15800	251000	Ahmad et al. 1984
Trichloroethene	Fathead minnow	Acute	13	158	1260	EPA 1980dd
	Flagfish	Acute	20	251	1260	Smith et al. 1991
	Bluegill	Acute	32	316	1990	EPA 1980dd
2-Trifluoromethyl-4-phenol	Brook trout	Chronic	100	501	3160	Dwyer et al. 1978
Trifluralin	Fathead minnow	Chronic	0.063	0.63	7.94	Macek et al. 1976b
1,3,5-Trinitrobenzene	Fathead minnow	Chronic	3.16	50	631	Van der Schalie 1983
	Rainbow trout	Chronic	13	158	1580	Van der Schalie 1983
	Rainbow trout	Chronic	13	158	1580	Van der Schalie 1983
Vinyl acetate	Fathead minnow	Acute	3.16	40	398	AQUIRE[a]
	Bluegill	Acute	10	126	794	AQUIRE[a]
	Guppy	Acute	25	251	1580	AQUIRE[a]

[a] EPA (n.d.)

Letter From Dan Flory, Chief, State Water Project Analysis Office

STATE OF CALIFORNIA -- THE RESOURCES AGENCY

GRAY DAVIS, *Governor*

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

JUL 18 2003

JUL 16 2003

Mr. Dan Masnada
General Manager
Castaic Lake Water Agency
27234 Bouquet Canyon Road
Santa Clarita, California 91350

Dear Mr. Masnada:

Enclosed for your records are the following fully executed documents:

1. A copy of the Settlement Agreement dated May 5, 2003 that settled Planning and Conservation League, et al. v. Department of Water Resources. Your agency's original signature is inserted within your copy.

2. An original of the Attachment A Amendment to your State Water Project water supply contract.

3. An original of the Cost Allocation Agreement which provides that the litigation costs will be allocated as incurred based on each contractor's proportion of total maximum Table A Amounts as of January 1, 2003.

If you need additional information or would like to discuss this further, please call me at (916) 653-4313.

Sincerely,

Robert B Cooke
for Dan Flory, Chief
State Water Project Analysis Office

Enclosures

SETTLEMENT AGREEMENT

by and among

Planning and Conservation League, Plumas County Flood Control and Water Conservation District, Citizens Planning Association of Santa Barbara County, Inc.

and

The State of California Department of Water Resources, Central Coast Water Authority, Kern Water Bank Authority and those State Water Project Contractors identified herein.

MAY 0 5 2003

________________, 2003

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LIST OF ATTACHMENTS AND EXHIBITS

Attachments

Attachment A	Amendment to SWP Contract
Attachment B	Principles Regarding State Water Project Reliability
Attachment C	Transfer Guidelines for Annual Table A Amounts
Attachment D	Principles Regarding Public Participation in SWP Contract Negotiations
Attachment E	Final Permanent Table A Amount Transfers from KCWA Subsequent to the Monterey Amendments

Exhibits

Exhibit 1	Plaintiffs' Expenses Trust Account Agreement
Exhibit 2	Kern Environmental Permits
Exhibit 3-A	Proposed 21168.9 Order
Exhibit 3-B	Proposed Writ of Mandate
Exhibit 4	Section VI Trust Account Agreement

SETTLEMENT AGREEMENT

This SETTLEMENT AGREEMENT is entered into as of MAY 0 5 2003, 2003, by and among Planning and Conservation League, Plumas County Flood Control and Water Conservation District, Citizens Planning Association of Santa Barbara County, Inc., The State of California Department of Water Resources, Central Coast Water Authority, Kern Water Bank Authority and those SWP Contractors who have executed this Settlement Agreement. Certain terms used herein are defined in Section I.

RECITALS

WHEREAS, in 1951, the State of California Legislature authorized the construction of the State Water Project ("SWP");

WHEREAS, eight years later, the Legislature authorized the submission for voter approval of a general obligation bond issue to build the SWP, which voters subsequently approved (California Water Code, Section 12930 et seq.);

WHEREAS, commencing in the early 1960's, DWR, as operator of the SWP, entered into certain SWP Contracts with various water districts throughout California;

WHEREAS, in 1994, as a result of disputes arising from water shortages experienced during an extended drought period, DWR and certain of the SWP Contractors entered into an agreement known as the Monterey Agreement and thereafter implemented the terms of the Monterey Agreement by execution of the so-called Monterey Amendments;

WHEREAS, pursuant to CEQA, the environmental impact report for the Monterey Amendments was prepared in 1995 by CCWA as "lead agency," and adopted by DWR as "responsible agency" (as those terms are defined in CEQA) (the "**1995 EIR**");

WHEREAS, on December 27, 1995, PCL filed the PCL Complaint against DWR and CCWA challenging the sufficiency of the 1995 EIR;

WHEREAS, on February 12, 1996, Plaintiffs filed a First Amended Complaint adding the Validation Cause of Action;

WHEREAS, the trial court ultimately determined that although CCWA was not the appropriate lead agency for the 1995 EIR, such designation of CCWA was not fatal to the EIR, and ruled against Plaintiffs with respect to their challenge to the sufficiency of the 1995 EIR. The trial court also granted summary adjudication in favor of DWR and CCWA on the Validation Cause of Action. Plaintiffs appealed the trial court's rulings;

WHEREAS, in Planning and Conservation League v. Department of Water Resources, 83 Cal. App. 4th 892 (2000), the Court of Appeal held that (i) DWR, not CCWA, had the statutory duty to serve as lead agency, (ii) the trial court erred by finding CCWA's EIR sufficient despite its failure to discuss implementation of Article 18, subdivision (b) of the SWP Contracts, as a no-project alternative, (iii) said errors mandate preparation of a new EIR under the direction of DWR, and (iv) the trial court erroneously dismissed the challenge to DWR's transfer of title to the KWB Lands (the Validation Cause of Action) and execution of amended SWP Contracts for failure to name and serve indispensable parties. The Court of Appeal remanded the case to the trial court, ordering it to take the following five actions: (1) vacate the trial court's grant of the motion for summary adjudication of the Validation Cause of Action; (2) issue a writ of mandate vacating the certification of the 1995 EIR; (3) determine the amount of attorney fees to be awarded Plaintiffs; (4) consider such orders it deems appropriate under Public Resources Code Section 21168.9(a) consistent with the views expressed in the Appellate Court's opinion; and (5) retain jurisdiction over the action until DWR, as lead agency, certifies an environmental impact report in accordance with CEQA standards and procedures, and the Superior Court determines that such environmental impact report meets the substantive requirements of CEQA;

WHEREAS, since the Court of Appeal ruling, representatives of the Parties to this Settlement Agreement have engaged in extensive settlement negotiations, mediated by retired Judge Daniel Weinstein, with the intent of avoiding further litigation and associated fees and providing for an effective way to cooperate in the preparation of a new environmental impact report and make such other improvements in the operation and responsiveness of the SWP as set forth in this Settlement Agreement;

WHEREAS, on July 22, 2002, an agreement was reached regarding the principles for a settlement; and

WHEREAS, the Parties now desire to formally enter into this Settlement Agreement.

<u>AGREEMENT</u>

NOW, THEREFORE, in exchange for the following covenants and agreements and other valuable and sufficient consideration, the receipt of which is acknowledged, the Parties agree as follows:

I. <u>**Definitions**</u>. Certain terms, as used in this Settlement Agreement, are defined as follows.

A. **"Attachment A Amendments"** means those amendments in the substantive form of <u>Attachment A</u> hereto (conformed to the format of each individual SWP Contract and the parties thereto), to be executed by DWR and the SWP Contractors who are signatories to this Settlement Agreement pursuant to and in accordance with the terms and conditions of this Settlement Agreement.

B. **"Attachment B Principles"** means those principles set forth in <u>Attachment B</u> hereto regarding SWP reliability.

C. **"Attachment C Guidelines"** means the guidelines set forth in <u>Attachment C</u> hereto regarding review of proposed permanent transfers of Annual Table A Amounts (as such latter term is used in the SWP Contracts).

D. **"Attachment D Principles"** means those principles set forth in <u>Attachment D</u> hereto regarding public participation in SWP Contract negotiations.

E. **"Attachment E Transfers"** means those water transfers identified on <u>Attachment E</u> hereto.

F. **"CEQA"** means the California Environmental Quality Act, California Public Resources Code Section 21000 et seq.

G. **"Citizens Planning Association"** means Citizens Planning Association of Santa Barbara County, Inc.

H. **"CCWA"** means Central Coast Water Authority.

I. **"Consent to Entry of Order Discharging Writ"** has the meaning given in Section VII(H)(1).

J. **"DWR"** means The State of California Department of Water Resources.

K. **"EIR Committee"** means a committee of no more than four (4) SWP Contractor representatives, and no more than four (4) Plaintiff representatives, chaired by a DWR representative, which has been formed for the purposes set forth in Section III(B).

L. **"HCP"** means the Habitat Conservation Plan/Natural Community Conservation Plan prepared for the Kern Water Bank Authority and approved through an Implementation Agreement dated October 2, 1997, with the United States Fish and Wildlife Service and California Department of Fish and Game.

M. **"Interim Implementation Order"** has the meaning given in Section VII(C).

N. **"JAMS Trust Account"** means the account established by DWR with, and maintained by, the Mediator for the purpose set forth in Section VI.

O. **"Kern-Castaic Transfer"** means the transfer of 41,000 acre-feet of water from Kern County Water Agency to the Castaic Lake Water Agency approved by DWR on March 31, 1999.

P. **"Kern Environmental Permits"** means the HCP and certain other permits, approvals and agreements relating to the Kern Water Bank, as set forth in and contemplated by the Addendum to the 1995 EIR, including those specified in Exhibit 2 hereto and similar, related permits, approvals and agreements.

Q. **"Kern Fan Element Transaction"** means DWR's transfer of the KWB Lands to Kern County Water Agency, as described in Article 52 of the Monterey

Amendments. Kern County Water Agency subsequently conveyed the KWB Lands to KWBA. Each of the stated conveyances occurred on August 9, 1996, based upon separate agreements dated December 13, 1995.

R. **"KWB Lands"** means the property known as the Kern Fan Element, as more specifically described in that certain Deed, executed by the Kern County Water Agency in favor of KWBA, dated August 9, 1996, and recorded in the Official Records of Kern County as Instrument No. 0196101606.

S. **"KWBA"** means Kern Water Bank Authority.

T. **"Mediator"** means retired Judge Daniel Weinstein, unless Judge Weinstein is unavailable, in which case the Mediator shall be another retired jurist mutually agreed to by DWR and the other members of the EIR Committee with respect to matters referred to the Mediator under Section III(H), and for all other matters another retired jurist approved by agreement of the Parties.

U. **"Mediation Issue"** means any issue relating exclusively to the compliance of the New EIR with any of the following requirements: (a) the requirements of CEQA; (b) the direction of the courts in the underlying litigation; or (c) the terms and conditions of this Settlement Agreement.

V. **"Monterey Agreement"** means the formal agreement, dated as of December 1, 1994, by and among DWR and certain SWP Contractors that memorializes fourteen principles to address the distribution of water during shortages and various other issues under the SWP Contracts.

W. **"Monterey Amendment"** means the amendment to the SWP Contracts entered into by DWR and certain SWP Contractors for purposes of implementing the Monterey Agreement.

X. **"New EIR"** has the meaning given in Section III.

Y. **"Party"** and **"Parties"** mean the signatories, individually and collectively, to this Settlement Agreement.

Z. **"PCL"** means Planning and Conservation League.

AA. **"PCL Complaint"** means the Complaint for Declaratory and Injunctive Relief and Petition for Writ of Mandate filed December 27, 1995, by PCL in the Superior Court, as amended and supplemented by the First Amended Complaint filed February 12, 1996.

BB. **"Plaintiffs"** means PCL, Citizens Planning Association and Plumas.

CC. **"Plaintiffs' Expenses Trust Account"** means the account maintained by JAMS for the purposes set forth in Section III(G).

DD. **"Plumas"** means Plumas County Flood Control and Water Conservation District.

EE. **"Plumas Amendment"** means an amendment to the Plumas SWP Contract to be entered into by DWR and Plumas pursuant to Section IV(C).

FF. **"Plumas Arrearages"** means any amount owed by Plumas to DWR under its SWP Contract that accrued prior to the resumption of payments by Plumas under Section IV(F).

GG. **"Return to Writ"** has the meaning given in Section VII(G).

HH. **"Rossmann"** means the Law Offices of Antonio Rossmann.

II. "**Section VI Trust Account Agreement**" means a trust account agreement regarding the disbursement by JAMS to Plaintiffs of those funds delivered by DWR pursuant to Section VI of this Settlement Agreement, the form of which agreement is attached hereto as Exhibit 4.

JJ. **"Superior Court"** means the Superior Court of the State of California, County of Sacramento.

KK. **"SWP"** means the State Water Project, officially called the State Water Resources Development System, as defined in Water Code Section 12931.

LL. **"SWP Contracts"** means those long-term contracts entered into by and between DWR, as the operator of the SWP, and individual SWP Contractors for the delivery of water from the SWP.

MM. **"SWP Contractors"** for purposes of this Settlement Agreement, means those contracting agencies identified in Table 1-6 of the DWR Bulletin 132-00, dated December 2001. All references to "SWP Contractors who are parties to this Settlement Agreement" are meant to exclude Plumas. Specific issues relating to Plumas are addressed in Section IV.

NN. **"Validation Cause of Action"** means the fifth cause of action of the PCL Complaint.

OO. **"Watershed Forum"** means a newly formed stakeholder group consisting of one or more representatives from each of Plumas, local community-based groups, DWR and the SWP Contractors who are parties to this Settlement Agreement, established for the purposes set forth in Section IV(B).

PP. **"Watershed Programs"** means programs, studies or projects approved by the Watershed Forum and implemented in pursuit of the goals set forth in Section IV, and other such activities approved by the Watershed Forum that are consistent with such purposes and goals.

QQ. **"1995 EIR"** means the Final Programmatic Environmental Impact Report for the Implementation of the Monterey Agreement Statement of Principles by State Water Project Contractors and the State of California Department of Water Resources for Potential Amendments to State Water Supply Contracts, prepared in October, 1995 by CCWA, as lead agency, and reviewed and considered in December 1995, by DWR, as a responsible agency, as each of those terms is defined in CEQA.

II. **Administration of the State Water Project Pending New Environmental Impact Report and Discharge of Writ of Mandate.**

Pending the Superior Court's issuance of an order discharging the writ of mandate in the underlying litigation, the Parties will jointly request that the Superior Court enter an order approving this Settlement Agreement, and an order, pursuant to California Public Resources Code Section 21168.9, authorizing on an interim basis the administration and operation of the SWP and the Kern Water Bank in accordance with the Monterey Amendments, the terms of this Settlement Agreement and the Attachment A Amendments, as more specifically set forth in Section VII of this Settlement Agreement.

III. **New Environmental Impact Report**

A. Preparation. As lead agency (as defined in CEQA), DWR shall cause a new environmental impact report to be prepared with respect to the proposed "project" (as that term is defined in Public Resources Code Section 21065 and Section

15378 of the CEQA Guidelines), in accordance with and as further described in Section III(C) below (the "**New EIR**").

B. EIR Committee. To effectuate the desire of the Parties that the New EIR be the product of a cooperative effort and comply with the requirements of CEQA and the direction of the courts in the underlying litigation, the EIR Committee has been formed to provide advice and recommendations to DWR in connection with the preparation of the draft and final versions of the New EIR.

C. New EIR Content. The proposed project to be analyzed in the New EIR will be specifically defined during the scoping process. Under all circumstances, in order to provide DWR, the responsible agencies, and the public with adequate disclosure to consider the potential environmental impacts of the Monterey Amendments, and the additional actions set forth in this Settlement Agreement, the environmental analysis in the New EIR shall evaluate, as components of the proposed project, the Monterey Amendments (including the provisions relating to the transfer of the KWB Lands) and the Attachment A Amendments. DWR shall ensure that the New EIR evaluates all proposed actions that are necessary to implement this Settlement Agreement. The New EIR shall include the following:

1. Information on water deliveries of the SWP over the relevant historical period (at least 1991 -2002), as well as data regarding the deliveries in the last extended drought (1987-1992), to be included in the description of the setting and the background for the proposed project;

2. As part of the CEQA-mandated "no-project" alternative analysis, and in light of the Court of Appeal's opinion, an analysis of the effect of pre-

Monterey Amendment SWP Contracts, including implementation of Article 18 therein. This analysis shall address, at a minimum, (a) the impacts that might result from application of the provisions of Article 18(b) of the SWP Contracts, as such provision existed prior to the Monterey Amendments, and (b) the related water delivery effects that might follow from any other provisions of the SWP Contracts;

3. Analysis of the potential environmental impacts of changes in SWP operations and deliveries resulting from implementation of the proposed project. If the proposed project results in modifications to the water sources relied upon for the SWP, those sources will be identified and the resulting environmental effects will be assessed;

4. Analysis of the potential environmental effects relating to (a) the Attachment E Transfers and (b) the Kern-Castaic Transfer, in each case as actions that relate to the potential environmental impacts of approving the Monterey Amendments; and

5. Analysis of the potential environmental effects relating to the implementation of this Settlement Agreement, including:

    a. Evaluation of the potential environmental impacts arising from the payments to Plumas as described in Section IV; and

    b. Analysis of the potential environmental effects relating to implementation of the provisions of this Settlement Agreement relating to the Kern Water Bank as discussed in Section V.

D. Acknowledgement and Agreement Regarding Attachment E Transfers. With respect to Section III(C)(4)(a), notwithstanding the analysis of the potential impacts of the Attachment E Transfers in the New EIR and without specifically endorsing or opposing those transfers or any prior environmental assessments of them, the Parties recognize that such water transfers are final. Each of the Parties agrees not to, and it shall be a condition to the initial and continuing effectiveness of this Settlement Agreement that Plaintiffs do not, hereafter challenge the effectiveness or validity of such water transfers.

E. Acknowledgement and Agreement Regarding Kern-Castaic Transfer. With respect to Section III(C)(4)(b) regarding the Kern-Castaic Transfer, the Parties recognize that such water transfer is subject to pending litigation in the Los Angeles County Superior Court following remand from the Second District Court of Appeal (*See* Friends of the Santa Clara River v. Castaic Lake Water Agency, 95 Cal. App. 4th 1373, 116 Cal. Rptr. 2d 54 (2002); *review denied* April 17, 2002). The Parties agree that jurisdiction with respect to that litigation should remain in that court and that nothing in this Settlement Agreement is intended to predispose the remedies or other actions that may occur in that pending litigation.

F. Acknowledgement and Agreement Regarding Kern Water Bank. With respect to Section III(C)(5)(b) relating to the Kern Water Bank, the Parties acknowledge that the Kern Water Bank is currently operating under the Kern Environmental Permits, which were entered into based on an Addendum to the 1995 EIR. The Parties recognize that the Addendum has been completed and agree not to challenge it in any manner. KWBA agrees that it will not rely on the Addendum to the 1995 EIR for any new KWBA project to the extent that such reliance is based on data or analysis incorporated into the Addendum from the 1995 EIR. In addition, the New EIR shall include an independent study by DWR, as the lead agency, and the exercise of its judgment regarding the impacts related to the transfer, development, and operation of the Kern Water Bank in light of the Kern Environmental Permits. Such study shall identify SWP and any non-SWP sources of water deliveries to the Kern Water Bank. The views of the trustee agencies, as evidenced by the requirements of the HCP, will be used to provide guidance to DWR. Finally, the Parties agree that this Settlement Agreement is not intended to and shall not affect the continuing effectiveness of the Kern Environmental Permits.

G. Reimbursement of Plaintiffs' Expenses for Participation in the Preparation of New EIR.

1. *DWR Obligation to Reimburse Plaintiffs.* Subject to and in accordance with clauses (2) and (3), DWR will provide up to $300,000 to Plaintiffs for expenses actually incurred as needed to support Plaintiffs' participation in DWR's preparation of the New EIR, including service on the EIR Committee.

2. *Deposit into Trust Account.* The Parties acknowledge that in accordance with the principles of settlement, DWR caused to be deposited $300,000 into the Plaintiffs' Expenses Trust Account at JAMS on August 22, 2002.

3. *Disbursement of Funds to Plaintiffs.* Funds provided by DWR under this Section III(G) are available for disbursement and will be disbursed to

Plaintiffs by JAMS from the Plaintiffs' Expenses Trust Account in accordance with that certain Plaintiff's Expenses Trust Account Agreement dated August 15, 2002, attached hereto as Exhibit 1 and incorporated herein by this reference.

H. Disputes Regarding Mediation Issues.

1. *Referral to Director of DWR.* If the Plaintiffs' or SWP Contractors' representatives on the EIR Committee, or both, disagree with DWR's proposed approach with respect to a Mediation Issue, such representatives may refer the issue in writing to the Director of DWR.

2. *Referral to Mediator.* If (a) two-thirds of Plaintiffs' representatives or (b) three-fourths of the SWP Contractors' representatives, or both, disagree with the DWR Director's written decision with respect to a Mediation Issue (which issue shall have first been referred to the Director pursuant to Section III(H)(1)), such representative(s) may refer the issue in writing for consideration to the Mediator.

3. *Notices to Other Parties.* DWR shall inform the Parties to this Settlement Agreement of any referrals made pursuant to this Section III(H).

4. *Advisory Opinion by Mediator.* In the event of a referral as described above, the Mediator will consider the views of the representatives of the EIR Committee and the DWR Director, and will provide a written advisory opinion on the issue to the EIR Committee and DWR Director.

5. *Final Decision by DWR.* After receipt of an advisory opinion from the Mediator, the DWR Director shall make a final decision on the issue.

6. *Mediator's Costs and Expenses.*

a. *Referrals by Plaintiffs' Representatives*. On any matter referred to the Mediator by Plaintiffs' representatives on the EIR Committee, the costs of the Mediator's services will be borne one-third (1/3) by the Plaintiffs and two-thirds (2/3) by DWR.

b. *Referrals by SWP Contractors' Representatives*. For any referral by the SWP Contractors who are representatives on the EIR Committee, the SWP Contractors who are signatory to this Settlement Agreement will compensate the Mediator for his services.

c. *Frivolous or Harassing Referrals*. In the event of frivolous or harassing matters referred to him/her, the Mediator shall have the authority to award costs to the prevailing party, as well as reasonable attorney fees in accordance with Section IX of this Settlement Agreement.

I. Filing of New EIR upon Completion. Upon completion of the New EIR, in accordance with the procedure set forth in CEQA, and after final consideration by and good faith consultation with the EIR Committee, DWR shall cause the New EIR to be filed with the Superior Court as a return to the writ of mandate issued by such court in connection with this case.

IV. **Plumas Matters.**

A. Monetary Settlement.

1. *Agreement to Pay.* In accordance with the procedures and subject to the conditions described herein, DWR shall pay to Plumas the sum of $8,000,000.

2. *Schedule of Payments.*

a. Annual Payments. A total sum of Four Million Dollars ($4,000,000) shall be paid in accordance with this Section IV(A)(2)(a). DWR shall pay to Plumas One Million Dollars ($1,000,000) within 30 days after approval of this Settlement Agreement by the Superior Court (or the first business day after said 30th day if the 30th day is not a business day).

On each anniversary date of the first $1,000,000 payment until (and inclusive of) the third (3rd) anniversary, DWR shall pay to Plumas One Million Dollars ($1,000,000).

b. Post Notice-of-Determination Payments. Subject to Section IV(A)(2)(c), the remaining Four Million Dollars ($4,000,000) shall be paid in four annual installments of $1,000,000 each, beginning on the later to occur of: (1) the date that is seventy days after the Notice of Determination (as defined in CEQA) has been filed for the New EIR (or the first business day after said 70th day if the 70th day is not a business day); or (2) the date that is one year after the last payment made under Section IV(A)(2)(a).

c. *Effects of Litigation on Payment Obligation.*

(1) Suspension of Payment Obligation. If litigation is commenced by anyone challenging CEQA compliance for, or the validity of, any Monterey Amendment (or any portion thereof), including matters pertaining to the Kern Fan Element Transaction, the monetary obligations of DWR under Section IV(A)(2)(b) shall be suspended until the date that is forty-five (45) days after final conclusion of that litigation (without further right of appeal) in a manner that does not invalidate any Monterey Amendment (or any portion thereof) or the Kern Fan Element Transaction. Within thirty (30) days after final conclusion of any such litigation in said manner, DWR shall pay to Plumas any amounts then owed by DWR under this Section IV.

(2) Termination of Payment Obligation. If any such litigation results in a final judgment (without further right of appeal) that invalidates any Monterey Amendment (or any portion thereof) or the Kern Fan Element Transaction, the obligation for payments under Section IV(A)(2)(b) shall automatically terminate.

3. *Use of Funds.*

a. *Funding of Watershed Programs*. Plumas shall apply a majority of all funds received each year pursuant to Section IV(A) to Watershed Programs.

b. *Balance of Funds to General Purposes*. Plumas may apply the balance of funds received each year to other district-related purposes, as determined by Plumas with due consideration for the needs of the Watershed Forum.

c. *Annual Carry-Over*. Funds received but not spent in any given year may be carried over to the succeeding year(s), provided, however, that any such funds shall continue to be subject to the restrictions under Sections IV(A)(3)(a) and (b).

B. Watershed Forum and Programs.

1. *Formation of Watershed Forum.* Prior to the date hereof, the Watershed Forum was formed. The Watershed Forum is locally driven but includes the active and committed participation of the SWP Contractor and DWR members of the Forum.

2. *Purpose and Goals*

a. *Generally*. The Watershed Forum's purpose is to implement watershed management and restoration activities for the mutual benefit of Plumas and the SWP. Forum activities include design of, participation in, implementation of, and review of studies and demonstration projects related to watershed restoration.

b. *Specific Goals*. The specific focus of the Watershed Forum's activities is to implement programs designed to achieve the following benefits:

(1) Improved retention (storage) of water for augmented base-flow in streams;

(2) Improved water quality (specifically, reduced sedimentation), and stream bank protection;

(3) Improved upland vegetative management; and

(4) Improved groundwater retention/storage in major aquifers.

c. *Emphasis on Feather River Watershed*. The Watershed Forum specifically promotes and encourages restoration of the Feather River watershed, with particular focus on the drainages of the three SWP Upper Feather River reservoirs. The Watershed Forum seeks to obtain funding and investments in the Feather River watershed in order to facilitate programs that will generate significant local environmental and water supply benefits.

d. *Technical Advisors*. The Watershed Forum will retain a committee of technical advisors to assist the Watershed Forum in identifying activities that can provide timely and practical benefits based on the best scientific and technical information.

3. *General Watershed Forum Issues*

a. *Cooperation*. The Watershed Forum shall seek to foster mutual cooperation and support among Plumas, DWR and other SWP Contractors in achieving local and state-wide goals.

b. *Dispute Resolution*. Any disputes between members of the Watershed Forum, or between Plumas and the Watershed Forum, with respect to Watershed Forum activities and funding will be resolved by retention of a third party neutral expert reasonably acceptable to all members of the Watershed Forum.

c. *Interruption in Funding*. If payments by DWR are interrupted due to litigation challenging any Monterey Amendment (or any portion thereof) or the Kern Fan Element Transaction, as set forth in Section IV(A)(2)(c), the Parties shall, depending on the success of the watershed work and the litigation situation, give due consideration to the importance of funding watershed work in consecutive years without interruption.

d. *No Limitation on DWR Obligations*. DWR's participation in the Watershed Forum shall not compromise DWR's obligation to be impartial in the distribution of matching funds from public funding sources under its jurisdiction.

C. Plumas Amendment. Upon completion of any necessary environmental review(s), DWR shall offer to Plumas the Plumas Amendment which shall include (1) DWR's agreement that water supplied to Plumas shall be determined based on availability of water supply from Lake Davis, and (2) DWR's agreement that water deliveries to Plumas will not be reduced during SWP shortages so long as sufficient water is available from Lake Davis. The Plumas Amendment shall apply only to the maximum Table A amount in Plumas' SWP Contract on the date that this Settlement Agreement is executed. The Plumas Amendment shall also contain assurances that Plumas' claim to area-of-origin rights will not be affected by the Amendment. The Plumas Amendment may also contain the Monterey Amendment, as modified to reflect current conditions relating to Plumas, and the Attachment A Amendments.

D. Dialogue between Plumas and DWR. Subject to Plumas' execution of this Settlement Agreement and compliance with the terms herein, DWR agrees to confer with Plumas to develop strategies and actions for the management, operation, and control of SWP facilities in Plumas County in order to increase water supply, recreational, and environmental benefits to Plumas from such facilities. In furtherance thereof, DWR and Plumas agree to evaluate and give due consideration to:

1. the potential re-operation of SWP facilities in Plumas County to increase the water supply available to Plumas;
2. the potential release of water from reservoirs, as part of planned operations, for Plumas' benefit; and
3. the appropriateness of certain charges in Plumas' SWP Contract in light of current circumstances and whether amendments thereto are warranted.

E. Future Relations. Upon the Superior Court's approval of this Settlement Agreement, Plumas agrees to maintain a positive relationship with the SWP Contractors and DWR, and to support the Monterey Amendments and the Attachment A Amendments. Plumas reserves the right to review critically the New EIR.

F. Contract Payments. Plumas shall resume and maintain timely payments under its SWP Contract. Such payments shall begin upon the earlier of (1) the first payment under Section IV(A)(2)(a) or (2) the date that Plumas or its member unit resumes taking water from Lake Davis, and shall cover the period beginning January 1 of that same year. DWR will not seek to collect the amount of any Plumas Arrearages.

V. **Kern Water Bank.**

A. Title. KWBA shall retain title to the KWB Lands. KWBA may continue to operate and administer the KWB Lands including the water bank, subject to the restrictions herein.

B. Restrictions on Use of KWB Lands.

1. *Continued Use as Water Bank.* As noted in Section III(F), the KWB Lands are subject to the HCP, which documents a plan to accomplish, among other things, certain water conservation and environmental objectives. Except as provided in Sections V(B)(2) and (3), the KWB Lands shall continue to be used for the operation of a water bank and other uses authorized by the HCP, so long as such use remains legally and economically feasible.

2. *Use of KWB Lands for other SWP Purposes.* If (a) the use of the KWB Lands as a water bank is determined by KWBA to no longer be economically and/or legally feasible, (b) DWR concurs with such determination, (c) the KWB Lands can be feasibly used for any of the SWP purposes provided in California Water Code §12930 et seq., and (d) DWR and KWBA agree on terms and conditions for such use, then the KWB Lands may be so used.

3. *Use of KWB Lands for other than SWP Purposes.* If (a) the KWB Lands can not feasibly be used for any of the SWP purposes provided in California Water Code §12930 et seq., or (b) KWBA and DWR are unable to agree on terms and conditions for such use, or (c) DWR determines not to use the KWB Lands for such purposes, then KWBA may transfer or develop all or a portion of the KWB Lands for alternative use(s), provided that any alternate use will not result in unmitigated environmental impacts. A finding by KWBA that such impacts will not occur will be subject to DWR's concurrence.

4. *The 490 Acres.* The approximately 490 acres currently subject to restrictions in the HCP, permitting use thereof as Conservation Bank Lands (as defined in the HCP), but which may be developed under the HCP, will continue to be subject to the restrictions in the HCP but may not be developed.

5. *Application of HCP Restrictions.* All of the KWB Lands, including the 490 acres, will remain subject to the restrictions contained in the HCP.

The restrictions will remain in effect regardless of amendment to, or termination of, the HCP, unless, in the event of such amendment or termination, DWR, after consultation with Plaintiffs, finds that such amendment or termination will not result in unmitigated environmental impacts. The provisions of this clause shall not apply to "Minor Amendments" to the HCP as that term is utilized in the HCP.

6. *Land Use Changes Subject to CEQA*. Changes to the allowable uses of the KWB Lands shall be subject to appropriate environmental review under CEQA.

C. Transfer/Development Proceeds. If all of the KWB Lands are transferred or developed by KWBA, the proceeds of such transfer or development (net of transaction or development costs) will be used for water management purposes identified by KWBA, subject to concurrence by DWR that such use is for bona fide water management purposes; provided, however, so long as the KWB Lands continue to be used for operation of a water bank, the proceeds (net of transaction or development costs) resulting from the transfer or development of a portion of the KWB Lands (which must be consistent with Section V(B)(5)) will be used for water management purposes identified by KWBA, subject to concurrence by DWR that the expenditure is consistent with such purposes.

D. Consultation with Plaintiffs.

1. Except as provided in Section V(D)(2), with respect to any matter that requires DWR's concurrence pursuant to Section V(B) and (C), DWR

shall consult with Plaintiffs prior to making any decision with respect thereto.

2. In lieu of consulting with Plaintiffs, following the conclusion of all litigation challenging CEQA compliance for, or the validity of, the Monterey Amendments, DWR may first provide notice and opportunity to comment to Plaintiffs and the public, and then, at Plaintiffs' request, shall consult with Plaintiffs.

E. Scope of Restrictions. The foregoing restrictions shall only apply to the KWB Lands and shall not affect the use or disposition of water stored under or withdrawn from the KWB Lands.

F. Effective Date of Restrictions. The foregoing restrictions in this Section V shall not be effective unless and until the court in the above-referenced litigation issues an order approving this Settlement Agreement and the Interim Implementation Order (as defined in Section VII(c)). The restrictions in this Section V shall become final only upon (1) filing of the Notice of Determination following the completion of New EIR, (2) discharge of the writ of mandate in the underlying litigation as provided below, and (3) conclusion of all litigation in a manner that does not invalidate any Monterey Amendment (or any portion thereof) or the Kern Fan Element Transaction. The continuing effectiveness of the restrictions in this Section V, and the obligations under this Settlement Agreement to comply with these restrictions, are subject to the terms of Section VII(K) below.

VI. Funding To Plaintiffs

A. Agreement to Pay. In accordance with the procedures and subject to the conditions described herein, DWR shall pay to Plaintiffs, collectively, the sum of $5,500,000 (in addition to the $300,000 paid pursuant to Section III(G)).

B. Schedule of Payments.

1. On or before the date that is thirty (30) days after approval of this Settlement Agreement by the Superior Court and issuance of the Interim Implementation Order under Section VII, DWR shall pay to Plaintiffs One Million Eight Hundred Seventy-Five Thousand Dollars ($1,875,000).

2. On or before the first anniversary after the date upon which delivery of funds are made by DWR pursuant to Section VI(B)(1), DWR shall pay to Plaintiffs One Million Eight Hundred Seventy-Five Thousand Dollars ($1,875,000).

3. Subject to Section VI(C), on or before the seventieth (70^{th}) day after the Notice of Determination has been filed for the New EIR (or the first business day after said 70^{th} day if the 70^{th} day is not a business day), DWR shall pay to Plaintiffs One Million Seven Hundred Fifty Thousand Dollars ($1,750,000).

4. All amounts to be paid by DWR under this Section VI(B) shall be paid by wire transfer, in immediately available funds, to a JAMS Trust Account from which funds are to be disbursed therefrom to Plaintiffs in accordance with the Section VI Trust Account Agreement.

C. Effects of Litigation on Payment Obligations.

1. *Suspension of Payment Obligation.* If litigation is commenced by anyone challenging CEQA compliance for, or the validity of, any Monterey Amendment (or any portion thereof), including matters pertaining to the Kern Fan Element Transaction, the monetary obligations of DWR under Section VI(B)(3) shall be suspended until the date that is forty-five (45) days after conclusion of such litigation (without further right of appeal) in a manner that does not invalidate any Monterey Amendment (or any portion thereof) or the Kern Fan Element Transaction. Within thirty (30) days after final conclusion of any such litigation in said manner, DWR shall pay to Plaintiffs any amounts then owing under this Section VI.

2. *Termination of Payment Obligation.* If any such litigation results in a final judgment that invalidates any Monterey Amendment (or any portion thereof) or the Kern Fan Element Transaction, the obligation for payments under Section VI(B)(3) shall automatically terminate.

D. Use of Funds. The funds paid to Plaintiffs under this Section VI shall be used to implement this settlement, as determined by Plaintiffs in their reasonable judgment, including watershed restoration projects, follow-up actions arising from this settlement, and technical studies.

E. Unrelated to Attorney Fees. The payments under this Section VI are exclusive of, and in addition to, any amounts owing by DWR with respect to Plaintiffs' attorney fees, the latter of which are addressed by Section VIII.

VII. **Sequence and Process for Implementation of Settlement**

This Section VII addresses the process of implementing the terms of this Settlement Agreement to the extent not already addressed in this Settlement Agreement. All issues relating to the implementation of this Settlement Agreement not addressed by this Section VII or elsewhere herein shall be resolved through good faith discussions and mutual agreement among the Parties. If the Parties are unable to agree, the disputed matter shall be referred to and resolved by the Mediator.

A. Non-Reliance on 1995 EIR. DWR and the SWP Contractors who are signatories to this Settlement Agreement agree that they will not approve any new project or activity in reliance on the 1995 EIR, that was not approved, initiated or implemented prior to March 26, 2001, and the approval, initiation or implementation of which would require a separate environmental impact report or negative declaration under CEQA (other than, or in addition to, the 1995 EIR).

B. Attachment A Amendments. Within sixty (60) days after this Settlement Agreement is executed by all of the Parties, each of the SWP Contractors who are parties to this Settlement Agreement shall cause a duly authorized representative to execute an Attachment A Amendment, and deliver the executed Amendment to DWR. Upon approval of this Settlement Agreement by the Superior Court and issuance of the Interim Implementation Order, as discussed in Section VII(C), DWR shall execute the Attachment A Amendments. Thereupon, the Attachment A Amendments shall be deemed effective on an interim basis, and will not thereafter be modified without the written consent of the Plaintiffs, prior to the discharge of the writ of mandate. The Attachment A Amendments shall become final upon (1) the filing of the Notice of Determination following the completion of the New EIR, (2) discharge of the writ of mandate in the underlying litigation as provided below, and (3) conclusion of all litigation in a manner that does not invalidate any Monterey Amendment (or any portion thereof) or the Kern Fan Element Transaction.

C. Motion for Order Approving Settlement Agreement and Interim Implementation Order. As soon as practical after the execution of this Settlement Agreement, the Parties shall jointly file with the Superior Court a motion for (1) an order approving this Settlement Agreement, and (2) an order (the "**Interim Implementation Order**") specifically authorizing on an interim basis, pursuant to Public Resources Code Section 21168.9, the administration and operation of the SWP and the KWB Lands, pending discharge of the writ of mandate in the underlying litigation, in accordance with the Monterey Amendments (as limited by Section VII(A) above), as supplemented by the Attachment A Amendments and the other terms and conditions of this Settlement Agreement, including the provisions in Section V(B) regarding the KWB Lands. Said motion shall include the proposed Section 21168.9 order attached hereto as Exhibit 3-A, and the proposed writ of mandate referenced therein and attached hereto as Exhibit 3-B. The parties shall jointly move the Superior Court for approval of said order and writ. Subject to Section VII(J), and except as provided in Section VII(I), Plaintiffs shall not seek any further order or writ concerning the Monterey Amendments or the New EIR.

D. Implementation of New Policies, Procedures and Guidelines. DWR has issued a [draft] Report of State Water Project Supply Reliability in response to paragraph 1 of the Attachment B Principles. Upon the Superior Court's approval of this Settlement Agreement, DWR shall issue Contractors' Memos on (1) the Attachment C Guidelines and (2) the Attachment D Principles. After the Superior Court's approval of this Settlement Agreement, and in no event later than January 1, 2004, DWR shall issue Contractors' Memos on the remainder of the Attachment B Principles (i.e., paragraphs 2 and 3). DWR may rely on DWR publications previously issued to comply with paragraph 2 of the Attachment B Principles, if appropriate.

E. Dismissal of Validation Cause of Action. Upon the execution of this Settlement Agreement by all the Parties and execution of the Attachment A Amendments as set forth in Section VII(B) and issuance by DWR of the Contractor Memos referenced in the second sentence of Section VII(D), Plaintiffs shall file a request for dismissal without prejudice of the Validation Cause of Action. So long as such conditions are timely met, Plaintiffs covenant and agree not to refile the Validation Cause of Action, nor any new cause of action relating thereto, nor a new claim challenging the validity of any Monterey Amendment (or any portion thereof) or the Kern Fan Element Transaction.

F. Tolling of Statute of Limitations. As between Plaintiffs, DWR and the SWP Contractors who are signatories to this Settlement Agreement, it is agreed that the statute of limitations relating to the Validation Cause of Action shall be tolled as to Plaintiffs until the date that is forty-five (45) days after the filing of the Notice of Determination for the New EIR.

G. Notice of Determination, Return to Writ and Motion for Order Discharging Writ. Upon completion of the New EIR, DWR will file with the Superior Court (1) a Notice of Determination including a copy of the New EIR, (2) a return to writ of mandate (the "**Return to Writ**"), (3) a request for an order discharging the writ of mandate previously issued by the Superior Court in the underlying case and (4) any other information required by the Superior Court for a discharge of writ.

H. Consent to Entry of Order Discharging Writ.

1. *Obligation to File*. Concurrent with DWR's filings referenced in Section VII(G), subject only to Sections VII(H)(2) and (3), and provided Plaintiffs have not challenged the Return to Writ (under the procedures set forth in Section VII(I)), Plaintiffs shall file with the Superior Court a pleading consenting to entry of an order discharging the writ of mandate (the "**Consent to Entry of Order Discharging Writ**").

2. *Conditions Precedent to Filing*. Plaintiffs' obligation to file the Consent to Entry of Order Discharging Writ shall be subject to, and conditioned upon, satisfaction of the requirement set forth in Section VII(B).

3. *Earliest Effective Date of Discharge of Writ*. The discharge of the writ of mandate shall not be effective until at least forty-five (45) days after the filing of the Notice of Determination for the New EIR.

I. Subsequent CEQA Challenge.

1. *Limited Basis for Challenge*. Plaintiffs may only challenge the Return to Writ if, during the preparation and review of the New EIR, (a) Plaintiffs

objected to the Mediator based on one or more Mediation Issues, (b) the Mediator upheld that objection in a written advisory opinion as described in Section III(H), (c) DWR rejected such written advisory opinion in its final decision, either expressly or as evidenced by the contents of the final New EIR, and (d) the challenge that Plaintiffs file to the Return to Writ is on the same ground(s) as the objection upheld by Mediator in the advisory opinion. Where such an objection was made to the Mediator and Plaintiffs file such a challenge to the Return to Writ, DWR shall maintain the advisory opinion as a public record. With respect to clause (c) of this subsection (I)(1), if the Parties dispute whether DWR has rejected the Mediator's advisory opinion, such matter shall be referred to the Mediator and (s)he shall make a final determination with respect thereto in accordance with Article IX.

2. *Stipulation to Continued Operations*. In the event of such a challenge, the challenging party will stipulate that, pending compliance with such writ as the court may issue, administration and operation of the SWP may continue in accordance with the Interim Implementation Order.

3. *Order for New EIR*. If such a challenge results in an order that DWR must prepare a new or supplemental environmental impact report, the provisions set out in Section III (regarding preparation of New EIR) shall be followed, and at the conclusion of the process, the provisions of Section VII(H) (filing of a Consent to Entry of Order Discharging Writ) and this Section VII(I) shall apply.

J. No Future Challenges. Except as specifically authorized herein, and as a condition to the initial and continuing effectiveness of this Settlement Agreement, Plaintiffs agree not to initiate any future litigation challenging the validity of any Monterey Amendment (or any portion thereof) or the Kern Fan Element Transaction.

K. Mutual Interdependency. On an interim and final basis, the Attachment A Amendments, the Plumas Amendment, the provisions regarding the KWB Lands described in Section V(B), and the continued operations of the SWP based on the Monterey Amendments are mutually interdependent.

L. Implementation Dispute Resolution. Disputes arising in the implementation of this Settlement Agreement shall be addressed in accordance with Section IX.

VIII. **Attorney Fees**

Within forty-five (45) days after the execution of this Settlement Agreement by all Parties, the Parties shall engage in arbitration to determine the amount of attorney fees and costs to be paid to Rossmann as Plaintiffs' counsel. Such arbitration shall be conducted pursuant to the following terms and conditions:

A. The arbitrator will be selected by mutual agreement of the Parties. If the Parties cannot agree on the arbitrator, the Mediator will designate the arbitrator. JAMS arbitration rules will apply, providing for limited and focused discovery, but the arbitrator may be anyone the Parties select regardless of his/her professional affiliation.

B. Within five (5) business days after commencement of the arbitration, Rossmann shall file with the arbitrator a petition for fees. The petition for fees shall identify, in sufficient detail acceptable to the arbitrator, all fees for: (1) past service in the underlying litigation; (2) fees for participation in the settlement mediation to the date thereof; and (3) projected fees for services to be rendered in implementing the Settlement Agreement, including fees incurred in advising Plaintiffs in connection with their participation in, and service on, the EIR Committee.

C. Rossmann may apply for a multiplier on fees earned in the underlying litigation. The award for fees relating to mediation and settlement implementation shall be subject to the lodestar amount and shall not include a multiplier.

D. The costs of the arbitration will be borne one-third (1/3) by Plaintiffs and two-thirds (2/3) by DWR.

E. DWR and CCWA reserve all rights and defenses, except the right to challenge Rossmann's entitlement to fees relating to the mediation and settlement implementation stages.

F. The arbitrator shall determine the amount of the award within thirty (30) days after submission of the fee petition to the arbitrator. The arbitrator's determination shall be binding upon the Parties.

G. DWR shall pay the fee award to Rossmann in accordance with the following schedule:

1. Sixty percent (60%) within thirty (30) days after the award;
2. Thirty percent (30%) within thirty (30) days after the filing of the Return to Writ with the Superior Court; and
3. Ten percent (10%) within thirty (30) days after the Plaintiffs' filing of the Consent to Entry of Order Discharging Writ with the Superior Court.

H. The amount of $100,000 previously paid as attorney fees to Rossmann by DWR will be credited toward the amount owed by DWR hereunder as determined by the arbitrator.

IX. Dispute Resolution

The Parties agree to cooperate in implementing this Settlement Agreement and to try in good faith to resolve any disputes. In addition, until the conclusion of the underlying litigation, as evidenced by the issuance of an order discharging the writ of mandate, the Mediator will decide all unresolved issues involving the interpretation and implementation of this Settlement Agreement and, to the extent permitted by law, will be authorized to enforce its terms, except for those matters properly reserved to the jurisdiction of the Superior Court. Any party may request a conference before the Mediator on seventy-two (72) hours' advance written notice to the Mediator and the other Parties. The Mediator will have the power to award reasonable attorney fees to the prevailing party in the event of frivolous, harassing or untimely motions. The party who initiates a dispute resolution proceeding with the Mediator pursuant to this Section IX shall be solely responsible for the payment of the Mediator's costs and expenses, except as otherwise provided herein.

X. Miscellaneous

A. No Admission. By entering into this Settlement Agreement, the Plaintiffs do not endorse or admit the validity of the Monterey Amendments, and neither DWR, KWBA, nor any of the SWP Contractors who are signatories hereto admit any of the Plaintiffs' allegations in the pending litigation including those concerning the Monterey Amendments and/or the Kern Fan Element Transaction.

B. Compliance with Laws. The Parties agree that nothing in this Settlement Agreement is intended to limit the discretion granted by law, including CEQA, to DWR, as lead agency and as the State agency responsible for administration and operation of the SWP, or the duty of DWR to comply with applicable requirements of law, including those of CEQA and the California Water Code.

C. Authority. Each of the Parties represents that: (1) it has the authority to execute and enter into this Settlement Agreement; (2) the individual executing this Settlement Agreement on behalf of the Party has the authority and has been specifically authorized to execute and deliver this Settlement Agreement on behalf of such Party; (3) upon execution by such person on behalf of the Party, this Settlement Agreement shall be valid and enforceable against such Party in accordance with the terms hereof; (4) the Party is authorized to implement this Settlement Agreement, without further action by the Party or its governing body, board of directors, or any other person or entity, as the case may be; and (5) the execution and entry into this Settlement Agreement and the implementation of its terms by the Party is not in violation of any applicable law or any other contract or agreement by which it is bound or to which it is a party. The Parties acknowledge that although DWR plans to make payments required under this Agreement pursuant to its authority under the State Water Resources Development System (Water Code Sections 12930 et seq.), and that under such authority accruals are continuously appropriated without regard to fiscal years (Water Code Section 12938), any such payments may nevertheless be contingent on the annual Budget Act and, under certain circumstances, payments may be delayed or halted by non-party government authorities. If any payment under this Settlement Agreement is delayed beyond the date it is due, the amount due shall accrue interest at the rate of the State Pooled Money Investment Fund for the first forty-five (45) days after it is due and at eight percent (8%) per annum thereafter. The foregoing does not limit Plaintiff's rights to seek legal or equitable relief in the event of a breach of this Settlement Agreement.

D. Not a General Appearance or Concession to Jurisdiction. The execution of this Settlement Agreement by the SWP Contractors and KWBA does not constitute a general appearance in the underlying litigation, nor does it constitute a concession to jurisdiction of the Superior Court over the SWP Contractors or KWBA other than for the purpose of enforcing the terms of this settlement.

E. Successors and Assigns. This Settlement Agreement shall be binding upon and inure to the benefit of the Parties and their respective heirs, legal representatives, successors and assigns. No Party may assign their rights under this Settlement Agreement without the prior written consent of the other Parties.

F. Governance. This Agreement shall be construed under and enforced in accordance with the substantive laws of the State of California.

G. Entirety of Agreement; No Amendment. This Settlement Agreement sets forth the entire agreement among the Parties and supersedes all prior oral or written agreements, negotiations, discussions, or understandings concerning the subject matter hereof. The terms of this Settlement Agreement may not be altered, amended, waived or modified, except by a further written agreement signed by all Parties.

H. Mutual Preparation. The Parties each cooperated in the drafting and preparation of this Settlement Agreement. Thus, the language of all parts of this Settlement Agreement shall in all cases be construed as a whole, according to its fair meaning, and not strictly for or against any Party as the drafter thereof.

I. Further Acts. Each Party agrees to make, execute and deliver such other instruments or documents, and to do or cause to be done such further or additional acts, as reasonably may be necessary in order to effectuate the purposes or to implement the terms of this Settlement Agreement.

J. No Waiver. No waiver of any breach of any term or provision of this Settlement Agreement shall be construed to be, nor shall be, a waiver of any other breach of this Settlement Agreement. No waiver shall be binding unless in writing and signed by the Party waiving the breach. With respect to any breach of this Settlement Agreement by Plaintiffs, such breach may only be waived in writing by DWR, KCWA and The Metropolitan Water District of Southern California. With respect to any breach of this Settlement Agreement by the non-Plaintiffs, such breach may only be waived in writing by the Plaintiffs.

K. No Representations or Warranties. Each of Parties represents and declares that in executing this Settlement Agreement, it has relied solely upon its own judgment, belief and knowledge, and on the advice and recommendations of its independently selected counsel, concerning the nature, extent and duration of its rights and claims and that it has not been influenced to any extent whatsoever in executing the same by any representations or statements covering any matters made by any of the Parties or by any person representing them or any of them.

Each Party acknowledges that no other Party nor any of their representatives has made any promise, representation or warranty whatsoever, written or oral, as any inducement to enter into this Settlement Agreement, except as expressly set forth in this Settlement Agreement.

L. Independent Investigations. Each Party has made such investigation of the facts pertaining to this settlement and this Settlement Agreement and of all matters pertaining thereto as it deems necessary.

M. Survival. The representations, warranties and covenants contained in this Settlement Agreement are deemed to and shall survive the execution and delivery of this Settlement Agreement by all of the Parties.

N. Headings. All headings in this Settlement Agreement are included for convenience and reference only and shall not constitute a part of this Settlement Agreement for any purpose.

O. Not Binding on Others. This Settlement Agreement is not intended to, nor shall it (1) bind any non-Party persons or entities as to any claims or defenses they may otherwise now or in the future hold, or (2) waive any claims or defenses any Party hereto may have now or in the future against such non-Party persons or entities.

P. Counterparts. This Settlement Agreement may be executed in counterparts, each of which shall constitute an original, but all of which shall constitute one and the same agreement, provided each signing Party shall have received a copy of the signature page signed by every other Party.

Q. Voluntary and Knowing Execution. EACH PARTY REPRESENTS AND WARRANTS THAT IT HAS THOROUGHLY READ AND CONSIDERED

ALL ASPECTS OF THIS SETTLEMENT AGREEMENT, THAT IT UNDERSTANDS ALL PROVISIONS OF THIS SETTLEMENT AGREEMENT, THAT IT HAS HAD THE OPPORTUNITY TO CONSULT WITH COUNSEL THROUGHOUT THIS PROCESS AND THAT IT IS VOLUNTARILY ENTERING INTO THIS SETTLEMENT AGREEMENT OF ITS OWN FREE WILL, WITHOUT DURESS OR COERCION OF ANY KIND.

R. Obligations Dependent on Validity of Monterey Amendments. With respect to any obligation in this Settlement Agreement that terminates or is suspended upon a challenge to or final judgment that invalidates any portion of any Monterey Amendment, such termination or suspension of such obligation may be avoided if such invalidity is explicitly and irrevocably waived in accordance with the procedures set forth in Paragraph 29 of the Monterey Amendments.

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{SIGNATURES CONSOLIDATED BY THE STATE WATER PROJECT ANALYSIS OFFICE OF THE DEPARTMENT OF WATER RESOURCES}

IN WITNESS WHEREOF, the Parties have executed this Settlement Agreement as of the date first set forth above.

PLANNING AND CONSERVATION LEAGUE

By: Sage Sweetwood
Name: Sage Sweetwood
Title: President

PLUMAS COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

By: B J Pearson
Name: B.J.Pearson
Title: Chair, Board of Supervisors
Ex-officio Chair, District Board of Directors

CITIZENS PLANNING ASSOCIATION OF SANTA BARBARA COUNTY, INC.

By: Louise Boucher
Name: Louise Boucher
Title: President,
Citizens Planning association of Santa Barbara, Inc.

[Remainder of Page Intentionally Blank – Additional Signatures Follow]

{SIGNATURES CONSOLIDATED BY THE STATE WATER PROJECT ANALYSIS OFFICE OF THE DEPARTMENT OF WATER RESOURCES}

STATE OF CALIFORNIA

DEPARTMENT OF WATER RESOURCES

By: [signature]

Name: Thomas M. Hannigan
Title: Director

Approved as to legal form and sufficiency:

By: [signature]

Name: Peggy Bernardy
Title: Chief Counsel

ALAMEDA COUNTY FLOOD CONTROL & WATER CONSERVATION DISTRICT, ZONE 7

By: [signature]

Name: William R. Stevens

Title: President, Board of Directors

Approved as to Form
RICHARD E. WINNIE, County Counsel

By [signature]

ALAMEDA COUNTY WATER DISTRICT

By: [signature]

Name: John H. Weed

Title: President

ANTELOPE VALLEY-EAST KERN WATER AGENCY

By: ______________________________

Name: ______________________________

Title: ______________________________

CASTAIC LAKE WATER AGENCY

By: [signature]

Name: DAN MASNADA

Title: GENERAL MANAGER

CITY OF YUBA

By: ______________________________

Name: ______________________________

Title: ______________________________

{SIGNATURES CONSOLIDATED BY THE STATE WATER PROJECT ANALYSIS OFFICE OF THE DEPARTMENT OF WATER RESOURCES}

ANTELOPE VALLEY-EAST KERN WATER AGENCY

By: Andy D. Rutledge

Name: Andy D. Rutledge

Title: Board President

CASTAIC LAKE WATER AGENCY

By: Dan Masnada

Name: DAN MASNADA

Title: GENERAL MANAGER

CITY OF YUBA

By: William P. Lewis

Name: WILLIAM P. LEWIS

Title: UTILITIES DIRECTOR

{SIGNATURES CONSOLIDATED BY THE STATE WATER PROJECT ANALYSIS OFFICE OF THE DEPARTMENT OF WATER RESOURCES}

COACHELLA VALLEY WATER DISTRICT

By: John W. McFadden

Name: John W. McFadden

Title: President of the Board of Directors

COUNTY OF BUTTE

By: R J Beeler

Name: R. J. BEELER

Title: Chairman, Board of Supervisors

COUNTY OF KINGS 3-25-03

By: Joe Neves

Name: JOE NEVES

Title: CHAIRMAN

CRESTLINE-LAKE ARROWHEAD WATER AGENCY

By: James J. McCrory

Name: James J. McCrory

Title: President, Board of Directors

{SIGNATURES CONSOLIDATED BY THE STATE WATER PROJECT ANALYSIS OFFICE OF THE DEPARTMENT OF WATER RESOURCES}

DESERT WATER AGENCY

By: [signature]

Name: Dan M. Ainsworth

Title: General Manager

DUDLEY RIDGE WATER DISTRICT

By: [signature]

Name: Joe MacIlvaine

Title: President

KERN COUNTY WATER AGENCY

By: [signature]

Name: Terry Rogers

Title: President

{SIGNATURES CONSOLIDATED BY THE STATE WATER PROJECT ANALYSIS OFFICE OF THE DEPARTMENT OF WATER RESOURCES}

LITTLEROCK CREEK IRRIGATION DISTRICT

By: Frances Young

Name: ______________________

Title: President

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

By: ______________________

Name: Ronald R Gastelum

Title: CEO

MOJAVE WATER AGENCY

By: ______________________

Name: Kirby Brill

Title: General Manager

NAPA COUNTY FLOOD CONTROL & WATER CONSERVATION DISTRICT

By: Mike Rippey

Name: Mike Rippey

Title: Vice-Chair

APPROVED 3/18/03
FLOOD CONTROL & WATER
CONSERVATION DISTRICT

~~MARY JEAN MCLAUGHLIN~~
SECRETARY OF THE DISTRICT

BY S. Vattuone Deputy

{SIGNATURES CONSOLIDATED BY THE STATE WATER PROJECT ANALYSIS OFFICE OF THE DEPARTMENT OF WATER RESOURCES}

OAK FLAT WATER DISTRICT

By: [signature]

Name: WILLIAM D. HARRISON

Title: MANAGER / SECRETARY

PALMDALE WATER DISTRICT

By: [signature]

Name: Leslie O. Carter

Title: President, Board of Directors

SAN BERNARDINO VALLEY MUNICIPAL WATER DISTRICT

By: [signature]

Name: C. Patrick Milligan

Title: President

SAN GABRIEL VALLEY MUNICIPAL WATER DISTRICT

By: [signature]

Name: J. C. Reichenberger

Title: President

{SIGNATURES CONSOLIDATED BY THE STATE WATER PROJECT ANALYSIS OFFICE OF THE DEPARTMENT OF WATER RESOURCES}

SAN GORGONIO PASS WATER AGENCY

By: ______________________

Name: Stephen P. Stockton

Title: General Manager/Chief Engineer

SAN LUIS OBISPO COUNTY FLOOD CONTROL & WATER CONSERVATION DISTRICT

By: ______________________

Name: MICHAEL P. RYAN

Title: Chairman of the Board of Supervisors

SANTA BARBARA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

By: ______________________

Name: ______________________

Title: ______________________

APPROVE AS TO ACCOUNTING:
ROBERT W. GEIS, CPA
AUDITOR-CONTROLLER

BY: ______________________
Deputy

ATTEST:
MICHAEL F. BROWN
CLERK OF THE BOARD

BY: ______________________
Deputy

APPROVED AS TO FORM:
STEPHEN SHANE STARK
COUNTY COUNSEL

BY: ______________________
Deputy

{SIGNATURES CONSOLIDATED BY THE STATE WATER PROJECT ANALYSIS OFFICE OF THE DEPARTMENT OF WATER RESOURCES}

SANTA CLARA VALLEY WATER DISTRICT

By: Stanley M. Williams

Name: Stanley M. Williams

Title: Chief Executive Officer

SOLANO COUNTY WATER AGENCY

By: Don Holdener

Name: Don Holdener

Title: Chairman, Board of Directors

TULARE LAKE BASIN WATER STORAGE DISTRICT

By: Thomas R. Hurlbutt

Name: THOMAS R. HURLBUTT

Title: PRESIDENT

VENTURA COUNTY FLOOD CONTROL DISTRICT

By: Jeff Pratt

Name: Jeff Pratt

Title: Director - Watershed Protection

{SIGNATURES CONSOLIDATED BY THE STATE WATER PROJECT ANALYSIS OFFICE OF THE DEPARTMENT OF WATER RESOURCES}

CENTRAL COAST WATER AUTHORITY

By: ______________________

Name: William J. Brennan

Title: Executive Director

KERN WATER BANK AUTHORITY

By: ______________________

Name: William D. Phillimore, Chairman

Title: Chairman

ATTACHMENT A

AMENDMENT TO STATE WATER PROJECT CONTRACT

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

AMENDMENT NO. ___ TO THE WATER SUPPLY CONTRACT BETWEEN THE STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES AND ___________________

This amendment is made this ____ day of ____________________, 2003, pursuant to the provisions of the California Water Resources Development Bond Act, the Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, hereinafter referred to as the "State", and ____, hereinafter referred to as the "District" [or "Agency"].

RECITALS

WHEREAS, the State and the District entered into and subsequently amended a water supply contract (the "contract") providing that the State shall supply certain quantities of water to the District and providing that the District shall make certain payments to the State, and setting forth the terms and conditions of such supply and such payments; and

WHEREAS, on December 1, 1994, the State and representatives of certain State Water Project contractors executed a document entitled "Monterey Agreement – Statement of Principles – By The State Water Contractors And The State Of California Department Of Water Resources For Potential Amendments To The State Water Supply Contracts" (the "Monterey Agreement"); and

WHEREAS, the State, the Central Coast Water Authority ("CCWA") and those contractors intending to be subject to the Monterey Agreement subsequently negotiated an amendment to their contracts to implement provisions of the Monterey Agreement, and such amendment was named the "Monterey Amendment"; and

WHEREAS, in October 1995, an environmental impact report ("EIR") for the Monterey Amendment was completed and certified by CCWA as the lead agency, and thereafter the District and the State executed the Monterey Amendment; and

WHEREAS, the EIR certified by the CCWA was challenged by several parties (the "Plaintiffs") in the Sacramento County Superior Court and thereafter in the Third District Court of Appeal, resulting in a decision in *Planning and Conservation League, et al. v. Department of*

Water Resources, 83 Cal.App.4th 892 (2000), which case is hereinafter referred to as "PCL v. DWR"; and

WHEREAS, in its decision, the Court of Appeal held that (i) the Department of Water Resources ("DWR"), not CCWA, had the statutory duty to serve as lead agency, (ii) the trial court erred by finding CCWA's EIR sufficient despite its failure to discuss implementation of Article 18, subdivision (b) of the State Water Project contracts, as a no-project alternative, (iii) said errors mandate preparation of a new EIR under the direction of DWR, and (iv) the trial court erroneously dismissed the challenge to DWR's transfer of title to certain lands to Kern County Water Agency (the "Validation Cause of Action") and execution of amended State Water Project contracts for failure to name and serve indispensable parties. The Court of Appeal remanded the case to the trial court, ordering it to take the following five actions: (1) vacate the trial court's grant of the motion for summary adjudication of the Validation Cause of Action; (2) issue a writ of mandate vacating the certification of the EIR; (3) determine the amount of attorney fees to be awarded Plaintiffs; (4) consider such orders it deems appropriate under Public Resources Code Section 21168.9(a) consistent with the views expressed in the Appellate Court's opinion; and (5) retain jurisdiction over the action until DWR, as lead agency, certifies an environmental impact report in accordance with CEQA standards and procedures, and the Superior Court determines that such environmental impact report meets the substantive requirements of CEQA; and

WHEREAS, the State, the contractors, and the Plaintiffs in *PCL v. DWR* reached an agreement to settle *PCL v. DWR*, as documented by that certain Settlement Agreement dated _________, 2003 (the "Settlement Agreement"), and in such Settlement Agreement have agreed that the contracts should be amended, for clarification purposes, to delete terms such as "annual entitlement" and "maximum annual entitlement" so that the public, and particularly land use planning agencies, will better understand the contracts; and

WHEREAS, pursuant to the Settlement Agreement, the State and the District desire to so amend the District's contract, with the understanding and intent that the amendments herein with respect to subsections (m), (n), and (o) of Article 1, subsection (b) of Article 6, and subsection (a) of Article 16, and to Table A of the District's contract are solely for clarification purposes and that such amendments are not intended to and do not in any way change the rights, obligations or limitations on liability of the State or the District established by or set forth in the contract; and

WHEREAS, pursuant to the Settlement Agreement, the State, the contractors and the Plaintiffs in *PCL v. DWR* also agreed that the contracts should be amended to include a new Article 58 addressing the determination of dependable annual supply of State Water Project water to be made available by existing Project facilities, and the State and District desire to so amend the District's contract.

NOW THEREFORE, IT IS MUTUALLY AGREED, as follows:

1. Article 1(n) is amended to read:[1]

(n) **Annual Table A Amount**

"Annual Table A Amount" shall mean the amount of project water set forth in Table A of this contract that the State, pursuant to the obligations of this contract and applicable law, makes available for delivery to the District at the delivery structures provided for the District. The term Annual Table A Amount shall not be interpreted to mean that in each year the State will be able to make that quantity of project water available to the District. The Annual Table A Amounts and the terms of this contract reflect an expectation that under certain conditions the District will receive its full Annual Table A Amount; but that under other conditions only a lesser amount, allocated in accordance with this contract, may be made available to the District. This recognition that full Annual Table A Amounts will not be deliverable under all conditions does not change the obligations of the State under this contract, including but not limited to, the obligations to make all reasonable efforts to complete the project facilities, to perfect and protect water rights, and to allocate among contractors the supply available in any year, as set forth in Articles 6(b), 6(c), 16(b) and 18, in the manner and subject to the terms and conditions of those articles and this contract. Where the term "annual entitlement" appears elsewhere in this contract, it shall mean "Annual Table A Amount." The State agrees that in future amendments to this and other contractor's contracts, in lieu of the term "annual entitlement," the term "Annual Table A Amount" will be used and will have the same meaning as "annual entitlement" wherever that term is used.

2. Article 1(o) is amended to read:

(o) Maximum Annual Table A Amount

"Maximum annual entitlement" shall mean the maximum annual amounts set forth in Table A of this contract, and where the term "maximum annual entitlement" appears elsewhere in this contract it shall mean "Maximum Annual Table A Amounts."

3. Article 1(m) is amended to read:

(m) Minimum Project Yield

"Minimum project yield" shall mean the dependable annual supply of project water to be made available assuming completion of the initial project conservation facilities and additional project conservation facilities. The project's capability of providing the minimum project yield shall be determined by the State on the basis of coordinated operations studies of initial project conservation facilities and additional project conservation facilities, which studies shall be based upon factors including but not limited to: (1) the estimated relative proportion of deliveries for agricultural use to deliveries for municipal use assuming Maximum Annual Table A Amounts

[1] The number of the articles is not the same for all the Water Supply Contractors. Article 1(n) is intended to be the article presently entitled "Annual Entitlement", whatever its number may be in each District's contract. The article numbers may have to be changed for each contractor to reflect the numbers in its contract.

for all contractors and the characteristic distributions of demands for these two uses throughout the year; and (2) agreements now in effect or as hereafter amended or supplemented between the State and the United States and others regarding the division of utilization of waters of the Delta or streams tributary thereto.

4. Article 6(b) is amended to read:

(b) District's Annual Table A Amounts

Commencing with the year of initial water delivery to the District, the State each year shall make available for delivery to the District the amounts of project water designated in Table A of this contract, which amounts shall be subject to change as provided for in Article 7(a) and are referred to in this contract as the District's Annual Table A Amounts.

5. Article 16(a) is amended to read:

(a) Limit on Total of all Maximum Annual Table A Amounts

The District's Maximum Annual Table A Amount hereunder, together with the maximum Table A amounts of all other contractors, shall aggregate no more than 4,185,000 acre-feet of project water.

6 Article 58 is added to read:

58. **Determination of Dependable Annual Supply of Project Water to be Made Available by Existing Project Facilities.**

In order to provide current information regarding the delivery capability of existing project conservation facilities, commencing in 2003 and every two years thereafter the State shall prepare and mail a report to all contractors, and all California city, county, and regional planning departments and agencies within the contractors' project service areas. This report will set forth, under a range of hydrologic conditions, estimates of overall delivery capability of the existing project facilities and of supply availability to each contractor in accordance with other provisions of the contractors' contracts. The range of hydrologic conditions shall include the delivery capability in the driest year of record, the average over the historic extended dry cycle and the average over the long-term. The biennial report will also include, for each of the ten years immediately preceding the report, the total amount of project water delivered to all contractors and the amount of project water delivered to each contractor.

7. Add the following language at the bottom of Table A:

In any year, the amounts designated in this Table A shall not be interpreted to mean that the State is able to deliver those amounts in all years. Article 58 describes the State's process for providing current information for project delivery capability.

8. Except for Article 58, the changes made by this amendment are solely for clarification purposes, and are not intended to nor do they in any way change the rights, obligations or

limitations on liability of the State or the District established by or set forth in the contract, and this amendment shall be interpreted in accordance with this intent.

9. At the time of execution of this Agreement and thereafter, the effectiveness of this Amendment is dependent upon the effectiveness of the District's Monterey Amendment (all provisions therein) and the Kern Fan Element Transaction.

IN WITNESS WHEREOF, the parties hereto have executed this amendment on the date first above written.

STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES

By: ______________________________
Name: ______________________________
Title: Director

Approved as to legal form and sufficiency:

By: ______________________________
Name: ______________________________
Title: Chief Counsel

Attest:

__________________ **DISTRICT**

By: ______________________________
Name: ______________________________
Title: ______________________________

ATTACHMENT B

PRINCIPLES REGARDING STATE WATER PROJECT AVAILABILITY

Note: These principles are prepared in connection with the settlement agreement between PCL and DWR and are only effective pursuant to the terms therein.

1. Commencing in 2003, and every two years thereafter, the Department of Water Resources (DWR) shall prepare and deliver to all State Water Project (SWP) contractors, all city and county planning departments, and all regional and metropolitan planning departments within the project service area a report which accurately sets forth, under a range of hydrologic conditions, the then existing overall delivery capability of the project facilities and the allocation of that capacity to each contractor. The range of hydrologic conditions shall include the historic extended dry cycle and long-term average. The biennial report shall also disclose, for each of the ten years immediately preceding the report, the total amount of project water delivered and the amount of project water delivered to each contractor. The information presented in each report shall be presented in a manner readily understandable by the public.

2. DWR shall develop and, by January 1, 2004, publish guidelines to assist Municipal and Industrial Contractors in providing accurate information to land-use planning agencies with jurisdiction within the Contractors' respective service areas regarding local and regional programs to manage or supplement SWP supplies. DWR shall consult with the plaintiffs and contractors in developing the guidelines.

3. DWR shall provide assistance to enable all Municipal and Industrial Contractors to provide complete and accurate information to relevant land-use planning agencies to assure that local land-use decisions reflect accurate information on the availability of water from state, local, and other sources.

ATTACHMENT C

DWR GUIDELINES FOR REVIEW OF PROPOSED PERMANENT TRANSFERS OF STATE WATER PROJECT ANNUAL TABLE A AMOUNTS

Note: These guidelines are prepared in connection with the settlement agreement between PCL and DWR and are only effective pursuant to the terms therein.

1. Purpose: The purpose of these guidelines is to describe the process for DWR's review of proposed permanent transfers of SWP Annual Table A Amounts and by so doing, provide disclosure to SWP Contractors and to the public of DWR's process and policy on approving permanent transfer of SWP Annual Table A Amounts. Such disclosure should assist contractors in developing their transfer proposals and obtaining DWR review expeditiously, and assist the public in participating in that review.

2. Coverage: These guidelines will apply to DWR's approval of permanent transfers of water among existing SWP Contractors and, if and when appropriate, to permanent transfers of water from an existing SWP Contractor to a new SWP Contractor.

3. Interpretation: These guidelines are in furtherance of the state policy in favor of voluntary water transfers and shall be interpreted consistent with the law, including but not limited to Water Code Section 109, the Burns-Porter Act, the Central Valley Project Act, the California Environmental Quality Act, area of origin laws, the public trust doctrine, and with existing contracts and bond covenants. These guidelines are not intended to change or augment existing law.

4. Format: The guidelines shall be issued by DWR as a "Notice to State Water Contractors."

5. Revisions: Revisions may be made to these guidelines as necessary to meet changed circumstances, changes in the law or long-term water supply contracts, or to address conditions unanticipated when the guidelines are adopted. Revisions shall be in accordance with the settlement agreement reached in *Planning and Conservation League vs. Department of Water Resources.*

6. Distribution: The transfer guidelines shall be published by DWR in the next available edition of Bulletin 132, and also as part of the biennial disclosure of SWP reliability as described in the PCL v. DWR Settlement Agreement.

7. Contract Amendment: Permanent transfers of SWP water are accomplished by amendment of each participating contractor's long-term water supply contract. The amendment consists of amending the Table A upwards for a buying contractor and downwards for a selling contractor. The amendment shall be in conformity with all provisions of the long-term water supply contracts, applicable laws, and bond covenants. Other issues to be addressed in the contract amendment will be subject to negotiation among DWR and the two participating contractors. The negotiations will be conducted in public, pursuant to the settlement agreement in PCL vs. DWR.

8. Financial issues: The purchasing contractor must demonstrate to the DWR's satisfaction that it has the financial ability to assume payments associated with the transferred water. If the purchasing entity was not a SWP Contractor as of 2001, special financial requirements pertain as described below, as well as additional qualifications.

9. Compliance with CEQA: Consistent with CEQA, the State's policy to preserve and enhance environmental quality will guide DWR's consideration of transfer proposals (Public Resources Code Section 21000). Identification of the appropriate lead agency will be based on CEQA, the CEQA Guidelines, and applicable caselaw, including *Planning and Conservation League vs. Department of Water Resources, 83 Cal. App. 4th 892 (2000).* CEQA requires the lead agency at a minimum to address the feasible alternatives to the proposed transfer and its potentially significant environmental impacts (1) in the selling contractor's service area; (2) in the buying contractor's service area; (3) on SWP facilities and operations; and (4) on the Delta and areas of origin and other regions as appropriate. Impacts that may occur outside of the transferring SWP Contractors' service areas and on fish and wildlife shall be included in the environmental analysis. DWR will not approve a transfer proposal until CEQA compliance is completed. The lead agency shall consult with responsible and trustee agencies and affected cities and counties; and when DWR is not the lead agency, shall provide an administrative draft of the draft EIR or Initial Study/Negative Declaration to DWR prior to the public review period. A descriptive narrative must accompany a checklist, if a checklist is used. The lead agency shall conduct a public hearing on the EIR during the public comment period and notify DWR's State Water Project Analysis Office of the time and place of such hearing in addition to other notice required by law.

10. Place of Use: The purchasing contractor must identify the place and purpose of use of the purchased water, including the reasonable and beneficial use of the water. Typically this information would be included in the environmental documentation. If a specific transfer proposal does not fit precisely into any of the alternatives listed below, DWR will use the principles described in these Guidelines to define the process to be followed. The information to be provided under this paragraph is in addition to the CEQA information described in paragraph 9 of these guidelines.

a) If the place of use is within the contractor's service area, the contractor should disclose the purpose of the transferred water, such as whether the water is being acquired for a specific development project, to enhance overall water supply reliability in the contractor's service area, or some other purpose. If the transferred water is for a municipal purpose, the contractor should state whether the transfer is consistent with its own Urban Water Management Plan or that of its member unit(s) receiving the water.

b) If the place of use is outside the contractor's service area, but within the SWP authorized place of use, and service is to be provided by an existing SWP Contractor: In addition to Paragraph 10(a) above, the contractor should provide DWR with copies of LAFCO approval and consent of the water agency with authority to serve that area, if any. In some instances, DWR's separate consent is required for annexations in addition to the approval for the transfer.

c) If the place of use is outside the SWP authorized place of use and service is to be provided by an existing SWP Contractor, the contractor should provide information in Paragraph 10(a) and 10(b). Prior to approving the transfer, DWR will consider project delivery capability, demands for water supply from the SWP, and the impact, if any, of the proposed transfer on such demand. If DWR approves the transfer, DWR will petition State Water Resources Control Board for approval of expansion of authorized place of use. Water will not be delivered until the place of use has been approved by the SWRCB and will be delivered in compliance with any terms imposed by the SWRCB.

d) If the place of use is outside the SWP authorized place of use and service is not to be provided by an existing SWP contractor, DWR will consider the transfer proposal as a proposal to become a new state water contractor. Prior to adding a new SWP Contractor, DWR will consider project delivery capability, demands for water supply from the SWP, and the impact, if any, of the proposed transfer on such demand. DWR will consult with existing SWP Contractors regarding their water supply needs and the proposed transfer. In addition to the information in Paragraph 10(a), 10(b), and 10(c), the new contractor should provide information similar to that provided by the original SWP contractors in the 1960's Bulletin 119 feasibility report addressing hydrology, demand for water supply, population growth, financial feasibility, etc. DWR will evaluate these issues independently and ordinarily will act as lead agency for CEQA purposes. In addition, issues such as area of origin claims, priorities, environmental impacts and use of water will be addressed. The selling contractor may not be released from financial obligations. The contract will be subject to a CCP 860 validation action initiated by the new contractor. If DWR approves the transfer, DWR will petition State Water Resources Control Board for approval of expansion of authorized place of use. Water will not be delivered until the place of use has been approved by the SWRCB and will be delivered in compliance with any terms imposed by the SWRCB.

11, DWR Discretion. Consistent with the long-term water supply contract provisions, CEQA, and other provisions of law, DWR has discretion to approve or deny transfers. DWR's exercise of discretion will incorporate the following principles:

(a) As required by CEQA, DWR as an agency with statewide authority will implement feasible mitigation measures for any significant environmental impacts resulting from a transfer, if such impacts and their mitigation are not addressed by other public agencies and are within DWR's jurisdiction.

(b) DWR will invoke "overriding considerations" in approving a transfer only as authorized by law, including but not limited to CEQA, and, to the extent applicable, the public trust doctrine and area of origin laws.

ATTACHMENT D

PRINCIPLES REGARDING PUBLIC PARTICIPATION PROCESS IN SWP CONTRACT NEGOTIATIONS

Note: These principles are prepared in connection with the settlement agreement between PCL and DWR and are only effective pursuant to the terms therein.

1. **Policy:** Given the importance of the State Water Project to the State of California, and the key role that the long-term water supply contracts play in the administration of the State Water Project, DWR agrees that public review of significant changes to these contracts is beneficial and in the public interest.

2. **Types of activities to be covered:** Project-wide contract amendments (i.e., contracts with substantially similar terms intended to be offered to all long-term SWP Contractors) and contract amendments to transfer entitlements between existing SWP Contractors will not be offered to the contractors for execution unless DWR has first complied with the public participation process as described in paragraphs (3), (4), (5) and (6).

3. **The Public Participation Process.**

1) Negotiations will be conducted in public;

2) The public will be provided with advance notice of the time and place of the negotiations; and

3) The public will be provided the opportunity to observe negotiations and comment in each negotiating session

4. **Timing of Public Participation:** Public participation ordinarily will precede the formulation of the project description in the CEQA process in order to assure that the public participation is meaningful. When DWR is a responsible agency, (e.g., when existing SWP Contractors agree to transfer entitlement between themselves), the public participation will be scheduled to facilitate coordination with the lead agency's CEQA process.

5. **Activities that will not be subject to public participation:** Informal discussions prior to exchange of formal drafts and discussion of topics that are authorized to be kept confidential by law will not be subject to the public participation process.

6. **Contract amendments resulting from litigation:** If litigation has been formally initiated, and settlement negotiations result in a proposal to adopt project-wide amendments to settle the litigation, all proposed contract amendments shall be subject to the public participation process before they are approved by DWR.

ATTACHMENT E

FINAL PERMANENT TABLE A AMOUNT TRANSFERS FROM KERN COUNTY WATER AGENCY SUBSEQUENT TO MONTEREY AMENDMENTS (January 1, 2003)

Note: This Exhibit is prepared in connection with the settlement agreement between PCL and DWR.

From (Kern County Water Agency Member Unit)	To	Amount (afy)	Year Effective
Berrenda Mesa Water District	Mojave Water Agency	25,000	1998
Belridge Water Storage District	Palmdale Water Agency	4,000	2000
Berrenda Mesa Water District	Alameda County Flood Control and Water Conservation District Zone 7	7,000	2000
Lost Hills Water District	Alameda County Flood Control and Water Conservation District Zone 7	15,000	2000
Belridge Water Storage District	Alameda County Flood Control and Water Conservation District Zone 7	10,000	2001
Belridge Water Storage District and Berrenda Mesa Water District	Solano County Water Agency	5,756	2001
Belridge Water Storage District and Berrenda Mesa Water District	Napa County Flood Control and Water Conservation District	4,025	2001

EXHIBIT 1

PLAINTIFFS' EXPENSES TRUST ACCOUNT AGREEMENT

This Agreement is entered into this fifteenth day of August 2002, by JAMS and DWR, for the purpose of transferring $300,000 in trust to JAMS for use in accordance with Principles of Settlement in PCL vs. DWR.

WHEREAS, JAMS has acted as mediator between the Department and other parties to the litigation in PCL v. DWR (Superior Court No. 95CS03216).

WHEREAS, the Principles of Settlement as agreed to by the parties on July 22, 2002, provides for the placement of $300,000 in trust with JAMS.

WHEREAS, the money placed in the trust is to be provided to plaintiffs for expenses actually incurred as needed to support plaintiffs' participation in developing the new EIR to be filed as a return to the writ.

WHEREAS, the Principles of Settlement also provides that the funds will be provided based on a budget and participation plan to be submitted by plaintiffs to the mediator specifying the purposes for which the funds will be expended.

The parties agree as follows:

1. JAMS agrees to accept $300,000 in trust in accordance with the Principles of Settlement.

2. JAMS agrees to maintain the monies in trust, and following receipt of a budget and participation plan from plaintiffs, to disburse funds to plaintiffs for actual expenditures incurred for such purpose and pursuant to such schedule, budget, and participation plan, all in conformance with the Principles of Settlement. The funds will be disbursed to the plaintiffs' attorney, Antonio Rossmann, Law Offices of Antonio Rossmann.

3. Costs incurred by JAMS in providing this service will be paid as part of the mediator services as part of the existing contract between JAMS and the California Department of Justice, Office of the Attorney General.

4. This agreement may be amended in writing by agreement of both parties.

5. Funds not disbursed upon termination of the trust shall be returned to DWR.

6. The trust shall terminate upon notice to JAMS by DWR of termination based on the earlier of (a) failure of the parties to the mediation to execute a settlement agreement by January 1, 2003; (b) notice of termination given by the Director of DWR to JAMS and plaintiffs that this trust is terminated, which notice shall not be given without

defendants' consultation with plaintiffs and the mediator; or c) filing of the Notice of Determination on the new EIR.

7. JAMS will incur no liability to DWR arising from any disbursement made pursuant to this agreement.

8. This agreement is not intended to and shall not create any rights in any third party.

APPROVED:

/s/ Steve Macaulay for	8/10/02	/s/ Julie Sager	8/15/02
Thomas M. Hannigan Director	Date	Vice President & CFO JAMS	Date

EXHIBIT 1

AMENDMENT NO. 1

PLAINTIFFS' EXPENSES TRUST ACCOUNT AGREEMENT

Paragraph 6 of this Agreement is amended to read as follows:

6. The trust shall terminate upon notice to JAMS by DWR of termination based on the earlier of (a) failure of the parties to the mediation to execute a settlement agreement by May 1, 2003, (b) notice of termination given by the Director of DWR to JAMS and plaintiffs that this trust is terminated, which notice shall not be given without defendants' consultation with plaintiffs and the mediator; or (c) filing of the Notice of Determination on the new EIR.

APPROVED:

Thomas M. Hannigan Director	Date	JAMS	Date

EXHIBIT 2

KERN WATER BANK AUTHORITY
AGREEMENTS AND PERMITS
WHICH MAY HAVE RELIED ON THE KWBA ADDENDUM

AGREEMENT/PERMIT	DATE	OTHER PARTIES
Incidental Take Permit - PRT-828086	2-Oct-97	Department of Interior, U.S. Fish & Wildlife Service
Approval/Management Authorization pursuant to California Endangered Species Act for Implementation of Kern Water Bank Habitat Conservation Plan/Natural Community Conservation Plan	2-Oct-97	Calif. Department of Fish & Game
Natural Community Conservation Plan/Habitat Conservation Plan Implementation Agreement	2-Oct-97	U.S. Fish & Wildlife Service; Calif Dept of Fish & Game; Kern Water Bank Authority
Approval, Cultural Resources Assessment and Plan for the KWBA Project	January, 1997	N/A
Memorandum of Understanding Regarding Operation and Monitoring of the Kern Water Bank Groundwater Banking Program	26-Oct-95	Numerous
Approval of Kern Water Bank Authority Mosquito Abatement Program	26-Oct-95	Mosquito Abatement Districts
Service Contracts for Operations and Maintenance	1996 - current	Numerous Vendors
Grazing Leases (Sheep and Cattle)	1997- current	Various Stockmen
Minor Amendment No. 1: Hunting/Research to the KWBA HCP/NCCP and Implementation Agreement	6/30/1998	California Department of Fish and Game and U.S. Fish and Wildlife Service
State of California Standard Agreement for "Improving Wildlife Habitat for Doves" (annual contract)	1998 - current	Calif. Department of Fish and Game
Conservation Credit Certificates	1998 - current	Conservation Credit Buyers
Construction and Service Contracts for Master Plan Construction Project - KWB Canal, Head-works, Aqueduct Turnout, New Wells, Well Rehabilitation, Pipelines	7/1999 - 8/2002	Numerous Contractors and Vendors
KWB Canal and Buena Vista Main Canal Joint Use Agreement	7/20/1999	Buena Vista Water Storage District

AGREEMENT/PERMIT	DATE	OTHER PARTIES
Business Loan Agreement ($21,000,000)	7/23/1999	Bank of America, N.A.
Agreement for Grant of Easement	September 1999	State of California Acting Through the Department of Parks and Recreation
Agreement for Construction, Operation, and Maintenance of the Kern Water Bank Turnout, a Permanent Turnout Within the California Aqueduct Right of Way	11/9/1999	Department of Water Resources
License Agreement for Kern River Canal Crossing	11/17/1999	City of Bakersfield
Loan Contract No. E75002 Under the "Safe, Clean, Reliable Water Supply Act Water Conservation and Ground Water Recharge Sub account ($5,000,000)	March 2000	State of California, Department of Water Resources, Division of Planning and Local Assistance
Reclamation Board Permit No. 17147-A GM Authorizing Construction of Pedestrian Bridge Across the Outlet Canal within the Kern River Designated Floodway	10/16/2000	State of California - The Resources Agency, Department of Water Resources
Reclamation Board Permit No. 16821 GM (Revised) Authorizing Construction of a 20-foot Wide Unlined Canal and Reinforced Concrete Gated Turnout Structure on the Right (North) Bank of the Designated Floodway and Install a 108-Inch Diameter, 700-foot long, Reinforced Concrete Pipe Across (Under the Kern River	2/26/2001	State of California - The Resources Agency, Department of Water Resources
Grant Awarded Under the "Safe Drinking Water, Clean Water, Watershed Protection and Flood Protection Act (Proposition 13) - Groundwater Storage Program ($3,375,000)	Jun-02	State of California, Department of Water Resources, Division of Planning and Local Assistance
Service Contracts for Well Testing and Rehabilitation Under the SB5X Program	2002	Various Vendors

EXHIBIT 3-A

PROPOSED 21168.9 ORDER

IN THE SUPERIOR COURT OF THE STATE OF CALIFORNIA

FOR THE COUNTY OF SACRAMENTO

PLANNING AND CONSERVATION LEAGUE, a California not for profit corporation, PLUMAS COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT, a California public agency; CITIZENS PLANNING ASSOCIATION OF SANTA BARBARA COUNTY, INC., a California not for profit corporation, Plaintiffs and Petitioners, v. DEPARTMENT OF WATER RESOURCES, a California State Agency, et al., Defendants and Respondents,	Case No: 95CS03216 [PROPOSED] ORDER PURSUANT TO PUBLIC RESOURCES CODE SECTION 21168.9

On remand from the Third District Court of Appeal on January ___, 2003, in Department 53 of the Sacramento Superior Court, the Honorable Loren E. McMaster, presiding, this proceeding came on for a status report and joint motion. Petitioners and Plaintiffs, Planning and Conservation League, Plumas County Flood Control and Water Conservation District, and Citizens Planning Association of Santa Barbara County ("Petitioners"), appeared through Antonio Rossmann and Roger B. Moore. Respondent and Defendant, Central Coast Water Authority (CCWA), appeared through Susan F. Petrovich of the Law Firm of Hatch & Parent. Respondent and Defendant, Department of Water Resources (DWR), appeared through Deputy Attorney General Marian E. Moe. Robert S. Draper of O'Melveny and Myers, LLP and Clifford W. Schulz appeared, respectively, on behalf of the Metropolitan Water District of Southern California and Dudley Ridge Water District, entities that submitted answers to the First

Amended Complaint subsequent to the Court of Appeal's final determination in this action and prior to any further order of this Court on remand.

In light of the direction from the Third District Court of Appeal on remand in Planning and Conservation League v. Department of Water Resources (2000) 83 Cal.App.4th 892, this Court hereby makes the following findings:

1. The parties to this lawsuit and other public agencies have engaged in extensive settlement negotiations, mediated by retired Judge Daniel Weinstein of JAMS Dispute Resolution, with the intent to avoid further litigation and associated expenses, to provide for an effective way to cooperate in the preparation of a new environmental impact report (EIR), and to make other specified improvements in the administration and operation of the State Water Project.

2. The mediation has resulted in an executed Settlement Agreement for approval by this Court, attached to this Order as Exhibit A.

3. DWR as lead agency has commenced the preparation of the new EIR.

4. As part of the Settlement Agreement, DWR and the State Water Project (SWP) contractors who are signatories to the Settlement Agreement have agreed that, pending DWR's filing of a return in satisfaction of the Writ of Mandate and this Court's dismissal of the Writ of Mandate, they will not approve any new project or activity (as defined in section VII.A of the Settlement Agreement) in reliance on the 1995 Environmental Impact Report for the Implementation of the Monterey Agreement.

5. This Order is made pursuant to the provisions of Public Resources Code section 21168.9 and pursuant to this Court's equitable powers. This Court finds that the actions described in this Order, including actions taken in compliance with the Writ of Mandate, comprise the actions necessary to assure DWR's compliance with Division 13 of the Public Resources Code. This Court further finds that this Order includes only those mandates necessary to achieve compliance with Division 13.

THEREFORE, IT IS HEREBY ORDERED as follows:

1. This Court's Final Judgment denying the petition for writ of mandate, entered August 15, 1996, is reversed in accordance with the directive of the Third District Court of Appeal's decision in Planning and Conservation League v. Department of Water Resources (2000) 83 Cal.App.4th 892.

2. This Court's order granting the summary adjudication on the fifth cause of action, entered June 10, 1996, is vacated.

3. The Settlement Agreement attached as Exhibit A is hereby approved.

4. A Peremptory Writ of Mandate directed to Respondents Central Coast Water Authority and DWR shall issue under seal of this Court in the form attached hereto as Exhibit B.

5. In accordance with the Settlement Agreement and this Order, pending DWR's filing of the return in compliance with the Peremptory Writ of Mandate and this Court's Order discharging the Writ of Mandate, DWR and CCWA shall not approve any new project or activity (as defined section VII.A of the Settlement Agreement) in reliance on the 1995 EIR for the Implementation of the Monterey Agreement.

6. In the interim, until DWR files its return in compliance with the Peremptory Writ of Mandate and this Court orders discharge of the Writ of Mandate, the administration and operation of the State Water Project and Kern Water Bank Lands shall be conducted pursuant to the Monterey Amendments to the State Water Contracts, as supplemented by the Attachment A Amendments to the State Water Contracts (as defined in the Settlement Agreement) and the other terms and conditions of the Settlement Agreement.

7. Plaintiffs and petitioners shall recover such costs and attorney's fees as provided in prior court orders and in an amount as determined in the arbitration procedures agreed to in the Settlement Agreement, or as otherwise agreed to by the parties.

8. Except as provided, the Peremptory Writ of Mandate shall not limit or constrain the lawful jurisdiction and discretion of DWR. This Court retains jurisdiction until DWR files a

return that complies with the terms of the Writ of Mandate, and this Court issues an order discharging the Writ of Mandate.

IT IS SO ORDERED.

Dated: ____________, 2003 ________________ ____________________________

Judge of the Superior Court

EXHIBIT 3-B

PROPOSED WRIT OF MANDATE

IN THE SUPERIOR COURT OF THE STATE OF CALIFORNIA

FOR THE COUNTY OF SACRAMENTO

PLANNING AND CONSERVATION LEAGUE, a California not for profit corporation, PLUMAS COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT, a California public agency; CITIZENS PLANNING ASSOCIATION OF SANTA BARBARA COUNTY, INC., a California not for profit corporation,	Case No: 95CS03216
Petitioners,	PROPOSED PEREMPTORY WRIT OF MANDATE (Public Resources Code § 21168.9)
v.	
DEPARTMENT OF WATER RESOURCES, a California State Agency, and CENTRAL COAST WATER AUTHORITY, A Joint Powers Agency	
Respondents.	

TO: Respondents California Department of Water Resources and Central Coast Water Authority:

The Third District Court of Appeal, in its decision in Planning and Conservation League v. Department of Water Resources (2000) 83 Cal.App.4th 892, having directed this Court to issue a Peremptory Writ of Mandate,

YOU ARE HEREBY COMMANDED to comply with the following:

1. Respondent Central Coast Water Authority shall set aside its October 26, 1995 certification that the Final Programmatic Environmental Impact Report for Implementation of

the Monterey Agreement (the 1995 Monterey Agreement EIR) was completed in compliance with the California Environmental Quality Act [AR 2183].

2. Respondent Department of Water Resources (DWR) shall:

(a) set aside its December 13, 1995 certification, as responsible agency, that the 1995 Monterey Amendment EIR is adequate under the California Environmental Quality Act [AR 1875]; and

(b) as lead agency, prepare and certify a new EIR. in compliance with the Court of Appeal's decision, the California Environmental Quality Act, and the Settlement Agreement.

3. Upon completion and certification of the new EIR, Respondent DWR shall make written findings and decisions and file a notice of determination identifying the components of the project analyzed in the new EIR, all in the manner prescribed by sections 15091 – 15094 of the CEQA Guidelines.

4. Respondent DWR shall, upon the filing of a Notice of Determination, submit the new EIR, the written findings, the Notice of Determination, and such additional documents as this Court may order by way of return to this writ of mandate.

5. This Court shall retain jurisdiction over this proceeding until DWR files a return that complies with this Writ of Mandate, and this Court issues an order discharging this Writ of Mandate. Except as provided, this Writ of Mandate shall not limit or constrain the lawful jurisdiction and discretion of the Department of Water Resources.

Dated: _____________, 2003

____

Clerk of the Superior Court

Let the foregoing writ issue:

____

Judge of the Superior Court

EXHIBIT 4

SECTION VI TRUST ACCOUNT AGREEMENT

This Section VI Trust Account Agreement (this "Trust Agreement") is entered into this ________ day of ______ 2003, by JAMS and the State of California Department of Water Resources (the "Department"), for the purposes of establishing and describing the trust account in accordance with that certain Settlement Agreement entered into in *Planning & Conservation League v. Department of Water Resources* ("PCL v. DWR").

WHEREAS, Judge Daniel Weinstein (ret.) of JAMS has acted as mediator between the Department and other parties to the litigation in *PCL v. DWR* (Sacramento Superior Court No. 95CS03216).

WHEREAS, the Settlement Agreement provides for the placement over time of $5,500,000 in trust with JAMS at the specific times and under the conditions in the Settlement Agreement.

The parties agree as follows:

1. JAMS will establish a trust account for receipt and disbursal of funds received from the Department for payment pursuant to the Settlement Agreement.

2. All funds deposited with JAMS pursuant to this agreement shall be placed into a trust account and shall be disbursed only in accordance with this Trust Agreement and the Settlement Agreement. Section VI of the Settlement Agreement provides that the funds shall be used to implement the Settlement Agreement, as determined by Plaintiffs in their reasonable judgment, including watershed restoration projects, follow-up actions arising from the Settlement Agreement, and technical studies.

3. JAMS agrees to maintain the monies in trust, and after receipt of a written statement executed by all Plaintiffs (as defined in the Settlement Agreement), to disburse funds to Plaintiffs in conformance with such statement. JAMS will provide a copy of the written statement to: Chief Counsel, The Office of the Chief Counsel, Department of Water Resources, P.O. Box 942836, Sacramento, CA 95814.

4. Costs incurred by JAMS in providing this service will be paid as part of the mediator services as part of the existing contract between JAMS and the California Department of Justice, Office of the Attorney General, or any successor contract.

5. This agreement may be amended only in writing by agreement of both parties.

6. Funds not disbursed before termination of this Trust Agreement shall be returned to DWR immediately upon termination of this Trust Agreement.

7. This Trust Agreement shall terminate if and when DWR notifies JAMS that the agreement is terminated, which notice shall not be given without DWR's consultation with Plaintiffs and the mediator.

8. JAMS will incur no liability to DWR arising from any disbursement made pursuant to this agreement.

9. This Trust Agreement is intended solely for the purposes of establishing and describing the trust account at JAMS and is not intended to and shall not create any rights in any third party.

APPROVED:

Thomas M. Hannigan Director	Date	JAMS	Date

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES

AMENDMENT NO. 19 TO THE WATER SUPPLY CONTRACT
BETWEEN
THE STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
AND
CASTAIC LAKE WATER AGENCY

This Amendment is made this 28th day of May, 2003, pursuant to the provisions of the California Water Resources Development Bond Act, the Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, hereinafter referred to as the "State," and Castaic Lake Water Agency, hereinafter referred to as the "Agency."

RECITALS

A. The State and the Agency entered into and subsequently amended a water supply contract (the "contract") providing that the State shall supply certain quantities of water to the Agency and providing that the Agency shall make certain payments to the State, and setting forth the terms and conditions of such supply and such payments.

B. On December 1, 1994, the State and representatives of certain State Water Project contractors executed a document entitled "Monterey Agreement – Statement of Principles – By The State Water Contractors And The State Of

California Department Of Water Resources For Potential Amendments To The State Water Supply Contracts" (the "Monterey Agreement").

C. The State, the Central Coast Water Authority ("CCWA") and those contractors intending to be subject to the Monterey Agreement subsequently negotiated an amendment to their contracts to implement provisions of the Monterey Agreement, and such amendment was named the "Monterey Amendment."

D. In October 1995, an environmental impact report ("EIR") for the Monterey Amendment was completed and certified by CCWA as the lead agency, and thereafter the Agency and the State executed the Monterey Amendment.

E. The EIR certified by the CCWA was challenged by several parties (the "Plaintiffs") in the Sacramento County Superior Court and thereafter in the Third District Court of Appeal, resulting in a decision in Planning and Conservation League, et al. v. Department of Water Resources, 83 Cal.App.4th 892 (2000), which case is hereinafter referred to as "PCL v. DWR."

F. In its decision, the Court of Appeal held that (i) the Department of Water Resources ("DWR"), not CCWA, had the statutory duty to serve as lead agency, (ii) the trial court erred by finding CCWA's EIR sufficient despite its failure to discuss implementation of Article 18, subdivision (b) of the State Water Project contracts, as a no-project alternative, (iii) said errors mandate preparation of a new EIR under the direction of DWR, and (iv) the trial court erroneously dismissed the challenge to DWR's transfer of title to certain lands to Kern County Water Agency (the "Validation Cause of Action") and execution of amended State Water Project contracts for failure to name and serve indispensable parties. The

Court of Appeal remanded the case to the trial court, ordering it to take the following five actions: (1) vacate the trial court's grant of the motion for summary adjudication of the Validation Cause of Action; (2) issue a writ of mandate vacating the certification of the EIR; (3) determine the amount of attorney fees to be awarded Plaintiffs; (4) consider such orders it deems appropriate under Public Resources Code Section 21168.9(a) consistent with the views expressed in the Appellate Court's opinion; and (5) retain jurisdiction over the action until DWR, as lead agency, certifies an environmental impact report in accordance with CEQA standards and procedures, and the Superior Court determines that such environmental impact report meets the substantive requirements of CEQA.

G. The State, the contractors, and the Plaintiffs in PCL v. DWR reached an agreement to settle PCL v. DWR, as documented by that certain Settlement Agreement dated MAY 0 5 2003, 2003 (the "Settlement Agreement"), and in such Settlement Agreement have agreed that the contracts should be amended, for clarification purposes, to delete terms such as "annual entitlement" and "maximum annual entitlement" so that the public, and particularly land use planning agencies, will better understand the contracts.

H. Pursuant to the Settlement Agreement, the State and the Agency desire to so amend the Agency's contract, with the understanding and intent that the amendments herein with respect to subsections (k), (l), and (m) of Article 1, subsection (b) of Article 6, and subsection (a) of Article 16, and to Table A of the Agency's contract are solely for clarification purposes and that such amendments are not intended to and do not in any way change the rights, obligations or limitations on liability of the State or the Agency established by or set forth in the contract.

I. Pursuant to the Settlement Agreement, the State, the contractors and the Plaintiffs in PCL v. DWR also agreed that the contracts should be amended to include a new Article 58 addressing the determination of dependable annual supply of State Water Project water to be made available by existing Project facilities, and the State and Agency desire to so amend the Agency's contract.

NOW THEREFORE, IT IS MUTUALLY AGREED, as follows:

1. Article 1(l) is amended to read:

(l) Annual Table A Amount

"Annual Table A Amount" shall mean the amount of project water set forth in Table A of this contract that the State, pursuant to the obligations of this contract and applicable law, makes available for delivery to the Agency at the delivery structures provided for the Agency. The term Annual Table A Amount shall not be interpreted to mean that in each year the State will be able to make that quantity of project water available to the Agency. The Annual Table A Amounts and the terms of this contract reflect an expectation that under certain conditions the Agency will receive its full Annual Table A Amount; but that under other conditions only a lesser amount, allocated in accordance with this contract, may be made available to the Agency. This recognition that full Annual Table A Amounts will not be deliverable under all conditions does not change the obligations of the State under this contract, including but not limited to, the obligations to make all reasonable efforts to complete the project facilities, to perfect and protect water rights, and to allocate among contractors the supply available in any year, as set forth in Articles 6(b), 6(c), 16(b) and 18, in the manner and subject to the terms and conditions of those articles and this contract. Where the term "annual entitlement" appears elsewhere in this contract, it shall mean "Annual Table A Amount." The State agrees that in future amendments to this and other contractor's contracts, in lieu of the term "annual entitlement," the term "Annual Table A Amount" will be used and will have the same meaning as "annual entitlement" wherever that term is used.

2. Article 1(m) is amended to read:

(m) Maximum Annual Table A Amount

"Maximum annual entitlement" shall mean the maximum annual amounts set forth in Table A of this contract, and where the term "maximum annual entitlement" appears elsewhere in this contract it shall mean "Maximum Annual Table A Amounts."

3. Article 1(k) is amended to read:

(k) Minimum Project Yield

"Minimum project yield" shall mean the dependable annual supply of project water to be made available assuming completion of the initial project conservation facilities and additional project conservation facilities. The project's capability of providing the minimum project yield shall be determined by the State on the basis of coordinated operations studies of initial project conservation facilities and additional project conservation facilities, which studies shall be based upon factors including but not limited to: (1) the estimated relative proportion of deliveries for agricultural use to deliveries for municipal use assuming Maximum Annual Table A Amounts for all contractors and the characteristic distributions of demands for these two uses throughout the year; and (2) agreements now in effect or as hereafter amended or supplemented between the State and the United States and others regarding the division of utilization of waters of the Delta or streams tributary thereto.

4. Article 6(b) is amended to read:

(b) Agency's Annual Table A Amounts

Commencing with the year of initial water delivery to the Agency, the State each year shall make available for delivery to the Agency the amounts of project water designated in Table A of this contract, which amounts shall be subject to change as provided for in Article 7(a) and are referred to in this contract as the Agency's Annual Table A Amounts.

5. Article 16(a) is amended to read:

(a) Limit on Total of all Maximum Annual Table A Amounts

The Agency's Maximum Annual Table A Amount hereunder, together with the maximum Table A amounts of all other contractors, shall aggregate no more than 4,185,000 acre-feet of project water.

6. Article 57 is intentionally left blank for future use.

7. Article 58 is added to read:

58. Determination of Dependable Annual Supply of Project Water to be Made Available by Existing Project Facilities.

In order to provide current information regarding the delivery capability of existing project conservation facilities, commencing in 2003 and every two years thereafter the State shall prepare and mail a report to all contractors, and all California city, county, and regional planning departments and agencies within the contractors' project service areas. This report will set forth, under a range of hydrologic conditions, estimates of overall delivery capability of the existing project facilities and of supply availability to each contractor in accordance with other provisions of the contractors' contracts. The range of hydrologic conditions shall include the delivery capability in the driest year of record, the average over the historic extended dry cycle and the average over the long-term. The biennial report will also include, for each of the ten years immediately preceding the report, the total amount of project water delivered to all contractors and the amount of project water delivered to each contractor.

8. Add the following language at the bottom of Table A:

In any year, the amounts designated in this Table A shall not be interpreted to mean that the State is able to deliver those amounts in all years. Article 58 describes the State's process for providing current information for project delivery capability.

9. Except for Article 58, the changes made by this amendment are solely for clarification purposes, and are not intended to nor do they in any way change the rights, obligations or limitations on liability of the State or the Agency established by or set forth in the contract, and this amendment shall be interpreted in accordance with this intent.

10. At the time of execution of this Agreement and thereafter, the effectiveness of this Amendment is dependent upon the effectiveness of the Agency's Monterey Amendment (all provisions therein) and the Kern Fan Element Transaction.

IN WITNESS WHEREOF, the parties hereto have executed this amendment on the date first above written.

Approved as to legal form
and sufficiency:

Chief Counsel
Department of Water Resources

STATE OF CALIFORNIA
DEPARTMENT OF WATER
RESOURCES

Director

CASTAIC LAKE WATER AGENCY

Name

GENERAL MANAGER
Title

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES

AGREEMENT BETWEEN THE STATE OF CALIFORNIA DEPARTMENT OF WATER RESOURCES AND CASTAIC LAKE WATER AGENCY REGARDING PAYMENT OF COSTS OF MONTEREY AMENDMENT LITIGATION

This Agreement is made this 28th day of May, 2003, pursuant to the provisions of the California Water Resources Development Bond Act, the Central Valley Project Act, and other applicable laws of the State of California, between the State of California, acting by and through its Department of Water Resources, hereinafter referred to as the "Department," and Castaic Lake Water Agency, hereinafter referred to as the "Agency."

RECITALS

A. The Department and the Agency entered into and subsequently amended a water supply contract (the "contract") providing that the Department shall supply certain quantities of water to the Agency and providing that the Agency shall make certain payments to the Department, and setting forth the terms and conditions of such supply and such payments.

B. On December 1, 1994, the Department and representatives of certain State Water Project contractors executed a document entitled "Monterey Agreement –

Statement of Principles – By The State Water Contractors And The State Of California Department Of Water Resources For Potential Amendments To The State Water Supply Contracts" (the "Monterey Agreement").

C. The Department, the Central Coast Water Authority ("CCWA") and certain other State Water Project contractors subsequently negotiated an amendment to their contracts to implement provisions of the Monterey Agreement, and such amendment was named the "Monterey Amendment."

D. In October 1995, an environmental impact report ("EIR") for the Monterey Amendment was completed and certified by CCWA as the lead agency, and thereafter the Agency and the Department executed the Monterey Amendment.

E. The EIR certified by the CCWA was challenged by several parties (the "Plaintiffs") in the Sacramento County Superior Court and thereafter in the Third District Court of Appeal, resulting in a decision in Planning and Conservation League, et al. v. Department of Water Resources, 83 Cal.App.4th 892 (2000), which case is hereinafter referred to as "PCL v. DWR."

F. The Department, the contractors, and the Plaintiffs in PCL v. DWR reached an agreement to settle PCL v. DWR, as documented by that certain Settlement Agreement dated MAY 05 2003, 2003 (the "Settlement Agreement"), and in such Settlement Agreement the Department has agreed to undertake various financial obligations and make certain payments to the various plaintiffs and their attorneys.

G. The purpose of this agreement is to establish the terms for the Department's allocation and reimbursement of costs of the Monterey Amendment litigation.

NOW THEREFORE, IT IS MUTUALLY AGREED, as follows:

1. All costs of the Monterey Amendment litigation (hereinafter "costs") incurred by the Department shall be allocated among all State Water Project contractors who have signed the Monterey Amendment as of January 1, 2003 proportionally based upon their maximum Table A Amounts as of January 1, 2003.
2. Costs of the Monterey Amendment litigation shall be included in the annual Statement of Charges for the year in which they are incurred by the Department, or in the next subsequent annual Statement of Charges, and shall not be amortized.
3. After the costs of the Monterey Amendment litigation are allocated as described in paragraph 2, such costs shall be billed and repaid to the Department annually as part of the Minimum OMP&R Component of the Transportation charge in the annual Statement of Charges, in accordance with the terms of the contract.
4. Payment of the costs of the Monterey Amendment litigation shall be subject to the payment, adjustment, and collection provisions of Articles 29 through 34 of the contract.

5. This agreement is being entered into solely for purposes of providing for payment of the costs of the Monterey Amendment litigation, and shall be effective for those purposes notwithstanding any contrary provision in the contract. It is not intended to nor does it change in any way any substantive rights, obligations or limitations on liability of the Department or the Agency established by or set forth in the contract, and this agreement shall be interpreted in accordance with this intent.

6. This agreement shall become effective on the date of approval of the Settlement Agreement by the Superior Court in PCL v. DWR and shall remain in effect until all costs of the Monterey Amendment litigation incurred by the Department have been paid in full.

IN WITNESS WHEREOF, the parties hereto have executed this agreement on the date first above written.

Approved as to legal form
and sufficiency:

Chief Counsel
Department of Water Resources

STATE OF CALIFORNIA
DEPARTMENT OF WATER
RESOURCES

Director

CASTAIC LAKE WATER AGENCY

Name

GENERAL MANAGER
Title

Diazinon Revised Risk Assessment and Agreement with Registrants

United States Environmental Protection Agency
Prevention, Pesticides And Toxic Substances (7506C)
Revised January 2001

EPA

Diazinon Revised Risk Assessment and Agreement with Registrants

Action and Rationale

EPA is releasing its revised risk assessment and announcing an agreement with registrants to remove and phase out certain uses of the organophosphate pesticide diazinon. Also known as Spectracide and other trade names, diazinon is one of the most widely-used insecticides in the U.S., especially for household lawn and garden pest control.

The Food Quality Protection Act, enacted in 1996, sets a more stringent safety standard for most pesticides and offers special protection for children. EPA has accepted a voluntary agreement from the manufacturers of diazinon to modify the uses of this pesticide to address the tough new safety standard of FQPA.

The Agency accepted the termination of all indoor residential and indoor non-residential uses of diazinon. EPA and the registrants also have agreed to phase out and cancel outdoor residential lawn and garden uses (i.e., all outdoor non-agricultural uses) over the next few years. Together, these actions will end about 75% of the current use of diazinon. EPA and the registrants have further agreed to remove about one third of the agricultural crop uses of diazinon. This action will also help mitigate risks to workers, birds and other wildlife, drinking water resources, and the environment.

Risk Mitigation

EPA and the registrants of diazinon have agreed to the following modifications:

Reducing Residential Risks... About 75% of diazinon currently is used in and around the home. Diazinon accounts for about 30% of the homeowner use insecticide market. The agreement will result in termination of all retail sale of diazinon for residential crack and crevice treatments and all other indoor uses by the end of 2002.

The agreement also virtually ends sales of the residential lawn care use of diazinon in 2003, and provides for orderly transition to a new product line. The home lawn care use accounts for most residential exposure but less risk than the indoor use of diazinon. Under the agreement, production of diazinon for home lawn care and all other outdoor non-agricultural uses must phase down at least 50% by 2003. Production, formulation, and sales to retailers are scheduled to phase out and end completely during 2003. Registrants will buy back any products from retailers that remain at the end of 2004. However, few retail products for home lawn care uses are expected to remain in the market by that time.

Reducing Ecological Risks... Broadcast application of diazinon to turf poses one of the greatest pesticide risks to birds. Just one granule or seed treated with diazinon is enough to kill a small bird. Diazinon had the highest number of reported bird kill incidents of any registered pesticide during 1994-1998. Birds of many species have been killed, including ducks, geese, hawks, songbirds, woodpeckers, and others. Since residential use of diazinon accounted for over half of these incidents, phasing out and canceling the outdoor residential uses is expected to further mitigate risks to birds and other wildlife.

Diazinon is one of the most commonly found pesticides in air, rain, and fog. Monitoring data indicate that while it is widespread in surface water nationally, diazinon is most commonly found in surface water in urban areas as a result of runoff from residential use. Phasing out and eventually canceling the outdoor residential uses of diazinon, as well as some current agricultural uses, will help reduce residues of diazinon in surface water and throughout the environment.

Reducing Drinking Water Risks... The agreement to phase out and cancel all outdoor residential uses of diazinon is expected to reduce human exposure to diazinon through drinking water, since residential applications are potentially a major source of drinking water contamination.

Reducing Worker Risks... Risks to agricultural workers who mix, load, and apply diazinon or harvest treated crops also are of concern to EPA. The agreement will help mitigate worker risks by canceling about 30% of the current agricultural uses of diazinon. The agreement also will maintain the Restricted Use Pesticide classification for remaining diazinon crop uses so they will continue to be limited to trained, certified applicators. These and other measures to reduce both worker and ecological risks will be discussed further in consultation with stakeholders as EPA develops an interim reregistration eligibility decision for diazinon.

Supporting Low-Risk Uses... The agreement allows about 70% of current diazinon agricultural uses to continue. The continuing diazinon uses are important to the production of many minor crops, and do not exceed the "risk cup" for diazinon. EPA will further consider worker and ecological risks in developing risk management options, considering public comments received during the next 60 days, and in completing an interim reregistration eligibility decision for diazinon.

Phased In Approach

The diazinon agreement phases in various restrictions and cancellations to address higher risk, indoor residential uses first. Because much pesticide risk reduction involves increasing margins of safety, it is reasonable to focus first on uses that achieve the greatest risk reduction for children. Allowing other uses to continue for specific periods of time will help ensure that appropriate alternatives are available for a reasonable and orderly transition.

Reregistration of Diazinon

The risk mitigation measures in this agreement represent an important step in EPA's review of diazinon. As the Agency continues its review of diazinon through the reregistration process, we will continue to look at both occupational and ecological risks to ensure that diazinon meets current safety standards. If EPA determines that unreasonable risks remain for workers or the environment, the Agency will incorporate additional risk mitigation measures as part of the interim reregistration eligibility decision.

Provisions of the Agreement and Associated EPA Actions

Home Uses		
Site	**Mitigation Measures**	**Effective Dates**
Indoor Uses All uses inside any structure, vehicle, vessel, aircraft, or enclosed area and/or on any contents therein (except mushroom houses), including residences, food/feed handling establishments, schools, museums, stores, hospitals, sports facilities, warehouses, and greenhouses. All indoor pet uses including pet collars.	Product registrations are being canceled or amended to delete indoor uses from end use product labels (except use in mushroom houses). EPA's Federal Register notice of January 10, 2001, proposed to delete these uses.	Cancellations become effective after the 30-day public comment period, upon issuance of a cancellation order in February 2001. As of March 1, 2001, manufacturing use products may no longer be used to formulate end use products for indoor uses. Retailers stop sale December 31, 2002
Outdoor Non-Agricultural Uses Home lawn, garden, and any other outdoor residential or outdoor non-agricultural uses	Production will phase down Uses will be phased out Technical registrants will buy back existing products from retailers Product registrations will (expire) be canceled, with no provision for existing stocks	Technical registrants reduce amount of diazinon produced by 50% or more by 2003. Stop formulation of products June 30, 2003 Stop sale to retailers August 31, 2003 Commencing December 31, 2004 December 31, 2004

Agricultural Uses Proposed for Cancellation		
Crop	**Action**	**Effective Dates**
Alfalfa Bananas Beans (dried) Bermudagrass Celery Red Chicory (radicchio) Citrus Clover Coffee Cotton Cowpeas Cucumbers Dandelions Kiwi Lespedeza Parsley Parsnips Pastures Peppers Irish Potatoes Sweet Potatoes Rangeland Sheep Sorghum Spinach Squash (summer and winter) Strawberries Swiss chard Tobacco Tomatoes Turnips	EPA published a Federal Register notice on January 10, 2001, proposing to delete these uses from product labels.	The proposed cancellations may become effective after the 30-day public comment period, upon issuance of a cancellation order in February 2001.

For Additional Information

For additional information on the diazinon agreement or other aspects of the Agency's pesticide regulatory program, contact EPA's Office of Pesticide Programs at (703) 305-5017, or visit our web site, www.epa.gov/pesticides.

For information on pesticides and their toxicity, contact the National Pesticide Telecommunications Network at 1-800-858-7378.

WATER QUALITY TECHNICAL REPORT

For: Riverpark

Prepared for:
Impact Sciences, Inc.
30343 Canwood Street
Suite 210
Agoura Hills, CA 91301

Prepared by:
PSOMAS
11444 W. Olympic Blvd
Suite 750
West Los Angeles, CA 90064
Tel: 310-954-9700
Fax: 310-954-3777

Date: February 2004

Psomas Job No: 1VAL021505

TABLE OF CONTENTS

1 INTRODUCTION

Storm water discharges consist of surface runoff generated from various land uses in hydrologic drainage basins that discharge into water bodies of the State and Waters of the United States. The quality of these discharges varies considerably and is affected by the hydrology, geology, land use, season, and sequence and duration of hydrologic events. Pollutants in storm water can have damaging effects on both human health and aquatic ecosystems. Absent special measures, development and urbanization typically increase pollutant loads for certain pollutants, volume and discharge velocity of storm water runoff. First, natural vegetated pervious ground cover is converted to impervious surfaces such as paved highways, streets, rooftops and parking lots. Second, urban development can create new storm water pollution sources as the increased density of human population brings proportionately higher levels of vehicle emissions, vehicle maintenance wastes, pesticides, household hazardous wastes, pet wastes, trash and other anthropogenic pollutants.

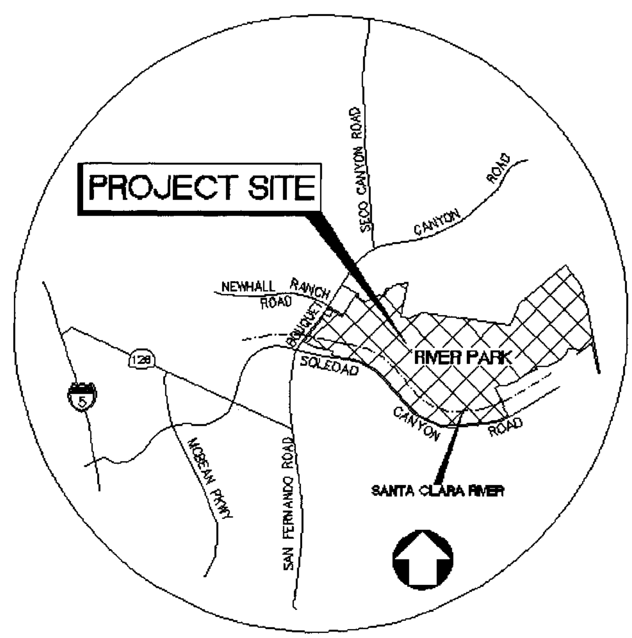
This report addresses storm water quality for the Riverpark project. It provides a technical discussion on water quality for existing, proposed, and cumulative project conditions.

1.1 PROJECT DESCRIPTION

1.1.1 Project Site

The Riverpark project lies in the center of the City of Santa Clarita, and within the watershed of an unnamed and roughly 835-acre tributary of the 1,634 square-mile Santa Clara River Basin Watershed (see Vicinity Map). The Santa Clara River flows through and adjacent to the project. The project site is located north of Soledad Canyon Road, east of Bouquet Canyon Road, and west of Golden Valley Road.

The site is currently vacant except for a small portion that is being used by a contractor as a temporary storage yard with several temporary buildings. The proposed Riverpark project lies within the Valley Center Concept ("VCC") area of the City's General Plan, which specifically outlines the type and intensity of development in the core of the City of Santa Clarita. The proposed project consists of 744 apartment units, 439 single-family detached units, and a maximum of 40,000 square feet of retail commercial. Site preparation will include a cut and fill grading operation totaling 5.2 million cubic yards for both project development and construction of master-planned roadways (Newhall Ranch Road and Santa Clarita Parkway) within the project boundaries. Additional remedial



VICINITY MAP
NOT TO SCALE

grading is proposed. Earthwork is proposed to be balanced onsite. The project also includes buried bank stabilization, erosion protection, and the construction of the Newhall Ranch Road/Golden Valley Road Bridge over the Santa Clara River. The bridge would include abutments and bank stabilization on the north and south side of the bridge, as well as piers within the River. The project does not include the Santa Clarita Parkway Bridge, which is part of the City's General Plan and is expected to be constructed in the future; however, this latter bridge is included in the cumulative analysis because it is a City-planned improvement and much of its construction would occur within the project site boundaries.

The site lies within that portion of the Santa Clara River designated as Reach 7 by the RWQCBLAR and as Reach 9 by the EPA (for convenience, this reach of the river will generally be referred to as Reach 7); this reach extends from the Lang Gauging Station (to the east of the project, downstream of Agua Dulce Canyon Creek) to Bouquet Canyon Road Bridge (located directly west of the project). Reach 7 contains relatively little water when compared to other reaches of the river during non flood conditions. Its intermittent flows occur generally only during the "rainy" season during and immediately after storm events of sufficient size to cause flows. Therefore, under dry-weather (i.e., non-storm flow, excluding storm events) conditions, Reach 7 does not impact downstream reaches of the river. When water is present in this reach, it is almost always during the rainy winter months and typically lasts only for a few days after a storm event large enough to create flow.

The project lies upstream from two sewage treatment plants. The Saugus Treatment Plant is located immediately downstream from the project, across Bouquet Canyon Road at Soledad Canyon Road, and the Valencia Treatment Plant is located further downstream. Both treatment plants discharge treated water into reaches of the river lying downstream from the project.

1.1.2 Project Description

The project is proposed for development into primarily residential uses. The project would result in conversion of approximately 40 percent of the mostly vacant site into commercial, residential, recreational and transportation land uses with associated infrastructure.

The proposed project incorporates a 29-acre active/passive park. This park will have direct access to the regional river trail.
With project development, concentrations of existing pollutants could increase and new pollutants could be introduced on the site. Where constituent levels increase, post-construction structural (treatment) best management practices (BMPs) are required. These BMPs must comply with local regulations (SUSMPs). Furthermore, by definition, implementation of BMPs must utilize Best Available Technologies (BATs) to the Maximum Extent Practicable (MEP).

Project Design Features can be grouped into 3 categories: site planning, source control, and treatment.

(a) Site Planning BMPs

Site planning BMPs are practices designed to minimize runoff and the introduction of pollutants in storm water runoff. Site planning principles that will be taken into account in preparing the SUSMP for the project are listed by design principal.

Minimize Impervious Area and Directly Connected Impervious Areas

- Minimize impervious areas by incorporating landscaped areas over substantial portions of the project area. Pervious areas are currently predicted to comprise approximately 74% of the site, with approximately 150 acres to be landscaped and irrigated.

- Minimize directly connected impervious area by draining parking lots to landscaped areas or bioretention facilities to promote filtration and infiltration of storm water, if landscaping slopes are less than 2 percent and the project is not adjacent to steep slopes; or treat with catch basin inserts.

- Utilize vegetated areas, e.g., setbacks, end islands, and median strips, for biofiltration and bioretention of nuisance and storm runoff flows from parking lots;

- Increase building density (number of stories above or below ground; build up rather than out).

Selection of Construction Materials and Design Practices

- Select building materials for roofs, roof gutters and downspouts that do not include exposed copper or zinc.

- Construct streets, sidewalks, and parking lot aisles to the minimum widths specified in by the City's requirements and in compliance with regulations for the Americans with Disabilities Act and safety requirements for fire and emergency vehicle access. Incorporate landscaped buffer areas between sidewalks and streets.

- Construct onsite detention facilities. Water quality basins will be incorporated into the development.

- Prohibit septic tanks.

Conserve Natural Areas

- Concentrate or cluster development on the least environmentally sensitive portions of the Project site while leaving the remaining land in a natural, undisturbed condition. For example, 330.8 acres consisting of the Santa Clara River and surrounding areas are being preserved.

- Use natural drainage systems to the maximum extent practicable or create drainages (e.g. vegetated swales) that mimic natural conveyances and allow for storm water infiltration as well as pollutant removal.

- Maximize canopy interception and water conservation by preserving existing native trees and shrubs (e.g. riparian area) and planting additional native or drought tolerant trees and large shrubs. The open space areas will help protect sensitive areas such as wildlife corridors and habitat of sensitive plant and animal species. A landscaping plan for the project will conform to County of Los Angeles/City of Santa Clarita requirements for use of drought resistant plants. Over one-half of the site would be preserved as open space, and the vegetation in these areas will remain.

Protect Slopes and Channels

- Protect slopes: minimize erosion potential (predominantly sandy soils) with vegetative cover, route flows safely from or away from steep and or sensitive slopes, stabilize disturbed slopes. All slopes within the project will be designed and constructed to minimize erosion.

- Protect channels: control and treat flows in landscaping and/or other controls prior to reaching existing natural drainage systems; stabilize channel crossings; ensure that increases in runoff velocity and frequency caused by the project do not erode the channel; install energy dissipaters, such as riprap, at the outlets of storm drains or conveyances.

(b) Source Controls

Effective management of wet and dry weather water quality begins with limiting pollutant sources and by retaining pollutants at their point of origin. The following source control management practices will be incorporated into the storm water management and treatment system for the project in order to help limit the change in runoff and the amount of pollutants in storm water runoff and dry weather (nuisance) flows.

- <u>Drain Inlet Stenciling or Signage.</u> Stenciling (or signage) is intended to raise public awareness and limit illegal dumping of trash, debris, oil, and other pollutants into storm drains. "Stenciling" will either be accomplished via a traditional stencil or via the use of grates with text or another equivalent method.

- <u>Irrigation Controls and Management.</u> Irrigation controls will help ensure that irrigation is conducted efficiently. Where feasible, plants with similar watering requirements will be grouped in order to reduce excess irrigation runoff and promote surface filtration. Efficient irrigation systems reduce irrigation runoff and conserve water resources; such systems may include computerized and/or radio telemetry that controls the amount of irrigation based on soil moisture or other indicators. Considering that irrigation in semi-arid areas substantially exceeds mean annual precipitation, irrigation control is clearly one of the most effective traditional controls for low flow runoff.

- <u>Proper Application of Fertilizers and Pesticides.</u> Best management practices will be implemented for minimizing the application of fertilizers, pesticides, and other landscape management products on slopes and landscaped areas maintained by either the homeowner's association (HOA) or apartment property owners. Examples of these management practices include, but are not to limited to: the use of slow release fertilizers, applying fungicides only to greens to limit the use of pesticides, and closely monitoring weather forecast to ensure appropriate timing (during dry periods) for the application of landscape management products.

- Community Education Program. Public education will be used to reduce the potential for hazardous materials entering the storm drain system. This will be accomplished through distribution of brochures or other materials to property managers, owners and occupants, and employees at the time of initial sale or lease of property or hiring of employees and periodically thereafter. These brochures will discuss, among other topics and as appropriate for the audience: 1) the importance of downstream water bodies, the storm water system, management of fertilizers, pesticides, and other harmful chemicals, 2) the impacts of dumping oil, antifreeze, pesticides, paints, and other pollutants into storm drains and proper handling and disposal of these materials, 3) effective cleaning practices such as the cleaning of vehicles only in maintenance areas where the water will be recycled or routed to the sanitary sewer system to prevent nuisance flows, 4) the benefits of the prevention of excessive erosion and sedimentation, 5) the benefits of proper landscaping practices, 6) pavement clean-up practices, 7) the impacts of over-irrigation, 8) swimming pool draining practices, and 9) other relevant issues.

- Prevention of all nuisance flows. Grease traps will be included for restaurants. Draining swimming pools into the storm drains will be prohibited.

- Pavement Sweeping Program. The majority of the roads in the project are proposed to be dedicated to the public, and would thus be maintained by the City of Santa Clarita. The City has street sweeping programs that will help control trash, vegetation debris and sediment that may accumulate on roadways. The parking areas in the proposed commercial area would be maintained by a private service.

- Litter Control Program & Design of Trash Storage Areas. The litter control program will focus on litter control for common areas. A program of this type typically consists of the placement and emptying of trash receptacles, ensuring that trash bins are maintained in the closed position. Removing trash from parking areas and landscaping is also a component of this program. In conjunction with the litter control program, trash storage areas will be designed to prevent introduction of this pollutant into runoff. The design principles to prevent this pollution from occurring are using impervious surfaces for storage areas which prevent run-on from adjacent areas, ensuring that there is no connection of trash drains to the storm drain system, and keeping lids on all trash receptacles in addition to the use of roofs or awnings to minimize direct precipitation.

- Centralized Car Washing Facilities: Centralized car washing facilities will be provided for the multi-family complexes with 100 units or more. The runoff from these facilities will be directed into the sewers, not the storm drains.

- Proper Connection and Maintenance of Sewer Lines: Sewer lines will be properly connected and adequately maintained.

- Activity restrictions (Conditions, Covenants, and Restrictions): City maintenance and implementation of BMPs or Conditions, Covenants, and Restrictions (CC&Rs) will be prepared requiring maintenance and implementation of BMPs by the HOA for the purpose of surface water quality protection, or use restrictions will be developed through lease terms.

- BMP maintenance: City or Home Owners Associations (HOAs) will be responsible for the inspection and maintenance of structural BMPs within their boundaries.

- Common Area Drainage Facility Inspection - Privately-owned common area drainage facilities will be inspected each year and, if necessary, cleaned and maintained prior to the storm season, no later than October 1st of each year. Drainage facilities include catch basins and inlets, water quality basins, detention basins, and open drainage channels. In conjunction with the litter control program trash storage areas will be designed prevent introduction of this pollutant into runoff. The design principles to prevent this from occurring are impervious surfaces for storage areas which prevent run-on from adjacent areas, no connection of trash drains to the storm drain system, and lids on all trash receptacles in addition to roofs or awnings to minimize direct precipitation.

(c) Structural and Treatment Control BMPs

Structural and Treatment Control BMPs are described below as part of the proposed project improvements.

1.1.3 Proposed Project Improvements

The following section discusses proposed improvements on the project site that would provide drainage and water quality measures (project design features, or PDFs), as well as flood and erosion control, and which would occur in and adjacent to the Santa Clara River.

(a) Drainage and Flood Control Project Improvements

At project buildout, runoff from nine drainage areas would continue to flow through the site, but would be channeled through a storm system that would be constructed from the developed upland areas of the site down to the Santa Clara River. Runoff through the site would be controlled through a combination of grading, storm drainpipes, channels, catch basins, outlet structures, and bank stabilization along the river. The proposed drainage and flood control project facilities are described below and their locations are illustrated in the Flood Technical

Report (Psomas 2004), which also illustrates the post-development drainage patterns for the project site.

- *Storm Drains*
- *Open Channels*
- *Low Flow Pipes and Outlet*
- *Catch Basins*
- *Debris Basins*
- *Energy Dissipaters*
- *Bank Stabilization*

Flood plain project features and project impact analyses are presented in the Flood Technical Report (Psomas 2004).

(b) Water Quality Project Improvements

Water quality measures include both Structural and Source Control Best Management Practices (BMPs or PDFs). The project Drainage Concept (as illustrated in Figure 1 **Drainage Concept Map,** map pocket) shows proposed structural BMPs that will address potential storm water quality impacts from the project. These structural BMPs generally include water quality detention basins, a grassy swale, and Hydrodynamic Separator Systems (HSS) and/or Gross Solids Removal Devices (GSRDs), such as Continuous Deflective Separator (CDS) units. Additional equivalent structural BMPs that could alternatively be implemented at the project site include catch basin inserts, storm water filters, and storm water clarifiers.

Parties typically responsible for the proposed BMPs post construction include public agencies, landscape maintenance districts, or homeowners' associations. Responsible parties for the proposed water quality improvements will be identified prior to final map approval.

In addition, trash areas for commercial areas will be paved, designed not to allow run-on, screened or walled to prevent off-site transport of trash; and covered to minimize direct precipitation. Connection of trash area drains to the municipal storm drain system will be prohibited. Storm water BMPs will be included to decrease the potential for erosion of slopes and/or channels, and may include appropriate conveyance structures, landscaping, etc. Hillside areas that are disturbed by project development shall be landscaped with deep-rooted, drought tolerant plant species selected for erosion control. In multi-family complexes larger than 100 dwelling units where car washing is allowed, a designated car wash area that does not drain to a storm drain system shall be provided for common usage. Wash waters from this area may be directed to the sanitary sewer (with the prior approval of the sewering agency); to an engineered infiltration system; or to an equally effective alternative. Pre-treatment may also be required.

Water Quality Detention Basins

To reduce pollutants in the "first flush" runoff, a series of pipes and outlets would intercept first flush runoff from paved developed areas and discharge it to water quality control detention basins.

As shown in the Drainage Concept Map, water quality control detention basins are proposed at the discharge points from hydrologic sub-area 200, including portions of sub-area 400 (Water Quality Basin A) and hydrologic sub-areas 300 and 350, including portions of sub-area 400 (Water Quality Basin B). Detention basins are proposed at these discharge points because they would effectively treat the majority of constituents generated at the site once developed and there is an availability of land at these locations. Specifically, Water Quality Basin A is located in sub-area 205 and is proposed for treating runoff from the 200 series drainage area. Water Quality Basin B is located in sub-area 308 and is proposed for treating runoff from the 300 and 400 series drainage areas.

The proposed water quality control detention basins are preliminarily sized to meet the minimum Los Angeles County SUSMP criteria, based on a 0.75 inch runoff event; however, the final capacity of the basins will be determined for project runoff, as well as runoff from undeveloped upstream areas, and would be designed to capture 80% of annual runoff, which could be more than the 0.75 inch event The size of the facilities will be finalized during the design stage by the project engineer with the final hydrology study, which is prepared and approved at the final engineering stage and prior to issuance of a grading permit. This report will be reviewed by both the City of Santa Clarita and the County of Los Angeles as both agencies will be accepting maintenance of different parts of the storm drain system. The water quality control detention basins would be designed to empty within 24 to 40 hours. The 24-hour limit would allow the minimum adequate settling time for the settable solids. Under no circumstances should residence time approach 72 hours, for human health and vector (e.g., mosquito) control reasons. Figures 2A, Schematic Detention Basin, and 2B, Water Quality Outlet, provide a conceptual schematic of a water quality outlet design used as a part of the detention basin design.

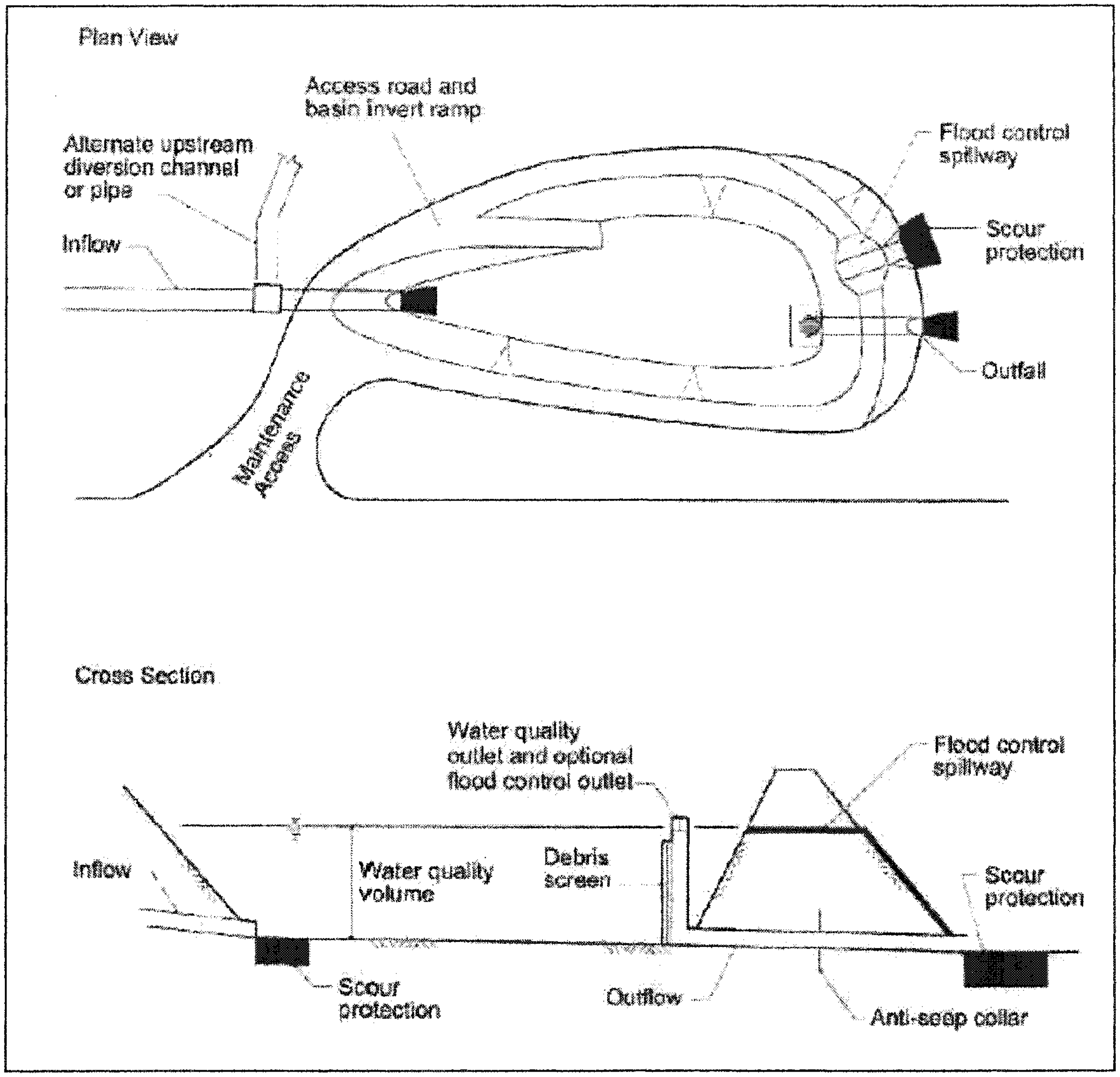


FIGURE 2A SCHEMATIC EDB

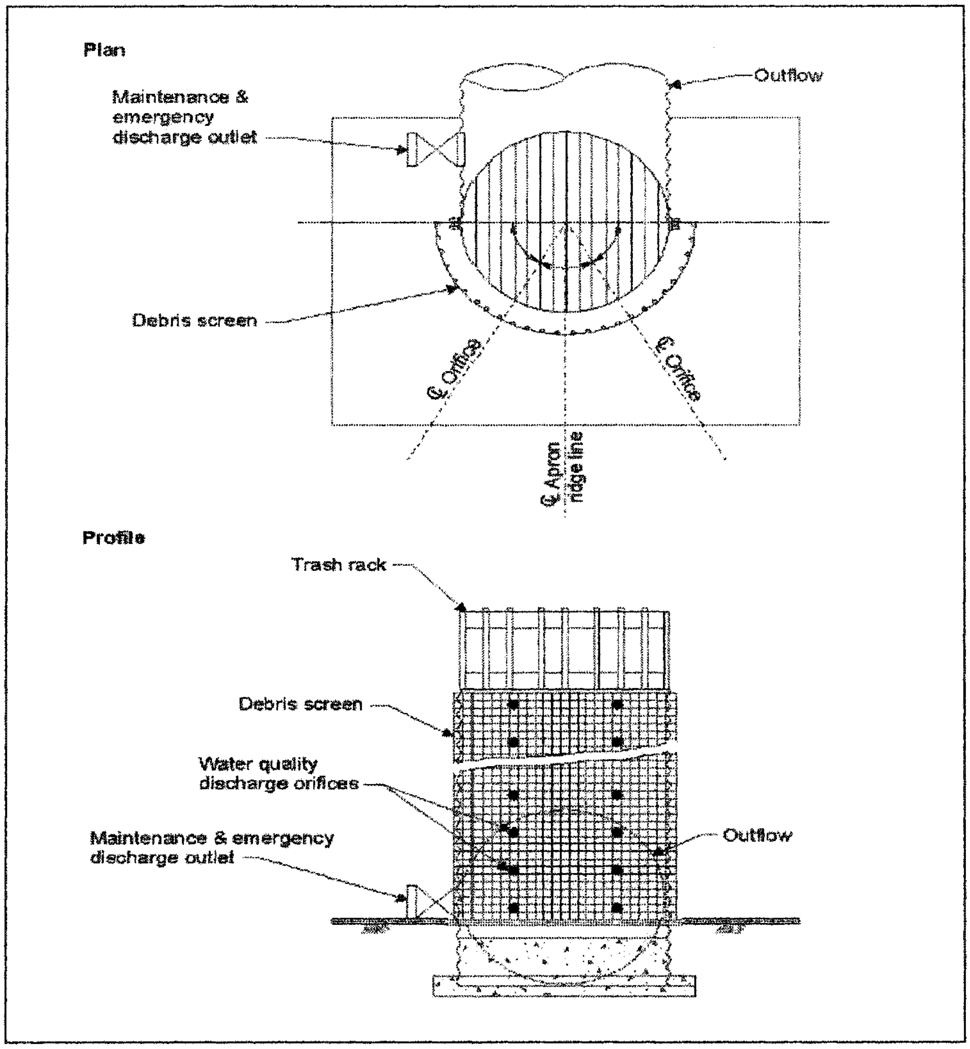


FIGURE 2B SCHEMATIC WQ OUTLET

Detention Basins have low to moderate maintenance requirements; however, maintenance is necessary to assure their performance, enhance aesthetics, and protect structural integrity. Typical operational and maintenance requirements for detention basins include:

- Dispersion of alluvial sediment deposition at inlet structures, thus limiting the extended localized ponding of water.
- Periodic sediment removal to ensure adequate storage and treatment volume.
- Monitoring of the basin to ensure it is completely and properly drained.
- Outlet riser cleaning.
- Vegetation management to prevent marsh vegetation from taking hold.
- Removal of graffiti, litter, vegetative and other debris.
- Preventative maintenance on monitoring equipment.
- Vegetative stabilization of eroding banks.

Biofiltration Swales

A biofiltration swale is a flow-based BMP proposed in sub-area 308 to convey runoff from developed areas in the canyon to proposed Water Quality Basin B. Biofiltration swales are vegetated channels specifically designed to remove particulates and to reduce the velocity of runoff through the storm system. Swales typically provide low to moderate treatment efficiencies and are mainly effective at removing debris and solid particles. Vegetated swales also help minimize overland and concentrated flow depths and velocities. Figure 3 shows a conceptual schematic of a biofiltration swale.

Typical maintenance and monitoring requirements for swales include:

- Vegetation management to maintain adequate hydraulic functioning.
- Animal and vector control.
- Periodic sediment removal to optimize performance.
- Trash, debris, grass trimmings, tree prunings, and leaf collection and removal to prevent obstruction.
- Removal of standing water, which may contribute to the development of aquatic plant communities or mosquito breeding areas.
- Erosion and structural maintenance to prevent the loss of soil and maintain the performance of the swale.

Hydrodynamic Separator Systems and Gross Solids Removal Devices

Hydrodynamic separation systems (HSS) and Gross Solids Removal Devices (GSRDs) are flow-based, flow-through BMPs that are installed within a storm drain line in order to remove large sediment particles and associated storm water pollutants, as well as trash, oils, and grease. They are typically designed to allow particulate matter to fall out of suspension and settle in a collection chamber, while floatable materials are collected above the water surface.

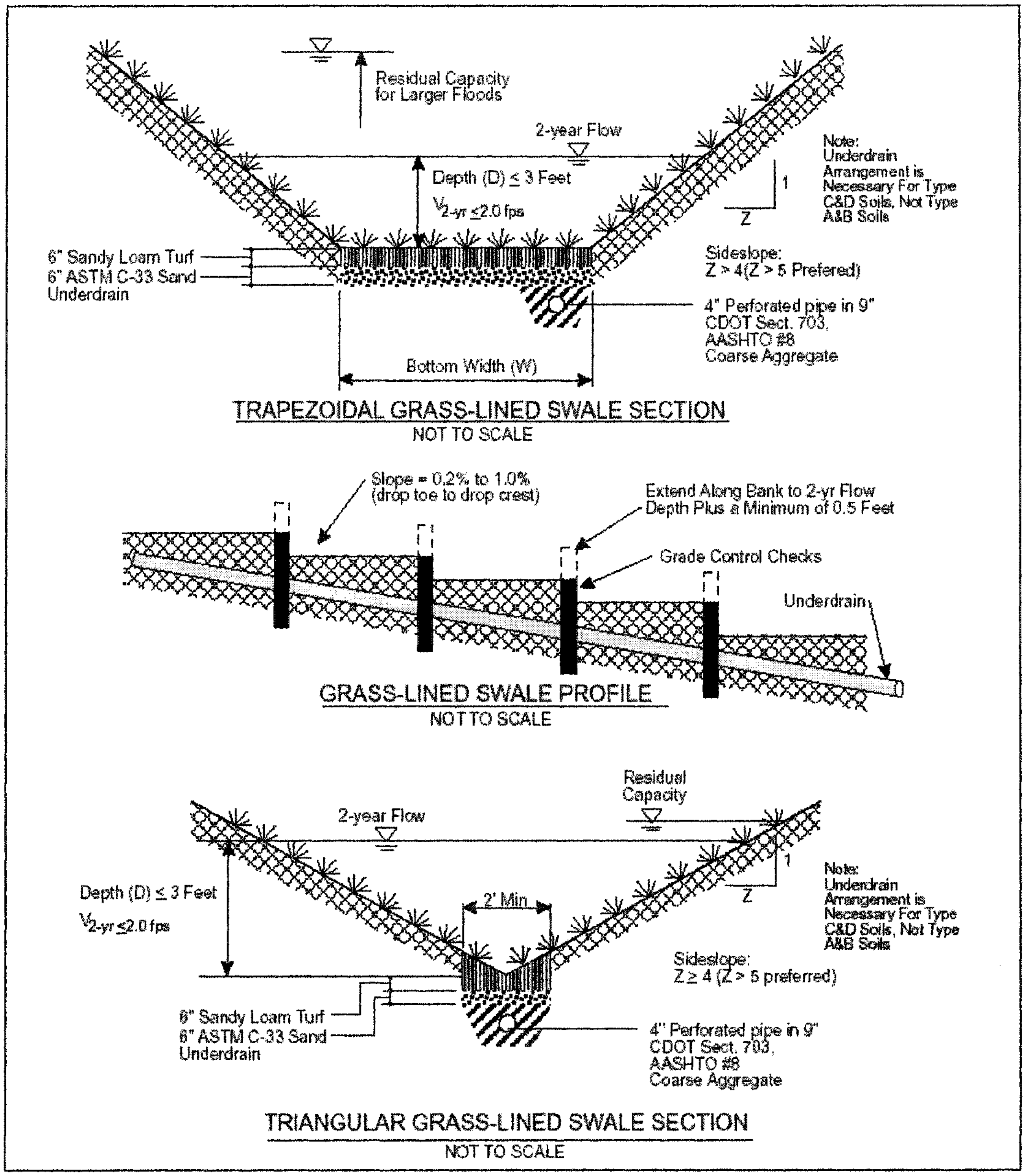


FIGURE 3 SCHEMATIC BIOFILTRATION SWALE

For the proposed Riverpark development, HSS and/or GSRDs, such as a Continuous Deflective Separator (CDS) unit with oil absorbent materials (such as pellets), are recommended for use at various locations in the proposed storm drain systems. These units are used based upon pollutants of concern and land availability. A CDS unit is recommended for treating runoff from sub-area 900. A CDS unit is proposed at this location because the land use is commercial, which will yield pollutants best treated by a CDS unit given the land area available. CDS units are also proposed to treat road runoff at collection point in subareas 100, 300 and 500. The systems typically provide low to moderate treatment efficiencies and are recommended for in-line treatment of storm water runoff from drainage areas where construction of larger BMPs may be infeasible; treatment efficiencies for hydrocarbons can be increased by the addition of oil absorbent materials. **Figure 4** shows a conceptual schematic of an HSS. **Figure 5** shows a conceptual schematic of an inclined screen GSRD, and **Figure 6** shows a conceptual schematic of a linear radial GSRD. Although maintenance requirements vary greatly depending on the particular model and manufacturer, they are typically maintained quarterly to yearly for clean-outs. Cleaning after a storm event may also be required. Inspection will be required to make certain that the unit is operating correctly and to make any repairs.

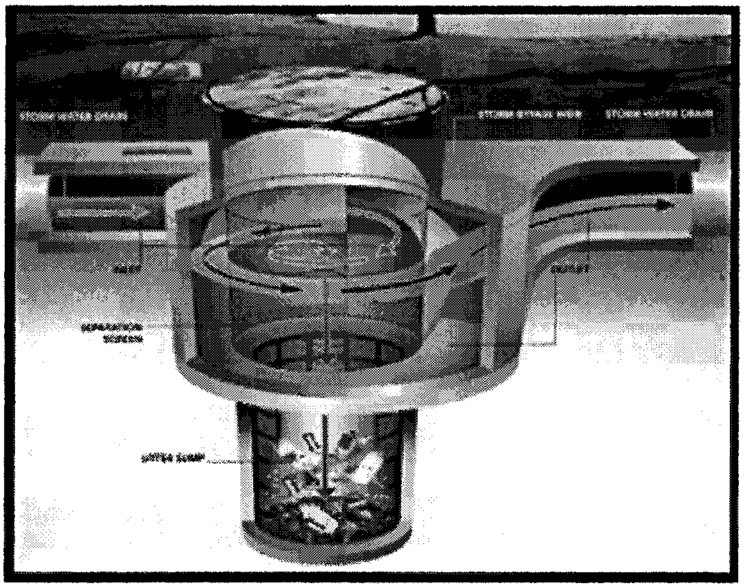


FIGURE 4 SCHEMATIC HSS

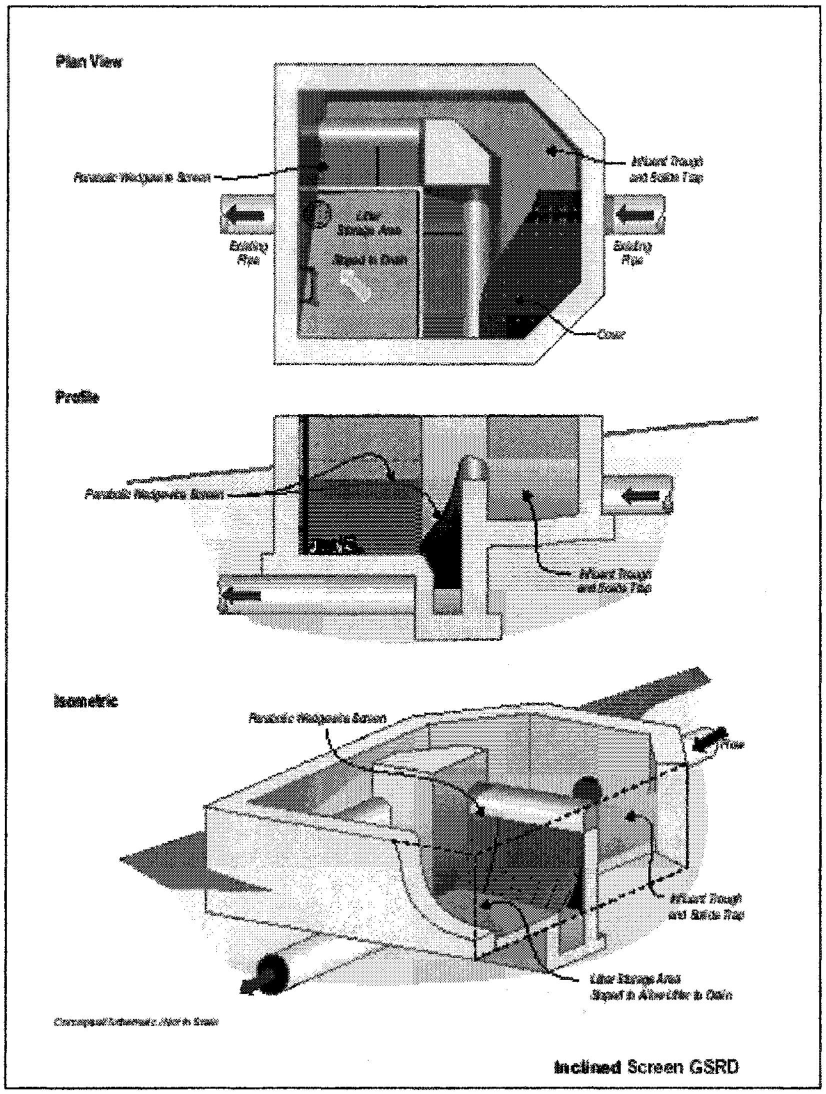


FIGURE 5 INCLINED SCREEN GSRD

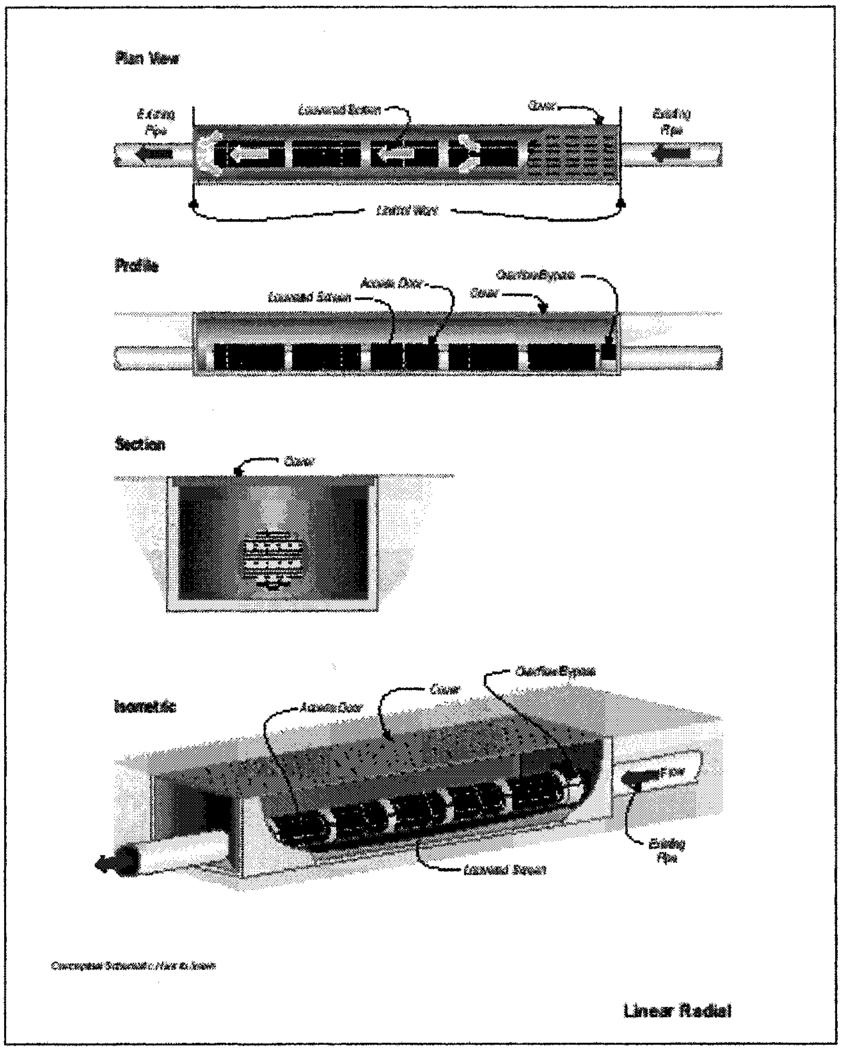


FIGURE 6 RADIAL SCREEN GSRD

Catch Basin Inserts

Catch basin inserts are flow-based BMP options for consideration at various locations to treat runoff before it enters the storm drain system by filtering or screening out sediments and associated storm water pollutants during dry weather and low flow events. Catch basin inserts (**Figure 7**) are one of the few BMPs that the County of Los Angeles will currently accept for maintenance (along with CDS units). During large flow events, they are typically designed to allow storm water runoff to bypass the inlet device and continue directly into the storm drain system. Although treatment levels are generally low for the pollutants of concern for this project, the inserts would provide pre-treatment of storm water runoff prior to further treatment at downstream BMPs. Drainage inserts could be replaced with HSS or GSRDs that perform similar functions and are interchangeable. For example, if for some reason the implementation of a CDS should be deemed infeasible at the final engineering stage, a catch basin insert would be used in its place.[1] Although maintenance requirements vary greatly depending on the particular model and manufacturer, they are typically maintained quarterly to yearly for clean-outs. Cleaning after a storm event and in anticipation of storm events after extended dry periods or periods of typical debris removal will also likely be required and is recommended. Inspection will be required to make certain that the unit is operating correctly and to make any repairs.

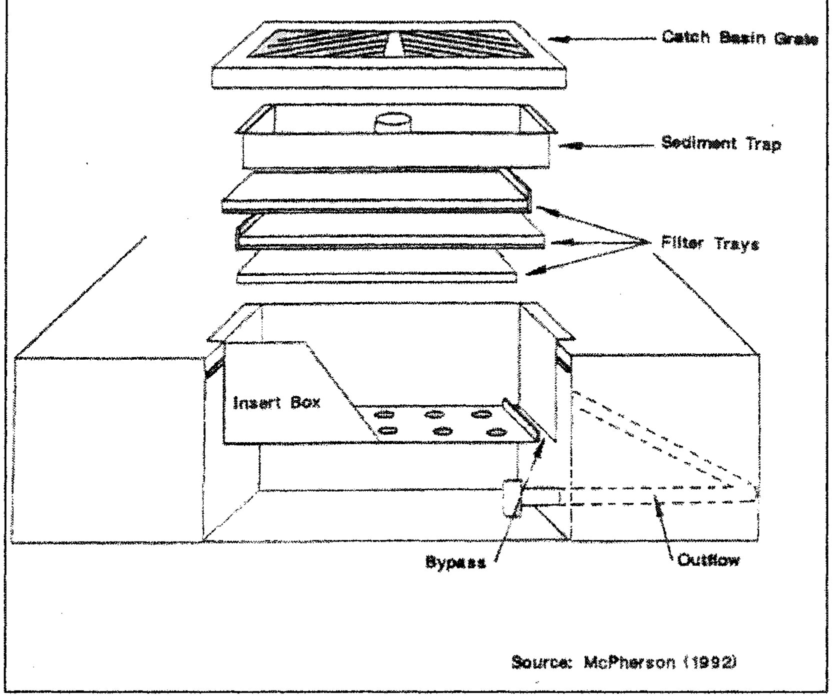


FIGURE 7 CATCH BASIN INSERTS

Storm Water Filters

Storm water filters are potential equivalent replacement BMPs that are effective in removing several common pollutants from storm water runoff and typically have high removal efficiencies for sediment, biochemical oxygen demand (BOD), and fecal coliform bacteria.

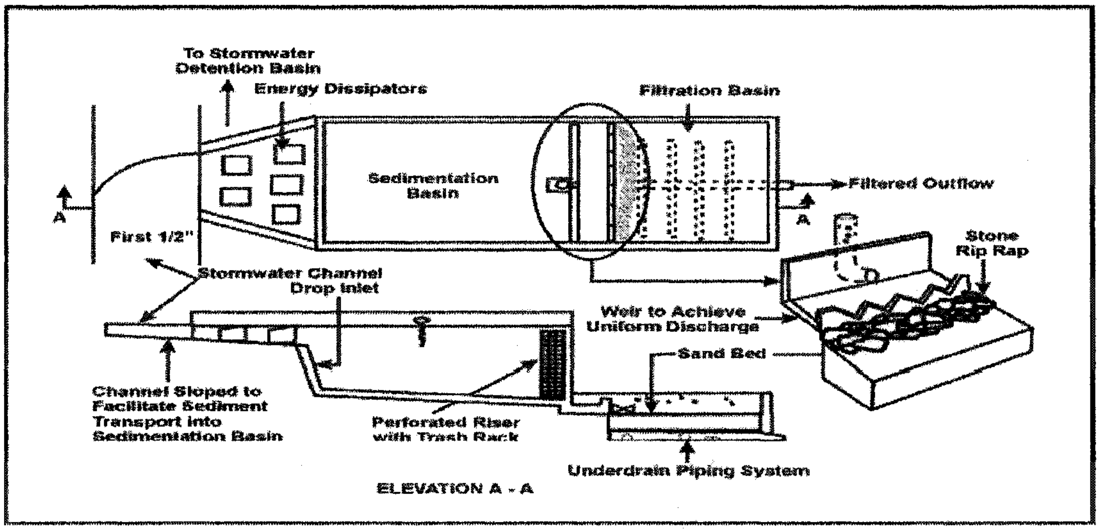
One of the many examples of a stormwater filter is the sand filter, which consists of two or three chambers or basins. The first is the sedimentation chamber, which removes floatables and heavy sediments. The second is the filtration chamber, which removes additional pollutants by filtering the runoff through a sand bed. Finally, the third is the discharge

[1] Drainage concept stipulates CDS or equivalent (as established by the approving agency), with final BMP selection to be established during development of construction documents.

chamber from which the treated filtrate is normally discharged through an underdrain system that could contain cartridges with various filter media alternatives. **Figure 8** shows an example of a stormwater filter.

Typical operational and maintenance requirements for sand filters include:

- Providing adequate access for inspection and maintenance,
- Removal of accumulated trash, paper and debris,
- Corrective maintenance including removal and replacement of top layers of media,
- Complete replacement of filter media every 3 to 5 years, and
- Periodic removal of vegetative growth.



Source: Schueler, 1992.

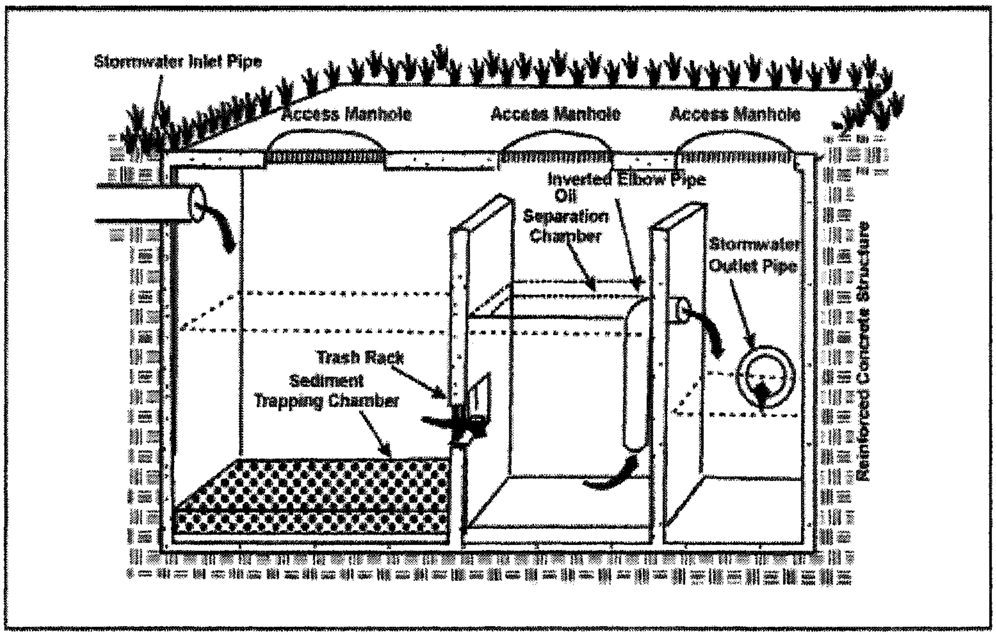
FIGURE 8 EXAMPLE STORMWATER FILTER

Storm Water Clarifiers

A storm water clarifier or equivalent is an option for treating storm runoff from the 500 series drainage area. Storm water clarifiers consist of water quality inlet devices (also commonly called oil/grit separators or oil/water separators) and a series of chambers that promote sedimentation of coarse materials and separation of free oil from runoff. The basic design of a storm water clarifier's series of chambers generally includes a sedimentation chamber, an oil separation chamber, and a discharge chamber. Additional screens may also be used to help retain larger or floating debris. A typical schematic of water quality inlet is shown as **Figure 9**.

Although maintenance requirements vary greatly depending on the particular model and manufacturer, they are typically maintained quarterly to yearly for clean-outs.

Cleaning after a storm event may also be required. Inspection will be required to make certain that the unit is operating correctly and to make any repairs.



Source: Berg, 1991.

FIGURE 9 STORM WATER CLARIFIER

1.2 DEFINITIONS

The following are definitions to several acronyms and terms, which will be frequently used in this Water Quality Technical Report.

Acute Toxicity	A toxic effect which occurs immediately or shortly after a single exposure.
Basin Plan	California Regional Water Quality Control Board, Los Angeles Region, Water Quality Control Plan (Basin Plan) for the Los Angeles Region
Beneficial Uses	The existing or potential uses of receiving waters in the permit area as designated by the Regional Board in the Basin Plan.[2]
Best Available Technology Economically Achievable (BAT)	A point source best management practice that reduces toxic (include heavy metals and man-made organics) and non-conventional (such as chloride, toxicity and nitrogen) pollutants in discharges.
Best Conventional Pollutant Control Technology (BCT)	A best management practice that reduces conventional pollutants (including TSS, oil and grease, fecal coliform, pH, and other pollutants) in discharges from construction sites.
Best Management Practices (BMPs)	In water pollution control, the best means available to control pollution of waterways from non-point sources, as opposed to best available technology, which applies to pollution control for point sources. Includes methods, measures, or practices designed and selected to reduce or eliminate the discharge of pollutants to surface waters from point and nonpoint source discharges including storm water. BMPs include site planning, structural and nonstructural controls, and operation and maintenance procedures, which can be applied before, during, and/or after pollution producing activities.[3]
Capital Flood	Theoretical 50-year design storm assumed to occur over a drainage area that has been burned and that contributes debris to runoff. Use in design is required by Los Angeles County for major systems and sump conditions.

[2] RWQCBLAR Order No. 01-182, NPDES Permit No. CAS004001, Glossary section.

[3] RWQCBLAR Order No. 01-182, NPDES Permit No. CAS004001, Glossary section.

CDFG	California Department of Fish and Game
Chronic Toxicity	A toxic effect that occurs after repeated or prolonged exposure.
CTR	California Toxics Rule (40 CFR 131.38).
CWA	The federal Clean Water Act (33 U.S.C. §§ 1251 et seq.).
ESA	Endangered Species Act (7 U.S.C. Section 136; 16 U.S.C. Sections 460 et seq.).
EMC	Event Mean Concentration, which is the average concentration of a pollutant in the runoff from a storm event, equal to the total mass of pollutant divided by the total volume of storm runoff.
First Flush	The first storm events typically have higher concentrations of pollutants due to accumulation during the dry months. Pollutants deposited onto exposed areas can be dislodged and entrained by runoff; therefore, the storm water that initially runs off an area will be more polluted than the storm water that runs off after the initial rainfall. The storm water containing this high initial pollutant load is called the "first flush." Storm events occurring later in the wet season will typically have lower concentrations as less time elapses between storm events and less accumulation occurs. In general terms, the water quality design storms defined by SUSMP approximate the first flush event (see SUSMP).
General MS4 Permit	Regional Water Quality Control Board, Los Angeles Region Order No. 01-182, NPDES Permit No. CAS004001 (December 13, 2001).
LACDPW	Los Angeles County Department of Public Works
MEP	Maximum Extent Practicable, the standard established by Section 402(p) of the federal Clean Water Act (33 U.S.C. § 1342(p)) for the implementation of storm water management programs to reduce pollutants in storm water. CWA § 402(p)(3)(B)(iii) requires that municipal permits "shall require controls to reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques and system, design and engineering methods, and such other provisions as the Administrator or the State determines appropriate for the control of such pollutants."[4] Extent to which an MS4 permit must require controls to reduce the discharge of pollutants. This standard has been defined to include technical feasibility, cost, and benefit derived, with the burden being on the

[4] RWQCBLAR Order No. 01-182, NPDES Permit No. CAS004001, Glossary section.

	municipality to demonstrate compliance with MEP by showing that a BMP is not technically feasible in the locality or that BMP costs would exceed any benefit to be derived[5].
MS4	Municipal Separate Storm Sewer System, a conveyance or system of conveyances (including roads with drainage systems, municipal streets, alleys, catch basins, curbs, gutters, ditches, manmade channels, or storm drains) owned by a State, city, county town or other public body, that is designed or used for collecting or conveying storm water, which is not a combined sewer, and which is not part of a publicly owned treatment works, and which discharges to "Waters of the United States" (see definition, below).[6]
Non-Storm Water Discharge	Any discharge to a storm drain that is not composed entirely of storm water.[7]
NPDES	National Pollutant Discharge Elimination System, the national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits and imposing and enforcing pretreatment requirements, under CWA §§ 307, 402, 318 and 405. [8]
Planning Management BMPs	In water pollution control, advanced planning for installation of the best means available to control pollution of waterways to minimize run-off from new development and to aid in siting infrastructure so as to discourage development in environmentally sensitive areas that are critical to maintaining water quality. Also referred to as "site design BMPs."
Receiving Waters	All surface water bodies in the Los Angeles Region that are identified in the Basin Plan and to which the proposed project discharges.[9]
RWQCB	Regional Water Quality Control Board
RWQCBLAR	Regional Water Quality Control Board, Los Angeles Region

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[5] February 11, 1993 memorandum issued by the Office of Chief Counsel of the State Water Resources Control Board.

[6] RWQCBLAR Order No. 01-182, NPDES Permit No. CAS004001, Glossary section.

[7] Id.

[8] Id.

[9] Id.

Source Control BMP	Any schedule of activities, prohibition of practices, maintenance procedures, managerial practices or operational practices that aim to prevent storm water pollution by reducing the potential for contamination at the source of pollution.[10]
SUSMP	The Los Angeles Countywide Standard Urban Storm Water Mitigation Plan, which addresses conditions and requirements of new development.[11]
SWRCB	State Water Resources Control Board
SQMP	The Los Angeles Countywide Stormwater Quality Management Plan, which includes descriptions of programs, collectively developed by the permittees under the General MS4 Permit in accordance with provisions of the NPDES Permit, to comply with applicable federal and State law, as the same is amended from time to time.[12]
SWPPP	Storm Water Pollution Prevention Plan, a plan, as required by a State General Construction Activity Storm Water Permit, identifying potential pollutant sources and describing the design, placement and implementation of BMPs, to effectively prevent non-storm water discharges and reduce pollutants in storm water discharges during activities covered by the General Permit.[13]
Structural BMP	Any structural facility designed and constructed to mitigate the adverse impacts of storm water and urban runoff pollution.[14]
Total Maximum Daily Load (TMDL)	The sum of the individual waste load allocations for point sources and load allocations for nonpoint sources and natural sources that a water body may receive without compromising the designated beneficial use.[15] TMDLs are designated only for impaired (i.e., Section 303(d) listed) water bodies and then only as necessary to address the impairment.
Treatment Control BMP	Any engineered system designed to remove pollutants by simple gravity settling of particulate pollutants, filtration, biological uptake,

[10] Id.
[11] See, id.
[12] Id.
[13] Id.
[14] Id.
[15] Id.

	media absorption or any other physical, biological, or chemical process.[16] (See Structural BMP.)
U.S. ACOE	United States Army Corps of Engineers.
U.S. EPA	United States Environmental Protection Agency.
U.S. FWS	United States Fish and Wildlife Service.
Waters of the U.S.	All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide; all interstate waters including interstate wetlands; all other waters, such as interstate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation, or destruction of which could affect interstate or foreign commerce including any such waters: (1) which are or could be used by interstate or foreign travelers for recreational or other purposes; or (2) from which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or (3) which are used or could be used for industrial purposes by industries in interstate commerce. Also included are all impoundments of waters otherwise defined as waters of the United States under the definition; tributaries of water identified above; the territorial seas; and wetlands adjacent to waters (other than the waters that are themselves wetlands) identified above.[17]
	By United States Army Corps of Engineers definition, "Waters of the United States" are defined by the "ordinary high water mark," which can be identified by physical characteristics, such as channel scouring, bank "shelving," areas cleared of terrestrial vegetation, litter and debris, or other indications that may be appropriate.
Wetlands	Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. [18]

[16] Id.

[17] 33 CFR Part 328.3a.

[18] 33 CFR Part 328.3b.

1.3 REFERENCE MATERIALS AND DOCUMENTS

Portions of the following documents were used in connection with the preparation of this Section.

- American Society of Civil Engineers. 2001. A Guide for Best Management Practice (BMP) Selection in Urban Developed Areas.
- *California Regional Water Quality Control Board, Los Angeles Region Order No. 01-182 NPDES Permit No. CAS004001 Waste Discharge Requirements for Municipal Storm Water and Urban Runoff Discharges within the County of Los Angeles, and the Incorporated Cities Therein, Except the City of Long Beach (adopted 13 December 2001)*
- *California Regional Water Quality Control Board, Los Angeles Region, Water Quality Control Plan (Basin Plan) for the Los Angeles Region (dated 13 June 1994 and approved 23 February 1995)*
- *California Stormwater Quality Task Force, Construction Storm Water Sampling and Analysis Guidance Document to Assist Dischargers in Complying with California State Water Resources Control Board Resolution No. 2001-046 (October 2001)*
- *California Water Resources Control Board Fact Sheet for Water Quality Order 99-08-DWQ: National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated With Construction Activity (General Permit).*
- *California Water Resources Control Board Resolution No. 2001-046: Modification of Water Quality Order 99-08-DWQ State Water Resources Control Board (SWRCB) National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction Activity (adopted by the SWRCB on 26 April 2001)*
- Caltrans, 2001. Gross Solids Removal Device Informational Guide. State of California Department of Transportation. June.
- Caltrans, 2001. Storm Water Quality Practice Guidelines. State of California, Department of Transportation. November.
- Center for Watershed Protection, 2000. The Practice of Watershed Protection.
- Currier B., et al. January 7-11, 2001. California Department of Transportation BMP Retrofit Pilot Program, Transportation Research Board 8th Annual Meeting, Washington, D.C.
- Environmental Protection Agency. 1993. Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters.
- Environmental Protection Agency. 1999. Sand Filters. EPA 832-F-99-007.
- Environmental Protection Agency. 1999. Water Quality Inlets. EPA 832-F-99-012.
- *Federal Emergency Management Agency (FEMA) Flood Insurance Map 060729 0345C, September 9, 1989*
- *GeoSyntec Consultants. September 24, 2002. Draft Storm Water Quality Assessment and Water Quality Management Plan for Newhall Ranch Development.*
- Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, EPA 840-B-92-002, January 1993
- John M. Tettemer & Associates, Natural River Management Plan for Santa Clara River from Castaic Creek to One-Half Mile Above the Los Angeles Aqueduct and Portions of

the San Francisquito Creek and the Santa Clara River, South Fork [of the Santa Clara River], May 1997.

- Larry Walker Associates, Inc. November 1999. Investigation of Structural Control Measures for New Development. Prepared for Sacramento Stormwater Management Program.
- *Los Angeles County Department of Public Works Hydrology Manual (December 1991) and Sedimentation Manual (June 1993)*
- *Los Angeles County Department of Public Works, Hydrology Manual & Appendix, 1991*
- Los Angeles County of Public Works, Development Planning for Storm Water Management, a Manual for the Standard Urban Storm Water Mitigation Plan (SUSMP). September 2002.
- Los Angeles County of Public Works, Level of Flood Protection and Drainage Protection Standards, 1986
- Los Angeles County, Environmental Document Reporting Procedures and Guidelines. Adopted November 17, 1987.
- Psomas. Flood Technical Report for Riverpark Project. February 2004
- State Water Resources Control Board, General Construction Activity Storm Water Permit (NPDES No. CAS000002, Order No. 99-08-DWQ), adopted August 19, 1999.
- State Water Resources Control Board, Modifications to the State Construction Activity Permit, Resolution Number 2001.046, adopted on April 26, 2001.
- *SWQTF, 1993. California Storm Water Best Management Practice Municipal Handbook. Prepared by CDM for the Storm Water Quality Task Force. March.*
- *United States, Federal Register, Volume 51, Number 219, Thursday, November 13, 1986.*
- Urban Runoff Quality Management, WEF Manual of Practice No. 23/ASCE Manual of Practice No. 87, (1998)
- United States Army Corps of Engineers & California Department of Fish and Game. Final Environmental Impact Statement/Environmental Impact Report. 404 1603 Streambed Alteration Agreement for Portions of the Santa Clara River and its Tributaries Los Angeles County, Natural River Management Plan. Applicant, Valencia Company. August 1998.
- United States Army Corps of Engineers, Santa Clara River Adopted Discharge Frequency Values. Adopted May 3, 1994 by the United States Army Corps of Engineers, the Ventura County Flood Control Department and the Los Angeles County Department of Public Works.
- Valencia Company, Natural River Management Plan (Permitted Projects and Activities under the United States Corps of Engineers 404 Permit, California Department of Fish and Game 1603 Agreement and 2081 Permit. November 1998.
- *WEF, 1998. Urban Runoff Quality Management, WEF Manual of Practice No. 23/ASCE Manual of Practice No. 87.*
- Winer, R. 2000. National Pollutant Removal Performance Database for Stormwater Treatment Practices: 2nd Edition. Center for Watershed Protection. Ellicott City, MD.

1.4 SUMMARY

Potential changes in water quality are addressed for each pollutant/constituent of concern based on runoff water quality modeling, literature information, and/or a qualitative assessment, depending on the data available for assessing each constituent. Impacts take into account the proposed project design features which have been designed to be consistent with or exceed federal, State and local requirements.

The Event Mean Conditions (EMCs; defined below) used to characterize the existing and post-development storm water quality at the proposed project site are based on the regional data (Geosyntec 2002), as well as on the Integrated Receiving Water Impacts Report (1994-2000), published by LACDPW as part of the Los Angeles Storm Water Monitoring Program. Existing conditions for the project development were modeled based primarily on vacant land use for on-site and off-site areas, with a small fraction of agricultural land use located in contributing undeveloped upstream areas and a small fraction of commercial (storage yard) land uses located on-site. Constituents modeled include total suspended solids (TSS), total phosphorus (TP), total nitrogen (TN), nitrate, total copper (Cu), total lead (Pb), total zinc (Zn), and chloride (Cl).

Three development scenarios are addressed in this report:

1. Existing,
2. Existing With Project, and
3. Cumulative Buildout.

Brief summaries of the water quality methodology are presented to provide the reader with background information and understanding of the methodology used to evaluate water quality impacts

2 EXISTING CONDITIONS

2.1 PHYSICAL CONDITIONS AND SETTING

The project site consists primarily of vacant, open space land located adjacent to the center of the City of Santa Clarita and surrounded by urban uses. The site lies within an approximately 835-acre tributary drainage area within the Santa Clara River Watershed, which includes many uses and conditions that contribute sediment and pollutants to the river and the tributary streams that feed the river. The site lies within that portion of the Santa Clara River designated as Reach 9 by the U.S. EPA and as Reach 7 by the RWQCBLAR; that reach extends from the Lang Gauging Station (to the east of the project, downstream of Agua Dulce Canyon Creek) to Bouquet Canyon Road Bridge (located directly west of the project). The project site is located adjacent to the western border of the reach (as discussed previously, for convenience, this reach of the river will generally be referred to as Reach 7).[19]

[19] As defined in the Water Quality Control Plan (Basin Plan) for the Los Angeles Region, the project area falls within the Santa Clara-Calleguas Hydrologic Unit (HU 403.00) and runoff from the

Reach 7 contains relatively little water when compared to other reaches of the river during non flood conditions. Its intermittent flows occur generally only during the "rainy" season during and immediately after storm events of sufficient size to cause flows. Therefore, under dry-weather (i.e., non-storm flow, excluding storm events) conditions, Reach 7 does not impact downstream reaches of the river. When water is present in this reach, it is almost always during the rainy winter months and typically lasts only for a few days after a storm event large enough to create flow.

The project lies upstream from two sewage treatment plants. The Saugus Treatment Plant is located immediately downstream from the project, across Bouquet Canyon Road at Soledad Canyon Road, and the Valencia Treatment Plant is located further downstream. Both treatment plants discharge treated water into reaches of the river lying downstream from the project.

The project site currently consists primarily of vacant/open space land with a small portion that is being used by a contractor as a temporary storage yard. There are no existing drainage or water quality control improvements located within the project site. A portion of the site has historically been used for agricultural operations on which pesticides and fertilizers may have been applied. Based on a review of 1947 aerial photographs, a portion of the Riverpark project site north of the Santa Clara River was planted with row crops and three areas of the terrace east of the small unnamed valley were plowed, apparently for hay. Row crops were also present on the flat land north of the site. Portions of the site have been used for dry farming since 1985. Because of the recent history of agricultural use of a portion of the site, existing storm water runoff at the site may still contain constituents common to agricultural uses. For instance, current high erosion rates from the disturbed soils at the site may result in elevated metal concentrations in the runoff.[20] Nitrates and pesticides may also be expected. Since no known grazing has occurred on the land, pathogens found on the site would be generated from sources typical of open space uses, such as rodents and other wild animal wastes.

2.2 Current Regulatory Setting

Storm runoff from the project site, and discharges of runoff into and/or encroachment upon natural drainages, wetlands, and/or flood plains are subject to the requirements of the federal Clean Water Act (33 U.S.C. §§ 1251 et seq.; CWA) and associated regulations, the State Porter-Cologne Water Quality Control Act (Cal. Water Code §§ 13000 et seq.) and associated regulations, and to requirements established by the U.S. EPA, CDFG, SWRCB, RWQCBLAR, and the Flood Control and Watershed Management Divisions of the Los Angeles County Department of Public Works (LACDPW). In addition, intrusions into jurisdictional areas are subject to the requirements of the CWA, Sections 1600–1607 of the State Fish and Game

Riverpark site discharges to the Santa Clara River, in the Upper Santa Clara River Hydrologic Area (HA 403.50) Eastern Hydrologic Sub-Area (HSA 403.51).

20 High erosion rates contribute to higher sediment transport rates which may, in turn, result in elevated metal concentrations in surface runoff, as metals both adsorb to solids particulate matter (total suspended solids) and get washed off in dissolved forms.

Code, and to requirements established by the U.S. ACOE and CDFG. Each of these requirements and agencies is discussed below.

2.2.1 Water Quality

(a) Clean Water Act

The project would be subject to federal permit requirements under the Clean Water Act.

In 1972, the Federal Water Pollution Control Act (later referred to as the CWA) was amended to require that the discharge of pollutants to waters of the United States from any point source be effectively prohibited, unless the discharge is in compliance with a National Pollutant Discharge Elimination System (NPDES) permit. In 1987, the CWA was again amended to add Section 402(p), requiring that the U.S. EPA establish regulations for permitting of storm water discharges by municipal and industrial facilities and construction activities under the NPDES permit program. The U.S. EPA published final regulations directed at MS4s serving a population of 100,000 or more, and storm water discharges associated with industrial activities, including construction activities, on November 16, 1990. The regulations require that municipal separate storm sewer system (MS4) discharges to surface waters be regulated by a NPDES permit (Phase I Final Rule, 55 Fed. Reg. 47990). The U.S. EPA published final regulations directed at storm water discharges not covered in the Phase I Final Rule, including, as applicable here, small construction projects of one to five acres, on December 8, 1999 (Phase II Final Rule, 64 Fed. Reg. 68722).

Section 402(p) of the CWA provides that MS4 permits must "require controls to reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques and system, design and engineering methods and such other provisions as the [U.S. EPA] Administrator or the State determines appropriate for the control of such pollutants." The Office of Chief Counsel of the State Water Resources Control Board (SWRCB) has issued a memorandum interpreting the meaning of MEP to include technical feasibility, cost, and benefit derived with the burden being on the municipality to demonstrate compliance with MEP by showing that a BMP is not technically feasible in the locality or that BMP costs would exceed any benefit to be derived (dated February 11, 1993).

The CWA authorizes the U.S. EPA to permit a state to serve as the NPDES permitting authority in lieu of the U.S. EPA. The State of California has in-lieu authority for an NPDES program. The Porter-Cologne Water Quality Control Act (Cal. Water Code §§ 13000 et seq.) authorizes the SWRCB, through (as applicable here) the RWQCBLAR, to regulate and control the discharge of pollutants into waters of the State. The SWRCB entered into a memorandum of agreement with the U.S. EPA, on September 22, 1989, to administer the NPDES Program governing discharges to waters of the U.S.

In addition, the CWA requires the States to adopt water quality standards for water bodies and have those standards approved by the EPA. Water quality standards consist of designated beneficial uses for a particular water body (e.g. wildlife habitat, agricultural supply, fishing etc.), along with water quality objectives necessary to support those uses. Water quality objectives can be numerical concentrations or levels of constituents, such as lead, and suspended sediment, or narrative statements that represent the quality of water needed to support a particular use. Because California had not established a complete list of acceptable water quality objectives to the U.S. EPA, the U.S. EPA, EPA Region IX (in which California lies) has established numeric water quality criteria applicable to all receiving waters for certain toxic constituents in the form of the California Toxics Rule ("CTR") (40 CFR 131.38).

When designated beneficial uses of a particular water body are being compromised and fail to meet water quality objectives, Section 303(d) of the CWA requires identifying and listing that water body as "impaired." Once a water body has been deemed impaired, a Total Maximum Daily Load ("TMDL") must be developed for each water quality constituent that compromises a beneficial use. A TMDL is an estimate of the total load of pollutants, from point, non-point, and natural sources that a water body may receive without exceeding applicable water quality standards (often with a "factor of safety" included). Once established, the TMDL is allocated among current and future dischargers into the water body.

Pursuant to Section 303(d) of the CWA, the reach of the river in which the project lies has been listed as being impaired for high coliform count. Although the RWQCBLAR has stated that it will be developing TMDLs for the Santa Clara watershed, it has not yet done so, and the project is expected to proceed before applicable TMDLs are adopted. The project site lies within U.S. EPA Reach 9, which has been listed as being impaired pursuant to Section 303(d) of the CWA. (**Table 1, 2002 CWA Section 303(d) Listing and TMDL Priority Scheduling for RWQCBLAR Reach 7- U.S. EPA Reach 9.**)

TABLE 1
2002 CWA SECTION 303(D) LISTING
AND TMDL PRIORITY SCHEDULING[1] FOR RWQCB LAR REACH 7 (U.S. EPA REACH 9)

Receiving Waters	Pollutant/Stressor	Source	TMDL Priority	Estimated Size Affected
Santa Clara River Bouquet Canyon Rd to Above Lang Gauging Station (Reach 9)	High Coliform Count	Nonpoint Source Nonpoint Source	Medium	21 miles
Notes: 1) 2002 CWA Section 303(d) List of Water Quality Limited Segment, Approved by SWRCB: 2/4/03				

Impairments listed in reaches downstream from the project site (but not in LARWQCB Reach 7/U.S. EPA Reach 9) include nutrients and their effects, salts, coliform bacteria, and historic pesticides. (See **Table 2 2002 CWA Section 303(d) Listing and TMDL Priority Scheduling for U.S. EPA Reaches 7 and 8.**)

TABLE 2
2002 CWA SECTION 303(D) LISTING
AND TMDL PRIORITY SCHEDULING[1] FOR U.S. EPA REACHES 7 AND 8

Receiving Waters	Pollutant/Stressor	Source	TMDL Priority	Estimated Size Affected
Santa Clara River W Pier Hwy 99 to Bouquet Canyon Rd (Reach 8)	Chloride High Coliform Count	Nonpoint/Point Source Nonpoint/Point Source	High Medium	5.2 miles 5.2 miles
Santa Clara River Blue Cut to West Pier Hwy 99 Bridge (Reach 7)	Chloride High Coliform Count Nitrate and Nitrite	Nonpoint/Point Source Nonpoint/Point Source Nonpoint/Point Source	High Medium Low	9.4 miles 9.4 miles 9.4 miles

Notes:
1) 2002 CWA Section 303(d) List of Water Quality Limited Segment, Approved by SWRCB: 2/4/03

(b) Statewide General NPDES Permits

To facilitate compliance with federal regulations, the SWRCB has issued two statewide general NPDES permits for storm water discharges: one for storm water from industrial sites (not applicable to the project), and the other for storm water from construction sites (NPDES No. CAS000002, General Construction Activity Storm Water Permit, reissued on April 17, 1997, updated 2001). Under the General Construction Activity Storm Water Permit as reissued and updated, facilities discharging storm water associated with construction projects with a disturbed area of one or more acres (March 2003) are required either to obtain individual NPDES permits for storm water discharges, or to be covered by a statewide general permit by completing and filing a Notice of Intent with the SWRCB. The General Construction Activity Storm Water Permit addresses both storm water and non-storm water discharges from construction sites.

The applicant under the General Construction Activity Storm Water Permit must ensure that a Storm Water Pollution Prevention Plan (SWPPP) is prepared, and a Notice of Intent (NOI) is filed with the SWRCB to comply with the State Permit prior to issuance of a grading permit. The General Construction Activity Storm Water Permit relies upon BMPs to control pollutants.

The RWQCBLAR is the enforcement authority in the Los Angeles Region for the two statewide general permits, and all NPDES storm water and non-storm water permits issued by the RWQCBLAR. These construction sites and discharges are also regulated under local laws and regulations.

(c) Water Quality Control Basin Plan

All of the activities under the NPDES program are aimed at meeting water quality objectives of receiving waters, which eventually discharge into receiving waters that often traverse multiple counties and cities.[21] The RWQCBLAR adopted the Water Quality Control Plan (Basin Plan) for the Los Angeles Region on June 13, 1994. The Basin Plan designates the beneficial uses of receiving waters, including, (Basin Plan) Reach 7 of the Santa Clara River to which the project site currently discharges and the project would discharge, and specifies both narrative and numerical water quality objectives for these receiving waters in Los Angeles County. Because these standards are applicable to receiving waters, they are not a direct measure of storm water quality from the project site. However, water quality criteria from the Basin Plan are useful as benchmarks and are compared to modeled results where possible in the analysis of potential impacts, below.

Again, the project site is located along Reach 7 of the Santa Clara River between Lang Gauging Station (to the east of the project, downstream of Agua Dulce Canyon Creek) and Bouquet Canyon Road Bridge (located directly west of the project). Under the Basin Plan, beneficial uses[22] for Reach 7 include Municipal and Domestic Supply; Industrial Supply; Industrial Process Supply; Agriculture; Groundwater; Contact Water Recreation; Non-Contact Water Recreation; Warm Freshwater Habitat; Wildlife Habitat; Rare, Threatened or Endangered Species; and Wetland Habitat. Downstream reaches of the Santa Clara River (to the west of the project) have additional beneficial uses, including Cold Freshwater Habitat and Migration of Aquatic Organisms.

Basin Plan Water Quality Objectives

Water quality objectives, as defined by the California Water Code Section 13050(h), are the "limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses or the prevention of nuisance within a specific area." Beneficial uses are designated under CWA Section 303 in accordance with regulations. The Basin Plan defines existing and potential beneficial uses for identified water bodies receiving discharges. The project is located along Reach 7 of the Santa Clara River. Beneficial uses identified for Reach 7 include those listed above.

Water quality objectives are the water quality standards used to assess the potential impact of project discharges on the water quality of receiving waters (not end-of-pipe discharges). **Table 4, Water Quality Objectives**, summarizes the numerical water quality objectives for the Santa Clara River reach (Reach 7) in which the project lies.

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21 Receiving waters are designated bodies of water that receive discharge from developed areas at specific discharge points.

22 As designated under CWA Section 303 in accordance with regulations contained in 40 CFR 131.

(d) California Toxics Rule (CTR)

The California Toxics Rule (CTR) is a federal regulation issued by the U.S. EPA providing water quality criteria for protection of surface waters of the State of California with designated uses protective of human health or aquatic life. CTR criteria are applicable to the receiving water body and therefore should be applied based upon the probable hardness[23] values of the receiving waters for evaluation of discrete-duration acute[24] criteria. At higher hardness values for the receiving water copper, lead, and zinc are more likely to be complexed (bound with) components in the water column. This in turn reduces the bioavailability and resulting toxicity of these metals.

Available storm water monitoring data indicates that hardness values for the receiving waters in this reach of the river range between 280 and 320 mg/L. To assure assessment of the greatest reasonable level of potential impacts, hardness values of both 200 and 400 mg/L have been used in this assessment.

Chronic CTR Criteria apply when aquatic life is exposed for a period of four days or longer. Because of the shorter, discrete-duration episodic nature of storm water flows, acute criteria are the more appropriate criteria for assessing project impacts due to storm water runoff.

CTR water quality criteria and water quality objectives and beneficial uses do not apply directly to discharges of storm water runoff. Nonetheless, these standards can provide a useful benchmark to assess the potential for project discharges to affect the water quality of receiving waters. In this analysis, the CTR and other water quality standards have been used as benchmarks to evaluate the potential ecological impacts of storm water runoff to the receiving waters of the proposed project.

Table 3, CRT Criteria and Associated Trace Metal Water Quality Parameters, shows the applied freshwater CTR criteria for two hardness values 200 mg/L and 400 mg/L.

23 Hardness is defined as the sum of calcium and magnesium concentrations, both expressed as calcium carbonate.

24 Acute toxicity means a toxic effect, which occurs immediately or shortly after a single exposure; as compared to chronic toxicity, which indicates that a toxic effect that occurs after repeated or prolonged exposure.

TABLE 3
CTR CRITERIA AND ASSOCIATED TRACE METAL WATER QUALITY PARAMETERS

		California Toxics Rule – Freshwater Criteria Dissolved Metal Concentrations	
		Hardness: 400 mg/L	Hardness: 200 mg/L
Parameter	Units	Acute	Acute
Copper (Cu)	μg/L[1]	52	27
Lead (Pb)	μg/L	480	200
Zinc (Zn)	μg/L	390	220

Notes:
1) μg/L stands for micrograms per liter.

(e) General MS4 Permit

As stated above, on November 16, 1990, pursuant to Section 402(p) of the CWA, the U.S.EPA promulgated federal regulations (40 Code of Federal Regulations [CFR] Part 122.26) establishing requirements for storm water discharges under the NPDES program. In California, the NPDES permit program is administered by the State Water Resources Control Board (SWRCB) through the RWQCBs as established by the State Porter-Cologne Water Quality Control Act.[25]

The project site, located within the City of Santa Clarita, falls within the jurisdiction of the RWQCBLAR (Region 4), and the project is subject to the waste discharge requirements of the RWQCBLAR Municipal Permit (General MS4 Permit) Order No. 01-182, NPDES No. CAS004001 (adopted December 13, 2001) (Appendix A). The City of Santa Clarita is a Permittee under the General MS4 permit and therefore has legal authority for enforcing the terms of the permit in its jurisdiction. The General MS4 Permit is intended to ensure that combinations of site planning, source control and treatment control BMPs are implemented to protect the quality of receiving waters. To do so, the General MS4 Permit requires that new development employ BMPs to the MEP (maximum extent practicable), including management practices, control and treatment techniques and systems, and site design planning to control the level of pollutants entering receiving waters.[26] Further, the Permittees under the MS4 Permit (the County of Los Angeles [Principal Permittee], and 84 incorporated cities, including the City of Santa Clarita) must ensure that storm water discharges from the MS4 shall neither cause nor contribute to the exceedence of water quality standards and objectives nor create conditions of nuisance in the receiving waters, and that the discharge of non-storm water to the

25 Division 7 of the California Water Code, also known as the Porter-Cologne Water Quality Control Act, establishes the SWRCB and the nine Regional Water Quality Control Boards (RWQCBs) as the principle state agencies responsible for the protection and, where possible, the enhancement of the quality of California's waters. The SWRCB sets statewide policy, and together with the RWQCBs, implements state and federal laws and regulations.

26 General MS4 Permit, Order No. 01-182, NPDES Permit No. CAS004001 (Appendix A), Finding Par. F.

MS4 has been effectively addressed.[27] The General MS4 Permit notes, by reference to the U.S. EPA's "Interim Permitting Approach for Water Quality-Based Effluent Limitations in Storm Water Permits" (August 26, 1996), that because of the nature of storm water discharges and the lack of detailed, documented, and accepted information on which to base numeric water quality-based effluent limitations (expressed as concentration and mass) for many pollutants of concern, the permitting approach utilizing BMPs does, indeed, provide for the attainment of water quality standards and negates the need for numerical effluent criteria as a standard.

Among other things, the General MS4 Permit requires the Permittees to prepare a SQMP (Stormwater Quality Management Plan) specifying the BMPs that will be implemented to reduce the discharge of pollutants in storm water to the MEP. The various components of the SQMP, taken together, are expected to reduce pollutants in storm water and urban runoff to the MEP. The emphasis of the SQMP is pollution prevention through education, public outreach, planning, and implementation as source control BMPs first, and then structural and treatment control BMPs.[28]

Permittees must comply with these requirements by timely implementation of control measures and other actions to reduce pollutants in the discharges in accordance with the SQMP and its components and other requirements of the General MS4 Permit including any modifications.[29] The General MS4 Permit has identified special provisions for proper and effective implementation of storm water pollution prevention programs. As part of the SQMP, the co-permittees are required to implement a Development Planning Program that would require control of post-development peak storm water runoff discharge rates, velocities, and duration in natural drainage systems to prevent accelerated stream erosion and to protect stream habitat.[30]

The U.S. EPA recommends that, for NPDES-regulated municipal storm water discharges, effluent limitations should be expressed as BMPs or other similar requirements, rather than as numeric effluent limits.[31] This approach involves implementing site design, source control and treatment control BMPs that reduce the discharge of pollutants in storm water to the maximum extent practicable (MEP). Under the General MS4 Permit, Permittees are to publish guidelines for creating SUSMPs. The Los Angeles County Department of Public Works, Flood Control Division has published its SUSMP manual, the "Manual for the Standard Urban Storm Water Mitigation Plan" adopted by the County in September of 2002 and subsequently approved by the RWQCBLAR (County SUSMP Manual). The EIR sets out the project's conceptual SUSMP which complies with both those County SUSMP guidelines and the General MS4 Permit.

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27 Id.

28 Id.; see also, id. Part 4.

29 Id.

30 General MS4 Permit, Part 4.

31 United States Federal Register, Vol. 61, No. 216, Wednesday, November 6, 1966. http://yosemite.epa.gov/R10/water.nsf/95537302e2c56cea8825688200708c9a/a57d8d905leee66488256c7200800a62/$FILE/FR61%2057425.pdf

(f) Los Angeles County Department of Public Works (LACDPW)

The Flood Control and Watershed Management Divisions of the LACDPW also regulate storm runoff and water quality as the Principal Permittee under the General MS4 Permit and under independent County ordinances. As previously mentioned, the City of Santa Clarita is a co-permittee under the General MS4 Permit and has legal authority for enforcing the terms of the permit in its jurisdiction.

Applicants for development projects have two major responsibilities under the General MS4 permit:

- The first responsibility is to submit and then implement a Standard Urban Storm Water Mitigation Plan (SUSMP) that contains design features and BMPs appropriate and applicable to the project. The RWQCBLAR approved Los Angeles County's SUSMP ordinance on March 8, 2000 which requires new construction and development projects to implement BMPs pursuant to the General MS4 Permit.

- The second responsibility, applicable to all construction projects with disturbed areas greater than one acre, is to prepare a Storm Water Pollution Prevention Plan (SWPPP).

For the Riverpark project, these plans must be submitted and approved by the City of Santa Clarita prior to issuance of a grading permit.

Design standards for post-construction structural or treatment control BMPs were established in the General MS4 Permit and the County and City SUSMP ordinances, and are explained in the County SUSMP Manual. The General MS4 Permit and the County SUSMP Manual require that new developments and re-development projects employ a variety of general and land use measures to reduce post-development discharges of pollutants from storm water conveyance systems to the "maximum extent practicable."

In addition, the General MS4 Permit requires that the co-permittees control post-development peak storm water runoff discharge rates, velocities, and duration in natural drainage systems, including the Santa Clara River, to prevent accelerated stream erosion and to protect stream habitat. This impact is addressed in the Flood Technical Report (Psomas 2004) and below in **Table 4**.

TABLE 4
WATER QUALITY OBJECTIVES

Issue	Objective
HYDROLOGY	
Hydrology	Control post-development peak storm water runoff discharge rate, velocities and duration in Natural Drainage Systems (mimic pre-development hydrology) to prevent accelerated stream erosion and to protect stream habitat (General MS4 Permit p. 34; see also SUSMP requirements).
Storm water runoff numeric sizing criteria	Design standards for post-construction structural or treatment control BMPs employ a variety of measures to reduce the post-project discharge of pollutants to the MEP level. The numeric sizing requirements are either volume-based or based on local flow design criteria. The volume-based criteria require that storm water runoff be infiltrated (or treated) and peak flows be controlled based on flow design criteria. There are four options for determining volume of runoff that needs to be treated (1) the 85th percentile 24-hour runoff, 2) unit basin volume to achieve 80% or more volume treatment, 3) volume produced from a 0.75 inch storm, or 4) volume based on historical 24-hour rainfall) (See SUSMP pp. 18-19 for complete description).
SURFACE WATER QUALITY	
MINERALS	
TDS	800 (mg/L) (Reach 7 of Santa Clara River Basin Plan p. 3-12)
Sulfate	150 mg/L (Reach 7 of Santa Clara River Basin Plan p. 3-12)
Chloride	100 mg/L (Reach 7 of Santa Clara River Basin Plan p. 3-12)
Boron	1.0 mg/L (Reach 7 of Santa Clara River Basin Plan p. 3-12)
Sodium absorption ratio (SAR)	5 mg/L (Reach 7 of Santa Clara River Basin Plan p. 3-12)
NUTRIENTS	
In General	
Nitrogen	5 mg/L ((Reach 7 of Santa Clara River Basin Plan p. 3-12)
Nitrogen (Nitrate, Nitrite)	Waters shall not exceed 10 mg/L nitrogen as nitrate-nitrogen plus nitrite-nitrogen, 45 mg/L as nitrate, 10 mg/L as nitrate-nitrogen, or 1 mg/L as nitrite-nitrogen.
Ammonia	See Reach 7 of Santa Clara River Basin Plan table 3-2 (WARM) for one-hour average concentrations for a range of pH and temperatures (as an example at 10 degrees C and pH of 7, total ammonia concentrations should be 25 mg/L).
Phosphorous	No criteria
Dissolved oxygen (DO)	As a minimum, the mean annual DO concentration greater than 7 mg/L; no single determination less than 5.0 mg/L. For WARM designations, the DO concentrations shall not be depressed below 5 mg/L as a result of waste discharge (Basin Plan p.3-11).

TABLE 4
WATER QUALITY OBJECTIVES

Issue	Objective
BOD (Biochemical oxygen demand)	Waters shall be free of substances that result in increase in BOD which adversely affects designated beneficial uses (Basin Plan)
Biostimulatory substances	Biostimulatory substances include excess nutrients and other compounds that stimulate aquatic growth. Waters shall not contain biostimulatory substances in concentrations that promote aquatic growth to the extent that such growth causes nuisance of adversely affects designated beneficial uses (Basin Plan)
TOXICS	
Toxicity	Waters maintained free of toxic substances in concentrations toxic to human, plant, animal, or aquatic life; survival of aquatic life in surface waters subject to waste discharge or other uncontrollable water quality factors shall not be less than for the same waterbody in areas unaffected by waste discharge; no acute toxicity in ambient waters including mixing zones; no chronic toxicity in ambient waters outside mixing zones (Basin Plan p.3-16)
Copper (acute)	27 μg/L (hardness value 200 mg/L) 52 μg/L (hardness value 400 mg/L) (CTR objectives)
Lead (acute)	200 μg/L (hardness value 200 mg/L) 480 μg/L (hardness value 400 mg/L) (CTR objectives)
Zinc (acute)	220 μg/L (hardness value 200 mg/L) 390 μg/L (hardness value 400 mg/L) (CTR objectives)
Chemical Constituents	MUN designated waters shall not contain concentrations of chemicals in excess of the limits specified in the Title 22 CCR (for inorganic and organic chemicals and fluoride) (Basin Plan p.3-8).
Bioaccumulation	Toxic pollutants shall not be present at levels that will bioaccumulate in aquatic life to levels which are harmful to aquatic life or human health (Basin Plan p.3-8).
Pesticides	Waters shall not contain concentrations of pesticides in excess of limiting concentrations in 22 CCR § 64444 (organics) (MUN) (Basin Plan p.3-15 and Table 3-7).
Turbidity	Waters shall be free of changes in turbidity that cause nuisance or adversely affect designated beneficial uses; increased in natural turbidity attributable to controllable water quality factors are limited as follows: 20% increase or less where natural turbidity is between 0 and 50 NTU; 10% increase or less where natural turbidity over 50 NTU (Basin Plan p.3-17).
Solid, suspended, or	Waters shall not contain suspended or settleable material in concentrations

TABLE 4
WATER QUALITY OBJECTIVES

Issue	Objective
settleable materials (including TSS)	that cause nuisance or adversely affect designated beneficial uses (Basin Plan p.3-16).
PATHOGENS/ BACTERIA	
E. coli density	Less than 126/100 ML (geometric mean limit) (REC-1) (Basin Plan amendment)
E. coli density	Less than 235/100 ML (single sample limit) (REC-1) (Basin Plan amendment)
Fecal coliform density	Less than 200/100mL (geometric mean limit) (REC-1) (Basin Plan amendment)
Fecal coliform density	Less than 400/100mL (single sample limit) (REC-1) (Basin Plan amendment)
QUALITATIVE BMP-BASED	
Chlorine, total residual	Shall not be present in surface water discharges at concentrations exceeding 0.1 mg/L; shall not persist in receiving waters at any concentration that causes impairment of designated beneficial uses (Basin Plan p.3-9).
MBAS (methylene blue activated substances), such as detergents and other anionic surfactants	Less than or equal to 0.5 mg/L (MUN) (Basin Plan p.3-11)
Floating materials	Waters shall not contain floating materials in concentrations that cause nuisance or adversely affect designated beneficial uses (Basin Plan p.3-9).
Oil & grease	Waters shall not contain oils, greases, waxes or other materials in concentrations that result in a visible film or coating on the surface of the water or on objects in the water, that cause nuisance, or that otherwise adversely affect designated beneficial uses (Basin Plan p. 3-11).
pH	Shall not be depressed below 6.5 or raised above 8.5 as a result of waste discharges; ambient pH levels shall not be changed more than 0.5 units from natural conditions as a result of waste discharge (Basin Plan p.3-15).
PCBs	Pass-through or uncontrollable discharge limited to 70 pg/L 30-day average (human health) and 14 mg/L daily average (aquatic life); purposeful discharge prohibited (Basin Plan p.3-15).
Temperature	Water temperature shall not be altered by greater than 5 degrees F above natural temperature; natural receiving water temperature shall not be altered unless it can be demonstrated that designated beneficial uses not adversely affected (Basin Plan p.3-16).
Taste and Odor	Waters shall not contain taste or odor-producing substances in concentrations that impart undesirable tastes or odors to fish/edible aquatic

TABLE 4
WATER QUALITY OBJECTIVES

Issue	Objective
	flesh, to adversely affect beneficial uses and cause nuisance (Basin Plan, p.3-16).
Radioactive Substances	Waters designated as MUN shall not contain concentrations of radionuclides in excess of Title 22 CCR (Basin Plan p.3-15).
RIVER PLAN CONSTITUENTS	
Exotic vegetation	Exotic vegetation shall not be introduced around stream courses to the extent that such growth causes nuisance or adversely affects designated beneficial uses (Basin Plan p.3-9).
Wetlands hydrology	Natural hydrologic conditions necessary to support physical, chemical and biological characteristics present in wetlands shall be protected to prevent significant adverse effects on a variety of parameters (Basin Plan p.3-17).
Wetlands habitat	Existing habitats and associated populations of wetlands fauna and flora shall be maintained (Basin Plan p.3-17).

(g) Water Quality Best Management Practices

This section describes the state of water quality best management practices and outlines current efforts and requirements for MS4 Permittees (City of Santa Clarita and County of Los Angeles).

In water pollution control, best management practices (BMPs) refer to the best means available to control pollution of waterways from non-point sources. For storm water runoff, Section 402(p) of the CWA provides that MS4 permits must require controls to reduce the discharge of pollutants to the MEP. The MEP standard was clarified by the federal courts, which held that MEP did not require that municipal storm water discharges strictly comply with numeric water quality standards (*Defenders of Wildlife v. Browner*, 191 F.3d 1159 (9th Cir. 1999)). The MEP standard is attained by the use of BMPs. For a particular permit, the U.S. EPA generally bases the MEP standard on technological feasibility, water quality objectives, and other site specific considerations.

BMPs are actions and procedures established to reduce the pollutant loadings in storm drain systems. The three main categories of BMPs are (1) site design (or planning and management), (2) source control and (3) treatment and structural control.

Site Planning BMPs
Site design or planning management BMPs are used to conserve natural areas and minimize impervious cover, especially in those areas directly connected to receiving waters. Site planning BMP strategies include:

- Minimizing Impervious Areas and Directly Connected Impervious Areas
- Selection of Construction Materials and Design Practices
- Conservation of Natural Areas
- Protection of Slopes and Channels with Vegetative Cover

Source Control BMPs

- Source control BMPs are usually the most effective and economical in preventing pollutants from entering storm and non-storm runoff. Examples of source control BMPs that are relevant to the project include:
  - Public Education/Participation activities which make information available to homeowner groups, associations, and municipalities for further distribution to homeowners and businesses.
  - Drain Inlet Stenciling This includes community and resort education and litter control program

Materials Management activities, such as:

- Materials Use Controls, which include good housekeeping practices (storage, use and cleanup) when handling potentially harmful materials, such as cleaning materials, fertilizers, paint, pool chemicals and, where possible, using safer alternative products;
- Material Exposure Controls, which prevent and reduce pollutant discharge to storm water by minimizing the storage of hazardous materials (such as pesticides) on site, storing materials in a designated area, installing secondary containment, conducting regular inspections, and training employees and subcontractors; and
- Material Disposal and Recycling, which includes storm drain system signs and stenciling with language to discourage illegal dumping of unwanted materials. Household hazardous waste and used oil recycling at collection centers and round-up activities are very productive BMPs.
- Spill Prevention and Cleanup activities, which are directed toward reducing the risk of spills during the outdoor handling and transport of chemicals, and toward developing plans and programs to contain and rapidly clean up spills before they get into a storm drain system. This BMP also deals with the prevention and reduction of pollution from vehicle leaks and spills from vehicles during transport, as well as aboveground storage tanks. This BMP would be relevant to the construction of a gasoline station on the proposed commercial site, should one occur.
- Illegal Dumping Controls, which consist of laws, ordinances and public education programs intended to prevent the dumping of waste products (solid waste/liquid waste and yard trash) into storm drain systems and water courses.
- Street and Storm Drain Maintenance activities that control the movement of pollutants and remove them from pavement through catch basin cleaning, storm drain flushing, street sweeping, and by regularly removing illegally dumped

material from storm channels and creeks. Modification of channel/creek characteristics to improve hydraulics and increase pollutant removals also enhances aesthetic and habitat value.

- Good Housekeeping practices including such activities as sweeping down driveways as opposed to washing them down.
- Irrigation Controls and Management, Proper Storage and Application of Fertilizers and Pesticides.
- Capture and re-use of storm water runoff and nuisance flows.

Treatment and Structural BMPs
Treatment and structural control BMPs involve physical treatment of the runoff, usually through structural means. Treatment control BMPs are also referred to as structural BMPs throughout this report. A variety of treatment control measures have been utilized throughout the country for storm water quality; however, the effectiveness of these controls is highly dependent on local conditions, such as climate, hydrology, soils, groundwater conditions, and extent of urbanization.

Some of the more common Treatment Controls are:

- Oil/water separators, which are designed to remove one specific group of contaminants: petroleum compounds and grease. However, separators will also remove floating debris and settable solids.

- Infiltration, which refers to a family of systems in which the majority of the runoff from small storms is infiltrated into the ground rather than discharged to a surface water body. Infiltration systems include: ponds, vaults, trenches, dry wells, porous pavement, and concrete grids.

- Biofilters, which are of two types: swale and strip. A swale is a vegetated channel that treats concentrated flow. A strip treats sheet flow and is placed parallel to the contributing surface.

- Extended water quality detention basins that are dry between storms. During a storm, the basin fills and a bottom outlet releases the storm water slowly to provide time for sediments to settle.

- Media filtration consists of a settling basin followed by a filter. Common filter are sands, peat/sand mixtures, and other filter media.

- Hydrodynamic Separator Systems such as Gross Solids Removal Devices (GSRDs) and Continuous Deflector Separation (CDS) Units

- Multiple systems which are a combination of two or more of the preceding controls in a series; also referred to as a "treatment train."

2.1.2 Intrusions into Jurisdictional Waters

(a) United States Army Corps of Engineers

The project would also be subject to federal permit requirements under Section 404 of the CWA. Section 404 of the CWA regulates activities that result in the location of a structure, excavation, or discharge of dredged or fill material into "Waters of the United States," which include wetlands along with non-wetland habitats, such as streams (including intermittent streams), rivers, lakes, ponds, etc., over which the U.S. ACOE has jurisdiction The Santa Clara River, including that portion of the river that flows through the site, is designated by the United State Geological Survey as "waters of the United States." Two other drainages within the site are also considered "waters of the United States" and fall under U.S. ACOE jurisdiction. Therefore, certain proposed activities in the river and drainages, such as the construction of the bank stabilization, toe protection and outlet structures (discussed later in this EIR section) and the Newhall Ranch Road/Golden Valley Road Bridge, may come under the jurisdiction of the U.S. ACOE pursuant to Section 404 of the CWA. These improvements were also analyzed and are permitted under the already approved Natural River Management Plan (ACOE Individual Permit No. 94-00-504-BAH)[32] (See discussion of the Natural River Management Plan, below).

(b) California Department of Fish and Game

The Santa Clara River and associated vegetation on the site are also potentially subject to regulation by the CDFG under Sections 1601-1603 of the California Fish and Game Code. Under Sections 1600-1607 of the Code, the CDFG regulates activities that would alter the flows, beds, channels or banks of streams and lakes. The term "stream" can include intermittent and ephemeral streams, rivers, creeks, dry washes, sloughs, blueline streams and watercourses with subsurface flows. In addition to the Santa Clara River, the site contains other drainages that site that fall under CDFG jurisdiction (see other related technical reports).

2.1.3 Natural River Management Plan (NRMP)

On November 30, 1998, the U.S. ACOE, CDFG and the RWQCBLAR approved the Natural River Management Plan (NRMP) for the Santa Clara River. The NRMP is a long-term, master plan that provides for the construction of various infrastructure improvements on lands adjacent to the Santa Clara River and portions of two of its tributaries. More specifically, the NRMP governs a portion of the main-stem of the Santa Clara River from Castaic Creek to one-half mile east of the Los Angeles Department of Water and Power Aqueduct and portions of San Francisquito Creek and the Santa Clara River South Fork, in Los Angeles County,

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32 The permit to construct improvements under the Natural River Management Plan comes from an Army Corps Section 404 Permit, Fish and Game Incidental Take and 1603 Permit. The Santa Clara Natural River Management Plan consists of new bank protection, new or widened bridges, inlet structures, storm drain outlets and utility line crossings associated with the infrastructure and land developments near the Santa Clara River and its tributaries in the Santa Clarita Valley.

California. The project site is located within the portion of the river now governed by the NRMP.

In connection with this approval, the following permits were issued by the following agencies:

- United States Army Corps of Engineers (USACOE) – Permit No. 94-00504-BAH under Section 404 of the federal Clean Water Act. Section 404 of the federal Clean Water Act allows for certain activities that result in the discharge of fill or dredged materials into "Waters of the United States" or in this case the Santa Clara River. Prior to issuing this permit, the Army Corps had completed an endangered species consultation (pursuant to Section 7 of the federal Endangered Species Act) with the United States Fish and Wildlife Service.

- California Department of Fish and Game (CDFG) - 1603 Streambed Alteration Agreement No. 5-502-97 and Incidental Take Permit No. 2081-1998-49-5. In summary, the Streambed Alteration Agreement allows for activities that alter the ".... natural flow or change the bed, channel or bank of the river...." The Incidental Take Permit applies to all state listed species pursuant to Fish and Game Code Section 2081(b).

- California Regional Water Quality Control Board (Los Angeles Region) (RWQCBLAR) – Order No. 99-104 related to waste discharge associated with the improvements included in the NRMP.

The NRMP was prepared in response to a U.S. Army Corps of Engineers request to prepare a long-range management plan for projects and activities potentially affecting the Santa Clara River and San Francisquito Creek. More specifically, the NRMP, and its certified EIS/EIR (NRMP EIS/EIR), analyze impacts associated with the implementation of various infrastructure improvements (bank stabilization, bridges, utility crossings, storm drain outlets, etc.) along and within portions of the Santa Clara River adjacent to Newhall Land properties, including the Riverpark project site.

The permits issued by the affected agencies (ACOE, CDFG, RWQCB) allow Newhall Land or its designee to engage in construction and maintenance activities for the various infrastructure improvements included within the NRMP. Within the project site, those improvements include the bank stabilization, toe or erosion protection, various outlet structures, and the Newhall Ranch Road/Golden Valley Road Bridge. The NRMP, through its permits and EIR/EIS, includes certain requirements, conditions and mitigation measures associated with the implementation of the approved improvements.

As indicated above, various infrastructure improvements and subsequent maintenance activities are governed by and permitted through the approved NRMP and accessory Agency permits. Those improvements addressed by the NRMP, and its EIS/EIR, that are located on the project site include the bridge and bank stabilization elements.

2.2 WATER QUALITY EVALUATION METHODOLOGY

The water quality evaluation methodology presented herein was developed with the following considerations:

1. The current regulatory and jurisdictional framework related to project development, and the basis of this framework,
2. Potential project impacts to water quality discharging from the project site,
3. Existing water quality as it relates to receiving waters and beneficial uses, and
4. Current technology and the state of reliable, defensible data and analysis approaches that are sufficient to serve as a sound basis for action.

The first three items were discussed previously; this section specifically addresses item 4. To address potential storm water quality impacts of the project, an assessment of existing conditions is necessary.[33]

Currently, however, there are limited monitored water quality data available for Reach 7 of the Santa Clara River. As discussed in Section 1.1.1, relative to downstream reaches, Reach 7 (as defined by RWQCBLAR) is not subject to many of the non-storm water discharges experienced downstream of Bouquet Canyon Road Bridge. When water is present in this reach, it is reportedly almost always during the rainy winter months and typically lasts only for a few days after a storm event large enough to create flow. Therefore, for this analysis, existing water quality for this reach of the river (i.e., the reach for which a basis for comparison is valid, and the reach to which the project site ultimately discharges) is based on published pollutant generation rates for various land uses.[34]

The area proposed for development was modeled for three land-use/scenarios: 1) existing conditions assuming open space is vacant land, 2) developed conditions without BMPs, and 3) developed conditions with BMPs.

Consistent with the state of the practice and available data and methodologies, a statistically-derived model based on relatively simple expressions describing rainfall/runoff relationships and estimated concentrations in storm water runoff was used to estimate project impacts. The volume of runoff is estimated from the Rational Equation, an empirical expression that relates runoff volume to the rainfall depth and the broad basin runoff response characteristics. The analysis methodology is described in more detail in Section 2.2.2.

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[33] Quantitative analysis of effectiveness will be limited to treatment and structural BMPs, since site specific data quantifying the effectiveness of planning and source control BMP measures are not available and subject to significant variability.

[34] Los Angeles County 1994-2000 Integrated Receiving water Impacts Report, Los Angeles County Department of Public Works (July 2000).

2.2.1 Pollutants of Concern

The applicable narrative and numerical standards, beneficial uses and CTR criteria for this reach of the river are set forth in **Table 4**. Reach 7 (U.S. EPA Reach 9) has been listed in CWA Section 303(d) as impaired for high coliform count (**Table 2**).

Pollutants of concern consist of any pollutants that exhibit one or more of the following characteristics: current loadings or historic deposits of the pollutant are impacting the beneficial uses of a receiving water, elevated levels of the pollutant are found in sediments of a receiving water and/or have the potential to bioaccumulate in organisms therein, or the detectable inputs of the pollutant are at concentrations or loads considered potentially toxic to humans and/or flora and fauna.[35] Pollutants of concern for the proposed project were chosen for discussion and analysis based upon typical pollutants found in urban runoff (EPA 1993), as well as pollutants that are impacting beneficial uses as evidenced by the CWA section 303(d) listing for designated reaches of the Santa Clara River (discussed below).[36] These include:

- Total Suspended Solids
- Nutrients (Phosphorus, Nitrogen)
- Trace Metals (Copper, Lead, Zinc)
- Pathogens
- Hydrocarbons
- Pesticides
- Chloride

The following constituents were chosen for the water quality modeling analysis:

- Total Suspended Solids (TSS)
- Total Phosphorous (TP)
- Total Nitrogen (TN)
- Nitrate
- Total Copper (Cu)
- Total Lead (Pb)
- Total Zinc (Zn)
- Chloride (Cl)

The analytical model used to estimate concentrations and loads uses EMCs (statistical measures of the concentrations of the modeled constituents based on storm water monitoring data) as model input. The above constituents were selected for modeling in this water quality analysis because statistically significant, suitable and high confidence monitoring data is available to estimate potential project effects (GeoSyntec 2002). These measures are more robust as the data for these parameters have been collected over a range of storm events using flow composite sampling methods at similar land uses, and the data for these constituents are consistently measured at levels above the method detection levels.

[35] County SUSMP Manual, p. 24.

[36] 2002 CWA Section 303(d) List of Water Quality Limited Segment, Approved by SWRCB (4 February 2003).

To the extent that there are reliable data on the effectiveness of structural BMPs, that data was used in the modeling; however, source controls were not included in the analysis, since it is difficult to model their impacts. Due to the absence of substantial research, BMP removal effectiveness data for nitrate and chloride are limited and therefore accurate modeling of the BMP effectiveness for these constituents with respect to ultimate effluent concentrations is not possible. The analysis for nitrate and chloride is therefore limited to assessing potential changes to water quality from existing to proposed conditions. The water quality model does not include analysis of loads following application of storm water treatment (or structural) BMPs (mitigated conditions). As a result, the comparison between existing and proposed conditions overestimates potential impacts.

The following constituents of concern are analyzed qualitatively in this analysis, but were not modeled due to limited storm water monitoring data and because the constituents are more difficult to accurately measure, and consequently are not amenable to developing reliable quantitative data.

- TDS (Total Dissolved Solids) – Water quality parameter defining the concentration of dissolved organic and inorganic chemicals in water. After suspended solids are filtered from water and water is evaporated, dissolved solids are the remaining residue. Due to lack of BMP removal data for TDS, chloride levels may be used for evaluations and as an indicator of behavior of minerals in general.

- Sulfate – A salt or ester of sulfuric acid, originating from the oxidation of sulfite ores, the presence of shales, and the existence of industrial wastes. Sulfate is one of the major dissolved constituents in rain. As with TDS, lack of BMP removal data for this constituent requires the evaluation of indicator pollutants, such as chloride.

- Boron – A trace mineral found mainly in sea water. As with TDS, lack of BMP removal data for this constituent requires the evaluation of indicator pollutants, such as chloride.

- SAR, or sodium absorption ratio – Ratio for irrigation waters, used to express the relative activity of sodium ions in exchange reactions with soil. As with TDS, lack of BMP removal data for this constituent requires the evaluation of indicator pollutants, such as chloride.

- Various forms of *hydrocarbons* are common constituents associated with urban runoff; however, these constituents are difficult to measure because of laboratory interference effects, sample collection challenges (hydrocarbons tend to coat sample bottles), and they are typically measured with single grab samples, making it difficult to develop reliable modeling data (e.g. storm water event mean concentrations [EMCs] which are used to represent probable concentrations in storm water runoff). Because it was not possible to represent conditions with confidence, this constituent could not be satisfactorily modeled.

- *Pesticides* in urban runoff are often at concentrations that are below detection limits for most commercial laboratories; and therefore there are limited statistically reliable data on pesticide concentrations in urban runoff. Furthermore, since the most effective BMPs are source control measures, it is not possible to accurately represent a quantification of pollutant removals.

- *Human pathogens* typically are not directly measured in storm water monitoring programs because of the difficulty and expense involved. Indicator bacteria such as fecal coliform or E. Coli are measured, however even these indicator are not very reliable for storm water conditions, in part because storm water tends to mobilize these bacteria from many other non-human sources, many of which include non-pathogenic bacteria. For this reason, and because holding times for bacterial samples are necessarily short, most storm water programs do not collect flow-weighted composite samples that potentially could produce reliable statistical estimates of pathogen concentrations.

An effective approach for addressing potential storm water impacts of urban development is to identify and impose project-specific BMPs to complement regional BMPs addressing water quality issues on a watershed or regional basis. Construction impacts are addressed, primarily through a SWPPP consistent with the requirements for coverage under the State's General Construction Activity Storm Water Permit (discussed below), and longer-term post-construction impacts are addressed, primarily, under a SUSMP. The SWPPP contains certain additional elements related to post-construction impacts, requiring, for example, descriptions of post-construction BMPs, but is not as comprehensive as the SUSMP. The BMPs specified in this document provide a framework for future preparation of the SUSMP.

2.2.2 Pollutant loading

(a) Runoff Estimation

Runoff must first be estimated before quantifying loading. Runoff is estimated using the Rational Equation (Novotny and Olem, 1994):

$$Q = Rv * I * A$$

where:

Q = runoff (volume or flow rate)
Rv = mean annual runoff coefficient
I = rainfall depth or rainfall intensity
A = drainage area

The runoff coefficient is a unit-less value that is a function of the imperviousness of the watershed and is approximated in the water quality model using the following equation:

$$Rv = 0.007 * (\% \text{ Imperviousness}) + 0.1$$

Percent imperviousness for each sub-area in the proposed development was estimated based on the distribution of land uses and land use specific percent impervious values presented in the Los Angeles Hydrology Manual (LACDPW, 1991).

Table 5 shows the percent impervious applied by land use for the proposed Riverpark project existing (and developed) conditions.

TABLE 5
PERCENT IMPERVIOUSNESS FOR SELECTED LAND USES

Land Use	Percent Imperviousness (%)
Agricultural[3]	10[2]
Transportation	100[2]
Single Family Residential	42[1]
Multi Family Residential	68[1]
Commercial	92[1]
Open Space	10[2]

Notes:
1) Source: Los Angeles County Hydrology Manual, Appendix F.
2) Source: GeoSyntec, 2002.
3) Source: Values are presented for non-irrigated and grassland agricultural use.

The application of percent imperviousness per land use was based on evaluation of dominant land uses in identified hydrologic sub-areas for both existing (and developed) conditions. Refer to the Flood Technical Report for delineation of the hydrologic sub-areas.

Table 6 presents results from rainfall analyses used for estimating pollutant loads (GeoSyntec 2002). The rainfall analysis for the Newhall Ranch Development based on data collected from the National Climatic Data Center (NCDC) for the Newhall Weather Station #046162. Hourly rainfall data collected from 1968 to 1998 was analyzed using the SYNOP statistical rainfall analysis program (EPA, 1989) to develop descriptive statistics for individual storm events.

TABLE 6
RESULTS OF THE RAINFALL ANALYSIS
(NEWHALL RANCH WEATHER STATION #046162[1])

Average annual rainfall from events larger than 0.1 inches in total depth	16.9 inches
Average number of events per year greater than 0.1 inches in total depth	15 events
Average duration of events larger than 0.1 inches in total depth	11 hours
Average depth of events larger than 0.1 inches in total depth	1.12 inches
Average intensity of events larger than 0.1 inches in total depth	0.102 in/hr
Notes: 1) Information presented based on rainfall analysis results for the Newhall Ranch Development (Geosyntec, 2002).	

(b) Water Quality Model Analysis

The water quality modeling analysis was based on a modified version of the Simple Method (Schueler, 1987). The constituent concentration is represented by an expected average constituent concentration, the Event Mean Concentration (EMC), and a measure of the variability. The EMCs and variability are estimated from available monitoring data and are strongly dependent on land-use type. This information is used in a model to estimate runoff volumes, and pollutant concentrations and loadings for the four scenarios. Annual pollutant loads were calculated using estimated runoff volumes and EMC values based on existing or project land uses as shown in the following equation:

Runoff Volume	X	EMC	X	Conversion Factor	=	Pollutant Load
(ft^3/year)		(mg/L)		(6.2428×10^{-5})		(lbs/year)

The EMCs summarized in **Table 7** were used to predict the storm water pollutant loads at the points of discharge from the project area into the Santa Clara River. As indicated above, the LA County data were used in modeling of total suspended solids (TSS), total phosphorous (P), total nitrogen (N), nitrate, total copper (Cu), total lead (Pb), total Zinc (Zn), and chloride (Cl).

As indicated previously, current land use within the project site and its adjacent upstream tributary areas are mostly open space and agricultural uses. The results of the pollutant load model for existing conditions are presented in Section 4 as part of the discussion for project impacts.

The effects of BMPs are accounted for via the estimation of the amount of runoff "captured" and treated by the BMP and estimates of the resulting effluent quality achieved based upon BMP performance information.

As described above, the existing site land uses consist of a mixture of open space, agriculture and a small percentage of commercial uses. Because there are multiple existing land uses, the water quality impacts of the project (with and without BMPs) could be compared to both open space uses and agriculture uses. To be conservative, the existing conditions were modeled based on the assumption that open space is vacant. However, it should be noted that this assumption likely overstates the impact of project development because the concentrations for all constituents of concern for vacant land use are lower than for agriculture use

(c) Event Mean Concentrations (EMCs)

Storm water runoff water quality will vary within a storm event depending on the rainfall pattern and storm duration (intra-event variability). Because of this variability, water quality concentrations are often expressed in the form of EMCs, which are the concentrations that would be measured if the entire runoff from an event were captured and mixed before sampling. The extensive use of EMCs to characterize storm water quality was initiated in the U.S. EPA's Nationwide Urban Runoff Program (NURP) (U.S. EPA, *Nationwide Urban Runoff Program*, Executive Summary, 1983).

Storm water runoff quality will also vary from storm to storm (inter-event variability) depending on a variety of conditions, including the characteristics of the storm event, the time between storms, conditions in the watershed, and time of year. This latter effect is particularly important in semi-arid environments where there is a dry and wet season, and where soil saturation and runoff vary greatly depending on the season and changes in long-term climate cycles. Because of this intra- and inter-event variability, storm water quality is often expressed and evaluated statistically.

The Ventura County Flood Control District conducts storm water monitoring from areas with specific land uses. Results from agricultural storm water monitoring efforts during the years 1997, 1998, and 1999 were used to develop model input concentrations for agricultural land use event mean concentrations (EMCs).[37] The Los Angeles County Storm Water Monitoring Program also conducts comprehensive wet weather monitoring and publishes EMCs for several different constituents and a variety of land uses (LARWQCB, 2001). This data was used to provide EMCs for the existing and proposed land uses because of the relatively close location of the Los Angeles County monitoring stations to the project site, because the monitored land uses were representative of the proposed development land uses, and because the data evaluates storm water quality unique to specific land uses.

The EMCs used to characterize the existing (and developed) storm water quality at the proposed project site are shown below in **Table 7**.

[37] An EMC is the average concentration of a pollutant in the runoff from a storm event, equal to the total mass of pollutant divided by the total volume of storm runoff.

TABLE 7
LAND USE REPRESENTATIVE EVENT MEAN CONCENTRATIONS (EMCS) USED TO CHARACTERIZE STORM WATER QUALITY CONDITIONS

Land Use[1]	Pollutant EMCs							
	TSS (mg/L)	TP (mg/L)	TN[3] (mg/L)	Nitrate (mg/L)	Cu (mg/L)	Pb (mg/L)	Zn (mg/L)	Chloride (mg/L)
Agriculture[2]	1176	2.7	18.83	11.1	0.132	0.047	0.324	24.2
Transportation	78	0.44	2.65	0.7	0.056	0.0103	0.29	5.6
Single Family Residential	95	0.39	3.84	0.86	0.015	0.0097	0.08	5
Multi Family Residential	46	0.19	3.16	1.1	0.012	0.0058	0.15	12.7
Commercial	66	0.39	4.04	0.48	0.039	0.018	0.24	49.8
Open Space[4]	186	0.16	1.89	1.05	0.015	0.0025	0.05	6.6

Notes:
1) EMCs for each land use are based on LA County Storm Water Monitoring Data (1994-2000), unless noted.
2) Calculated mean concentrations for agricultural land uses are based on analysis of Ventura County Agricultural Monitoring Data (Geosyntec, 2002).
3) Total nitrogen estimated from sum of Total Kjeldahl Nitrogen (TKN) and nitrates.
4) Includes park uses.

Based on monitoring data from Ventura County, EMC values for many pollutants of concern from agricultural uses are typically about 4 to 19 times higher than they are from open space/vacant land uses. Because a small portion of the Riverpark site has historically been under agricultural production the expected existing storm water pollutant loads at the site should be in the range between those expected from open space and those expected from agricultural uses. Loads within this range will vary since the various pollutants have different survival rates and behavior over time and under various conditions.

(d) Land Uses under Existing Conditions

The land use assumptions used for the pre- and post-development conditions are shown in **Table 8 Dominant Land Uses under Existing Conditions**. Pre-development conditions were modeled based primarily on open space land use, with a small fraction of agricultural and commercial (storage yard) land uses (existing scenario). Post-development conditions at the site would include open space, commercial, transportation, single family residential and multi family residential land uses. Land uses for off-site tributary areas consist primarily of open space land uses with a small fraction of agricultural uses.

TABLE 8
DOMINANT LAND USES UNDER EXISTING CONDITIONS

Land Use		Total Watershed Area (ac)	Total Watershed Area (ft^2)	Percent Total (%)
Existing Conditions in Tributary Watershed	Open Space	784.57	34,175,602	93.2%
	Agriculture	38.5	1,677,047	4.6%
	Commercial	18.4	801,498	2.2%
	Total[1]	841.47	36,654,147	100%

Again, the assumption that the existing condition of the site is primarily open space and vacant results in understating the site's actual condition. Even though the site is primarily open space now, portions have historically been put to agricultural use, and the effects of that use (i.e., the use of pesticides) may still affect the quality of the runoff from the site. Consequently, the assumption that the site is primarily open space and vacant is conservative, and the actual level of the modeled constituents is likely higher than shown below.

2.2.3 Existing Surface Water Quality

As stated above, analysis of pollutants of concern for the project were analyzed quantitatively where there was sufficient reliable data on which to base the analysis, and qualitatively where such data was not available.

(a) Assessment of Quantitatively Addressed Pollutants

To help address potential storm water quality for the proposed Riverpark development, a pollutant load model was developed for analysis of existing, proposed and mitigated conditions.

Under existing conditions the project site is currently vacant and there are no water quality control improvements located within the project site. The water quality parameters that were incorporated in the pollutant load computation methodology for the pre-development, as well as post- and mitigated- development, conditions were presented above. The pollutant load computation methodology was also discussed above. The following summary includes discussion of pollutants of concern, event mean concentrations, rainfall and runoff estimation methods, a brief description of the calculations used in the pollutant load model for the Riverpark development and the applied CTR criteria. Pre-developed conditions were modeled based primarily on open space land use, with a small fraction of agricultural and commercial (storage yard) land uses.

TABLE 9
POLLUTANT CONCENTRATION RESULTS FOR RIVERPARK DEVELOPMENT BASED ON ASSUMPTION OF EXISTING VACANT LAND USES

Total Area		Runoff Volume	Modeled Constituents							
			TSS	TP	TN[2]	Nitrate[1]	Cu	Pb	Zn	Chloride[1]
(ac)	(ft^2)	(ft^3/yr)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
841.5	36,654,147	9,423,531	217	0.29	2.8	1.43	0.02	0.0058	0.08	11.2
(ac)	(ft^2)	(ft^3/yr)	(lbs/yr)	(lbs/yr)	(lbs/yr)	(lbs/yr)	(lbs/yr)	(lbs/yr)	(lbs/yr)	(lbs/yr)
			127,946	170	1,648	840	13	3	46	6,589

Notes:
1) Mitigated Pollutant Removal not Included in Water Quality Model
2) Total nitrogen estimated from sum of Total Kjeldahl Nitrogen (TKN) and nitrates.

(b) Assessment of Qualitatively Addressed Constituents

Many constituents of concern, including sulfates, boron, SAR, ammonia, pathogens, pesticides, and hydrocarbons, as discussed below, are not easily modeled due to limited or non-existent monitoring data, difficulty in measuring pollutant concentrations, or due to pollutant concentrations that are below reporting limits.

- Sulfates, Boron and SAR (Salts)

  These constituents are most often associated with marine soils and coastal environments, so are not likely to appear in project site runoff.

- *Ammonia (Nutrient)*
  Ammonia is typically found in low concentrations in runoff, as it is easily diluted and oxidized to nitrate. Consequently, its presence in runoff is measured by the nitrate concentrations in runoff.

- *Pathogens*
  Pathogens in the Santa Clara River may adversely affect the potential and existing designated beneficial uses of the river, particularly water contact recreation. Typical sources of pathogens in urban storm water runoff include pet wastes, improperly functioning septic tanks, and illicit sewer connections to the storm drain system. Other sources of pathogens are primarily due to non-domestic animal wastes, particularly waterfowl.

  The concentrations of pathogens associated the existing open space use are difficult to evaluate for a number of reasons. Measurements of indicator organisms are not necessarily reliable indicators of viable pathogenic viruses, bacteria, or protozoa. Moreover, there are numerous sources of pathogens including birds and other wildlife, as well as domesticated animals and pets. Open space areas can potentially have high levels of coliform associated with this type of land use due to wildlife sources, but are typically lower in pathogen concentration than urban land uses.

- *Pesticides*
  While pesticides are subject to degradation, they vary in how long they maintain their ability to eradicate pests. Some break down almost immediately into nontoxic by-products, while others can remain active for longer periods of time. Currently, pesticide sampling data is unavailable for the soils of the planned construction areas of the proposed project site. The open space areas proposed for residential development are in a natural condition and are not known to been maintained with pesticides. However, pesticides were likely used on the portion of the site historically devoted to agricultural use, and on the off-site agricultural areas that drain onto the site.

- *Hydrocarbons*
  Various forms of hydrocarbons (oil and grease) are common in urban runoff; however, these constituents are difficult to measure and are typically measured with grab samples, making it difficult to develop reliable EMCs for modeling. Based on this consideration, hydrocarbons were not modeled but are addressed qualitatively.

  Hydrocarbons are a broad class of compounds, most of which are non-toxic. Hydrocarbons are hydrophobic (low solubility in water), have the potential to volatilize, and most forms are biodegradable. A subset of hydrocarbons, Polynuclear Aromatic Hydrocarbons (PAHs), can be toxic depending on the concentration levels, exposure history and sensitivity of the receptor organisms. Of particular concern are those PAHs compounds associated with transportation related combustion products.

  The current concentration of hydrocarbons in the runoff is likely to be relatively small, as the project site is generally vacant open space land. However, there may be some hydrocarbon-containing runoff from the construction storage yard located in the valley in the central portion of the site.

- *Runoff Volume, Velocity and Duration*
  The existing project site is not subject to hydraulic control structures (except facilities associated with transportation uses) that would alter the natural hydrologic and hydraulic responses to rainfall (volume, velocities, and durations). Based on relative watershed size and characteristics of the Santa Clara River, runoff from the project site will not have any appreciable impact on potentially erosive flows in the River. Locally (e.g., at storm drain outlets), energy dissipation is provided to reduce potential for erosion. Furthermore, water quality basins will reduce the frequency, volume, and duration of potentially erosive flows. Additional discussion is provided in the Flood Technical Report.

3 PROJECT CONDITIONS

The Riverpark project conditions as they relate to water quality are discussed in this section. Both construction and post-construction/development phases (including the effectiveness of mitigation) of the project are addressed here.

3.1 WATER QUALITY IMPACTS DURING CONSTRUCTION

The following discussion addresses anticipated construction-related BMPs. It should be noted that the project will be required to prepare and receive approval of a Storm Water Pollution and Prevention Plan (SWPP), which will detail the final construction BMP's for the project.

During construction, pollutants from the site could increase substantially as a result of soil disturbance and construction operations. As discussed above, runoff from land with a history of agricultural production typically contain total suspended solids (sediments), pesticides, trace metals (associated with sediment), nutrients, and pathogens. Initial clearing and grading operations during construction would expose much of the surface soils and release these pollutants into site runoff. Unless adequate erosion controls are installed and maintained at the site during construction, sediment may be delivered to the downstream receiving waters, along with attached soil nutrients and organic matter, resulting in an adverse water quality impact.

Other pollutants that could be generated on the site during construction include nutrients, trace metals, pesticides, construction chemicals, and miscellaneous wastes. Each of these is discussed below:

- *Nutrients:* Nitrogen, phosphorous, and potassium are the major nutrients used for fertilizing new landscape at construction sites. Heavy use of commercial fertilizers can result in discharge of nutrients to water bodies where they may cause excessive algae growth.

- *Trace Metals:* Over half of the metal load carried in storm water is associated with sediments as metals both adsorb[38] to solids particulate matter (total suspended solids) and get washed off in dissolved forms. Galvanized metals, paint, or preserved wood may contain metals which may, if uncontrolled, enter the storm water and impact downstream receiving waters.

- *Pesticides:* Unnecessary or improper application of pesticides may directly or indirectly contaminate surface water bodies.

- *Other Toxic Chemicals:* If improperly stored and/or disposed of, synthetic organic compounds that may be used at construction sites (such as adhesives, cleaners, sealants, and solvents) may have an adverse impact on receiving waters.

- *Miscellaneous Wastes:* Miscellaneous wastes may include wash water from concrete mixers, paints and painting equipment cleaning activities, solid wastes from land clearing activities, wood and paper material from packaging of building material, and sanitary wastes. Improper disposal of construction wastes may directly or indirectly pollute runoff and receiving water bodies.

38 Adsorption refers to the process of one material attracting and holding molecules of another substance to the surface of its molecules.

However, as discussed above, the project must comply with the State's General Construction Activity Storm Water Permit and the General MS4 Permit. To do so, the project construction sites must ensure, as a minimum, that: (1) sediments generated on the project site are retained using adequate treatment control or structural control BMPs; (2) construction-related materials, wastes, spills, or residues are retained at the project site to avoid discharge to streets, drainage facilities, receiving waters, or adjacent properties by wind or runoff; (3) non-storm water runoff from equipment and vehicle washing and any other activity are contained at the project site; and (4) erosion from slopes and channels are controlled by implementing an effective combination of BMPs (as approved in RWQCBLAR Resolution No. 99-03), such as, for example, limiting of grading scheduled during the wet season; inspecting graded areas during rain events; planting and maintenance of vegetation on slopes; and covering erosion susceptible slopes.[39]

In addition, a local SWPPP must be prepared and submitted for approval prior to issuance of a grading permit for the construction of the project.[40] The SWPPP would be designed and implemented to address site-specific conditions related to project construction. The SWPPP would identify the sources of sediment and other pollutants that may affect the quality of storm water discharges, and would identify appropriate construction site BMPs and maintenance schedules, and the rationale for selecting or rejecting BMPs.[41] The following BMPs are typical construction site BMPs and are recommended for the project. The recommended BMP categories include measures for temporary sediment control, temporary soil stabilization, scheduling, preservation of existing vegetation, conveyance controls, wind control, temporary stream crossings, and waste management, silt fencing and sand bags, as well as many other measures which may be implemented during the construction of the project (See General Construction Activity Storm Water Permit). These measures are consistent with requirements set forth in the General Construction Activity Storm Water Permit. The following is a brief overview of the main BMPs directed at reducing storm runoff pollutants and eliminating non-storm water discharges.

1. <u>Erosion Control</u>.

During construction, erosion control techniques to retain soil and sediment on the site must be implemented. Particular attention must be paid to large mass-graded sites where the potential for soil exposure to the erosive effects of rainfall and wind is great. Typical measures that may be considered include appropriate vegetation of exposed areas, minimizing disturbed areas, diversion of runoff (such as earth dikes, temporary drains, slope drains), and velocity reduction (outlet protection, check dams, and slope roughening/terracing), as well as dust control measures (such as sand fences, watering, etc.).

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39 General MS4 Permit, Part 4, E.

40 Id.

41 Id.

2. Stabilization.

Disturbed and exposed areas of the construction site must be stabilized during the project. Example measures may include: blankets, reinforced channel liners, soil cement, fiber matrices, geotextiles, or other erosion resistant soil coverings or treatments. The construction entrance/exit will also likely require stabilization (e.g., aggregate underdrain with filter cloth).

3. Sediment Control.

These measures include BMPs that will prevent a net increase of sediment load in storm water discharge relative to pre-construction levels. Sediment control BMPs are recommended at appropriate locations along the site perimeter and at all operational internal inlets to the storm drain system at all times during the rainy season. Sediment control practices may include filtration devices and barriers (such as fiber rolls, silt fence, straw bale barriers, and gravel inlet filters) and/or settling devices (such as temporary sediment traps or basins).

4. Non-Storm Water Management

Possible non-storm water discharges from the construction site to receiving waters must be properly controlled. Examples of non-storm water discharges include: watering for dust control purposes and vehicle and equipment wash down wastes. Non-storm discharges (e.g., irrigation or equipment cleaning) should be eliminated or reduced to avoid impacts. Appropriate measures generally focus on good housekeeping activities, including: designating and lining concrete washout areas, removing construction debris in a timely manner, providing enclosures and, if appropriate, secondary containment for fuels and lubricants, and avoiding over-applying fertilizers and pesticides as part of soil stabilization and landscaping. . Receptacles for trash and other smaller debris will be required. Wash-out areas for concrete trucks and equipment, paint and stucco equipment, and other construction materials shall be designated, and containment measures employed, to prevent discharges of construction materials. Construction vehicle wash areas shall be designated and containment measures employed to prevent discharges of wash water. Construction street and pavement washing shall be controlled to preclude discharges of wash water. Discharging super-chlorinated water pipe and sprinkler system flushing and test water to storm drain system shall be prohibited.

In addition to the construction related, non-storm water discharges discussed above, additional types of discharges in this category would include discharges from activities such as dewatering, water line testing and sprinkler system testing. It is typically not feasible to contain these sorts of construction-related discharges onsite. The General Construction Activity Storm Water Permit authorizes these types of activities, so long as associated discharges (a) comply with Section A.9 of the General Construction Activity Storm Water Permit, (b) do not cause or contribute to a violation of any water quality standard, and (c) do not violate any other provisions of the General

Construction Activity Permit, and (d) are not prohibited by the Basin Plan. The SWPPP will contain BMPs designed to control pollutants in these types of discharges, including a prohibition against discharging super-chlorinated water associated with line flushing and testing into storm drains, and control mechanisms for discharges related to dewatering activities for grading.

3.2 POST-DEVELOPMENT WATER QUALITY IMPACTS

For the constituents of concern discussed above for which sufficient measured data exist, post-development water quality impacts are estimated using a statistically-based model. The model is used to estimate the impact of the project both with and without the BMPs that have been incorporated into the project as project design features (PDFs). For the constituents that cannot be modeled (because of insufficient data), a qualitative assessment of the project's potential impacts is provided.

3.2.1 Compliance with the General MS4 Permit

The Los Angeles MS4 Permit was developed to protect the beneficial uses of receiving waters in Los Angeles County. To meet the objective, the permit requires Permittees to reduce or prevent pollutants in storm water discharges through the development and implementation of BMPs to the Maximum Extent Practicable (MEP) for municipal storm water activities. The Permittees, including the County of Los Angeles and City of Santa Clarita, required Standard Urban Stormwater Mitigation Plans (SUSMPs) as prescriptive minimum project design criteria that when properly implemented, are presumed to protect water quality.

The permit also notes, by reference to EPA's "Interim Permitting Approach for Water Quality-Based Effluent Limitations in Storm Water Permits (August 26, 1996), that because of the nature of storm water discharges and the lack of detailed, documented, and accepted information on which to base numeric water quality-based effluent limitations (expressed as concentration and mass) for many pollutants of concern, the permitting approach utilizing BMPs does, indeed, provide for the attainment of water quality standards and negates the need for numerical effluent criteria as a standard.

3.2.2 Assessment of Modeled Constituents

As previously discussed, a water quality model was developed to estimate storm water constituent loads and concentrations. The model results for the developed conditions include predicted loads and concentrations from the modeled project areas before and after treatment in the modeled treatment BMPs.

(a) Runoff Volumes – Water Quality Modeling

As with existing conditions, estimates of pollutant loads require estimates of runoff volumes. Relevant equations, rainfall estimates and typical land use characteristics were presented in Section 2. **Table 10** lists both existing (for reference) and proposed land use distributions that are the basis for water quality modeling.

TABLE 10
DOMINANT LAND USES UNDER EXISTING AND PROPOSED CONDITIONS

Land Use		Total Watershed Area		Percent Total
		(ac)	(ft^2)	(%)
Existing Conditions in Tributary Watershed	Open Space	784.57	34,175,602	93.2%
	Agriculture	38.5	1,677,047	4.6%
	Commercial	18.4	801,498	2.2%
	Total[1]	841.47	36,654,147	100%
Proposed Conditions in Tributary Watershed	Open Space	547.1	23,831,490	65.2%
	Agriculture	38.5	1,677,047	4.6%
	Commercial	22.2	967,024	2.6%
	Transportation	34.07	1,484,078	4.1%
	Single Family	152.1	6,625,424	18.1%
	Multi Family	45.6	1,986,320	5.4%
	Total[1]	839.57	36,571,384	100%

Note:
1) Slight reduction in the proposed condition total area (2 acres) is due to on-site grading and rounding of numbers.

TABLE 11
AVERAGE STORM RUNOFF VOLUMES FOR WATER QUALITY MODELING

Site Conditions	Average Annual Runoff Volume (acre-feet)
Existing	216.3
Developed	316.8
Developed w/ BMPs	316.8
% Change[1]	46%

Notes:
1) % Change from Existing to Developed with BMPs (negative sign indicates decrease)
Percent computations are correct and based on the results generated with more decimal places (than the ones presented here).

(b) Constituents of Concern-Quantitative

The runoff volume estimates by the water quality model are used in combination with storm water event mean concentrations (EMCs) to estimate the average annual pollutant loads and concentrations contained in the following sections.

(b.1) TSS, Nutrients and Minerals: Concentrations and Loads

Table 12, Annual Average Storm Water TSS, Nutrient and Mineral Loads Comparison to Existing Land Uses, shows the predicted average annual TSS, TP, TN (nitrogen), nitrate and chloride loads for existing and developed conditions. Loads of TSS, TP, TN (nitrogen), nitrate and chloride are predicted to increase for the developed conditions without treatment by BMPs; however, after treatment in the storm water management system, TSS loads are predicted to decrease below unmitigated levels.

TABLE 12
AVERAGE ANNUAL STORM WATER TSS, NUTRIENT AND MINERAL LOADS COMPARISON TO EXISTING LAND USES

Site Conditions	Modeled Constituent – Loads				
	TSS (lbs/yr)	TP (lbs/yr)	TN[1] (lbs/yr)	Nitrate[2] (lbs/yr)	Chloride[2] (lbs/yr)
Existing (OS)	127,946	170	1648	840	6,589
Developed	135,523	308	2,846	1,035	8,605
Dev w/ BMPs	108,031	236	2,612	N/A	N/A
% Change[3]	-16%	39%	58%	23%[2]	31%[2]

Notes:
1) Total nitrogen estimated from sum of Total Kjeldahl Nitrogen (TKN) and nitrates.
2) Because the BMP effectiveness for nitrates and chloride are not well established, the percent change for nitrate and chloride are based on load without BMPs, presenting a worst-case scenario.
3) % Change from Existing to Developed with BMPs (negative sign indicates decrease)
4) Percent computations are based on the results generated with more decimal places (than the ones presented here).

The comparison of the existing land use model pre- and post-development concentration results are shown in **Table 13, Average Annual Storm Water TSS, Nutrient & Mineral Concentrations Comparison to Existing Land Uses**. Small reductions in TSS, nitrate and chloride concentrations are predicted with development without the BMPs due to the change from open space to urban land uses, while total phosphorus (TP) and total nitrogen (TN) concentrations are predicted to increase prior to treatment. With treatment, the concentration of TSS is predicted to decrease by about 42%. However, the concentrations of TN in both the developed and the developed with PDF conditions are expected to increase slightly over existing conditions.

TABLE 13
AVERAGE ANNUAL STORM WATER TSS, NUTRIENT AND MINERAL CONCENTRATIONS
COMPARISON TO EXISTING LAND USES

Site Conditions	Modeled Constituent – Concentrations				
	TSS (mg/L)	TP (mg/L)	TN[1] (mg/L)	Nitrate[2] (mg/L)	Chloride[2] (mg/L)
Existing (OS)	217	0.29	2.85	1.43	11.2
Developed	157	0.36	3.3	1.20	10.0
Dev w/ BMPs	125	0.27	3.0	N/A	N/A
% Change[3]	-42%	-5%	8%	-16%[2]	-11%[2]

Notes:
1) Total nitrogen estimated from sum of Total Kjeldahl Nitrogen (TKN) and nitrates.
2) Because the BMP effectiveness for nitrates and chloride are not well established, the percent change for nitrate and chloride are based on concentrations without BMPs, presenting a worst-case scenario.
3) % Change from Existing to Developed with BMPs (negative sign indicates decrease)
Percent computations are correct and based on the results generated with more decimal places (than the ones presented here).

Even though the concentrations of TN in both the developed and the developed with BMP conditions are expected to increase slightly over existing conditions, with proper implementation of all the recommended BMPs (structural and nonstructural), impacts are expected to be lessened.

(b.2) Copper, Lead and Zinc: Constituent Loads and Concentrations

Due to consistently low concentrations of dissolved lead in the available storm water runoff data (most reported dissolved lead values are below detection levels in urban runoff), it was not possible to develop reliable EMC parameters for most land uses in order to model dissolved lead. This constituent was therefore modeled as total lead. The results for total lead are compared to the dissolved metal criteria in order to assess the likelihood of exceeding applicable water quality criteria. This renders the lead comparisons to criteria values very conservative, as lead is highly associated with particulates in urban runoff (80 to 95% is typically in the particulate form) and is therefore readily removed from runoff through sedimentation.

Table 14, Average Annual Storm Water Trace Metal Loads Comparison to Existing Land Uses, shows that loads of trace metals are predicted to increase with development before treatment by the BMPs. With treatment, however, only a modest increase in developed loads of dissolved copper, zinc and lead is predicted. **Table 15, Average Annual Storm Water Trace Metal Concentrations Comparison to Existing Land Uses**, shows that, with the implementation of the BMPs, decreases in the concentration of dissolved copper and lead are predicted with BMPs as compared to the existing condition, while moderate increases in the concentration of zinc would remain.

TABLE 14
AVERAGE ANNUAL STORM WATER TRACE METAL LOADS COMPARISON TO EXISTING LAND USES

Site Conditions	Modeled Constituent – Loads		
	Dissolved[1] Copper (lbs/yr)	Total Lead (lbs/yr)	Dissolved[1] Zinc (lbs/yr)
Existing (OS)	13	3	46
Developed	22	7	100
Dev w/ BMPs	17	5	89
% Change[2]	31%	67%	93%

Notes:
1) Dissolved fractions are assumed to equal total loads in order to yield a more conservative estimate.
2) % Change from Existing to Developed with BMPs (negative sign indicates decrease)
Percent computations are correct and based on the results generated with more decimal places (than the ones presented here).

TABLE 15
AVERAGE ANNUAL STORM WATER TRACE METAL CONCENTRATIONS COMPARISON TO EXISTING LAND USES

Site Conditions	Modeled Constituent – Concentrations		
	Dissolved[1] Copper (mg/L)	Total Lead (mg/L)	Dissolved[1] Zinc (mg/L)
Existing (OS)	.02	.0058	.08
Developed	.02	.0083	.12
Dev w/ BMPs	.02	.0056	.10
% Change[2]	-10%	-3%	31%

Notes:
1) Dissolved fractions are assumed to equal total loads in order to yield a more conservative estimate.
2) % Change from Existing to Mitigated Conditions (negative sign indicates decrease)
Percent computations are correct and based on the results generated with more decimal places (than the ones presented here).

However, even though the concentrations of dissolved zinc in both the developed and the developed with PDF conditions are expected to increase moderately over existing conditions, those concentrations would be considerably lower than the benchmark CTR criteria. Converting the **Table 15** concentrations to µg/L (micrograms per liter), the concentrations of dissolved zinc in the development (no PDF) condition would be 120 µg/L and in the developed with BMPs would be 100 µg/L. Both concentrations are substantially lower than the receiving water criteria for zinc of 220 µg/L (hardness of 200 mg/L) and 390 µg/L (hardness of 400 mg/L) that are used as benchmarks. As such, the concentration of dissolved zinc in the project's runoff would not jeopardize the river's water quality.

(b.3) Project vs. Existing Water Quality

Prior to treatment in the proposed storm water management system, loads of all modeled constituents are predicted to increase for the project under developed conditions as compared to the existing open space scenario. The increases in pollutant loads are the result of the predicted increases in storm water runoff volumes after development due to the increased amount of impervious areas as well as changes in pollutant concentrations. After implementation of the BMPs, loads of TSS are predicted to decrease to below existing levels, but the increases in all other analyzed constituents are expected to remain.

In contrast, storm water pollutant concentrations are predicted to decrease prior to consideration of BMPs for TSS, nitrate, chloride and dissolved copper. Increased concentrations are predicted for TP, TN, lead, and dissolved zinc with development prior to treatment in the BMPs. With BMPs, however, concentrations of TP, dissolved copper and total lead are predicted to decrease, while TN and dissolved zinc concentrations are still predicted to increase slightly, but to remain well below the benchmarks.

In converting the **Table 15** concentrations to µg/L (micrograms per liter), the concentrations of dissolved zinc in the development condition would be 120 µg/L and in the developed with BMPs would be 100 µg/L; both concentrations are substantially lower than the receiving water criteria for zinc of 220 µg/L (hardness of 200 mg/L) and 390 µg/L (hardness of 400 mg/L).

The first storm events typically have higher concentrations of pollutants due to accumulation during the dry months. Storm events occurring later in the wet season will typically have lower concentrations as less time elapses between storm events and less accumulation occurs. Given the low pollutant concentrations in site runoff expected with BMP treatment, the conservative nature of the approach used for the water quality analysis, and the predicted low concentrations relative to the CTR criteria, it is not expected that there would be detrimental effects to the receiving waters from dissolved metal concentrations.

(b.4) Comparison with Water Quality Criteria

Model results are compared below to Basin Plan surface water quality objectives and CTR acute criteria for metals and inland surface water designated MUN[42] for TSS and nutrients and

[42] In 1988, the State Board adopted the Sources of Drinking Water Policy (SWRCB Resolution No. 88- 63) which

salts in order to assess the potential for post-development pollutant loads or concentrations to exceed the receiving waters standards. For results of comparison to Basin Plan surface water quality objectives, see **Table 16, Analysis of Project Development Against Basin Plan Surface Water Quality Objectives for Reach 7 of the Santa Clara River**, immediately below. Numeric water quality objectives provided in the Basin Plan that were modeled in the pollutant loading analysis include watershed specific objectives for nitrogen and chloride.

TABLE 16
ANALYSIS OF PROJECT DEVELOPMENT AGAINST BASIN PLAN SURFACE WATER QUALITY OBJECTIVES FOR REACH 7 OF THE SANTA CLARA RIVER

Parameter	Units	Existing Conditions	Proposed Conditions	Mitigated Conditions	Basin Plan Objectives[1]
Chloride	mg/L	11.2	10.0	10.0	100
Nitrogen	mg/L	2.8	3.3	3.03	5

Notes:
1) Source: Los Angeles Region Basin Plan, June 1994. Provided for informational purposes and not used in determination of "thresholds of significance".

(b.5) Total Suspended Solids and Salts

The Basin Plan requires that "Inland surface waters shall not contain suspended or settleable solids in amounts which cause a nuisance or adversely affect beneficial uses as a result of controllable water quality factors" and that "Waters shall be free of changes in turbidity that cause nuisance or adversely affect designated beneficial uses; increased in natural turbidity attributable to controllable water quality factors are limited as follows: 20% increase or less where natural turbidity is between 0 and 50 NTU; 10% increase or less where natural turbidity over 50 NTU (Basin Plan)." TSS (total suspended solids) was modeled as an indicator of turbidity, solid, suspended or settleable materials. Based on the open space scenario results, the mean annual TSS concentration in storm water runoff from the project area to receiving waters would be about 125 mg/L after implementation of the PDFs (BMPs). This concentration is well below the numerical Basin Plan Water Quality Objectives for Reach 7 of 800 mg/L.

The Basin Plan also requires that receiving waters not exceed the following concentrations of salts: 100 mg/L of chloride, 1.0 mg/L of boron, 150 mg/L of sulfates, and 5 mg/L of SAR (sodium absorption ratio). As explained above, chloride was modeled as an indicator of salts. As shown above, the mean annual chloride concentration in storm water runoff from the project area tributary to receiving waters would be about 10 mg/L without implementation of the BMPs. Again, the applicable BMPs would be expected to reduce these concentrations further, but by an amount that cannot currently be quantified. Even without quantifying the

directed the Regional Boards to add the Municipal and Domestic Supply (MUN) Beneficial Use for all water bodies not already so designated, unless they met certain exception criteria." (SARWQCB, 1995). The receiving waters in the area are not specifically designated MUN, the MU criteria are used for comparison purposes in this instance.

effectiveness of the BMPs for chloride, the expected concentration is already well below the numerical Basin Plan Water Quality objective of 100 mg/L. Moreover, during wet weather, discharge of salts is expected to decrease because the project's increase in areas of imperviousness results in less flow through soils (which add salts to runoff). Discharge of salts could increase during dry weather flows because dry weather flows often contain irrigation runoff; in that event, however, low flow would be treated in the proposed storm water BMPs.

The Basin Plan sets forth water quality objectives for organic and inorganic chemicals based on Maximum Contaminant Levels for municipal beneficial use specified in 22 CCR § 64444. These criteria apply only to receiving water bodies designated for use as domestic or municipal supply.

For these reasons, the predicted levels of TSS and salt concentrations would not likely cause a nuisance or adversely affect beneficial uses of the receiving waters or water quality.

(b.6) Nutrients

The Basin Plan includes within this category of constituents nitrogen, nitrogen as nitrate and nitrite, ammonia, phosphorous, dissolved oxygen, biochemical oxygen demand, and biostimulatory substances. The Basin Plan's narrative objectives for ammonia, dissolved oxygen, biochemical oxygen demand and biostimulatory substances are shown in **Table 17**, below. The Basin Plan does not contain numeric or narrative objectives for total phosphorus or TN. The criteria for nitrate-nitrogen and nitrite-nitrogen are 10 mg/L for nitrogen as nitrate-nitrogen plus nitrite-nitrogen, 45 mg/L as nitrate, 10 mg/L as nitrate-nitrogen, or 1 mg/L as nitrite-nitrogen, and that for nitrogen is 5 mg/L. As **Table 17** shows, the objective for ammonia is based on its oxidizing to nitrate.

The existing scenario model results predict nitrate concentrations on the order of 1.20 mg/L before implementation of BMPs, which is a reduction from existing conditions and which is well below the Basin Plan's numeric objective. The model results further predict TN concentrations of 3.3 before, and 3.0 after BMPs, which is a slight increase over existing conditions, but well below the applicable water quality criteria. Due to lack of sufficiently accurate and defensible BMP and pollutant removal data, further extrapolations and interpretations of results would have high uncertainty, and are therefore not presented.

While the Basin Plan does not contain objectives for TP for comparison with model results, model results show that, with the implementation of the BMPs, concentrations of TP would be expected to decrease as compared to existing conditions. The decreases in TP and nitrate concentrations indicate that the project would result in reducing nutrients and, correspondingly, reducing the conditions that create dissolved oxygen; further, source control BMPs would control the chemical sources that contribute to dissolved oxygen, such as anti-freeze. Finally, source control BMPs, including covering sources of food waste (such as restaurant trash, if restaurants locate at the project) and directing flows away from the sources of such waste to Continuous Deflective Separator units (CDS) or other filtering mechanisms, will control wastes that contribute to increased biochemical oxygen demand and biostimulatory substances.

(b.7) Metals

As stated above, the existing scenario results for lead are given as total lead loads and concentrations due to the limited storm water monitoring data above the laboratory detection limit available for dissolved lead from developed land uses. Sufficient data was available to model dissolved concentrations of copper and zinc.

Mean storm concentrations for the metal results are shown in **Table 17** along with CTR criteria based on hardness values of 400 mg/L and 200 mg/L. Metal results are substantially lower than the acute criteria for copper, lead, and zinc. This indicates that it is highly unlikely that metal concentrations will result in toxic effects to biota in the receiving waters, and, therefore, these concentrations will likely not impair water quality.

Table 17 presents a comprehensive discussion of all constituents of concern.

TABLE 17
ANALYSIS OF PROJECT DEVELOPMENT AGAINST HYDROLOGIC AND SURFACE WATER QUALITY OBJECTIVES (BASIN PLAN AND CTR OBJECTIVES)

Issue	Objective	Project Development
HYDROLOGY	Control post-development peak storm water runoff discharge rate, velocities and duration in Natural Drainage Systems (mimic pre-development hydrology) to prevent accelerated stream erosion and to protect stream habitat (General MS4 Permit p. 34; see also SUSMP requirements).	At project discharge locations (to the Santa Clara River) mitigation measures address downstream impacts that would potentially accelerate erosion and stream habitat. Typically, in smaller natural riverine systems, frequent discharges (on the order of the average annual and 2-year flows) dictate stream geomorphology. Extended and frequent discharges at these critical flow rates would potentially impact stream health. The project proposes water quality basins, which will capture small, frequent storms and release flows at non-erosive rates. To reduce storm flow velocities during smaller, more frequent flows (i.e., 2-year storm events) and to prevent erosion at storm water discharge points into the river, the project has incorporated energy dissipaters consisting of either rip-rap or larger standard impact type energy dissipaters would be constructed at affected storm system outlets in the River. These energy dissipaters would slow the rate of flow of runoff into the river in order to prevent erosion of the stream channel. Impacts associated with erosion and sediment deposition and streambed modification within the Santa Clara River are evaluated as a function of in-stream velocities, which are indicators for potential riverbed scouring. There would be no substantial increases in velocity during the 5- and 10-year storm events, and decreases in river velocity for the 20- to 100-year storm events. Increases in areas of the floodplain that would be subject to velocities over 4 feet/second, an indicator velocity for erosion potential, during a 2-year storm event would be minimal, localized, and would be caused only by the smallest event scenario.

TABLE 17
ANALYSIS OF PROJECT DEVELOPMENT AGAINST HYDROLOGIC AND SURFACE WATER QUALITY OBJECTIVES (BASIN PLAN AND CTR OBJECTIVES)

Issue	Objective	Project Development
Storm water runoff numeric sizing criteria	Design standards for post-construction structural or treatment control BMPs employ a variety of measures to reduce the post-project discharge of pollutants to the MEP level. The numeric sizing requirements are either volume-based or based on local flow design criteria. The volume-based criteria require that storm water runoff be infiltrated (or treated) and peak flows be controlled based on flow design criteria. There are four options for determining volume of runoff that needs to be treated (1) the 85th percentile 24-hour runoff, 2) unit basin volume to achieve 80% or more volume treatment, 3) volume produced from a 0.75 inch storm, or 4) volume based on historical 24-hour rainfall) (See SUSMP pp. 18-19 for complete description).	The proposed water quality control extended detention basins (EDBs) are preliminarily sized to meet the minimum County SUSMP criteria, based on a 0.75 inch runoff event; however, the final capacity of the basins will be determined for project runoff and would be designed to capture 80% of annual runoff, which could be more than the 0.75 inch event. The size of the facilities will be finalized during the design stage by the project engineer with the final hydrology study, which is prepared and approved at the final engineering stage and prior to issuance of a grading permit.
SURFACE WATER QUALITY		
MINERALS		
TDS	800 (mg/L) (Reach 7 of Santa Clara River Basin Plan p. 3-12)	Post project development, wet weather TDS levels are expected to decrease because of the increased area of imperviousness (less exposed soil). Due to lack of BMP removal data for this constituent, chloride levels may be used for evaluations and as an indicator of relative behavior of minerals in general. Even without taking into consideration the BMPs, post-project storm water levels of chloride were found to be lower than existing conditions. With proper implementation of the recommended structural BMPs (e.g. basins and swales), as well as source control BMPs the mitigated levels are expected to be further lowered and in compliance with the water quality objectives. Post development, minerals in dry weather flows may increase because dry weather flows often consist of irrigation runoff. However, dry weather flows will be treated in the proposed structural BMPs and are not likely to discharge untreated. Furthermore, with implementation of other recommended source control BMPs (such as education programs for proper irrigation of landscaped areas, swales and basins), no adverse

TABLE 17
ANALYSIS OF PROJECT DEVELOPMENT AGAINST HYDROLOGIC AND SURFACE WATER QUALITY OBJECTIVES (BASIN PLAN AND CTR OBJECTIVES)

Issue	Objective	Project Development
		impact on TDS would occur.
Sulfate	150 mg/L (Reach 7 of Santa Clara River Basin Plan p. 3-12)	See TDS, Chloride.
Chloride	100 mg/L (Reach 7 of Santa Clara River Basin Plan p. 3-12)	This objective would not be exceeded, as project development would be expected to generate 10.0 mg/L without the application of any BMP. With the proper application of the recommended measures, chloride levels are expected to be further lowered. See TDS.
Boron	1.0 mg/L (Reach 7 of Santa Clara River Basin Plan p. 3-12)	See TDS.
Sodium absorption ratio	5 mg/L (Reach 7 of Santa Clara River Basin Plan p. 3-12)	See TDS.
NUTRIENTS		
In General		Implementation of construction and post-construction BMPs would control chemicals (antifreeze), fertilizers and other possible sources of nutrients per General Construction Activity Storm Water Permit and General MS4 Permit Requirements. Potential source control BMPs include containment for vehicle maintenance areas during construction, chemical source control education guidelines for residents, containment BMPs for post-development vehicle maintenance land uses (such as gas stations), efficient irrigation, and an integrated fertilizer and pesticide management program for common areas. The recommended structural BMPs (detention basin, swale, and CDS units) are also expected to lower the nutrient concentrations and loads post project development because dry weather flows would not likely leave the site untreated. Quantitative assessment of pre- and post-development levels of Total Phosphorous (TP), show a reduction in concentrations post-development (mitigated conditions). Post-development nitrate levels are expected to decrease without any BMP and remain below the water quality objective (see below). While Total Nitrogen (TN) concentration is predicted to increase post-development (but lowered with the proposed BMPs), it also remains below the water quality objective (see below).
Nitrogen	5 mg/L (Reach 7 of Santa Clara River Basin Plan p. 3-12)	This objective would not be exceeded, as project development (with BMPs) would be expected to generate a Total Nitrogen (TN) concentration of 3.0 mg/L
Nitrogen (Nitrate, Nitrite)	Waters shall not exceed 10 mg/L nitrogen as nitrate-nitrogen plus nitrite-nitrogen, 45 mg/L as nitrate, 10 mg/L as nitrate-nitrogen, or 1 mg/L as nitrite-nitrogen.	In the nitrogen cycle, nitrogen forms in the order of decreasing oxidation state are: nitrate, nitrite, ammonia, and organic nitrogen. Nitrates are the most common form of nitrogen in water and are the necessary nutrients for algae and phytoplankton growth. Discharge of nitrates to surface water bodies greatly accelerates the natural process of eutrophication, causing algal blooms which ultimately lead to depleted oxygen levels and generally poor water quality.

TABLE 17
ANALYSIS OF PROJECT DEVELOPMENT AGAINST HYDROLOGIC AND SURFACE WATER QUALITY OBJECTIVES (BASIN PLAN AND CTR OBJECTIVES)

Issue	Objective	Project Development
		This objective would not be exceeded, as project development (without BMPs) would be expected to generate a Nitrate level of 1.2 mg/L, well below the standards of the objective. With proper implementation of the recommended BMPs, this level would be further reduced. Also, the expected post-development (with BMPs) total nitrogen level of 3.0 mg/L, is again well below the standard.
Ammonia	See Reach 7 of Santa Clara River Basin Plan table 3-2 (WARM) for one-hour average concentrations for a range of pH and temperatures (as an example at 10 degrees C and pH of 7, total ammonia concentrations should be 25 mg/L).	Ammonia is not a pollutant typically associated with urban development of the type proposed, but rather is more often associated with discharges from point sources such a treatment plants. Ammonia is easily diluted and converted to nitrate. Both existing and post-project Nitrate levels are well below water quality objectives, making it unlikely that any ammonia present in storm water could form nitrate sufficient to exceed the applicable water quality objectives. See Nutrients, In General.
Phosphorous	No criteria	Based on modeling, the post-development (with BMPs) TP concentrations and loads are expected to be lower than existing conditions.
Dissolved oxygen (DO)	As a minimum, the mean annual DO concentration greater than 7 mg/L; no single determination less than 5.0 mg/L. For WARM designations, the DO concentrations shall not be depressed below 5 mg/L as a result of waste discharge (Basin Plan p.3-11).	Adequate DO levels are required to support aquatic life. Depressed levels may lead to anaerobic conditions. Source control BMPs would control chemical sources contributing to DO depressions (e.g., antifreeze and fertilizer) (See Nutrients, In General). Modeling shows TP and Nitrate will be reduced from existing conditions. TN will be well under water quality objectives. Therefore, it is expected that the project (with BMPs) will not adversely impact water quality DO levels and will be in compliance with the regulatory standards. See Nutrients, In General.
BOD (Biochemical oxygen demand)	Waters shall be free of substances that result in increase in BOD which adversely affects designated beneficial uses (Basin Plan).	Source control BMPs, including covering sources of food waste such as restaurant trash and commercial loading areas and directing flows from restaurants and commercial loading areas to CDS units or other filtering mechanisms, will control wastes that contribute to increased BOD. See, also anticipated post-development nutrient reductions and compliance with the regulatory objectives. See also, General, DO.

TABLE 17
ANALYSIS OF PROJECT DEVELOPMENT AGAINST HYDROLOGIC AND SURFACE WATER QUALITY OBJECTIVES (BASIN PLAN AND CTR OBJECTIVES)

Issue	Objective	Project Development
Biostimulatory substances	Biostimulatory substances include excess nutrients and other compounds that stimulate aquatic growth. Waters shall not contain biostimulatory substances in concentrations that promote aquatic growth to the extent that such growth causes nuisance of adversely affects designated beneficial uses (Basin Plan).	With proper application of the recommended BMPs (source control and structural) the expected nutrients levels are expected to be below the water quality objectives. No adverse effect relating to these substances is expected.
TOXICS		
Toxicity	Waters maintained free of toxic substances in concentrations toxic to human, plant, animal, or aquatic life; survival of aquatic life in surface waters subject to waste discharge or other uncontrollable water quality factors shall not be less than for the same waterbody in areas unaffected by waste discharge; no acute toxicity in ambient waters including mixing zones; no chronic toxicity in ambient waters outside mixing zones (Basin Plan p.3-16).	Toxics typically associated with urban development of the type proposed may include heavy metals, including copper, lead and zinc, associated with the design elements and car operations, as well as pesticides used in landscaping applications. During construction of the project, synthetic organic compounds (such as adhesives, cleaners, sealants ad solvents), pesticides, trace metals as well as other waste products (e.g. paint, concrete mix, solid/sanitary wastes) could have the potential to create to adverse toxic conditions. However, with proper implementation of the recommended source-control and structural BMPs, these adverse impacts will likely be prevented. Quantitative analysis indicates that post-development metals concentrations should be well below CTR criteria. Construction and post-construction BMPs (both structural and source control) would be implemented to control heavy metals and pesticides in storm water runoff per the requirements of the General Construction Activity Storm Water Permit and the General MS4 Permit. Pesticides, and other applied chemicals would be controlled through source control BMPs, including efficient irrigation, integrated fertilizer and pesticide application and management plan, restrictions on residential design elements (such as copper downspouts), as well as structural measures (detention basin, swale and CDS units) which will provide treatment of both wet weather and dry weather flows. Recent bans on most urban use of chlorpyrifos and diazinon will also reduce toxics (pesticides). Furthermore, A SWPPP will be developed prior to the construction project and implemented to control construction related impacts from the project. The key elements of the SWPPP will address: source identification, erosion control, stabilization, sediment control, post-construction BMPs and non-storm water management, as well as "good housekeeping"/waste management and control, maintenance, repair training and inspection issues. With the proper implementation of the SWPPP's recommended source control and structural BMPs, toxics are not expected to be

TABLE 17
ANALYSIS OF PROJECT DEVELOPMENT AGAINST HYDROLOGIC AND SURFACE WATER QUALITY OBJECTIVES (BASIN PLAN AND CTR OBJECTIVES)

Issue	Objective	Project Development
		discharged from the construction site.
Copper (acute)	27 µg/L (hardness value 200 mg/L) 52 µg/L (hardness value 400 mg/L)	Post development dissolved copper is predicted to be 20 µg/L, below the acute CTR criteria (at both hardness levels). In comparisons with the CTR objectives, the acute levels were considered due to the episodic nature of storm events. Heavy metal toxicity is usually much lower in hard water than in soft water. The CTR criteria at a 200 mg/L hardness was primarily used for comparison with model results. The 200 mg/L hardness is somewhat larger than the mean land use specific runoff range reported by LA County (25 to 185 mg/L), but much lower than the monitored average value of 408 mg/L for the area (Geosyntec, 2002). Therefore, the 200 mg/L assumption is believed to be conservative as the CTR criteria are applicable to receiving waters only (not storm water runoff). See Toxicity.
Lead (acute)	200 µg/L (hardness value 200 mg/L) 480 µg/L (hardness value 400 mg/L)	Post development dissolved lead is predicted to be 5.6 µg/L, well below the acute CTR criteria (at both hardness levels). In comparisons with the CTR objectives, the acute levels are considered due to the episodic nature of storm events. Heavy metal toxicity is usually much lower in hard water than in soft water. The CTR criteria at a 200 mg/L hardness was primarily used for comparison with model results. The 200 mg/L hardness is somewhat larger than the mean land use specific runoff range reported by LA County (25 to 185 mg/L), but much lower than the monitored average value of 408 mg/L for the area (Geosyntec, 2002). Therefore, the 200 mg/L assumption is believed to be conservative as the CTR criteria are applicable to receiving waters only (not storm water runoff). See Toxicity.
Zinc (acute)	220 µg/L (hardness value 200 mg/L) 390 µg/L (hardness value 400 mg/L)	Post development dissolved lead is predicted to be 103 µg/L, well below the acute CTR criteria (at both hardness levels). In comparisons with the CTR objectives, the acute levels are considered due to the episodic nature of storm events. Heavy metal toxicity is usually much lower in hard water than in soft water. The CTR criteria at a 200 mg/L hardness was primarily used for comparison with model results. The 200 mg/L hardness is somewhat larger than the mean land use specific runoff range reported by LA County (25 to 185 mg/L), but much lower than the monitored average value of 408 mg/L for the area (Geosyntec, 2002). Therefore, the 200 mg/L assumption is believed to be conservative as the CTR criteria are applicable to receiving waters only (not storm water runoff). See Toxicity.
Chemical Constituents	MUN designated waters shall not contain concentrations of chemicals in excess of the limits specified in the Title 22 CCR	With proper implementation of the recommended BMPs (both source control and structural) the chemical constituents in storm water discharged from the site will be controlled per General MS4 and General Construction Activity Storm Water Permit requirements. The heavy metals

TABLE 17
ANALYSIS OF PROJECT DEVELOPMENT AGAINST HYDROLOGIC AND SURFACE WATER QUALITY OBJECTIVES (BASIN PLAN AND CTR OBJECTIVES)

Issue	Objective	Project Development
	(for inorganic and organic chemicals and fluoride) (Basin Plan p.3-8).	compounds are anticipated to be well below CTR criteria and the nitrogen compounds well below the Basin Plan standards. As a result, no adverse effect from these chemical constituents is anticipated as a result of the project. See Toxicity
Bioaccumulation	Toxic pollutants shall not be present at levels that will bioaccumulate in aquatic life to levels which are harmful to aquatic life or human health (Basin Plan p.3-8).	With proper implementation of the recommended BMPs (both source control and structural) toxics in storm water discharged from the site will be controlled per General MS4 and General Construction Activity Storm Water Permit requirements. Heavy metals are anticipated to be well below CTR criteria. As a result, no adverse effect on bioaccumulation is anticipated as a result of the project. See Toxicity.
Pesticides	Waters shall not contain concentrations of pesticides in excess of limiting concentrations in 22 CCR § 64444 (organics) (MUN) (Basin Plan p.3-15 and Table 3-7).	When properly implemented and designed, the recommended source control and structural BMPs will control pesticides and other toxics in storm water per General MS4 and General Construction Activity Storm Water Permit requirements. Heavy metals are anticipated to be well below CTR criteria. With the proper implementation of the recommended BMPs (both source control and structural BMPs, no adverse effect on bioaccumulation is anticipated as a result of the project. Recent bans on most urban use of chlorpyrifos and diazinon will also reduce toxics (pesticides). See Toxicity.
SOLID, SUSPENDED OR SETTLEABLE MATERIALS		
Turbidity	Waters shall be free of changes in turbidity that cause nuisance or adversely affect designated beneficial uses; increased in natural turbidity attributable to controllable water quality factors are limited as follows: 20% increase or less where natural turbidity is between 0 and 50 NTU; 10% increase or less where natural turbidity over 50 NTU (Basin Plan p.3-17).	Insoluble particles of soil, as well as other materials impede the passage of light through water by scattering and absorbing the rays (reference: Hammer M, 1931, "Water and Waste-Water Technology"). Reduction in TSS, which is primarily reduction of sediment in storm water, will result in a reduction in turbidity. Therefore, the 42 % reduction in TSS levels (see Solids, below) will contribute to lower turbidity in the post-developed conditions. With project development no adverse impacts are expected. However, during the construction project, the grading and other soil disturbance activities have the potential to cause erosion and sedimentation and therefore release of solids (suspended or settleable). Without any controls, this could contribute to adverse turbidities. However, with the proper implementation of the SWPPP and the recommended erosion and sediment control practices, these potential impacts are not expected to occur.
Solid, suspended, or settleable materials (including TSS)	Waters shall not contain suspended or settleable material in concentrations that cause nuisance or adversely affect	With project development (without BMPs), less TSS may be expected from the site (157 v. 217 mg/L). With the proper implementation of the BMPs, an even further reduction (about 42%) is expected as compared to existing conditions (125 v. 217 mg/L). However, during the

TABLE 17
ANALYSIS OF PROJECT DEVELOPMENT AGAINST HYDROLOGIC AND SURFACE WATER QUALITY OBJECTIVES (BASIN PLAN AND CTR OBJECTIVES)

Issue	Objective	Project Development
	designated beneficial uses (Basin Plan p.3-16).	construction project, the grading and other soil disturbance activities may cause erosion and sedimentation and therefore release of solids (suspended or settleable). Without any controls, this may attribute cause adverse conditions. However, with the proper implementation of the SWPPP and the recommended erosion and sediment control practices, these impacts are not expected to be appreciable.
PATHOGENS/BACTERIA		Changes in concentrations of pathogens associated with urban development are difficult to evaluate for a number of reasons. Because holding times for bacterial samples are necessarily short, most storm water programs do not collect flow-weighted composite samples that potentially could produce reliable statistical estimates of pathogen concentrations. Measurements of indicator organisms are not necessarily reliable indicators of viable pathogenic viruses, bacteria or protozoa. Moreover, there are numerous sources of pathogens, including birds and other wildlife, as well as domesticated animals and pets. Open space areas can have high levels of coliform associated with wildlife sources, but are typically lower in pathogen concentrations than urban land uses. Development of the project site would reduce the natural sources of pathogens, but without source control BMPs would increase pet waste sources. Septic tanks would not be used in the project and illicit sewer connections would not be expected, eliminating a major urban source of pathogens in runoff. The project will require source control and structural BMPs in compliance with the General MS4 and General Construction Activity Storm Water Permits, including pet waste collection bags, pet waste educational materials, adequate connection and maintenance of sewer lines, and sediment removal BMPs, such as WQBs. With proper implementation of the recommended BMPs, the post-development bacteria concentrations are anticipated to be lowered. However, due to lack of reliable data for modeling, it is not possible to reliably quantify the expected EMCs (and loads) for bacteria.
E. coli density	Less than 126/100 ML (geometric mean limit) (REC-1) (Basin Plan amendment)	See pathogens/bacteria general
E. coli density	Less than 235/100 ML (single sample limit) (REC-1) (Basin Plan amendment)	See pathogens/bacteria general
Fecal coliform density	Less than 200/100mL (geometric mean limit) (REC-1) (Basin Plan amendment)	See pathogens/bacteria general
Fecal coliform density	Less than 400/100mL (single sample limit) (REC-1) (Basin Plan amendment)	See pathogens/bacteria general
QUALITATIVE BMP-BASED		

TABLE 17
ANALYSIS OF PROJECT DEVELOPMENT AGAINST HYDROLOGIC AND SURFACE WATER QUALITY OBJECTIVES (BASIN PLAN AND CTR OBJECTIVES)

Issue	Objective	Project Development
Chlorine, total residual	Shall not be present in surface water discharges at concentrations exceeding 0.1 mg/L; shall not persist in receiving waters at any concentration that causes impairment of designated beneficial uses (Basin Plan p.3-9).	The main typical source of chlorine is the disinfection of wastewaters with chlorine. The proposed land uses are not expected to produce chlorine-type wastes. However, construction and post-development source control BMPs would be employed in compliance with the General MS4 and General Construction Activity Storm Water Permits to address possible sources of chlorine discharge. BMPs will include educational materials for residents prohibiting draining of pools to storm drains as well as prohibitions for building contractors precluding any discharge of test water for water pipes and sprinkler systems to storm drain systems. Non-storm water management measures will be implemented during the construction project.
MBAS (methylene blue activated substances), such as detergents and other anionic surfactants	Less than or equal to 0.5 mg/L (MUN) (Basin Plan p.3-11)	MBAS, related to presence of detergents in runoff, may be incidentally associated with new urban development, but more commonly with point sources such as treatment plants. The project will have no planned illicit sewer connections or septic tanks, eliminating domestic sources from contributing to this pollution problem. Further, the project would employ source control and structural BMPs consistent with the General MS4 and General Construction Activity Storm Water Permit to control wash water from various sources (e.g., educational materials for homeowners regarding elimination of discharges from car washing to the storm drain system, control of construction vehicle wash water, control of construction street and pavement washing activities).
Floating materials	Waters shall not contain floating materials in concentrations that cause nuisance or adversely affect designated beneficial uses (Basin Plan p.3-9).	Floating materials including trash and debris controlled through source control BMPs (education and outreach programs, street sweeping) as well as structural BMPs (CDS, detention basins, drainage inlet screens; as well possible use of catch basin inserts).
Oil & grease	Waters shall not contain oils, greases, waxes or other materials in concentrations that result in a visible film or coating on the surface of the water or on objects in the water, that cause nuisance, or that otherwise adversely affect designated beneficial uses (Basin Plan p. 3-11).	The structural control measures proposed for this project (detention basin, swale and CDS units with oil-absorbent materials), when properly designed and maintained have a high potential for removing oil and grease. Additional measures may include storm water filters and clarifiers which also have very good removal capabilities. In addition, source control measures are proposed to control excessive concentrations during and post-construction of the project. With the proper implementation of these measures, no adverse impacts are expected.
CONSTITUENTS NOT TYPICALLY ASSOCIATED WITH URBAN DEVELOPMENT-BMP CONTROLLED		

TABLE 17
ANALYSIS OF PROJECT DEVELOPMENT AGAINST HYDROLOGIC AND SURFACE WATER QUALITY OBJECTIVES (BASIN PLAN AND CTR OBJECTIVES)

Issue	**Objective**	**Project Development**
pH	Shall not be depressed below 6.5 or raised above 8.5 as a result of waste discharges; ambient pH levels shall not be changed more than 0.5 units from natural conditions as a result of waste discharge (Basin Plan p.3-15).	BMPs in accordance with General MS4 and General Construction Activity Storm Water Permits will control discharge of the few constituents associated with urban development that could that be associated with changes in pH. For example, construction BMPs to control applications involving fresh concrete and lime would be included in the SWPPP as well as non-visible pollutant monitoring in cases where discharge might be expected. Post-development BMPs include restrictions on residential design features (metal roofs, copper features). Post development features, such as cured concrete storm drains and WQBs can be expected to provide substantial buffering for any post-development high pH storm water flows.
PCBs	Pass-through or uncontrollable discharge limited to 70 pg/L 30-day average (human health) and 14 mg/L daily average (aquatic life); purposeful discharge prohibited (Basin Plan p.3-15).	The project would not include PCB-producing uses. Paving would stabilize soils that may contain pre-existing PCBs (from historical uses); structural BMPs such as detention basins and swales trap particulate matter. On this basis, no adverse impacts are expected.
Temperature	Water temperature shall not be altered by greater than 5 degrees F above natural temperature; natural receiving water temperature shall not be altered unless it can be demonstrated that designated beneficial uses not adversely affected (Basin Plan p.3-16).	The Santa Clara River has only episodic flows primarily during the "rainy" season during and immediately after storm events of sufficient magnitude to cause flows. With BMPs, the proposed project land uses would likely not substantially increase temperature of storm water runoff.
Taste and Odor	Waters shall not contain taste or odor-producing substances in concentrations that impart undesirable tastes or odors to fish/edible aquatic flesh, to adversely affect beneficial uses and cause nuisance (Basin Plan, p.3-16).	There are no known taste- or odor-producing substances expected from the proposed land uses at the project site and/or during the construction project. Even so, the recommended source control and structural BMPs would likely control substances that may substantially change taste and odor.
Radioactive Substances	Waters designated as MUN shall not contain concentrations of radionuclides in excess of Title 22 CCR (Basin Plan	In addition to natural sources, radioactive substances are typically generated from mining and/or industrial activities. Based on the proposed land uses, radioactive substances are not expected from the project site.

TABLE 17
ANALYSIS OF PROJECT DEVELOPMENT AGAINST HYDROLOGIC AND SURFACE WATER QUALITY OBJECTIVES (BASIN PLAN AND CTR OBJECTIVES)

Issue	Objective	Project Development
	p.3-15).	
RIVER PLAN CONSTITUENTS		
Exotic vegetation	Exotic vegetation shall not be introduced around stream courses to the extent that such growth causes nuisance or adversely affects designated beneficial uses (Basin Plan p.3-9).	Meets Natural River Management Plan requirements.
Wetlands hydrology	Natural hydrologic conditions necessary to support physical, chemical and biological characteristics present in wetlands shall be protected to prevent significant adverse effects on a variety of parameters (Basin Plan p.3-17).	Meets Natural River Management Plan requirements
Wetlands habitat	Existing habitats and associated populations of wetlands fauna and flora shall be maintained (Basin Plan p.3-17).	Meets Natural River Management Plan requirements

3.2.3 Qualitative Assessment of Constituents of Concern

(a) Constituents of Concern-Qualitative

Many constituents of concern, including sulfates, boron, SAR, pathogens, pesticides, and hydrocarbons, as discussed below, are not easily modeled due to limited or non-existent monitoring data, difficulty in measuring pollutant concentrations, or due to pollutant concentrations that are below reporting limits.

(a.1) Sulfates, Boron and SAR (Salts)

As stated previously, during wet weather, discharge of salts would be expected to decrease under post-development conditions because the project would increase the percent imperviousness of the site, resulting in less flow through soils. Although discharge of salts could increase during dry weather flows, because dry weather flows often contain irrigation runoff, low flow will be treated in the proposed storm water structural BMPs and would not, therefore, discharge to the receiving waters. For these reasons, the concentrations of these constituents would likely not cause a nuisance or adversely affect beneficial uses of the receiving waters or water quality.

(a.2) Ammonia (Nutrient)

Ammonia is typically found in low concentrations in runoff, as it is easily diluted and oxidized to nitrate. As shown by the modeling, the nitrate concentration in project runoff is expected to decrease even before the effect of BMPs is taken into consideration. Therefore, concentrations of ammonia in project runoff would likely not cause a nuisance or adversely affect beneficial uses of the receiving waters or water quality.

(a.3) Pathogens

Pathogens in the Santa Clara River may adversely affect the potential and existing designated beneficial uses of the river, particularly water contact recreation. Typical sources of pathogens in urban storm water runoff include pet wastes, improperly functioning septic tanks, and illicit sewer connections to the storm drain system. Other sources of pathogens are primarily due to non-domestic animal wastes, particularly waterfowl.

The change in concentrations of pathogens associated with development of the site compared to the existing open space or agriculture uses is difficult to evaluate for a number of reasons. Measurements of indicator organisms are not necessarily reliable indicators of viable pathogenic viruses, bacteria, or protozoa. Moreover, there are numerous sources of pathogens including birds and other wildlife, as well as domesticated animals and pets. Open space and agriculture areas can potentially have high levels of coliform associated with this type of land use due to wildlife sources, but are typically lower in pathogen concentration than urban land uses. Also, because holding times for bacterial samples are necessarily short, most storm water programs do not collect flow-weighted composite samples that potentially could produce reliable statistical estimates of pathogen concentrations. The development of the project site would reduce the natural sources of pathogens by reducing use of these areas by wildlife. Septic tanks would not be used in the project, eliminating a potential source of pathogens in runoff. In addition, illicit sewer connections would not be permitted in the new development areas.

While the conversion of open spaces or agriculture to urban development may result in some increase in pathogens levels, source and treatment control BMPs would help control coliform levels. Additional BMPs that contribute to control of pathogens to be employed in the project include: availability of pet waste collection bags ("mutt mitts"), distribution of pet waste educational material, and adequate connection and maintenance of sanitary sewer lines, as well as maintenance of BMPs for removal of bacteria and all pollutants associated with sediment in the water quality basins. This occurs through periodic removal and proper disposal of accumulated sediments in the water quality basins.

(a.4) Pesticides and Other Toxics

Toxics typically associated with urban development of the type proposed may include heavy metals, including copper, lead and zinc (discussed above), pesticides used in landscaping applications, and other chemical constituents.

Pesticide sampling data are unavailable for the soils of the planned construction areas of the proposed project site. The open space areas proposed for residential development are in a natural condition and there is no knowledge of maintenance with pesticides in recent years. For the post-development condition, pesticides would be used to maintain landscaping. Any pesticide use in the project areas would be required to comply with the BMPs relevant to chemical application.

The U.S. EPA has recently banned the pesticides diazinon and chlorpyrifos (commonly used urban pesticides) for most urban applications (U.S. EPA, June, 2002)[43]. These pesticides will not be used for landscape maintenance in the post-development conditions of the project. Source control measures such as education programs for owners, occupants, and employees in the proper application, storage, and disposal of pesticides are the most promising strategies for

[43] Changes to the use of chlorpyrifos include reductions in the residue tolerances for agricultural use, phases out nearly all indoor and outdoor residential uses, and also stops non-residential uses where children may be exposed. In Orange County, residential use accounts for around 90% of total chlorpyrifos (USEPA, June 2002). Retail sales of chlorpyrifos were stopped by December 31, 2001, and structural (e.g. construction) uses will be phased out by December 31, 2005. Some continued uses will be allowed, for example public health use for fire ant eradication and mosquito control will be permitted by professionals.

Permissible uses of diazinon will also be restricted. All indoor uses are prohibited (as of 12/2002) and retailers were required to end sales for indoor use on December, 2002. All outdoor non-agricultural uses will be phased out by December 31, 2004. Therefore it is likely that the EPA agreement will eliminate most of the use of diazinon within the area. The use of diazinon for many agricultural crops has been eliminated (U.S. EPA 2001), while some use of this chemical will continue to be permitted for some agricultural activities.

controlling the pesticides that will be used post-development and are recommended for both the residential and commercial portions of the project. Structural controls are typically not as effective due to the persistent nature of many pesticides; also these compounds generally exhibit varied potential for biodegradation. Some pesticides are relatively insoluble in water and therefore tend to adsorb to the surfaces of sediment, which may settle out of the water column in the water quality basins. Sedimentation should achieve some removal of these pesticides from storm water in the BMPs.

While pesticides are subject to degradation, they vary in how long they maintain their ability to eradicate pests. Some break down almost immediately into nontoxic by-products, while others can remain active for longer periods of time. While pesticides that degrade rapidly are less likely to adversely affect non-targeted organisms, in some instances it may be more advantageous to apply longer lasting pesticides if it results in fewer applications or smaller amounts of pesticide use. While some increase in pesticide use is likely to occur as the result of development due to maintenance of landscaped areas particularly in the residential portions of the development, careful selection, storage and application of these chemicals will help prevent water quality impacts from occurring. With appropriate management and storage of pesticides, no adverse impacts are expected to occur with development.

Pesticides from the historical agricultural use of the site would decrease in site runoff with site development. Any residual agricultural pesticides on the site would not enter site runoff because the soils containing them would be overcovered with impervious surfaces or landscaping that would cover or stabilize sediments.

With proper implementation of the recommended BMPs (both source control and structural), the chemical constituents in storm water discharged from the site will be controlled as required pursuant to the General MS4 and General Construction Activity Storm Water Permits. As a result, no adverse effect from chemical constituents or from bioaccumulation is anticipated as a result of the project.

With such controls over the use of pesticides, with the metals below CTR criteria, and with the proper implementation of BMPs, including efficient irrigation, an integrated fertilizer and pesticide management plan, restrictions on residential design features (such as copper downspouts), BMPs to treat dry weather flows, and bans on substances such as chlorpyrifos and diazinon, water quality would likely not be adversely impacted by toxic substances.

(a.5) Hydrocarbons

Various forms of hydrocarbons (oil and grease) are common in urban runoff; however, these constituents are difficult to measure and are typically measured with grab samples, making it difficult to develop reliable EMCs for modeling. Based on this consideration, hydrocarbons were not modeled but are addressed qualitatively.

Hydrocarbons are a broad class of compounds, most of which are non-toxic. Hydrocarbons are hydrophobic (low solubility in water), have the potential to volatilize, and most forms are biodegradable. A subset of hydrocarbons, Polynuclear Aromatic Hydrocarbons (PAHs), can be toxic depending on the concentration levels, exposure history and sensitivity of the receptor organisms. Of particular concern are those PAHs compounds associated with transportation related combustion products.

The concentration of hydrocarbons is expected to increase slightly under post-development project conditions with treatment of storm water runoff in the BMPs. Because of the nature of the development (primarily residential and limited commercial), the major source of oil and grease would be from roads, driveways and parking areas.

The BMPs are expected to prevent hydrocarbons from reaching levels of concern in storm water runoff discharged from the project site. The proposed structural BMPs (PDFs) are expected to remove considerable amounts of these pollutants from site runoff prior to its discharge into the river. CDS units with oil absorbent pellets placed in the solids containment chamber to promote higher removals of free oil and grease are recommended for the site. Biofiltration swales and water quality basins would also reduce oil and grease concentrations in the runoff and are included in the project description. Although vehicle emissions and leaks are the primary source of hydrocarbons in urban areas, it is anticipated that the majority of vehicles in the proposed development will in general be well maintained and newer models which will also help to limit emissions and leaks.

One source of information on PAH levels in urban runoff is the Los Angeles County Monitoring Program. Los Angeles County conducted PAH analyses on 27 storm water samples from a variety of land uses in the period 1994-2000. For those land uses where sufficient samples were taken and were above detection levels to estimate statistics, the mean concentrations of individual PAH compounds ranged from 0.04 to 0.83 µg/L. The reported means were less than acute toxicity criteria available from the literature (Suter and Tsao, 1996). Moreover, the Los Angeles County data do not account for any treatment, whereas the treatment in the project BMPs should result in a reduction in hydrocarbon concentrations. This makes it very unlikely that impacts will occur to the receiving water due to hydrocarbon loads or concentrations.

(a.6) Constituents Addressed Through BMP-Based Objectives and the Natural River Management Plan

The Basin Plan also contains a category of constituents with BMP-based objectives, also listed in **Table 17**.

The project does not include any known chlorine-producing sources, and the project SUSMP would prohibit draining swimming pools or test pipes to storm drains. Methylene blue activated substances, such as detergents and other anionic surfactants would be controlled through source control BMPs; the project would not include septic tanks. The ambient pH of the receiving waters would likely not be altered by the project's implementation of SWPPP BMPs controlling runoff from fresh concrete and lime, and through source controls including restrictions on residential design features (banning metal roofs and exposed copper). The project would not include PCB-producing uses; and paving would stabilize soils that may currently contain PCBs. Ambient temperature levels in the receiving waters would likely not be appreciably affected by the project, as project use is not expected to increase water temperature; floating materials would be controlled through source control BMPs and structural BMPs, including HSS/GSRDs (CDS units), and by covering public trash areas. Additionally, the project is not expected to generate taste/odor altering or radioactive substances. Finally, the project will protect the Santa Clara River environment as required by the River Plan, including removal of exotic vegetation and preservation of natural hydrologic conditions and existing habitats.

(b) Volume, Velocity and Discharge Duration

The Los Angeles MS4 Permit notes that increased volume, velocity, and discharge duration of storm water runoff from developed areas potentially accelerate downstream erosion and impair stream habitat. As a result, the Permit stipulates that "Permittees shall control post-peak storm water runoff in Natural Drainage Systems to prevent accelerated stream erosion and protect stream habitat" and that Permittees must implement numerical criteria though a Hydromodification Control Plan. Because this plan has not yet been developed, the following discussion supports the conclusion that there are no adverse downstream impacts potentially accelerating erosion and stream habitat.

Noticeable declines in biological integrity occur where approximately 10 percent of the natural watershed is converted from natural to impervious surfaces. (Center for Watershed Protection, 2000) Riverpark project represents less than 0.1% of the Santa Clara River Watershed, and therefore is not a major contributor to potential downstream impacts.

In smaller natural riverine systems, frequent discharges (on the order of the average annual and 2-year flows) dictate stream geomorphology. Extended and frequent discharges at these critical flow rates would potentially impact stream health. The proposed water quality mitigation measures include water quality basins, which capture small, frequent storms and release flows at non-erosive rates. Furthermore, the Santa Clara River is too large to be greatly impacted by discharges from the Riverpark project; at 1.28 square miles, the Riverpark project impacts less than 0.1% of the 1,634-sq. mile Santa Clara River watershed.

Without the PDFs, there would have been the potential for highly localized erosion at flow outlets. However, energy dissipation facilities are included as BMPs in the project design to reduce any potential impacts.

(c) Non-Storm Flows (Dry Weather Flows)

In urban areas with land uses similar to River Park's proposed development plan, dry weather (or nuisance) flows are typically due to activities such as irrigation of landscaped areas and/or car and street washing. The land uses proposed for the River Park development are mostly single family and apartment type residential uses, streets, open space/park areas, and small areas of commercial uses. Of the overall 695.4 acre development, approximately 445.8 acres are dedicated to the City of Santa Clarita and the remaining 249.6 acres represent the actual River Park development (which includes open spaces).

Sediment mobilization in urban areas is generally associated with storm water events and associated rainfall intensity. Dry weather flows are typically low in sediment because the flows are relatively slow, which causes sediment to settle out or to be filtered out by algae and other plants growing in the receiving waters. As a result, pollutants associated with suspended solids (e.g., phosphorous, some trace metals, and some pesticides) are typically found in very low concentrations in dry weather flows.

Geosyntec (2002) has estimated that dry weather flow contributions from urbanized areas are about 2.93×10^{-4} cfs/acre. Using this rough estimate, it could be expected that as much as 0.15 acre-feet of dry weather flow could be generated on a daily basis from the River Park urbanized areas. The proposed structural BMPs are also proposed to be designed to accommodate for the treatment of dry weather flows for the River Park development. Source control BMPs (irrigation practices, pool draining, etc.) are also important for mitigation of dry weather flows.

(d) Groundwater Quality

The concern for groundwater quality impacts arises largely from the potential for the infiltration of water contaminated with pollutants associated with urban runoff. Of particular concern is the infiltration of storm water collected and treated in water quality basins and in other types of water quality controls (e.g., landscaped areas used for bioretention). Research conducted on the effects on groundwater from storm water infiltration is cited in the MS4 permit and indicates that the potential for contamination is strongly dependent on a number of factors including the local hydrogeology and the chemical characteristics of the pollutants of concern.

4 CUMULATIVE PROJECT CONDITIONS

Without mitigation, the cumulative effects on water quality from future development within the Santa Clara River watershed could be adverse. The nature of the land uses involved, the manner in which runoff is controlled prior to discharge pursuant to the requirements of the controlling jurisdiction (i.e., LACDPW and Ventura County Flood Control District), and the manner in which urban wastes are managed and prevented from becoming part of the storm water runoff would all serve to lessen any such cumulative water quality impacts.

It has been estimated that approximately 4 percent of that portion of the Santa Clara River watershed found in Los Angeles County would be developed and approximately 2.5 percent of the portion of the watershed found in Ventura County would be developed.[44] Each development project in the Santa Clara River watershed (1,634 sq. miles) will be of varying character and size, will have its own unique topographic and geologic characteristics, will have flood impacts that will be unique to the geologic/soil conditions of the site and the tributary

[44] Alex Sheydayi, Deputy Director, Ventura County Public Works Agency, Flood Control Department, statement made at the Santa Clara River Enhancement and Management Plan Steering Committee Meeting, May 30, 1995.

watershed in which it is located, and will be subject to the development criteria of the jurisdiction in which it is located.

All development within the portion of the watershed of the Santa Clara River located in Los Angeles County, including that within the City of Santa Clarita, is required to comply with the LACFWD SUSMP requirements to protect water quality and the beneficial uses of receiving waters. As MS4 Permittees, the County and City are required through their project approval processes to ensure that water quality mitigation measures are implemented to the MEP and do not exceed water quality objectives. Therefore, as a result of compliance, overall storm runoff discharge quantities from the watershed under post-development runoff conditions would likely not result in adverse impacts to the river environment.

The project would increase storm water runoff volumes in the watershed by increasing impervious surfaces at the site; however, as discussed in **Flood Technical Report**, potentially erosive flows, volumes, and durations are not expected to increase substantially. Moreover, as discussed above, water quality of the runoff from the site could be expected generally to improve over the existing conditions, given the historical conditions in the agricultural areas.

Those constituents whose concentrations and/or loading in runoff may increase with the proposed development are not expected to be substantial and are anticipated to be controlled effectively through the use of project-specific BMPs (PDFs). With source control and treatment control measures in place, dry weather flows are expected to remain similar to current conditions.

Regional plans and programs, including, without limitation, the Basin Plan and the General MS4 Permit are designed to preserve and enhance water quality and protect the beneficial uses of all regional waters within Region 4. The Basin Plan and the General MS4 Permit include narrative and numerical water quality objectives for several constituents and parameters that must be attained or maintained to protect the designated beneficial uses of the river and its tributaries. Through such means, the RWQCBLAR regulates water quality in Los Angeles and Ventura Counties, including the Santa Clara River watershed, and as previously stated, it is the responsibility of the local jurisdictions (i.e., the City of Santa Clarita, LACDPW Watershed Management Division and the Ventura County Flood Control District) to ensure that future development within the watershed would comply with the same or similar types of water quality requirements as the proposed project. Therefore, with these requirements in place, no cumulative water quality impacts are anticipated.

Conclusion

In conclusion, all cumulative projects within the Santa Clara River watershed are required to meet the same or similar general water quality requirements as the proposed project, and other site-specific requirements that the LACDPW Flood Control Division, Watershed Management Division, and the RWQCBLAR would specifically identify for those projects. These requirements serve to avoid the potential for water quality impacts in the Santa Clara River and its tributaries.

APPENDIX

APPENDIX A MS4 PERMIT

ATTACHMENT A
LIST OF PERMITTEES
BY
WATERSHED MANAGEMENT AREAS

<u>Santa Monica Bay</u>

<u>Malibu Creek and Other Rural</u>
Agoura Hills
*Calabasas
Los Angeles County Flood Control
Los Angeles County
Malibu
Westlake Village

<u>Ballona Creek and Other Urban</u>
Beverly Hills
Culver City
El Segundo
Hermosa Beach
Los Angeles (City of)
Los Angeles County Flood Control
Los Angeles (County of)
Manhattan Beach
Palos Verdes Estates
Rancho Palos Verdes
Redondo Beach
Rolling Hills
Rolling Hills Estates

*Santa Monica
West Hollywood

<u>Dominguez Channel/ Los Angeles Harbor Drainage</u>
Carson
Gardena
Hawthorne
Inglewood
Lawndale
Lomita
Los Angeles (City of)
Los Angeles County Flood Control

Los Angeles (County of)
*Torrance

<u>Los Angeles River</u>
Alhambra
Arcadia
Bell
Bell Gardens
Burbank
Commerce
Compton
Cudahy
El Monte
*Glendale
Hidden Hills
Huntington Park
La Canada Flintridge
Los Angeles (City of)
Los Angeles County Flood Control
Los Angeles (County of)
Lynwood
Maywood
Monrovia
Montebello
Monterey Park
Paramount

Pasadena
Rosemead
San Fernando
San Gabriel
San Marino
Sierra Madre
Signal Hill
South El Monte
South Gate
South Pasadena
Temple City
Vernon

<u>San Gabriel River</u>
Artesia
Azusa
Baldwin Park
Bellflower
Bradbury
Cerritos
Claremont
Covina
Diamond Bar
Downey
Duarte
Glendora
Hawaiian Gardens
Industry
Irwindale
La Habra Heights
La Mirada
La Puente
La Verne
Lakewood
*Long Beach[1]
Los Angeles County Flood Control
Los Angeles (County of)
Norwalk
Pomona
Pico Rivera
San Dimas
Santa Fe Springs
Walnut
West Covina
Whittier

<u>Santa Clara River</u>
*Santa Clarita
Los Angeles County Flood Control
Los Angeles (County of)

*Italicized agencies are present in more than one Watershed Management Area. *Indicates City with the largest watershed population other than County of Los Angeles and the City of Los Angeles.*

[1] *The City of Long Beach is covered under order No. 99-060*

ATTACHMENT B
Critical Sources Categories[1]

Tier 1 Categories

Municipal Landfills (SIC 4953)

Hazardous Waste Treatment, Disposal and Recovery Facilities[2]

Facilities Subject to SARA Title III (also known as EPCRA)[2]

Restaurants[3]

Wholesale trade (scrap, auto dismantling) (SIC 50)

Automotive service facilities[3]

Fabricated metal products (SIC 34)

Motor freight (SIC 42)

Chemical/allied products (SIC 28)

Automotive Dealers/Gas Stations (SIC 55)

Primary Metals Products (SIC 33)

Tier 2 Categories

Electric/Gas/Sanitary (SIC 49)

Air Transportation (SIC 45)

Rubbers/Miscellaneous Plastics (SIC 30)

Local/Suburban Transit (SIC 41)

Railroad Transportation (SIC 40)

Oil & Gas Extraction (SIC 13)

Lumber/Wood Products (SIC 24)

Machinery Manufacturing (SIC 35)

Transportation Equipment (SIC 37)

Stone, Clay, Glass, Concrete (SIC 32)

Leather/Leather Products (SIC 31)

Miscellaneous Manufacturing (SIC 39)

Food and kindred Products (SIC 20)

Mining of Nonmetallic Minerals (SIC 14)

Printing and Publishing (SIC 27)

Electric/Electronic (SIC 36)

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[1] Italicized categories belong to Phase 1 facilities
[2] Various categories subject to these requirements
[3] See Definition in Part 5. of the permit

STATE OF CALIFORNIA

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LOS ANGELES REGION

ORDER NO. 01-182
NPDES PERMIT NO. CAS004001
WASTE DISCHARGE REQUIREMENTS
FOR
MUNICIPAL STORM WATER AND URBAN RUNOFF DISCHARGES WITHIN THE COUNTY OF LOS ANGELES, AND THE INCORPORATED CITIES THEREIN, EXCEPT THE CITY OF LONG BEACH

December 13, 2001

Table of Contents

STATE OF CALIFORNIA

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LOS ANGELES REGION

ORDER NO. 01-182
NPDES PERMIT NO. CAS004001
WASTE DISCHARGE REQUIREMENTS
FOR
MUNICIPAL STORM WATER AND URBAN RUNOFF DISCHARGES WITHIN THE COUNTY OF LOS ANGELES, AND THE INCORPORATED CITIES THEREIN, EXCEPT THE CITY OF LONG BEACH

The California Regional Water Quality Control Board, Los Angeles Region (hereinafter referred to as the Regional Board) finds:

A. Existing Permit

The Los Angeles County Flood Control District, the County of Los Angeles, and 84 incorporated cities within the Los Angeles County Flood Control District (see Attachment A, List of Permittees), hereinafter referred to separately as Permittees and jointly as the Discharger, discharge or contribute to discharges of storm water and urban runoff from municipal separate storm sewer systems (MS4s), also called storm drain systems. The discharges flow to water courses within the Los Angeles County Flood Control District and into receiving waters of the Los Angeles Region. These discharges are covered under countywide waste discharge requirements contained in Order No. 96-054 adopted by this Regional Board on July 15, 1996, which replaced Order No. 90-079 adopted by this Regional Board on June 18, 1990. Order No. 96-054 also serves as a National Pollutant Discharge Elimination System (NPDES) permit for the discharge of municipal storm water.

B. Nature of Discharges and Sources of Pollutant

1. Storm water discharges consist of surface runoff generated from various land uses in all the hydrologic drainage basins that discharge into water bodies of the State. The quality of these discharges varies considerably and is affected by the hydrology, geology, land use, season, and sequence and duration of hydrologic events. The primary constituents of concern currently identified by the Los Angeles County Flood Control District Integrated Receiving Water Impacts Report (1994-2000) are cyanide, indicator bacteria, total dissolved solids, turbidity, total suspended solids, nutrients, total aluminum, dissolved cadmium, copper, lead, total mercury, nickel, zinc, bis(2-ethylhexyl)phthalate, polycyclic aromatic hydrocarbons (PAHs), diazinon, and chlorpyrifos.

2. Certain pollutants present in storm water and/or urban runoff may be derived from extraneous sources that Permittees have no or limited jurisdiction over. Examples of such pollutants and their respective sources are: PAHs which are products of internal combustion engine

operation, nitrates, bis (2-ethylhexyl) phthalate and mercury from atmospheric deposition, lead from fuels, copper from brake pad wear, zinc from tire wear, dioxins as products of combustion, and natural-occurring minerals from local geology. However, the implementation of the measures set forth in this Order is intended to reduce the entry of these pollutants into storm water and their discharge to receiving waters.

3. Water quality assessments conducted by the Regional Board identified impairment, or threatened impairment, of beneficial uses of water bodies in the Los Angeles Region. The causes of impairments include pollutants of concern identified in municipal storm water discharges by the County of Los Angeles in the Integrated Receiving Water Impacts Report (1994-2000). Pollutants in storm water can have damaging effects on both human health and aquatic ecosystems.

4. The Los Angeles County Grand Jury, September 2000, completed an investigation into the health risks of swimming near beaches in Los Angeles County and made several recommendations to reduce public health risks (Final Report, Grand Jury, Los Angeles County, 1999-2000). The Grand Jury recommended that the Regional Board consider among other actions, (i) a focus on setting contaminant limits rather than programmatic evaluations, (ii) audit of MS4 Permittee programs; and (iii) clarifying enforcement responsibilities between the State and local governments.

5. Studies and research conducted by other Regional agencies, academic institutions, and universities have also identified storm water and urban runoff as significant sources of pollutants to surface waters in Southern California. See, e.g., [*Surface Runoff to the Southern California Bight*, Southern California Coastal Water Research Project, (1992); *Impacts of Urban Runoff on Santa Monica Bay and Surrounding Ocean Waters* (Gersberg, R.M., 1995); *State of the Bay 1998*, Santa Monica Bay Restoration Project; *Storm Water Impact*, In, Southern California Environmental Report Card 1999, Institute of the Environment, University of California, Los Angeles (Stenstrom, M.S., 1999); *Distribution of Anthropogenic and Natural Debris on the Mainland Shelf of Southern California Bight,* Shelly L. Moore and M. James Allen (1999); *The Health Effects of Swimming in Ocean Water Contaminated by Storm Drain Runoff*, Haile, R.W. et al. (1999); *Huntington Beach Closure Investigation: Technical Review* (University of Southern California, 2000); *A Regional Survey of the Microbiological Water Quality Along the Shoreline of the Southern California Bight,* Rachel T. Noble *et al.* (2001*); Integrated Receiving Water Impacts Report (1994-2000)*, County of Los Angeles (2001)].

6. Development and urbanization increase pollutant load, volume, and discharge velocity. First, natural vegetated pervious ground cover is converted to impervious surfaces such as paved highways, streets, rooftops and parking lots. Natural vegetated soil can both absorb rainwater and remove pollutants providing an effective natural purification process. In contrast, pavement and concrete can neither absorb water nor remove pollutants, and thus the natural purification characteristics are

lost. Second, urban development creates new pollution sources as the increased density of human population brings proportionately higher levels of vehicle emissions, vehicle maintenance wastes, municipal sewage waste, pesticides, household hazardous wastes, pet wastes, trash, and other anthropogenic pollutants. Development and urbanization especially threaten environmentally sensitive areas. Such areas have a much lower capacity to withstand pollutant shocks than might be acceptable in the general circumstance. In essence, development that is ordinarily insignificant in its impact on the environment may in a particular sensitive environment become significant. These environmentally sensitive areas designated by the State and/or the County of Los Angeles include Areas of Special Biological Significance (ASBS), water bodies designated as supporting a RARE beneficial use, Significant Natural Areas (SNAs), and Significant Ecological Areas (SEAs).

7. The increased volume, increased velocity, and discharge duration of storm water runoff from developed areas has the potential to greatly accelerate downstream erosion and impair stream habitat in natural drainages. Studies have demonstrated a direct correlation between the degree of imperviousness of an area and the degradation of its receiving waters. Significant declines in the biological integrity and physical habitat of streams and other receiving waters have been found to occur with as little as 10 percent conversion from natural to impervious surfaces. Percentage impervious cover is a reliable indicator and predictor of potential water quality degradation expected from new development. (*Impervious Cover as An Urban Stream Indicator and a Watershed Management Tool*, Schueler, T. and R. Claytor, In, Effects of Water Development and Management on Aquatic Ecosystems (1995), ASCE, New York; Leopold, L. B., (1973), *River Channel Change with Time: An Example*, Geological Society of America Bulletin, v. 84, p. 1845-1860; Hammer, T. R., (1972), *Stream Channel Enlargement Due to Urbanization: Water Resources Research*, v. 8, p. 1530-1540; Booth, D. B., (1991), *Urbanization and the Natural Drainage System--Impacts, Solutions and Prognoses*: The Northwest Environmental Journal, v. 7, p. 93-118; Klein, R. D., (1979), *Urbanization and Stream Quality Impairment*: Water Resources Bulletin, v. 15, p. 948-963; May, C. W., Horner, R. R., Karr, J. R., Mar, B. W., and Welch, E. B., (1997), *Effects of Urbanization on Small Streams in the Puget Sound Lowland Ecoregion*: Watershed Protection Techniques, v. 2, p. 483-494; Morisawa, M. and LaFlure, E. *Hydraulic Geometry, Stream Equilibrium and Urbanization* In Rhodes, D. P. and Williams, G. P. *Adjustments to the Fluvial System* p.333-350. (1979); Dubuque, Iowa, Kendall/Hunt. Tenth Annual Geomorphology Symposia Series; and *The Importance of Imperviousness*: Watershed Protection Techniques, 1(3), Schueler, T. (1994).)

8. The County of Los Angeles has identified as the seven highest priority industrial and commercial critical source types, (i) wholesale trade (scrap recycling, auto dismantling); (ii) automotive repair/parking; (iii) fabricated metal products; (iv) motor freight; (v) chemical and allied products; (vi) automotive dealers/gas stations; (vii) primary metal products (*Critical*

Source Selection and Monitoring Report, Los Angeles County Department of Public Works -Sept 1996). Monitoring conducted by Los Angeles County and the Regional Board demonstrates that the priority industrial sectors and auto repair facilities (one of the commercial sectors) on the list, contribute significant concentrations of heavy metals to storm water (*Los Angeles County 1999-2000 Storm Water Monitoring Report*, Los Angeles County Department of Public Works -July 2000; *Compliance Assessment of the Auto Dismantling Industry; Evaluation of the California General Industrial Storm Water Permit*, H. Chang, (2001), 70 pp., California Regional Water Quality Control Board, Los Angeles Region).

9. The discharge of washwaters and contaminated storm water from industries and businesses specified in this Order for inspection by Permittees is an environmental threat and can also adversely impact public health and safety. For example, a review of industrial waste/ pretreatment records performed in 1995 in the County of Los Angeles on illicit discharges indicates that automotive service facilities and food service facilities sometimes discharge polluted washwaters to the MS4. The pollutants of concern in such washwaters include food waste, oil and grease, and toxic chemicals. Other storm water/industrial waste programs in California have reported similar observations. Illicit discharges from automotive service facilities and food service facilities have been identified elsewhere as a major cause of widespread contamination and water quality problems (Washtenaw County Statutory Drainage Board - 1987 Huron River Pollution Abatement Program).

10. Studies indicate that facilities with paved surfaces subject to frequent motor vehicular traffic (such as parking lots and fast food restaurants), or facilities that perform vehicle repair, maintenance, or fueling (automotive service facilities) are potential sources of pollutants of concern in storm water. [References: Pitt *et* al., *Urban Storm Water Toxic Pollutants: Assessment, Sources, and Treatability*, Water Environment Res., 67, 260 (1995)*; Results of Retail Gas Outlet and Commercial Parking Lot Storm Water Runoff Study*, Western States Petroleum Association and American Petroleum Institute, (1994); *Action Plan Demonstration Project, Demonstration of Gasoline Fueling Station Best Management Practices*, Final Report, County of Sacramento (1993); *Source Characterization*, R. Pitt, In Innovative Urban Wet-Weather Flow Management Systems (2000) Technomic Press, Field, R *et al.* editors; *Characteristics of Parking Lot Runoff Produced by Simulated Rainfall*, , L.L. Tiefenthaler *et al.* Technical Report 343, Southern California Coastal Water Research Project (2001).]

11. Retail Gasoline Outlets (RGOs) are points of convergence for vehicular traffic and are similar to parking lots and urban roads. Studies indicate that storm water discharges from RGOs have high concentrations of hydrocarbons and heavy metals. [*The Quality of Trapped Sediments and Poor Water within Oil Grit Separators in Suburban MD,* Schueler T. and Shepp D. (1992), and *Concentrations of Selected Constituents in Runoff from Impervious Surfaces in Four Urban Catchments of Different*

Landuse, Ranabal, F.I., and T.J. Gizzard (1995), In Proceedings of the Fourth Biennial Stormwater Research Conference, Florida, pp-42-52]. Pilot studies indicate that treatment control best management practices installed at retail gasoline stations are effective in removing pollutants, reasonable in capital cost, easy to operate, and do not present safety risks [*Rouge River National Wet Weather Demonstration Project, Task Product Memorandum – Evaluation of On-line Media Filters RPO-NPS-TPM59.00*, Wayne County, MI, March 1999]. The Regional Board and the San Diego Regional Board have jointly prepared a Technical Report on the applicability of new development BMP design criteria for retail gasoline outlets, (*Retail Gasoline Outlets: New Development Design Standards for Mitigation of Storm Water Impacts*, (June 2001)). Retail Gasoline Outlets in Western U.S. States (such as Washington and Oregon) are already subject to numerical BMP design criteria, as well in other U.S. States.

C. Permit Background

1. The essential components of the Storm Water Management Program, as established by federal regulations [40 CFR 122.26(d)] are: (i) Adequate Legal Authority, (ii) Fiscal Resources, (iii) Storm Water Quality Management Program (SQMP) - (Public Information and Participation Program, Industrial/Commercial Facilities Program, Development Planning Program, Development Construction Program, Public Agency Activities Program, Illicit Connection and Illicit Discharges Elimination Program), and (iv) Monitoring and Reporting Program.

2. The Permittees have filed a Report of Waste Discharge (ROWD), dated February 1, 2001, and applied for renewal of their waste discharge requirements that serves as an NPDES permit to discharge wastes to surface waters. The ROWD includes a proposed SQMP and a Monitoring Program. The proposed SQMP contains programs previously approved under Board Order No. 96-054 in the following areas:

   Public Information and Participation
   Development Planning
   Development Construction
   Public Agency Activities
   Illicit Connection/Illicit Discharge Elimination Program

   These programs are revised pursuant to the provisions of this Order after adoption.

3. The County of Los Angeles has previously conducted source identification and pollutant characterization consistent with 40 CFR 122.26(d)(1)(ii) and (iii) under its storm water Monitoring Program. The Monitoring Program submitted with the ROWD proposes to advance the assessment of receiving water impacts, identification of sources of pollution, evaluation of Best Management Practices (BMPs), and measurement of long term trends in mass emissions.

4. The Regional Board has reviewed the ROWD and has determined it to be complete under the reapplication policy of MS4s issued by the U.S. Environmental Protection Agency (USEPA) (61 *Fed. Reg.* 41697). The Regional Board finds that the Permittees' proposed SQMP, incorporating the additional and/or revised provisions contained in this Order would meet the minimum requirements of federal regulations.

5. The City of Los Angeles has conducted shoreline and nearshore water quality monitoring off the Santa Monica Bay since the 1950s under the monitoring program for the Hyperion Waste Water Treatment Plant (NPDES No. CA0109991). The monitoring results indicate that effluent from Hyperion's 5-Mile Outfall does not impinge the shoreline, and that elevated bacterial counts are associated with runoff from storm drains and discharges from piers. In 1994, the Regional Board approved the relocation of Hyperion's shoreline stations to implement a bay-wide, regional shoreline-monitoring program associated with storm drain outfalls in the Santa Monica Bay. The City of Los Angeles requested that the shoreline-monitoring requirement be incorporated in this Order. The shoreline pathogen monitoring requirements are outlined in the Monitoring Program for this Order.

D. Permit Coverage

1. The requirements in this Order cover all areas within the boundaries of the Permittee municipalities (see Attachment A) over which they have regulatory jurisdiction as well as unincorporated areas in Los Angeles County within the jurisdiction of the Regional Board. The Permittees serve a population of about 9.5 million [Reference: *2000 Census of Population and Housing,* Bureau of the Census, U.S. Department of Commerce (2001)] in an area of approximately 3,100 square miles.

2. Federal, state, regional or local entities within the Permittees' boundaries or in jurisdictions outside the Los Angeles County Flood Control District, and not currently named in this Order, may operate storm drain facilities and/or discharge storm water to storm drains and watercourses covered by this Order. The Permittees may lack legal jurisdiction over these entities under state and federal constitutions. The Regional Board will coordinate with these entities to implement programs that are consistent with the requirements of this Order. The Regional Board will consider such facilities for coverage in 2003 under its NPDES permitting scheme pursuant to USEPA Phase II storm water regulations.

3. Sources of discharges into receiving waters in the County of Los Angeles but in jurisdictions outside its boundary include the following:

   About 34 square miles of unincorporated area in Ventura County, which drain into Malibu Creek and then to Santa Monica Bay,

   About 9 square miles of the City of Thousand Oaks, which also drain into Malibu Creek and then to Santa Monica Bay, and

About 86 square miles of area in Orange County, which drain into Coyote Creek and then into the San Gabriel River.

The Regional Board will ensure that storm water management programs for the areas in Ventura County and the City of Thousand Oaks that drain into Santa Monica Bay are consistent with the requirements of this Order. The Regional Board will coordinate with the Santa Ana Regional Board so that storm water management programs for the areas in Orange County that drain into Coyote Creek are consistent with the requirements of this Order.

4. This permit is intended to develop, achieve, and implement a timely, comprehensive, cost-effective storm water pollution control program to reduce the discharge of pollutants in storm water to the Maximum Extent Practicable (MEP) from the permitted areas in the County of Los Angeles to the waters of the U.S. subject to the Permittees' jurisdiction.

5. Permittees have expressed their intention to work cooperatively to control the contribution of pollutants from one portion of the MS4 to another portion of the system. Permittees may control the contribution of pollutants to the MS4 from non-permittee dischargers such as Caltrans, the U.S. Department of Defense, and other state and federal facilities, through interagency agreements.

E. Federal, State, and Regional Regulations

1. The Water Quality Act of 1987 added Section 402(p) to the federal Clean Water Act (CWA) (33 U.S.C. § 1251-1387). This section requires the USEPA to establish regulations setting forth NPDES requirements for storm water discharges in two phases.

   - The USEPA Phase I storm water regulations were directed at MS4s serving a population of 100,000 or more, including interconnected systems and storm water discharges associated with industrial activities, including construction activities. The Phase I Final Rule was published on November 16, 1990 (55 *Fed. Reg.* 47990).

   - The USEPA Phase II storm water regulations are directed at storm water discharges not covered in Phase I, including small MS4s (serving a population of less than 100,000), small construction projects (one to five acres), municipal facilities with delayed coverage under the Intermodal Surface Transportation Efficiency Act of 1991, and other discharges for which the USEPA Administrator or the State determines that the storm water discharge contributes to a violation of a water quality standard, or is a significant contributor of pollutants to waters of the United States. The Phase II Final Rule was published on December 8, 1999 (64 *Fed. Reg.* 68722).

2. The USEPA published an 'Interim Permitting Approach for Water Quality-Based Effluent Limitations in Storm Water Permits' on August 26, 1996 (61 *Fed. Reg.* 43761). This policy discusses the appropriate kinds of

water quality-based effluent limitations to be included in NPDES storm water permits to provide for the attainment of water quality standards.

3. The USEPA published an 'Interpretative Policy Memorandum on Reapplication Requirements' for MS4 permits on August 9, 1996 (61 *Fed. Reg.* 41697). This policy requires that MS4 reapplication for reissuance for a subsequent five-year permit term contain certain basic information and information for proposed changes and improvements to the storm water management program and monitoring program.

4. The USEPA has entered into a Memorandum of Agreement (MOA) with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service for enhancing coordination regarding the protection of endangered and threatened species under Section 7 of the Endangered Species Act and the CWA's Water Quality Standards and NPDES programs. Among other actions, the MOA establishes a framework for coordination of actions by the USEPA, the Services, and CWA delegated States on CWA permit issuance under Section 402 of the CWA [66 *Fed. Reg.* 11202 – 11217].

5. USEPA regulations at 40 CFR 122.26(d)(2)(iv)(A) and 40 CFR 122.26(d)(2)(iv)(C) require that MS4 permittees implement a program to monitor and control pollutants in discharges to the municipal system from industrial and commercial facilities that contribute a substantial pollutant load to the MS4. The regulations require that permittees establish priorities and procedures for inspection of industrial facilities and priority commercial establishments. This permit, consistent with the USEPA policy, incorporates a cooperative partnership, including the specifications of minimum expectations, between the Regional Board and the Permittees for the inspection of industrial facilities and priority commercial establishments to control pollutants in storm water discharges (58 *Fed. Reg.* 61157).

6. Section 402 (p) of the CWA (33 U.S.C. § 1342(p) provides that MS4 permits must "require controls to reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques and system, design engineering method and such other provisions as the [EPA] Administrator or the State determines appropriate for the control of such pollutants." The State Water Resources Control Board's (State Board) Office of Chief Counsel (OCC) has issued a memorandum interpreting the meaning of MEP to include technical feasibility, cost, and benefit derived with the burden being on the municipality to demonstrate compliance with MEP by showing that a BMP is not technically feasible in the locality or that BMPs costs would exceed any benefit to be derived (dated February 11, 1993).

7. The CWA authorizes the USEPA to permit a state to serve as the NPDES permitting authority in lieu of the USEPA. The State of California has in-lieu authority for an NPDES program. The Porter-Cologne Water Quality Control Act authorizes the State Board, through the Regional Boards, to regulate and control the discharge of pollutants into waters of the State. The State Board entered into a MOA with the USEPA, on

September 22, 1989, to administer the NPDES Program governing discharges to waters of the U.S.

8. Section 303(d) of the CWA requires that the State identify a list of impaired water-bodies and develop and implement Total Maximum Daily Loads (TMDLs) for these waterbodies (33 U.S.C. §1313(d)(1)). A TMDL specifies the maximum amount of a pollutant that a water-body can receive, still meet applicable water quality standards and protect beneficial uses. The USEPA entered into a consent decree with the Natural Resources Defense Council (NRDC), Heal the Bay, and the Santa Monica BayKeeper on March 22, 1999, under which the Regional Board must adopt all TMDLs for the Los Angeles Region within 13 years from that date. This permit incorporates a provision to implement and enforce approved load allocations for municipal storm water discharges and requires amending the SQMP after pollutants loads have been allocated and approved.

9. Section 6217(g) of the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA) requires coastal states with approved coastal zone management programs to address non-point pollution impacting or threatening coastal water quality. CZARA (16 U.S.C. § 1451-1465) amends the Coastal Zone Management Act of 1972, to address five sources of non-point pollution: agriculture, silviculture, urban, marinas, and hydromodification. This NPDES permit addresses the management measures required for the urban category, with the exception of septic systems. The Regional Board addresses septic systems through the administration of other programs.

10. On May 18, 2000, the USEPA established numeric criteria for priority toxic pollutants for the State of California (California Toxics Rule (CTR)) 65 *Fed. Reg.* 31682 (40 CFR 131.38), for the protection of human health and aquatic life. These apply as ambient water quality criteria for inland surface waters, enclosed bays, and estuaries. The State Board adopted the *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (SIP) – 2000,* on March 2, 2000, for implementation of the CTR (State Board Resolution No. 2000-15 as amended by Board Resolution No. 2000-030). This policy requires that discharges comply with TMDL-derived load allocations as soon as possible but no later than 20 years from the effective date of the policy.

11. The State Board adopted a revised Water Quality Control Plan for Ocean Waters of California (Ocean Plan) on July 23, 1997. The Ocean Plan contains water quality objectives which apply to all discharges to the coastal waters of California.

12. The State Board in *In Re*: California Department of Transportation (State Board Order WQ 2001-08), determined that the discharge of storm water to ASBS is subject to the prohibition in the Ocean Plan against the discharge of wastes to an ASBS.

13. The Regional Board adopted an updated Water Quality Control Plan (Basin Plan) for the Los Angeles Region on June 13, 1994, '*Water Quality Control Plan, Los Angeles Region: Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties*, (1994).' The Basin Plan designates beneficial uses of receiving waters and specifies both narrative and numerical water quality objectives for the receiving waters in Los Angeles County.

14. The Regional Board on September 19, 2001, adopted amendments to the Basin Plan, to incorporate TMDLs for trash in the Los Angeles River (Resolution No. 01-013) and Ballona Creek (Resolution No. 01-014). After approval by the State Board, the Office of Administrative Law, and the USEPA, the TMDLs for trash will be effective and enforceable.

15. The Regional Board on April 13, 1998, approved BMPs for sidewalk rinsing to minimize the discharge of wash waters to the storm drain system (Resolution No. 98-08). By the same resolution, the Regional Board prohibited the discharge of municipal street wash waters to the storm drain system.

16. The Regional Board on April 13, 1998, approved recommended BMPs for industrial/commercial facilities (Resolution No. 98-08).

17. The Regional Board on April 22, 1999, approved a list of BMPs for use in development planning and development construction (Resolution No. 99-03)

18. The Regional Board adopted and approved requirements for new development and significant redevelopment projects in Los Angeles County to control the discharge of storm water pollutants in post-construction storm water, on January 26, 2000, in Board Resolution No. R-00-02. The Regional Board Executive Officer issued the approved Standard Urban Storm Water Mitigation Plans (SUSMPs) on March 8, 2000. The State Board in large part affirmed the Regional Board action and SUSMPs in State Board Order No. WQ 2000-11 issued on October 5, 2000.

    - The State Board's Chief Counsel has issued a statewide policy memorandum (dated December 26, 2000), which interprets the Order to provide broad discretion to Regional Boards and identifies potential future areas for inclusion in SUSMPs and the types of evidence and findings necessary. Such areas include ministerial projects, projects in environmentally sensitive areas, and water quality design criteria for RGOs.
    - The State Board's Chief Counsel interprets the Order to encourage regional solutions and endorses a mitigation fund or "bank" that may be funded by developers who obtain waivers from the numerical design standards for new development and significant redevelopment.

19. 40 CFR 131.10(a) prohibits states from designating waste transport or waste assimilation as a use for any water of the U.S. Authorizing the

construction of a storm water/ urban runoff treatment facility in a jurisdictional water body would be tantamount to accepting waste assimilation as an appropriate use for that water body. Furthermore, the construction and operation of a pollution control facility in a water body can impact the physical, chemical, and biological integrity as well as the beneficial uses of the water body. Therefore, storm water treatment and/or mitigation in accordance with SUSMPs and any other requirements of this Order must occur prior to the discharge of storm water into a water of the U.S.

20. The Regional Board supports a Watershed Management Approach to address water quality protection in the region. The objective of the Watershed Management Approach should be to provide a comprehensive and integrated strategy towards water resource protection, enhancement, and restoration while balancing economic and environmental impacts within a hydrologically defined drainage basin or watershed. It emphasizes cooperative relationships between regulatory agencies, the regulated community, environmental groups, and other stakeholders in the watershed to achieve the greatest environmental improvements with available resources.

21. To promote a watershed management approach, the County of Los Angeles is divided into six Watershed Management Areas (WMAs) as follows:

    Malibu Creek and Rural Santa Monica Bay WMA
    Ballona Creek and Urban Santa Monica Bay WMA
    Los Angeles River WMA
    San Gabriel River WMA
    Dominguez Channel/Los Angeles Harbor WMA, and
    Santa Clara River WMA

    Attachment A shows the list of Permittees under each WMA and some Permittees have expressed an intent to form sub-watershed groups within the WMA to promote regional solutions for the mitigation of storm water discharge pollution.

22. To facilitate compliance with federal regulations, the State Board has issued two statewide general NPDES permits for storm water discharges: one for storm water from industrial sites [NPDES No. CAS000001, General Industrial Activity Storm Water Permit (GIASP)] and the other for storm water from construction sites [NPDES No. CAS000002, General Construction Activity Storm Water Permit (GCASP)]. The GCASP was reissued on August 19, 1999. The GIASP was reissued on April 17, 1997. Facilities discharging storm water associated with industrial activities and construction projects with a disturbed area of five acres or more are required to obtain individual NPDES permits for storm water discharges, or to be covered by a statewide general permit by completing and filing a Notice of Intent (NOI) with the State Board. The USEPA guidance anticipates coordination of the state-administered programs for

industrial and construction activities with the local agency program to reduce pollutants in storm water discharges to the MS4.

The Regional Board is the enforcement authority in the Los Angeles Region for the two statewide general permits regulating discharges from industrial facilities and construction sites, and all NPDES storm water and non-storm water permits issued by the Regional Board. These industrial and construction sites and discharges are also regulated under local laws and regulations.

23. The State Board, on October 28, 1968, adopted Resolution No. 68-16, which established an anti-degradation policy for the State and Regional Boards. This policy restricts the degradation of surface waters and protects waterbodies where existing water quality is higher than is necessary for the protection of beneficial uses.

24. The State Board, on June 17, 1999, adopted Order No. WQ 99-05, which, in a precedential decision, identifies acceptable receiving water limitations language to be included in municipal storm water permits issued by the State and Regional Boards. The receiving water limitations included herein are consistent with the State Board Order, USEPA Policy, and the U.S. Appellate court decision in, *Defenders of Wildlife v. Browner* (9^{th}. Cir, 1999). The State Board OCC has determined that the federal court decision did not conflict with State Board Order No. WQ 99-05 (memorandum dated October 14, 1999)

25. California Water Code (CWC) § 13263(a) requires that waste discharge requirements issued by the Regional Board shall implement any relevant water quality control plans that have been adopted; shall take into consideration the beneficial uses to be protected and the water quality objectives reasonably required for that purpose; other waste discharges; the need to prevent nuisance; and provisions of CWC § 13241. The Regional Board has considered the requirements of § 13263 and § 13241, and applicable plans, policies, rules, and regulations in developing these waste discharge requirements.

26. CWC § 13370 *et seq.* requires that waste discharge requirements issued by the Regional Boards be consistent with provisions of the federal CWA and its amendments.

27. On March 12, 2001, the U.S. Court of Appeals ruled that it is necessary to obtain a NPDES permit for application of aquatic pesticides to waterways. (*Headwaters, Inc. vs. Talent Irrigation District,* 243 F.3d. 526 (9^{th} Cir., 2001)) This decision is controlling in California for nonagricultural applications of pesticides to waterways. The State Board adopted a general NPDES permit (Order No. 2001-12-DWQ) on July 19, 2001, for public entities that discharge pollutants to waters of the U.S. associated with the application of aquatic pesticides for resource or pest management. Public entities that conduct such activities must seek coverage under the general permit.

F. Implementation

1. The California Environmental Quality Act (CEQA) (Cal. Pub. Resources Code § 21000 *et seq.*) requires that public agencies consider the environmental impacts of the projects they approve for development. CEQA applies to projects that are considered discretionary and does not apply to ministerial projects, which involve the use of established standards or objective measurements. A ministerial project may be made discretionary by adopting local ordinance provisions or imposing conditions to create decision-making discretion in approving the project. In the alternative, Permittees may establish standards and objective criteria administratively for storm water mitigation for ministerial projects. For water quality purposes, the Regional Board considers that all new development and significant redevelopment activity in specified categories, that receive approval or permits from a municipality, are subject to storm water mitigation requirements.

2. The objective of this Order is to protect the beneficial uses of receiving waters in Los Angeles County. To meet this objective, this Order requires that the SQMP specify BMPs that will be implemented to reduce the discharge of pollutants in storm water to the maximum extent practicable. Further, Permittees are to assure that storm water discharges from the MS4 shall neither cause nor contribute to the exceedance of water quality standards and objectives nor create conditions of nuisance in the receiving waters, and that the discharge of non-storm water to the MS4 has been effectively prohibited.

3. The SQMP required in this Order builds upon the programs established in Order Nos. 90-079, and 96-054, consists of the components recommended in the USEPA guidance manual, and was developed with the cooperation of representatives from the regulated community and environmental groups. The SQMP includes provisions that promote customized initiatives, both on a countywide and watershed basis, in developing and implementing cost-effective measures to minimize discharge of pollutants to the receiving water. The various components of the SQMP, taken as a whole rather than individually, are expected to reduce pollutants in storm water and urban runoff to the maximum extent practicable. Provisions of the SQMP are fully enforceable under provisions of this Order.

4. The emphasis of the SQMP is pollution prevention through education, public outreach, planning, and implementation as source control BMPs first and then Structural and Treatment Control BMPs next. Successful implementation of the provisions of the SQMP will require cooperation and coordination of all public agencies in each Permittee's organization, among Permittees, and with the regulated community.

5. The implementation of a Public Information and Participation Program is a critical component of a storm water management program. An informed and knowledgeable community is critical to the success of a storm water management program since it helps insure the following: (i) greater support for the program as the public gains a greater understanding of

the reasons why it is necessary and important, and (ii) greater compliance with the program as the public becomes aware of the personal responsibilities expected of them and others in the community, including the individual actions they can take to protect or improve the quality of area waters.

6. This Order includes a Monitoring Program that incorporates Minimum Levels (MLs) established under the SIP. The SIP's MLs represent the lowest quantifiable concentration for priority toxic pollutants that is measurable with the use of proper method-based analytical procedures and factoring out matrix interference. The SIP's MLs therefore represent the best available science for determining MLs and are appropriate for a storm water monitoring program. The use of MLs allows the detection of toxic priority pollutants at concentrations of concern using recent advances in chemical analytical methods.

7. This Order provides flexibility for Permittees to petition the Regional Board Executive Officer to substitute a BMP under the SQMP with an alternative BMP, if they can provide information and documentation on the effectiveness of the alternative, equal to or greater than the prescribed BMP in meeting the objectives of this Order.

8. This Order contemplates that the Permittees are responsible for considering potential storm water impacts when making planning decisions in order to fulfill the Permittees' CWA requirement to reduce the discharge of pollutants in municipal storm water to the MEP from new development and redevelopment activities. However, the Permittees retain authority to make the final land-use decisions and retain full statutory authority for deciding what land uses are appropriate at specific locations within each Permittee's jurisdiction. This Order and its requirements are not intended to restrict or control local land use decision-making authority.

9. This Order is not intended to prohibit the inspection for or abatement of vectors by the State Department of Health Services or local vector agencies in accordance with Cal. Health and Safety Code § 2270 *et seq.* and §116110 *et seq.* Certain Treatment Control BMPs if not properly designed, operated or maintained may create habitats for vectors (e.g. mosquito and rodents). This Order contemplates that the Permittees will closely cooperate and collaborate with local vector control agencies and the State Department of Health Services for the implementation, operation, and maintenance of Treatment Control BMPs in order to minimize the risk to public health from vector borne diseases.

G. Public Process

1. The Regional Board has notified the Permittees and interested agencies and persons of its intent to issue waste discharge requirements for this discharge, and has provided them with an opportunity to submit their written view and recommendations.

2. The Regional Board, in a public hearing, heard and considered all comments pertaining to the discharge and to the tentative requirements.

3. The Regional Board has conducted public workshops to discuss drafts of the permit. On April 24, 2001, Regional Board staff conducted a workshop outlining the reasoning behind the changes proposed for the new permit and received input from the Permittees and the public regarding those proposed changes. On July 26, 2001, a second public workshop was held at a special Regional Board meeting. The Permittees and the public had another opportunity to express their opinions regarding the proposed changes to the permit in front of the Regional Board members. A significant number of working meetings with the Permittees and other interested parties have occurred throughout the period from the submittal of the ROWD and completion of the tentative draft, in an attempt to incorporate and address all the comments presented.

4. The Los Angeles County Flood Control District, the County of Los Angeles and the other municipalities are co-permittees as defined in 40 CFR 122.26 (b)(1). Los Angeles County Flood Control District will coordinate with the other municipalities and facilitate program implementation. Each Permittee is responsible only for a discharge for which it is the operator.

5. This Order shall serve as a NPDES Permit, pursuant to CWA § 402, or amendments thereto, and shall take effect 50 days from Order adoption provided the Regional Administrator of the USEPA has no objections.

6. The action to adopt an NPDES permit is exempt from the provisions of Chapter 3 of CEQA (Cal. Pub. Resources Code § 21100 *et seq.*), in accordance with CWC § 13389.

7. Pursuant to CWC §13320, any aggrieved party may seek review of this Order by filing a petition with the State Board. A petition must be sent to: State Water Resources Control Board, P.O. Box 100, Sacramento, California, 95812, within 30 days of adoption of the Order by the Regional Board.

8. This Order may be modified or alternatively revoked or reissued prior to its expiration date, in accordance with the procedural requirements of the NPDES program, and the CWC for the issuance of waste discharge requirements.

IT IS HEREBY ORDERED that the Los Angeles County Flood Control District, Los Angeles County, and the Cities of Agoura Hills, Alhambra, Arcadia, Artesia, Azusa, Baldwin Park, Bell, Bellflower, Bell Gardens, Beverly Hills, Bradbury, Burbank, Calabasas, Carson, Cerritos, Claremont, Commerce, Compton, Covina, Cudahy, Culver City, Diamond Bar, Downey, Duarte, El Monte, El Segundo, Gardena, Glendale, Glendora, Hawaiian Gardens, Hawthorne, Hermosa Beach, Hidden Hills, Huntington Park, Industry, Inglewood, Irwindale, La Cañada Flintridge, La Habra Heights, Lakewood, La Mirada, La Puente, La Verne, Lawndale, Lomita, Los Angeles, Lynwood, Malibu, Manhattan Beach, Maywood, Monrovia, Montebello, Monterey Park, Norwalk, Palos Verdes Estates, Paramount, Pasadena, Pico Rivera, Pomona, Rancho Palos Verdes, Redondo Beach, Rolling Hills, Rolling Hills Estates, Rosemead, San Dimas, San Fernando, San Gabriel, San Marino, Santa Clarita, Santa Fe Springs, Santa Monica, Sierra Madre, Signal Hill, South El Monte, South Gate, South Pasadena, Temple City, Torrance, Vernon, Walnut, West Covina, West Hollywood, Westlake Village, and Whittier, in order to meet the provisions contained in Division 7 of the CWC and regulations adopted thereunder, and the provisions of the CWA, as amended, and regulations and guidelines adopted thereunder, shall comply with the following:

Part 1. DISCHARGE PROHIBITIONS

The Permittees shall effectively prohibit non-storm water discharges into the MS4 and watercourses, except where such discharges:

1. Are covered by a separate individual or general NPDES permit for non-storm water discharges; or
2. Fall within one of the categories below, and meet all conditions when specified by the Regional Board Executive Officer:
    a) Category A - Natural flow:
        (1) Natural springs and rising ground water;
        (2) Flows from riparian habitats or wetlands;
        (3) Stream diversions, permitted by the State Board; and
        (4) Uncontaminated ground water infiltration [as defined by 40 CFR 35.2005(20)].
    b) Category B - Flows from emergency fire fighting activity.
    c) Category C - Flows incidental to urban activities:
        (1) Reclaimed and potable landscape irrigation runoff;
        (2) Potable drinking water supply and distribution system releases (consistent with American Water Works Association guidelines for dechlorination and suspended solids reduction practices);
        (3) Drains for foundations, footings, and crawl spaces;
        (4) Air conditioning condensate;
        (5) Dechlorinated/debrominated swimming pool discharges;
        (6) Dewatering of lakes and decorative fountains;
        (7) Non-commercial car washing by residents or by non-profit organizations; and
        (8) Sidewalk rinsing.

    The Regional Board Executive Officer may add or remove categories of non-storm water discharges above. Furthermore, in the event that any of the above categories of non-storm water discharges are determined to be a source of pollutants by the Regional Board Executive Officer, the discharge will no longer be exempt from this prohibition unless the Permittee implements conditions approved by the Regional Board Executive Officer to ensure that the discharge is not a source of pollutants. Notwithstanding the above, the Regional Board Executive Officer may impose additional prohibitions of non-storm water discharges in consideration of anti-degradation policies and TMDLs.

Part 2. RECEIVING WATER LIMITATIONS

1. Discharges from the MS4 that cause or contribute to the violation of Water Quality Standards or water quality objectives are prohibited.

2. Discharges from the MS4 of storm water, or non-storm water, for which a Permittee is responsible for, shall not cause or contribute to a condition of nuisance.

3. The Permittees shall comply with Part 2.1. and 2.2. through timely implementation of control measures and other actions to reduce pollutants in the discharges in accordance with the SQMP and its components and other requirements of this Order including any modifications. The SQMP and its components shall be designed to achieve compliance with receiving water limitations. If exceedances of Water Quality Objectives or Water Quality Standards (collectively, Water Quality Standards) persist, notwithstanding implementation of the SQMP and its components and other requirements of this permit, the Permittee shall assure compliance with discharge prohibitions and receiving water limitations by complying with the following procedure:

   a) Upon a determination by either the Permittee or the Regional Board that discharges are causing or contributing to an exceedance of an applicable Water Quality Standard, the Permittee shall promptly notify and thereafter submit a Receiving Water Limitations (RWL) Compliance Report (as described in the Program Reporting Requirements, Section I of the Monitoring and Reporting Program) to the Regional Board that describes BMPs that are currently being implemented and additional BMPs that will be implemented to prevent or reduce any pollutants that are causing or contributing to the exceedances of Water Quality Standards. This RWL Compliance Report may be incorporated in the annual Storm Water Report and Assessment unless the Regional Board directs an earlier submittal. The RWL Compliance Report shall include an implementation schedule. The Regional Board may require modifications to the RWL Compliance Report.

   b) Submit any modifications to the RWL Compliance Report required by the Regional Board within 30 days of notification.

   c) Within 30 days following the approval of the RWL Compliance Report, the Permittee shall revise the SQMP and its components and monitoring program to incorporate the approved modified

BMPs that have been and will be implemented, an implementation schedule, and any additional monitoring required.

d) Implement the revised SQMP and its components and monitoring program according to the approved schedule.

4. So long as the Permittee has complied with the procedures set forth above and is implementing the revised SQMP and its components, the Permittee does not have to repeat the same procedure for continuing or recurring exceedances of the same receiving water limitations unless directed by the Regional Board to develop additional BMPs.

Part 3. STORM WATER QUALITY MANAGEMENT PROGRAM (SQMP) IMPLEMENTATION

A. General Requirements

1. Each Permittee shall, at a minimum, implement the SQMP. The SQMP is an enforceable element of this Order. The SQMP shall be implemented no later than February 1, 2002, unless a later date has been specified for a particular provision in this Order.

2. The SQMP shall, at a minimum, comply with the applicable storm water program requirements of 40 CFR 122.26(d)(2). The SQMP and its components shall be implemented so as to reduce the discharges of pollutants in storm water to the MEP.

3. Each Permittee shall implement additional controls, where necessary, to reduce the discharges of pollutants in storm water to the MEP.

4. Permittees that modify the countywide SQMP (i.e., implement additional controls, implement different controls than described in the countywide SQMP, or determine that certain BMPs in the countywide SQMP are not applicable in the area under its jurisdiction), shall develop a local SQMP, no later than August 1, 2002. The local SQMP shall be customized to reflect the conditions in the area under the Permittee's jurisdiction and shall specify activities being implemented under the appropriate elements described in the countywide SQMP.

B. Best Management Practice Implementation

The Permittees shall implement or require the implementation of the most effective combination of BMPs for storm water/urban runoff pollution control. When implemented, BMPs are intended to result in the reduction of pollutants in storm water to the MEP.

C. Revision of the Storm Water Quality Management Program

The Permittees shall revise the SQMP, at the direction of the Regional Board Executive Officer, to incorporate program implementation amendments so as to comply with regional, watershed specific requirements, and/or waste load allocations developed and approved pursuant to the process for the designation and implementation of Total Maximum Daily Loads (TMDLs) for impaired water bodies.

D. Designation and Responsibilities of the Principal Permittee

The Los Angeles County Flood Control District is hereby designated as the Principal Permittee. As such, the Principal Permittee shall:

1. Coordinate and facilitate activities necessary to comply with the requirements of this Order, but is not responsible for ensuring compliance of any individual Permittee;
2. Coordinate permit activities among Permittees and act as liaison between Permittees and the Regional Board on permitting issues;
3. Provide personnel and fiscal resources for the necessary updates of the SQMP and its components;
4. Provide technical and administrative support for committees that will be organized to implement the SQMP and its components;
5. Convene the Watershed Management Committees (WMCs) constituted pursuant to Part F, below, upon designation of representatives;
6. Implement the Countywide Monitoring Program required under this Order and evaluate, assess and synthesize the results of the monitoring program;
7. Provide personnel and fiscal resources for the collection, processing and submittal to the Regional Board of annual reports and summaries of other reports required under the SQMP; and
8. Comply with the "Responsibilities of the Permittees" in Part 3.E., below.

E. Responsibilities of the Permittees

Each Permittee is required to comply with the requirements of this Order applicable to discharges within its boundaries (see Findings D.1, D.2. and D.3.) and not for the implementation of the provisions applicable to the Principal Permittee or other Permittees. Each Permittee shall, within its geographic jurisdiction:

1. Comply with the requirements of the SQMP and any modifications thereto;
2. Coordinate among its internal departments and agencies, as appropriate, to facilitate the implementation of the requirements of the SQMP applicable to such Permittee in an efficient and cost-effective manner;
3. Designate a technically knowledgeable representative to the appropriate WMC;

4. Participate in intra-agency coordination (e.g. Fire Department, Building and Safety, Code Enforcement, Public Health, etc.) necessary to successfully implement the provisions of this Order and the SQMP.

5. Prepare an annual Budget Summary of expenditures applied to the storm water management program. This summary shall identify the storm water budget for the following year, using estimated percentages and written explanations where necessary, for the specific categories noted below:

   a) Program management
      - Administrative costs

   b) Program Implementation
      Where information is available, provide an estimated percent breakdown of expenditures for the categories below:
      - Illicit connection/illicit discharge
      - Development planning
      - Development construction
      - Construction inspection activities
      - Industrial/Commercial inspection activities
      - Public Agency Activities
        - Maintenance of Structural BMPs and Treatment Control BMPs
        - Municipal Street Sweeping
        - Catch basin clean-up
        - Trash collection
        - Capital costs

   c) Public Information and Participation

   d) Monitoring Program

   e) Miscellaneous Expenditures

6. Each Permittee, in addition to the Budget Summary, shall report any supplemental dedicated budgets for the same categories.

F. Watershed Management Committees (WMCs)

1. Each WMC shall be comprised of a voting representative from each Permittee in the WMA.

2. The WMC's chair and secretary shall be chosen by the WMC upon Order adoption and on an annual basis, thereafter. In the absence of volunteer Permittee(s) for the positions, the Principal Permittee shall assume those roles until the WMC chooses members of the committee for the positions.

3. Each WMC shall:

   a) Facilitate cooperation and exchange of information among Permittees;

b) Establish additional goals and objectives and associated deadlines for the WMA, as the program implementation progresses;

c) Prioritize pollution control efforts based on beneficial use impairment(s), watershed characteristics and analysis of results from studies and the monitoring program;

d) Develop and/or update and monitor the adequate implementation, on an annual basis, of the tasks identified for the WMA;

e) Assess the effectiveness of, prepare revisions for, and recommend appropriate changes to the SQMP and its components;

f) Continue to prioritize the Industrial/Commercial critical sources for investigation, outreach and follow-up; and

g) Meet four times per year and, as necessary.

G. Legal Authority

1. Permittees shall possess the necessary legal authority to prohibit non-storm water discharges to the storm drain system, including, but not limited to:

   a) Illicit discharges and illicit connections and require removal of illicit connections;

   b) The discharge of wash waters to the MS4 from the cleaning of gas stations, auto repair garages, or other types of automotive service facilities;

   c) The discharge of runoff to the MS4 from mobile auto washing, steam cleaning, mobile carpet cleaning, and other such mobile commercial and industrial operations;

   d) The discharge of runoff to the MS4 from areas where repair of machinery and equipment which are visibly leaking oil, fluid or antifreeze, is undertaken;

   e) The discharge of runoff to the MS4 from storage areas of materials containing grease, oil, or other hazardous substances, and uncovered receptacles containing hazardous materials;

   f) The discharge of chlorinated/ brominated swimming pool water and filter backwash to the MS4;

   g) The discharge of runoff from the washing of toxic materials from paved or unpaved areas to the MS4;

   h) Washing impervious surfaces in industrial/commercial areas that results in a discharge of runoff to the MS4;

i) The discharge of concrete or cement laden wash water from concrete trucks, pumps, tools, and equipment to the MS4; and

j) Dumping or disposal of materials into the MS4 other than storm water, such as:

(1) Litter, landscape debris and construction debris;

(2) Any state or federally banned or unregistered pesticides;

(3) Food and food processing wastes; and

(4) Fuel and chemical wastes, animal wastes, garbage, batteries, and other materials that have potential adverse impacts on water quality.

2. The Permittees shall possess adequate legal authority to:

a) Require persons within their jurisdiction to comply with conditions in Permittees' ordinances, permits, contracts, model programs, or orders (i.e. hold dischargers to its MS4 accountable for their contributions of pollutants and flows);

b) Utilize enforcement mechanisms to require compliance with Permittees ordinances, permits, contracts, or orders;

c) Control pollutants, including potential contribution, in discharges of storm water runoff associated with industrial activities (including construction activities) to its MS4 and control the quality of storm water runoff from industrial sites (including construction sites). This requirement applies to Source Control, and Treatment Control BMPs;

d) Carry out all inspection, surveillance and monitoring procedures necessary to determine compliance and non-compliance with permit conditions, including the prohibition of illicit discharges to the MS4. Permittees must possess authority to enter, sample, inspect, review and copy records, and require regular reports from industrial facilities (including construction sites) discharging polluted or with the potential to discharge polluted storm water runoff into its MS4;

e) Require the use of BMPs to prevent or reduce the discharge of pollutants to MS4s to MEP; and

f) Require that Treatment Control BMPs be properly operated and maintained to prevent the breeding of vectors.

3. Each Permittee shall, no later than November 1, 2002, amend and adopt (if necessary), a Permittee-specific storm water and urban runoff ordinance to enforce all requirements of this permit.

4. Each Permittee shall submit no later than December 2, 2002, a new or updated statement by its legal counsel that the Permittee has obtained all

necessary legal authority to comply with this Order through adoption of ordinances and/or municipal code modifications.

Part 4. SPECIAL PROVISIONS

Maximum Extent Practicable Standard

This permit, and the provisions herein, are intended to develop, achieve, and implement a timely, comprehensive, cost-effective storm water pollution control program to reduce the discharge of pollutants in storm water to the MEP from the permitted areas in the County of Los Angeles to the waters of the State.

A. General Requirements

1. Best Management Practice Substitution

   The Regional Board Executive Officer may approve any site-specific BMP substitution upon petition by a Permittee(s), if the Permittee can document that:

   a) The proposed alternative BMP or program will meet or exceed the objective of the original BMP or program in the reduction of storm water pollutants; or

   b) The fiscal burden of the original BMP or program is substantially greater than the proposed alternative and does not achieve a substantially greater improvement in storm water quality; and,

   c) The proposed alternative BMP or program will be implemented within a similar period of time.

B. Public Information and Participation Program (PIPP)

The Principal Permittee shall implement a Public Information and Participation Program (PIPP) that includes, but is not limited to, the requirements listed in this section. The Principal Permittee shall be responsible for developing and implementing the Public Education Program, as described in the SQMP, and shall coordinate with Permittees to implement specific requirements.

The objectives of the PIPP are as follows:

- To measurably increase the knowledge of the target audiences regarding the MS4, the impacts of storm water pollution on receiving waters, and potential solutions to mitigate the problems caused;
- To measurably change the waste disposal and runoff pollution generation behavior of target audiences by encouraging implementation of appropriate solutions; and
- To involve and engage socio-economic groups and ethnic communities in Los Angeles County to participate in mitigating the impacts of storm water pollution.

The Principal Permittee shall convene an advisory committee to provide input and assistance in meeting the goals and objectives of the public education campaign. The advisory committee shall be consulted during the process of developing the PIPP campaign, and shall provide comments and advice during the process of preparing a Request For Proposals for a storm water public education contractor. The committee may participate as a part of a working group that evaluates contractor proposals and other tasks as appropriate. The committee shall be comprised of representatives of the environmental community, Permittee cities, Regional Board staff, and experts in the fields of public education and marketing. The Principal Permittee shall ensure that the committee meets at least once a year.

1. Residential Program

a) "No Dumping" Message

Each Permittee shall mark all storm drain inlets that they own with a legible "no dumping" message. In addition, signs with prohibitive language discouraging illegal dumping must be posted at designated public access points to creeks, other relevant water bodies, and channels no later than February 2, 2004. Signage and storm drain messages shall be legible and maintained as necessary during the term of the permit.

b) Countywide Hotline

The 888-CLEAN-LA hotline will serve as the general public reporting contact for reporting clogged catch basin inlets and illicit discharges/dumping, faded or lack of catch basin stencils, and general storm water management information. Each Permittee may establish its own hotline if preferred. Permittees shall include this information, updated when necessary, in public information, and the government pages of the telephone book, as they are developed or published. The Principal Permittee shall compile a list of the general public reporting contacts from all Permittees and make this information available on the web site (888CleanLA.com) and upon request. Permittees shall provide the Principal Permittee with their reporting contacts no later than March 1, 2002. Permittees are responsible for providing current, updated information to the Principal Permittee.

c) Outreach and Education

(1) The Principal Permittee shall continue to implement the following activities that were components of the first five-year PIPP:

(i) Advertising;

(ii) Media relations;

(iii) Public service announcements;

(iv) "How To" instructional material distributed in a targeted and activity-related manner;

(v) Corporate, community association, environmental organization and entertainment industry tie-ins; and

(vi) Events targeted to specific activities and population subgroups.

(2) The Principal Permittee shall develop a strategy to educate ethnic communities and businesses through culturally effective methods. Details of this strategy should be incorporated into the Public Education Program, and implemented, no later than February 3, 2003.

(3) The Principal Permittee shall enhance the existing outreach efforts to residents and businesses related to the proper disposal of cigarette butts.

(4) Each Permittee shall conduct educational activities within its jurisdiction and participate in countywide events.

(5) The Principal Permittee shall organize Public Outreach Strategy meetings for Permittees on a quarterly basis, beginning no later than May 1, 2002. The Principal Permittee shall provide guidance for Permittees to augment the countywide outreach and education program. Permittees shall coordinate regional and local outreach and education to reduce duplication of efforts. Permittees are encouraged to include other interested parties in the outreach strategy to strengthen and coordinate educational efforts.

(6) The Principal Permittee shall ensure that a minimum of 35 million impressions per year are made on the general public about storm water quality via print, local TV access, local radio, or other appropriate media.

(7) The Principal Permittee, in cooperation with the Permittees, shall provide schools within each School District in the County with materials, including, but not limited to, videos, live presentations, and other information necessary to educate a minimum of 50 percent of all school children (K-12) every 2 years on storm water pollution.

(8) Permittees shall provide the contact information for their appropriate staff responsible for storm water public education activities to the Principal Permittee no later than April 1, 2002, and changes to contact information no later than 30 days after a change occurs.

(9) The Principal Permittee shall develop a strategy to measure the effectiveness of in-school educational programs. The protocol shall include assessment of students' knowledge of storm water pollution problems and

solutions before and after educational efforts are conducted. The protocol shall be developed and submitted to the Regional Board Executive Officer for approval no later than May 1, 2002. It shall be implemented upon approval.

(10) In order to ensure that the PIPP is demonstrably effective in changing the behavior of the public, the Principal Permittee shall develop a behavioral change assessment strategy no later than May 1, 2002. The strategy shall be developed based on sociological data and studies (such as the County Segmentation Study). The Principal Permittee shall submit the assessment strategy to the Regional Board Executive Office for approval. It shall be implemented on approval.

d) Pollutant-Specific Outreach

The Principal Permittee, in cooperation with Permittees, shall coordinate to develop outreach programs that focus on the watershed-specific pollutants listed in Table 1 no later than February 3, 2003. Metals may be appropriately addressed through the Industrial/Commercial Facilities Program (e.g. distribute education materials on appropriate BMPs for metal waste management to facilities that have been identified as a potential source, such as metal fabricating facilities). Region-wide pollutants may be included in the Principal Permittee's mass media outreach efforts.

Table 1.

Watershed	***Target Pollutants for Outreach***
Ballona Creek	Trash, Indicator Bacteria, Metals, PAHs
Malibu Creek	Trash, Nutrients (Nitrogen), Indicator Bacteria, Sediments
Los Angeles River	Trash, Nutrients (Nitrogen), Indicator Bacteria, Metals, Pesticides, PAHs
San Gabriel River	Trash, Nutrients (Nitrogen), Indicator Bacteria, Metals
Santa Clara River	Nutrients (Nitrogen), Coliform
Dominguez Channel	Trash, Indicator Bacteria, PAHs

Each Permittee shall make outreach materials available to the general public and target audiences, such as schools, community groups, contractors and developers, and at appropriate public counters and events. Outreach material shall include information on pollutants, sources of concern, and source abatement measures.

2. Businesses Program

a) Corporate Outreach

The Principal Permittee shall develop and implement a Corporate Outreach program to educate and inform corporate managers about storm water regulations. The program shall target RGOs and restaurant chains. At a minimum, this program shall include:

(1) Conferring with corporate management to explain storm water regulations;

(2) Distribution and discussion of educational material regarding storm water pollution and BMPs, and provide managers with suggestions to facilitate employee compliance with storm water regulations.

Corporate Outreach for all RGOs and restaurant chain corporations shall be conducted not less than twice during the permit term, with the first outreach contact to begin no later than February 3, 2003.

b) Business Assistance Program

The Principal Permittee and Permittees may implement a Business Assistance Program to provide technical resource assistance to small businesses to advise them on BMPs implementation to reduce the discharge of pollutants in storm water runoff. Programs may include:

(1) On-site technical assistance or consultation via telephone to identify and implement storm water pollution prevention methods and best management practices; and

(2) Making available, distributing, and discussing of applicable BMP and educational materials.

C. Industrial/Commercial Facilities Control Program

Each Permittee shall require implementation of pollutant reduction and control measures at industrial and commercial facilities, with the objective of reducing pollutants in storm water runoff. Except as specified in other sections of this Order, pollutant reduction and control measures can be used alone or in combination, and can include Structural and Source Control BMPs, and operation and maintenance procedures, which can be applied before, during, and/or after pollution generating activities. At a minimum, the Industrial/Commercial Facilities Control Program shall include requirements to: (1) track, (2) inspect, and (3) ensure compliance at industrial and commercial facilities that are critical sources of pollutants in storm water.

1. Track Critical Sources

a) Each Permittee shall maintain a watershed-based inventory or database of all facilities within its jurisdiction that are critical sources of storm water pollution. Critical sources to be tracked are summarized below, and also specified in Attachment B:

(1) Commercial Facilities
- restaurants;
- automotive service facilities; and
- RGOs and automotive dealerships.

(2) USEPA Phase I Facilities (Tier 1 and 2)

(3) Other Federally-mandated Facilities [as specified in 40 CFR 122.26(d)(2)(iv)(C)]
- municipal landfills;
- hazardous waste treatment, disposal, and recovery facilities; and
- facilities subject to SARA Title III (also known as EPCRA).

b) Each Permittee shall include the following minimum fields of information for each industrial and commercial facility:
- name of facility and name of owner/operator;
- address;
- coverage under the GIASP or other individual or general NPDES permits; and
- a narrative description including SIC codes that best reflects the industrial activities at and principal products of each facility.

The Regional Board encourages Permittees to add other fields of information, such as material usage and/or industrial output, and discrepancies between SIC Code designations (as reported by facility operators) and the actual type of industrial activity has the potential to pollute storm water. In addition, the Regional Board recommends use of an automated database system, such as a Geographical Information System (GIS) or Internet-based system; however, this is not required.

c) Each Permittee shall update its inventory of critical sources at least annually. The update may be accomplished through collection of new information obtained through field activities or through other readily available intra-agency informational databases (e.g. business licenses, pretreatment permits, sanitary sewer hook-up permits).

2. Inspect Critical Sources

Each Permittee shall inspect all facilities in the categories and at a level and frequency as specified in the following subsections.

a) Commercial Facilities

(1) Restaurants

Frequency of Inspections: Twice during the 5-year term of the Order, provided that the first inspection occurs no later than August 1, 2004, and that there is a minimum interval of one year in between the first compliance inspection and the second compliance inspection.

Level of inspections: Each Permittee, in cooperation with its appropriate department (such as health or public works), shall inspect all restaurants within its jurisdiction to confirm that storm water BMPs are being effectively implemented in compliance with State law, County and municipal ordinances, Regional Board Resolution 98-08, and the SQMP. At each restaurant, inspectors shall verify that the restaurant operator:

- has received educational materials on storm water pollution prevention practices;
- does not pour oil and grease or oil and grease residue onto a parking lot, street or adjacent catch basin;
- keeps the trash bin area clean and trash bin lids closed, and does not fill trash bins with washout water or any other liquid;
- does not allow illicit discharges, such as discharge of washwater from floormats, floors, porches, parking lots, alleys, sidewalks and street areas (in the immediate vicinity of the establishment), filters or garbage/trash containers;
- removes food waste, rubbish or other materials from parking lot areas in a sanitary manner that does not create a nuisance or discharge to the storm drain.

(2) Automotive Service Facilities

Frequency of Inspections: Twice during the 5-year term of the Order, provided that the first inspection occurs no later than August 1, 2004, and that there is a minimum interval of one year in between the first compliance inspection and the second compliance inspection.

Level of inspections: Each Permittee shall inspect all automotive service facilities within its jurisdiction to confirm that storm water BMPs are effectively implemented in compliance with County and municipal ordinances, Regional Board Resolution 98-08, and the SQMP. At each automotive service facility, inspectors shall verify that each operator:

- maintains the facility area so that it is clean and dry and without evidence of excessive staining;
- implements housekeeping BMPs to prevent spills and leaks;
- properly discharges wastewaters to a sanitary sewer and/or contains wastewaters for transfer to a legal point of disposal;
- is aware of the prohibition on discharge of non-storm water to the storm drain;
- properly manages raw and waste materials including proper disposal of hazardous waste;
- protects outdoor work and storage areas to prevent contact of pollutants with rainfall and runoff;
- labels, inspects, and routinely cleans storm drain inlets that are located on the facility's property; and
- trains employees to implement storm water pollution prevention practices.

(3) Retail Gasoline Outlets and Automotive Dealerships

Frequency of Inspection: Twice during the 5-year term of the Order, provided that the first inspection occurs no later than August 1, 2004, and that there is a minimum interval of one year in between the first compliance inspection and the second compliance inspection.

Level of Inspection: Each Permittee shall confirm that BMPs are being effectively implemented at each RGO and automotive dealership within its jurisdiction, in compliance with the SQMP, Regional Board Resolution 98-08, and the Stormwater Quality Task Force Best Management Practice Guide for RGOs. At each RGO and automotive dealership, inspectors shall verify that each operator:

- routinely sweeps fuel-dispensing areas for removal of litter and debris, and keeps rags and absorbents ready for use in case of leaks and spills;
- is aware that washdown of facility area to the storm drain is prohibited;
- is aware of design flaws (such as grading that doesn't prevent run-on, or inadequate roof covers and berms), and that equivalent BMPs are implemented;
- inspects and cleans storm drain inlets and catch basins within each facility's boundaries no later than October 1st of each year;

- posts signs close to fuel dispensers, which warn vehicle owners/operators against "topping off" of vehicle fuel tanks and installation of automatic shutoff fuel dispensing nozzles;
- routinely checks outdoor waste receptacle and air/water supply areas, cleans leaks and drips, and ensures that only watertight waste receptacles are used and that lids are closed; and
- trains employees to properly manage hazardous materials and wastes as well as to implement other storm water pollution prevention practices.

b) Phase I Facilities

Permittees need not inspect facilities that have been inspected by the Regional Board within the past 24 months. For the remaining Phase I facilities that the Regional Board has not inspected, each Permittee shall conduct compliance inspections as specified below.

Frequency of Inspection

Facilities in Tier 1 Categories: Twice during the 5-year term of the Order, provided that the first inspection occurs no later than August 1, 2004, and that there is a minimum interval of one year in between the first compliance inspection and the second compliance inspection.

Facilities in Tier 2 Categories: Twice during the 5-year term of the permit, provided that the first inspection occurs no later than August 1, 2004. Permittees need not perform additional inspections at those facilities determined to have no risk of exposure of industrial activity to storm water. For those facilities that do have exposure of industrial activities to storm water, a Permittee may reduce the frequency of additional compliance inspections to once every 5 years, provided that the Permittee inspects at least 20% of the facilities in Tier 2 each year.

Level of Inspection: Each Permittee shall confirm that each operator:

- has a current Waste Discharge Identification (WDID) number for facilities discharging storm water associated with industrial activity, and that a Storm Water Pollution Prevention Plan is available on-site, and
- is effectively implementing BMPs in compliance with County and municipal ordinances, Regional Board Resolution 98-08, and the SQMP.

c) Other Federally-mandated Facilities

Frequency of Inspection: Twice during the 5-year term of the Order, provided that the first inspection occurs no later than August 1, 2004, and that there is a minimum interval of one year in between the first compliance inspection and the second compliance inspection.

Level of Inspection: Each Permittee shall confirm that each operator:

- has a current Waste Discharge Identification (WDID) number for facilities discharging storm water associated with industrial activity, and that a Storm Water Pollution Prevention Plan is available on-site, and
- is effectively implementing BMPs in compliance with County and municipal ordinances, Regional Board Resolution 98-08, and the SQMP.

3. Ensure Compliance of Critical Sources

a) **BMP Implementation:** In the event that a Permittee determines that a BMP specified by the SQMP or Regional Board Resolution 98-08 is infeasible at any site, that Permittee shall require implementation of other BMPs that will achieve the equivalent reduction of pollutants in the storm water discharges. Likewise, for those BMPs that are not adequate to achieve water quality objectives, Permittees may require additional site-specific controls, such as Treatment Control BMPs.

b) **Environmentally Sensitive Areas and Impaired Waters:** For critical sources that are in ESAs or that are tributary to CWA § 303(d) impaired water bodies, Permittees shall consider requiring operators to implement additional controls to reduce pollutants in storm water runoff that are causing or contributing to the exceedences of Water Quality Objectives.

c) **Progressive Enforcement:** Each Permittee shall implement a progressive enforcement policy to ensure that facilities are brought into compliance with all storm water requirements within a reasonable time period as specified below.

(1) In the event that a Permittee determines, based on an inspection conducted above, that an operator has failed to adequately implement all necessary BMPs, that Permittee shall take progressive enforcement action which, at a minimum, shall include a follow-up inspection within 4 weeks from the date of the initial inspection.

(2) In the event that a Permittee determines that an operator has failed to adequately implement BMPs after a follow-up inspection, that Permittee shall take further enforcement action as established through authority in its municipal code and ordinances or through the judicial system.

(3) Each Permittee shall maintain records, including inspection reports, warning letters, notices of violations, and other enforcement records, demonstrating a good faith effort to bring facilities into compliance.

d) Interagency Coordination

(1) **Referral of Violations of the SQMP, Regional Board Resolution 98-08, and Municipal Storm Water Ordinances:** A Permittee may refer a violation(s) to the Regional Board provided that that Permittee has made a good faith effort of progressive enforcement. At a minimum, a Permittee's good faith effort must include documentation of:

- Two follow-up inspections, and
- Two warning letters or notices of violation.

(2) **Referral of Violations of the GIASP, including Requirements to File a Notice of Intent:** For those facilities in violation of the GIASP, Permittees may escalate referral of such violations to the Regional Board after one inspection and one written notice to the operator regarding the violation. In making such referrals, Permittees shall include, at a minimum, the following documentation:

- Name of the facility;
- Operator of the facility;
- Owner of the facility;
- Industrial activity being conducted at the facility that is subject to the GIASP; and
- Records of communication with the facility operator regarding the violation, which shall include at least an inspection report and one written notice of the violation.

Permittees shall, at a minimum, make such referrals on a quarterly basis.

(3) **Investigation of Complaints Regarding Facilities – Transmitted by the Regional Board Staff:** Each Permittee shall initiate, within one business day, investigation of complaints (other than non-storm water discharges) regarding facilities within its jurisdiction. The initial investigation shall include, at a minimum, a limited

inspection of the facility to confirm the complaint to determine if the facility is effectively complying with the SQMP and municipal storm water/urban runoff ordinances, and to oversee corrective action.

(4) **Support of Regional Board Enforcement Actions:** As directed by the Regional Board Executive Officer, Permittees shall support Regional Board enforcement actions by: assisting in identification of current owners, operators, and lessees of facilities; providing staff, when available, for joint inspections with Regional Board inspectors; appearing as witnesses in Regional Board enforcement hearings; and providing copies of inspection reports and other progressive enforcement documentation.

(5) **Participation in a Task Force:** The Permittees, Regional Board, and other stakeholders may form a Storm Water Task Force, the purpose of which is to communicate concerns regarding special cases of storm water violations by industrial and commercial facilities and to develop a coordinated approach to enforcement action.

D. Development Planning Program

The Permittees shall implement a development-planning program that will require all Planning Priority development and Redevelopment projects to:

- Minimize impacts from storm water and urban runoff on the biological integrity of Natural Drainage Systems and water bodies in accordance with requirements under CEQA (Cal. Pub. Resources Code § 21100), CWC § 13369, CWA § 319, CWA § 402(p), CWA § 404, CZARA § 6217(g), ESA § 7, and local government ordinances ;
- Maximize the percentage of pervious surfaces to allow percolation of storm water into the ground;
- Minimize the quantity of storm water directed to impervious surfaces and the MS4;
- Minimize pollution emanating from parking lots through the use of appropriate Treatment Control BMPs and good housekeeping practices;
- Properly design and maintain Treatment Control BMPs in a manner that does not promote the breeding of vectors; and
- Provide for appropriate permanent measures to reduce storm water pollutant loads in storm water from the development site.

1. Peak Flow Control

The Permittees shall control post-development peak storm water runoff discharge rates, velocities, and duration (peak flow control) in Natural

Drainage Systems (i.e., mimic pre-development hydrology) to prevent accelerated stream erosion and to protect stream habitat. Natural Drainage Systems are located in the following areas:

a) Malibu Creek;

b) Topanga Canyon Creek;

c) Upper Los Angeles River;

d) Upper San Gabriel River;

e) Santa Clara River; and

f) Los Angeles County Coastal streams (see Basin Plan Table 2-1).

The Principal Permittee in consultation with Permittees shall develop numerical criteria for peak flow control, based on the results of the Peak Discharge Impact Study (see Monitoring Program Section II.I).

Each Permittee shall, no later than February 1, 2005, implement numerical criteria for peak flow control.

A Permittee or group of Permittees may substitute for the countywide peak flow control criteria with a Hydromodification Control Plan (HCP), on approval by the Regional Board, in the following circumstances:

(1) Stream or watershed-specific conditions indicate the need for a different peak flow control criteria, and the alternative numerical criteria is developed through the application of hydrologic modeling and supporting field observations; or

(2) A watershed-wide plan has been developed for implementation of control measures to reduce erosion and stabilize drainage systems on a watershed basis.

2. Standard Urban Storm Water Mitigation Plans (SUSMPs)

a) Each Permittee shall amend codes and ordinances not later than August 1, 2002 to give legal effect to SUSMP changes contained in this Order. Changes to SUSMP requirements shall take effect not later than September 2, 2002.

b) Each Permittee shall require that a single-family hillside home:

(1) Conserve natural areas;

(2) Protect slopes and channels;

(3) Provide storm drain system stenciling and signage;

(4) Divert roof runoff to vegetated areas before discharge unless the diversion would result in slope instability; and

(5) Direct surface flow to vegetated areas before discharge unless the diversion would result in slope instability.

c) Each Permittee shall require that a SUSMP as approved by the Regional Board in Board Resolution No. R 00-02 be implemented for the following categories of developments:

(1) Ten or more unit homes (includes single family homes, multifamily homes, condominiums, and apartments);

(2) A 100,000 or more square feet of impervious surface area industrial/ commercial development;

(3) Automotive service facilities (SIC 5013, 5014, 5541, 7532-7534, and 7536-7539);

(4) Retail gasoline outlets;

(5) Restaurants (SIC 5812);

(6) Parking lots 5,000 square feet or more of surface area or with 25 or more parking spaces; and

(7) Redevelopment projects in subject categories that meet Redevelopment thresholds.

d) Each Permittee shall submit an ESA Delineation Map for its jurisdictional boundary, based on the Regional Board's ESA Definition, no later than June 3, 2002, for approval by the Regional Board Executive Officer in consultation with the California Department of Fish and Game, and the California Coastal Commission.

e) Each Permittee shall require the implementation of SUSMP provisions no later than September 2, 2002, for all projects located in or directly adjacent to or discharging directly to an ESA, where the development will:

(1) Discharge storm water and urban runoff that is likely to impact a sensitive biological species or habitat; and

(2) Create 2,500 square feet or more of impervious surface area.

3. Numerical Design Criteria

The Permittees shall require that post-construction Treatment Control BMPs incorporate, at a minimum, either a volumetric or flow based treatment control design standard, or both, as identified below to mitigate (infiltrate, filter or treat) storm water runoff:

a) Volumetric Treatment Control BMP

(1) The 85th percentile 24-hour runoff event determined as the maximized capture storm water volume for the area, from

the formula recommended in *Urban Runoff Quality Management, WEF Manual of Practice No. 23/ ASCE Manual of Practice No. 87, (1998)*; or

(2) The volume of annual runoff based on unit basin storage water quality volume, to achieve 80 percent or more volume treatment by the method recommended in *California Stormwater Best Management Practices Handbook – Industrial/ Commercial,* (1993); or

(3) The volume of runoff produced from a 0.75 inch storm event, prior to its discharge to a storm water conveyance system; or

(4) The volume of runoff produced from a historical-record based reference 24-hour rainfall criterion for "treatment" (0.75 inch average for the Los Angeles County area) that achieves approximately the same reduction in pollutant loads achieved by the 85^{th} percentile 24-hour runoff event.

b) Flow Based Treatment Control BMP

(1) The flow of runoff produced from a rain event equal to at least 0.2 inches per hour intensity; or

(2) The flow of runoff produced from a rain event equal to at least two times the 85^{th} percentile hourly rainfall intensity for Los Angeles County; or

(3) The flow of runoff produced from a rain event that will result in treatment of the same portion of runoff as treated using volumetric standards above.

4. Applicability of Numerical Design Criteria

The Permittees shall require the following categories of Planning Priority Projects to design and implement post-construction treatment controls to mitigate storm water pollution:

a) Single-family hillside residential developments of one acre or more of surface area;

b) Housing developments (includes single family homes, multifamily homes, condominiums, and apartments) of ten units or more;

c) A 100,000 square feet or more impervious surface area industrial/ commercial development;

d) Automotive service facilities (SIC 5013, 5014, 5541, 7532-7534 and 7536-7539) [5,000 square feet or more of surface area];

e) Retail gasoline outlets [5,000 square feet or more of impervious surface area and with projected Average Daily Traffic (ADT) of 100 or more vehicles]. Subsurface Treatment Control BMPs which may endanger public safety (i.e., create an explosive environment) are considered not appropriate;

f) Restaurants (SIC 5812) [5,000 square feet or more of surface area];

g) Parking lots 5,000 square feet or more of surface area or with 25 or more parking spaces;

h) Projects located in, adjacent to or discharging directly to an ESA that meet threshold conditions identified above in 2.e; and

i) Redevelopment projects in subject categories that meet Redevelopment thresholds.

5. Not later than March 10, 2003, each Permittee shall require the implementation of SUSMP and post-construction control requirements for the industrial/commercial development category to projects that disturb one acre or more of surface area.

6. Site Specific Mitigation

Each Permittee shall, no later than September 2, 2002, require the implementation of a site-specific plan to mitigate post-development storm water for new development and redevelopment not requiring a SUSMP but which may potentially have adverse impacts on post-development storm water quality, where one or more of the following project characteristics exist:

a) Vehicle or equipment fueling areas;

b) Vehicle or equipment maintenance areas, including washing and repair;

c) Commercial or industrial waste handling or storage;

d) Outdoor handling or storage of hazardous materials;

e) Outdoor manufacturing areas;

f) Outdoor food handling or processing;

g) Outdoor animal care, confinement, or slaughter; or

h) Outdoor horticulture activities.

7. Redevelopment Projects

The Permittees shall apply the SUSMP, or site specific requirements including post-construction storm water mitigation to all Planning Priority Projects that undergo significant Redevelopment in their respective categories.

a) Significant Redevelopment means land-disturbing activity that results in the creation or addition or replacement of 5,000 square feet or more of impervious surface area on an already developed site.

Where Redevelopment results in an alteration to more than fifty percent of impervious surfaces of a previously existing development, and the existing development was not subject to post development storm water quality control requirements, the entire project must be mitigated. Where Redevelopment results in an alteration to less than fifty percent of impervious surfaces of a previously existing development, and the existing development was not subject to post development storm water quality control requirements, only the alteration must be mitigated, and not the entire development.

b) Redevelopment does not include routine maintenance activities that are conducted to maintain original line and grade, hydraulic capacity, original purpose of facility or emergency redevelopment activity required to protect public health and safety.

c) Existing single family structures are exempt from the Redevelopment requirements.

8. Maintenance Agreement and Transfer

Each Permittee shall require that all developments subject to SUSMP and site specific plan requirements provide verification of maintenance provisions for Structural and Treatment Control BMPs, including but not limited to legal agreements, covenants, CEQA mitigation requirements, and or conditional use permits. Verification at a minimum shall include:

a) The developer's signed statement accepting responsibility for maintenance until the responsibility is legally transferred; and either

b) A signed statement from the public entity assuming responsibility for Structural or Treatment Control BMP maintenance and that it meets all local agency design standards; or

c) Written conditions in the sales or lease agreement, which requires the recipient to assume responsibility for maintenance and conduct a maintenance inspection at least once a year; or

d) Written text in project conditions, covenants and restrictions (CCRs) for residential properties assigning maintenance responsibilities to the Home Owners Association for maintenance of the Structural and Treatment Control BMPs; or

e) Any other legally enforceable agreement that assigns responsibility for the maintenance of post-construction Structural or Treatment Control BMPs.

9. Regional Storm Water Mitigation Program

A Permittee or Permittee group may apply to the Regional Board for approval of a regional or sub-regional storm water mitigation program to substitute in part or wholly SUSMP requirements. Upon review and a determination by the Regional Board Executive Officer that the proposal is technically valid and appropriate, the Regional Board may consider for approval such a program if its implementation will:

a) Result in equivalent or improved storm water quality;

b) Protect stream habitat;

c) Promote cooperative problem solving by diverse interests;

d) Be fiscally sustainable and has secure funding; and

e) Be completed in five years including the construction and start-up of treatment facilities.

Nothing in this provision shall be construed as to delay the implementation of SUSMP requirements, as approved in this Order.

10. Mitigation Funding

The Permittees may propose a management framework, for endorsement by the Regional Board Executive Officer, to support regional or sub-regional solutions to storm water pollution, where any of the following situations occur:

a) A waiver for impracticability is granted;

b) Legislative funds become available;

c) Off-site mitigation is required because of loss of environmental habitat; or

d) An approved watershed management plan or a regional storm water mitigation plan exists that incorporates an equivalent or improved strategy for storm water mitigation.

11. California Environmental Quality Act (CEQA) Document Update

Each Permittee shall incorporate into its CEQA process, with immediate effect, procedures for considering potential storm water quality impacts and providing for appropriate mitigation when preparing and reviewing CEQA documents. The procedures shall require consideration of the following:

a) Potential impact of project construction on storm water runoff;

b) Potential impact of project post-construction activity on storm water runoff;

c) Potential for discharge of storm water from areas from material storage, vehicle or equipment fueling, vehicle or equipment maintenance (including washing), waste handling, hazardous materials handling or storage, delivery areas or loading docks, or other outdoor work areas;

d) Potential for discharge of storm water to impair the beneficial uses of the receiving waters or areas that provide water quality benefit;

e) Potential for the discharge of storm water to cause significant harm on the biological integrity of the waterways and water bodies;

f) Potential for significant changes in the flow velocity or volume of storm water runoff that can cause environmental harm; and

g) Potential for significant increases in erosion of the project site or surrounding areas.

12. General Plan Update

a) Each Permittee shall amend, revise or update its General Plan to include watershed and storm water quality and quantity management considerations and policies when any of the following General Plan elements are updated or amended: (i) Land Use, (ii) Housing, (iii) Conservation, and (iv) Open Space.

b) Each Permittee shall provide the Regional Board with the draft amendment or revision when a listed General Plan element or the General Plan is noticed for comment in accordance with Cal. Govt. Code § 65350 *et seq*.

13. Targeted Employee Training

Each Permittee shall train its employees in targeted positions (whose jobs or activities are engaged in development planning) regarding the development planning requirements on an annual basis beginning no later than August 1, 2002, and more frequently if necessary. For Permittees with a population of 250,000 or more (2000 U.S. Census), training shall be completed no later than February 3, 2003.

14. Developer Technical Guidance and Information

a) Each Permittee shall develop and make available to the developer community SUSMP (development planning) guidelines immediately.

b) The Principal Permittee in partnership with Permittees shall issue no later than February 2, 2004, a technical manual for the siting and design of BMPs for the development community in Los Angeles County. The technical manual may be adapted from the revised California Storm Water Quality Task Force Best Management Practices Handbooks scheduled for publication in September 2002. The technical manual shall at a minimum include:

(1) Treatment Control BMPs based on flow-based and volumetric water quality design criteria for the purposes of countywide consistency;

(2) Peak Flow Control criteria to control peak discharge rates, velocities and duration;

(3) Expected pollutant removal performance ranges obtained from national databases, technical reports and the scientific literature;

(4) Maintenance considerations; and

(5) Cost considerations.

E. Development Construction Program

1. Each Permittee shall implement a program to control runoff from construction activity at all construction sites within its jurisdiction. The program shall ensure the following minimum requirements are effectively implemented at all construction sites:

   a) Sediments generated on the project site shall be retained using adequate Treatment Control or Structural BMPs;

   b) Construction-related materials, wastes, spills, or residues shall be retained at the project site to avoid discharge to streets, drainage facilities, receiving waters, or adjacent properties by wind or runoff;

   c) Non-storm water runoff from equipment and vehicle washing and any other activity shall be contained at the project site; and

   d) Erosion from slopes and channels shall be controlled by implementing an effective combination of BMPs (as approved in Regional Board Resolution No. 99-03), such as the limiting of grading scheduled during the wet season; inspecting graded areas during rain events; planting and maintenance of vegetation on slopes; and covering erosion susceptible slopes.

2. For construction sites one acre and greater, each Permittee shall comply with all conditions in section E.1. above and shall:

   a) Require the preparation and submittal of a Local Storm Water Pollution Prevention Plan (Local SWPPP), for approval prior to issuance of a grading permit for construction projects.

   The Local SWPPP shall include appropriate construction site BMPs and maintenance schedules. (A Local SWPPP may substitute for the State SWPPP if the Local SWPPP is at least as inclusive in controls and BMPs as the State SWPPP). The Local SWPPP must include the rationale used for selecting or rejecting BMPs. The project architect, or engineer of record, or authorized qualified designee, must sign a statement on the Local SWPPP to the effect:

"As the architect/engineer of record, I have selected appropriate BMPs to effectively minimize the negative impacts of this project's construction activities on storm water quality. The project owner and contractor are aware that the selected BMPs must be installed, monitored, and maintained to ensure their effectiveness. The BMPs not selected for implementation are redundant or deemed not applicable to the proposed construction activity."

The landowner or the landowner's agent shall sign a statement to the effect:

"I certify that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, to the best of my knowledge and belief, the information submitted is true, accurate, and complete. I am aware that submitting false and/or inaccurate information, failing to update the Local SWPPP to reflect current conditions, or failing to properly and/or adequately implement the Local SWPPP may result in revocation of grading and/or other permits or other sanctions provided by law."

The Local SWPPP certification shall be signed by the landowner as follows, for a corporation: by a responsible corporate officer which means (a) a president, secretary, treasurer, or vice president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation, or (b) the manager of the construction activity if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures; for a partnership or sole proprietorship: by a general partner or the proprietor; or for a municipality or other public agency: by an elected official, a ranking management official (e.g., County Administrative Officer, City Manager, Director of Public Works, City Engineer, District Manager), or the manager of the construction activity if authority to sign Local SWPPPs has been assigned or delegated to the manager in accordance with established agency policy.

b) Inspect all construction sites for storm water quality requirements during routine inspections a minimum of once during the wet season. The Local SWPPP shall be reviewed for compliance with local codes, ordinances, and permits. For inspected sites that have not adequately implemented their Local SWPPP, a follow-up inspection to ensure compliance will take place within 2 weeks. If compliance has not been attained, the Permittee will take additional actions to achieve compliance (as specified in municipal codes). If compliance has not been achieved, and the site is also covered under a statewide general construction storm water permit, each Permittee shall enforce their local ordinance requirements, and if non-compliance continues the Regional Board shall be notified for further joint enforcement actions.

c) Require, no later than March 10, 2003, prior to issuing a grading permit for all projects less than five acres requiring coverage under a statewide general construction storm water permit, proof of a Waste Discharger Identification (WDID) Number for filing a Notice of Intent (NOI) for permit coverage and a certification that a SWPPP has been prepared by the project developer. A Local SWPPP may substitute for the State SWPPP if the Local SWPPP is at least as inclusive in controls and BMPs as the State SWPPP.

3. For sites five acres and greater, each Permittee shall comply with all conditions in Sections E.1. and E.2. and shall:

a) Require, prior to issuing a grading permit for all projects requiring coverage under the state general permit, proof of a Waste Discharger Identification (WDID) Number for filing a Notice of Intent (NOI) for coverage under the GCASP and a certification that a SWPPP has been prepared by the project developer. A Local SWPPP may substitute for the State SWPPP if the Local SWPPP is at least as inclusive in controls and BMPs as the State SWPPP.

b) Require proof of an NOI and a copy of the SWPPP at any time a transfer of ownership takes place for the entire development or portions of the common plan of development where construction activities are still on-going.

c) Use an effective system to track grading permits issued by each Permittee. To satisfy this requirement, the use of a database or GIS system is encouraged, but not required.

4. GCASP Violation Referrals

a) Referral of Violations of the SQMP, Regional Board Resolution 98-08, and municipal storm water ordinances:

A Permittee may refer a violation(s) to the Regional Board provided that the Permittee has made a good faith effort of progressive enforcement. At a minimum, a Permittee's good faith effort must include documentation of:

- Two follow-up inspections within 3 months, and
- Two warning letters or notices of violation.

b) Referral of Violations of GCASP Filing Requirements:

For those projects subject to the GCASP, Permittees shall refer non-filers (i.e., those projects which cannot demonstrate that they have a WDID number) to the Regional Board, within 15 days of making a determination. In making such referrals, Permittees shall include, at a minimum, the following documentation:

- Project location;
- Developer;
- Estimated project size; and
- Records of communication with the developer regarding filing requirements.

5. Each Permittee shall train employees in targeted positions (whose jobs or activities are engaged in construction activities including construction inspection staff) regarding the requirements of the storm water management program no later than August 1, 2002, and annually thereafter. For Permittees with a population of 250,000 or more (2000 U.S. Census), initial training shall be completed no later than February 3, 2003. Each Permittee shall maintain a list of trained employees.

F. Public Agency Activities Program

Each Permittee shall implement a Public Agency program to minimize storm water pollution impacts from public agency activities. Public Agency requirements consist of:

- Sewage Systems Maintenance, Overflow, and Spill Prevention
- Public Construction Activities Management
- Vehicle Maintenance/Material Storage Facilities/Corporation Yards Management
- Landscape and Recreational Facilities Management
- Storm Drain Operation and Management
- Streets and Roads Maintenance
- Parking Facilities Management
- Public Industrial Activities Management
- Emergency Procedures
- Treatment Feasibility Study

1. Sewage System Maintenance, Overflow, and Spill Prevention

   a) Each Permittee shall implement a response plan for overflows of the sanitary sewer system within their respective jurisdiction, which shall consist at a minimum of the following:

      (1) Investigation of any complaints received;

      (2) Upon notification, immediate response to overflows for containment; and

      (3) Notification to appropriate sewer and public health agencies when a sewer overflows to the MS4.

   b) In addition to 1.a.1, 1.a.2, and 1.a.3 above, for those Permittees, which own and/or operate a sanitary sewer system, the Permittee shall also implement the following requirements:

(1) Procedures to prevent sewage spills or leaks from sewage facilities from entering the MS4; and

(2) Identify, repair, and remediate sanitary sewer blockages, exfiltration, overflow, and wet weather overflows from sanitary sewers to the MS4.

2. Public Construction Activities Management

a) Each Permittee shall implement the Development Planning Program requirements (Permit Part 4.D) at public construction projects.

b) Each Permittee shall implement the Development Construction Program requirements (Permit Part 4.E) at Permittee owned construction sites.

c) Each Permittee shall obtain coverage under the GCASP for public construction sites 5 acres or greater (or part of a larger area of development) except that a municipality under 100,000 in population (1990 U.S. Census) need not obtain coverage under a separate permit until March 10, 2003.

d) Each Permittee, no later than March 10, 2003, shall obtain coverage under a statewide general construction storm water permit for public construction sites for projects between one and five acres.

3. Vehicle Maintenance/Material Storage Facilities/Corporation Yards Management

a) Each Permittee, consistent with the SQMP, shall implement SWPPPs for public vehicle maintenance facilities, material storage facilities, and corporation yards which have the potential to discharge pollutants into storm water.

b) Each Permittee shall implement BMPs to minimize pollutant discharges in storm water including but not be limited to:

(1) Good housekeeping practices;

(2) Material storage control;

(3) Vehicle leaks and spill control; and

(4) Illicit discharge control.

c) Each Permittee shall implement the following measures to prevent the discharge of pollutants to the MS4:

(1) For existing facilities, that are not already plumbed to the sanitary sewer, all vehicle and equipment wash areas (except for fire stations) shall either be:

(i) Self-contained;

(ii) Equipped with a clarifier;

(iii) Equipped with an alternative pre-treatment device; or

(iv) Plumbed to the sanitary sewer.

(2) For new facilities, or during redevelopment of existing facilities (including fire stations), all vehicle and equipment wash areas shall be plumbed to the sanitary sewer and be equipped with a pre-treatment device in accordance with requirements of the sewer agency.

4. Landscape and Recreational Facilities Management

Each Permittee shall implement the following requirements:

a) A standardized protocol for the routine and non-routine application of pesticides, herbicides (including pre-emergents), and fertilizers;

b) Consistency with State Board's guidelines and monitoring requirements for application of aquatic pesticides to surface waters (WQ Order No. 2001-12 DWQ);

c) Ensure no application of pesticides or fertilizers immediately before, during, or immediately after a rain event or when water is flowing off the area to be applied;

d) Ensure that no banned or unregistered pesticides are stored or applied;

e) Ensure that staff applying pesticides are certified by the California Department of Food and Agriculture, or are under the direct supervision of a certified pesticide applicator;

f) Implement procedures to encourage retention and planting of native vegetation and to reduce water, fertilizer, and pesticide needs;

g) Store fertilizers and pesticides indoors or under cover on paved surfaces or use secondary containment;

h) Reduce the use, storage, and handling of hazardous materials to reduce the potential for spills; and

i) Regularly inspect storage areas.

5. Storm Drain Operation and Management

a) Each Permittee shall designate catch basin inlets within its jurisdiction as one of the following:

Priority A: Catch basins that are designated as consistently generating the highest volumes of trash and/or debris.

Priority B: Catch basins that are designated as consistently generating moderate volumes of trash and/or debris.

Priority C: Catch basins that are designated as generating low volumes of trash and/or debris.

b) Permittees subject to a trash TMDL (Los Angeles River and Ballona Creek WMAs) shall continue to implement the requirements listed below until trash TMDL implementation measures are adopted. Thereafter, the subject Permittees shall implement programs in conformance with the TMDL implementation schedule, which shall include an effective combination of measures such as street sweeping, catch basin cleaning, installation of treatment devices and trash receptacles, or other BMPs. Default requirements include:

(1) Inspection and cleaning of catch basins between May 1 and September 30 of each year;

(2) Additional cleaning of any catch basin that is at least 40% full of trash and/or debris;

(3) Record keeping of catch basins cleaned; and

(4) Recording of the overall quantity of catch basin waste collected.

If the implementation phase for the Los Angeles River and Ballona Creek Trash TMDLs has not begun by October 2003, subject Permittees shall implement the requirements described below in subsection 5(c), until such time programs in conformance with the subject Trash TMDLs are being implemented.

c) Permittees not subject to a trash TMDL shall:

(1) Clean catch basins according to the following schedule:

Priority A: A minimum of three times during the wet season and once during the dry season every year.

Priority B: A minimum of once during the wet season and once during the dry season every year.

Priority C: A minimum of once per year.

In addition to the schedule above, between February 1, 2002 and July 1, 2003, Permittees shall ensure that any catch basin that is at least 40% full of trash and/or debris shall be cleaned out. After July 1, 2003, Permittees shall ensure that any catch basin that is at least 25% full of trash and debris shall be cleaned out.

(2) For any special event that can be reasonably expected to generate substantial quantities of trash and litter, include provisions that require for the proper management of trash and litter generated, as a condition of the special use permit issued for that event. At a minimum, the municipality who issues the permit for the special event shall arrange for either temporary screens to be placed on catch basins or for catch basins in that area to be cleaned out subsequent to the event and prior to any rain event.

(3) Place trash receptacles at all transit stops within its jurisdiction that have shelters no later than August 1, 2002, and at all other transit stops within its jurisdiction no later than February 3, 2003. All trash receptacles shall be maintained as necessary.

d) Each Permittee shall inspect the legibility of the catch basin stencil or label nearest the inlet. Catch basins with illegible stencils shall be recorded and re-stenciled or re-labeled within 180 days of inspection.

e) Each Permittee shall implement BMPs for Storm Drain Maintenance that include:

(1) A program to visually monitor Permittee-owned open channels and other drainage structures for debris at least annually and identify and prioritize problem areas of illicit discharge for regular inspection;

(2) A review of current maintenance activities to assure that appropriate storm water BMPs are being utilized to protect water quality;

(3) Removal of trash and debris from open channel storm drains shall occur a minimum of once per year before the storm season;

(4) Minimize the discharge of contaminants during MS4 maintenance and clean outs; and

(5) Proper disposal of material removed.

6. Streets and Roads Maintenance

a) Each Permittee shall designate streets and/or street segments within its jurisdiction as one of the following:

Priority A: Streets and/or street segments that are designated as consistently generating the highest volumes of trash and/or debris.

Priority B: Streets and/or street segments that are designated as consistently generating moderate volumes of trash and/or debris.

Priority C: Streets and/or street segments that are designated as generating low volumes of trash and/or debris.

b) Each Permittee shall perform street sweeping of curbed streets according to the following schedule:

Priority A: These streets and/or street segments shall be swept at least two times per month.

Priority B: Each Permittee shall ensure that each street and/or street segments is swept at least once per month.

Priority C: These streets and/or street segments shall be swept as necessary but in no case less than once per year.

c) Each Permittee shall require that:

(1) Sawcutting wastes be recovered and disposed of properly and that in no case shall waste be left on a roadway or allowed to enter the storm drain;

(2) Concrete and other street and road maintenance materials and wastes shall be managed to prevent discharge to the MS4; and

(3) The washout of concrete trucks and chutes shall only occur in designated areas and never discharged to storm drains, open ditches, streets, or catch basins.

d) Each Permittee shall, no later than August 1, 2002, train their employees in targeted positions (whose interactions, jobs, and activities affect storm water quality) regarding the requirements of the storm water management program to:

(1) Promote a clear understanding of the potential for maintenance activities to pollute storm water; and

(2) Identify and select appropriate BMPs.

For Permittees with a population of 250,000 or more (2000 U.S. Census) training shall be completed no later than February 1, 2003.

7. Parking Facilities Management

Permittee-owned parking lots exposed to storm water shall be kept clear of debris and excessive oil buildup and cleaned no less than 2 times per month and/or inspected no less than 2 times per month to determine if cleaning is necessary. In no case shall a Permittee-owned parking lot be cleaned less than once a month.

8. Public Industrial Activities Management

Each Permittee shall, for any municipal activity considered a discharge of storm water associated with industrial activity, obtain separate coverage under the GIASP except that a municipality under 100,000 in population (1990 U.S. Census) need not file the Notice Of Intent to be covered by said permit until March 10, 2003 (with the exception of power plants, airports, and uncontrolled sanitary landfills).

9. Emergency Procedures

Each Permittee shall repair essential public services and infrastructure in a manner to minimize environmental damage in emergency situations such as: earthquakes; fires; floods; landslides; or windstorms. BMPs shall be implemented to the extent that measures do not compromise public health and safety. After initial emergency response or emergency repair activities have been completed, each Permittee shall implement BMPs and programs as required under this Order.

10. Treatment Feasibility Study

The Permittees in cooperation with the County Sanitation Districts of Los Angeles County shall conduct a study to investigate the possible diversion of dry weather discharges or the use of alternative Treatment Control BMPs to treat flows from their jurisdiction which may impact public health and safety and/or the environment. The Permittees shall collectively review their individual prioritized lists and create a watershed based priority list of drains for potential diversion or treatment and submit the priority listing to the Regional Board Executive Officer, no later than July 1, 2003.

G. Illicit Connections and Illicit Discharges Elimination Program

Permittees shall eliminate all illicit connections and illicit discharges to the storm drain system, and shall document, track, and report all such cases in accordance with the elements and performance measures specified in the following subsections.

1. General

a) Implementation: Each Permittee must develop an Implementation Program which specifies how each Permittee is implementing revisions to the IC/ID Program of the SQMP. This Implementation Program must be documented, and available for review and approval by the Regional Board Executive Officer, upon request.

b) Tracking: All Permittees shall, no later than February 3, 2003, develop and maintain a listing of all permitted connections to their storm drain system. All Permittees shall map at a scale and in a format specified by the Principal Permittee all illicit connections and discharges on their baseline maps, and shall transmit this information to the Principal Permittee. No later than February 3, 2003, the Principal Permittee shall use this information as well as results of baseline and priority screening for illicit connections (as set forth in subsection 2 below) to start an annual evaluation of patterns and trends of illicit connections and illicit discharges, with the objectives of identifying priority areas for elimination of illicit connections and illicit discharges.

c) Training: All Permittees shall train all targeted employees who are responsible for identification, investigation, termination, cleanup, and reporting of illicit connections and discharges. For Permittees with a population of less than 250,000 (2000 U.S. Census), training shall be completed no later than August 1, 2002. For Permittees with a population of 250,000 or more (2000 U.S. Census), training shall be completed no later than February 3, 2003. Furthermore, all Permittees shall conduct refresher training on an annual basis thereafter.

2. Illicit Connections

a) Screening for Illicit Connections

(1) Field Screening: All Permittees shall field Screen the storm drain system for illicit connections in accordance with the following schedule:

(i) Open channels: No later than February 3, 2003;

(ii) Underground pipes in priority areas: No later than February 1, 2005; and

(iii) Underground pipes with a diameter of 36 inches or greater: No later than December 12, 2006.

Permittees shall report, to the Principal Permittee, on the location and length of open channels or underground pipes that have been Screened *vis a vis* the entire storm drain network, and on the status of suspected, confirmed, and terminated illicit connections. Permittees shall maintain a list containing all permitted connections and the status of connections under investigation for possible illicit connection.

(2) Permit Screening: No later than December 12, 2006, Permittees shall complete a review of all permitted connections to the storm drain system, to confirm compliance with Part 1 (Discharge Prohibition).

b) Response to Illicit Connections

(1) Investigation: Upon discovery or upon receiving a report of a suspected illicit connection, Permittees shall initiate an investigation within 21 days, to determine the source of the connection, the nature and volume of discharge through the connection, and the responsible party for the connection.

(2) Termination: Upon confirmation of the illicit nature of a storm drain connection, Permittees shall ensure termination of the connection within 180 days, using enforcement authority as needed.

3. Illicit Discharges

a) Abatement and Cleanup: Permittees shall respond, within one business day of discovery or a report of a suspected illicit discharge, with activities to abate, contain, and clean up all illicit discharges, including hazardous substances.

b) Investigation: Permittees shall investigate illicit discharges as soon as practicable (during or immediately following containment and cleanup activities), and shall take enforcement action as appropriate.

Part 5. DEFINITIONS

The following are definitions for terms applicable to this Order:

"Adverse Impact" means a detrimental effect upon water quality or beneficial uses caused by a discharge or loading of a pollutant or pollutants.

"Anti-degradation policies" means the *Statement of Policy with Respect to Maintaining High Quality Water in California* (State Board Resolution No. 68-16) which protects surface and ground waters from degradation. In particular, this policy protects waterbodies where existing quality is higher than that necessary for the protection of beneficial uses including the protection of fish and wildlife propagation and recreation on and in the water.

"Applicable Standards and Limitations" means all State, interstate, and federal standards and limitations to which a "discharge" or a related activity is subject under the CWA, including "effluent limitations, "water quality standards, standards of performance, toxic effluent standards or prohibitions, "best management practices," and pretreatment standards under sections 301, 302, 303, 304, 306, 307, 308, 403 and 404 of CWA.

"**Areas of Special Biological Significance (ASBS)**" means all those areas of this state as ASBS, listed specifically within the California Ocean Plan or so designated by the State Board which, among other areas, includes the area from Mugu Lagoon to Latigo Point: Oceanwater within a line originating from Laguna Point at 34° 5' 40" north, 119° 6'30" west, thence southeasterly following the mean high tideline to a point at Latigo Point defined by the intersection of the meanhigh tide line and a line extending due south of Benchmark 24; thence due south to a distance of 1000 feet offshore or to the 100 foot isobath, whichever distance is greater; thence northwesterly following the 100 foot isobath or maintaining a 1,000-foot distance from shore, whichever maintains the greater distance from shore, to a point lying due south of Laguna Point, thence due north to Laguna Point.

"Authorized Discharge" means any discharge that is authorized pursuant to an NPDES permit or meets the conditions set forth in this Order.

"Automotive Service Facilities" means a facility that is categorized in any one of the following Standard Industrial Classification (SIC) codes: 5013, 5014, 5541, 5511, 7532-7534, or 7536-7539. For inspection purposes, Permittees need not inspect facilities with SIC codes 5013, 5014, 5541, 5511, provided that these facilities have no outside activities or materials that may be exposed to storm water.

"Basin Plan" means the Water Quality Control Plan, Los Angeles Region, Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties, adopted by the Regional Board on June 13, 1994 and subsequent amendments.

"Beneficial Uses" means the existing or potential uses of receiving waters in the permit area as designated by the Regional Board in the Basin Plan.

"Best Management Practices (BMPs)" means methods, measures, or practices designed and selected to reduce or eliminate the discharge of pollutants to surface waters from point and nonpoint source discharges including storm water. BMPs include structural and nonstructural controls, and operation and maintenance procedures, which can be applied before, during, and/or after pollution producing activities.

"Commercial Development" means any development on private land that is not heavy industrial or residential. The category includes, but is not limited to: hospitals, laboratories and other medical facilities, educational institutions, recreational facilities, plant nurseries, car wash facilities, mini-malls and other business complexes, shopping malls, hotels, office buildings, public warehouses and other light industrial complexes.

"Construction" means constructing, clearing, grading, or excavation that results in soil disturbance. Construction includes structure teardown. It does not include routine maintenance to maintain original line and grade, hydraulic capacity, or original purpose of facility; emergency construction activities required to immediately protect public health and safety; interior remodeling with no outside exposure of construction material or construction waste to storm water; mechanical permit work; or sign permit work.

"Control" means to minimize, reduce, eliminate, or prohibit by technological, legal, contractual or other means, the discharge of pollutants from an activity or activities.

"Dechlorinated/Debrominated Swimming Pool Discharge" means swimming pool discharges which have no measurable chlorine or bromine and do not contain any detergents, wastes, or additional chemicals not typically found in swimming pool water. The term does not include swimming pool filter backwash.

"Development" means any construction, rehabilitation, redevelopment or reconstruction of any public or private residential project (whether single-family, multi-unit or planned unit development); industrial, commercial, retail and other non-residential projects, including public agency projects; or mass grading for future construction. It does not include routine maintenance to maintain original line and grade, hydraulic capacity, or original purpose of facility, nor does it include emergency construction activities required to immediately protect public health and safety.

"Directly Adjacent" means situated within 200 feet of the contiguous zone required for the continued maintenance, function, and structural stability of the environmentally sensitive area.

"Director" means the Director of a municipality and Person(s) designated by and under the Director's instruction and supervision.

"Discharge" means when used without qualification the "discharge of a pollutant."

"**Discharging Directly**" means outflow from a drainage conveyance system that is composed entirely or predominantly of flows from the subject, property, development, subdivision, or industrial facility, and not commingled with the flows from adjacent lands.

"Discharge of a Pollutant" means: any addition of any "pollutant" or combination of pollutants to "waters of the United States" from any "point source" or, any addition of any pollutant or combination of pollutants to the waters of the "contiguous zone" or the ocean from any point source other than a vessel or other floating craft which is being used as a means of transportation. The term discharge includes additions of pollutants into waters of the United States from: surface runoff which is collected or channeled by man; discharges through pipes, sewers, or other conveyances owned by a State, municipality, or other person which do not lead to a treatment works; and discharges through pipes, sewers, or other conveyances, leading into privately owned treatment works.

"Disturbed Area" means an area that is altered as a result of clearing, grading, and/or excavation.

"Environmentally Sensitive Areas (ESAs)" means an area in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which would be easily disturbed or degraded by human activities and developments (California Public Resources Code § 30107.5). Areas subject to storm water mitigation requirements are: areas designated as Significant Ecological Areas by the County of Los Angeles (*Los Angeles County Significant Areas Study, Los Angeles County Department of Regional Planning (1976)* and amendments); an area designated as a Significant Natural Area by the California Department of Fish and Game's Significant Natural Areas Program, provided that area has been field verified by the Department of Fish and Game; an area listed in the

Basin Plan as supporting the "Rare, Threatened, or Endangered Species (RARE)" beneficial use; and an area identified by a Permittee as environmentally sensitive.

"General Construction Activities Storm Water Permit (GCASP)" means the general NPDES permit adopted by the State Board which authorizes the discharge of storm water from construction activities under certain conditions.

"General Industrial Activities Storm Water Permit (GIASP)" means the general NPDES permit adopted by the State Board which authorizes the discharge of storm water from certain industrial activities under certain conditions.

"Hillside" means property located in an area with known erosive soil conditions, where the development contemplates grading on any natural slope that is 25% or greater and where grading contemplates cut or fill slopes.

"Illicit Connection" means any man-made conveyance that is connected to the storm drain system without a permit, excluding roof drains and other similar type connections. Examples include channels, pipelines, conduits, inlets, or outlets that are connected directly to the storm drain system.

"Illicit Discharge" means any discharge to the storm drain system that is prohibited under local, state, or federal statutes, ordinances, codes, or regulations. The term illicit discharge includes all non storm-water discharges except discharges pursuant to an NPDES permit, discharges that are identified in Part 1, "Discharge Prohibitions" of this order, and discharges authorized by the Regional Board Executive Officer.

"Illicit Disposal" means any disposal, either intentionally or unintentionally, of material(s) or waste(s) that can pollute storm water.

"Industrial/Commercial Facility" means any facility involved and/or used in the production, manufacture, storage, transportation, distribution, exchange or sale of goods and/or commodities, and any facility involved and/or used in providing professional and non-professional services. This category of facilities includes, but is not limited to, any facility defined by the Standard Industrial Classifications (SIC). Facility ownership (federal, state, municipal, private) and profit motive of the facility are not factors in this definition.

"Infiltration" means the downward entry of water into the surface of the soil.

"Inspection" means entry and the conduct of an on-site review of a facility and its operations, at reasonable times, to determine compliance with specific municipal or other legal requirements. The steps involved in performing an inspection, include, but are not limited to:

1. Pre-inspection documentation research.;
2. Request for entry;
3. Interview of facility personnel;
4. Facility walk-through.
5. Visual observation of the condition of facility premises;
6. Examination and copying of records as required;
7. Sample collection (if necessary or required);

8. Exit conference (to discuss preliminary evaluation); and,
9. Report preparation, and if appropriate, recommendations for coming into compliance.

In the case of restaurants, a Permittee may conduct an inspection from the curbside, provided that such "curbside" inspection provides the Permittee with adequate information to determine an operator's compliance with BMPs that must be implemented per requirements of this Order, Regional Board Resolution 98-08, County and municipal ordinances, and the SQMP.

"Large Municipal Separate Storm Sewer System (MS4)" means all MS4s that serve a population greater than 250,000 (1990 Census) as defined in 40 CFR 122.26 (b)(4). The Regional Board designated Los Angeles County as a large MS4 in 1990, based on: (i) the U.S. Census Bureau 1990 population count of 8.9 million, and (ii) the interconnectivity of the MS4s in the incorporated and unincorporated areas within the County.

"Local SWPPP" means the Storm Water Pollution Prevention Plan required by the local agency for a project that disturbs one or more acres of land.

"Maximum Extent Practicable (MEP)" means the standard for implementation of storm water management programs to reduce pollutants in storm water. CWA § 402(p)(3)(B)(iii) requires that municipal permits "shall require controls to reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques and system, design and engineering methods, and such other provisions as the Administrator or the State determines appropriate for the control of such pollutants. See also State Board Order WQ 2000-11 at page 20.

"Method Detection Limit (MDL)" means the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero, as defined in 40 CFR 136, Appendix B.

"Minimum Level (ML)" means the concentration at which the entire analytical system must give a recognizable signal and acceptable calibration point. The ML is the concentration in a sample that is equivalent to the concentration of the lowest calibration standard analyzed by a specific analytical procedure, assuming that all the method specified sample weights, volumes, and processing steps have been followed.

"Municipal Separate Storm Sewer System (MS4)" means a conveyance or system of conveyances (including roads with drainage systems, municipal streets, alleys, catch basins, curbs, gutters, ditches, manmade channels, or storm drains) owned by a State, city, county, town or other public body, that is designed or used for collecting or conveying storm water, which is not a combined sewer, and which is not part of a publicly owned treatment works, and which discharges to Waters of the United States.

"National Pollutant Discharge Elimination System (NPDES)" means the national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under CWA §307, 402, 318, and 405. The term includes an "approved program."

"Natural Drainage Systems" means unlined or unimproved (not engineered) creeks, streams, rivers or similar waterways.

"New Development" means land disturbing activities; structural development, including construction or installation of a building or structure, creation of impervious surfaces; and land subdivision.

"Non-Storm Water Discharge" means any discharge to a storm drain that is not composed entirely of storm water.

"Nuisance" means anything that meets all of the following requirements: (1) is injurious to health, or is indecent or offensive to the senses, or an obstruction to the free use of property, so as to interfere with the comfortable enjoyment of life or property; (2) affects at the same time an entire community or neighborhood, or any considerable number of persons, although the extent of the annoyance or damage inflicted upon individuals may be unequal.; (3) occurs during, or as a result of, the treatment or disposal of wastes.

"Parking Lot" means land area or facility for the parking or storage of motor vehicles used for businesses, commerce, industry, or personal use, with a lot size of 5,000 square feet or more of surface area, or with 25 or more parking spaces.

"Permittee(s)" means Co-Permittees and any agency named in this Order as being responsible for permit conditions within its jurisdiction. Permittees to this Order include the Los Angeles County Flood Control District, Los Angeles County, and the cities of Agoura Hills, Alhambra, Arcadia, Artesia, Azusa, Baldwin Park, Bellflower, Bell Gardens, Beverly Hills, Bradbury, Burbank, Calabasas, Carson, Cerritos, Claremont, Commerce, Compton, Covina, Cudahy, Culver City, Diamond Bar, Downey, Duarte, El Monte, El Segundo, Gardena, Glendale, Glendora, Hawaiian Gardens, Hawthorne, Hermosa Beach, Hidden Hills, Huntington Park, Industry, Inglewood, Irwindale, La Canada Flintridge, La Habra Heights, Lakewood, La Mirada, La Puente, La Verne, Lawndale, Lomita, Los Angeles, Lynwood, Malibu, Manhattan Beach, Maywood, Monrovia, Montebello, Monterey Park, Norwalk, Palos Verdes Estates, Paramount, Pasadena, Pico Rivera, Pomona, Rancho Palos Verdes, Redondo Beach, Rolling Hills, Rolling Hills Estates, Rosemead, San Dimas, San Fernando, San Gabriel, San Marino, Santa Clarita, Santa Fe Springs, Santa Monica, Sierra Madre, Signal Hill, South El Monte, South Gate, South Pasadena, Temple City, Torrance, Vernon, Walnut, West Covina, West Hollywood, Westlake Village, and Whittier.

"Planning Priority Projects" means those projects that are required to incorporate appropriate storm water mitigation measures into the design plan for their respective project. These types of projects include:

1. Ten or more unit homes (includes single family homes, multifamily homes, condominiums, and apartments)
2. A 100,000 or more square feet of impervious surface area industrial/ commercial development (1 ac starting March 2003)
3. Automotive service facilities (SIC 5013, 5014, 5541, 7532-7534, and 7536-7539)
4. Retail gasoline outlets
5. Restaurants (SIC 5812)
6. Parking lots 5,000 square feet or more of surface area or with 25 or more parking spaces

7. Redevelopment projects in subject categories that meet Redevelopment thresholds
8. Projects located in or directly adjacent to or discharging directly to an ESA, which meet thresholds; and
9. Those projects that require the implementation of a site-specific plan to mitigate post-development storm water for new development not requiring a SUSMP but which may potentially have adverse impacts on post-development storm water quality, where the following project characteristics exist:

    a) Vehicle or equipment fueling areas;
    b) Vehicle or equipment maintenance areas, including washing and repair;
    c) Commercial or industrial waste handling or storage;
    d) Outdoor handling or storage of hazardous materials;
    e) Outdoor manufacturing areas;
    f) Outdoor food handling or processing;
    g) Outdoor animal care, confinement, or slaughter; or
    h) Outdoor horticulture activities.

"Pollutants" means those "pollutants" defined in CWA §502(6) (33.U.S.C.§1362(6)), and incorporated by reference into California Water Code §13373.

"Potable Water Distribution Systems Releases" means sources of flows from drinking water storage, supply and distribution systems including flows from system failures, pressure releases, system maintenance, distribution line testing, fire hydrant flow testing; and flushing and dewatering of pipes, reservoirs, vaults, and minor non-invasive well maintenance activities not involving chemical addition(s). It does not include wastewater discharges from activities that occur at wellheads, such as well construction, well development (i.e., aquifer pumping tests, well purging, etc.), or major well maintenance.

"Project" means all development, redevelopment, and land disturbing activities. The term is not limited to "Project" as defined under CEQA (Pub. Resources Code §21065).

"Rain Event" means any rain event greater than 0.1 inch in 24 hours except where specifically stated otherwise.

"Rare, Threatened, or Endangered Species (RARE)" means a beneficial use for waterbodies in the Los Angeles Region, as designated in the Basin Plan (Table 2-1), that supports habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened, or endangered.

"Receiving Waters" means all surface water bodies in the Los Angeles Region that are identified in the Basin Plan.

"Redevelopment" means land-disturbing activity that results in the creation, addition, or replacement of 5,000 square feet or more of impervious surface area on an already developed site. Redevelopment includes, but is not limited to: the expansion of a building footprint;

addition or replacement of a structure; replacement of impervious surface area that is not part of a routine maintenance activity; and land disturbing activities related to structural or impervious surfaces. It does not include routine maintenance to maintain original line and grade, hydraulic capacity, or original purpose of facility, nor does it include emergency construction activities required to immediately protect public health and safety.

"Regional Administrator" means the Regional Administrator of the Regional Office of the USEPA or the authorized representative of the Regional Administrator.

"Restaurant" means a facility that sells prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption (SIC Code 5812).

"Retail Gasoline Outlet" means any facility engaged in selling gasoline and lubricating oils.

"Runoff" means any runoff including storm water and dry weather flows from a drainage area that reaches a receiving water body or subsurface. During dry weather it is typically comprised of base flow either contaminated with pollutants or uncontaminated, and nuisance flows.

"Screening" means using proactive methods to identify illicit connections through a continuously narrowing process. The methods may include: performing baseline monitoring of open channels, conducting special investigations using a prioritization approach, analyzing maintenance records for catch basin and storm drain cleaning and operation, and verifying all permitted connections into the storm drains. Special investigation techniques may include: dye testing, visual inspection, smoke testing, flow monitoring, infrared, aerial and thermal photography, and remote control camera operation.

"Sidewalk Rinsing" means pressure washing of paved pedestrian walkways with average water usage of 0.006 gallons per square foot, with no cleaning agents, and properly disposing of all debris collected, as authorized under Regional Board Resolution No. 98-08.

"Significant Ecological Area (SEA)" means an area that is determined to possess an example of biotic resources that cumulatively represent biological diversity, for the purposes of protecting biotic diversity, as part of the Los Angeles County General Plan.[1]
Areas are designated as SEAs, if they possess one or more of the following criteria:

1. The habitat of rare, endangered, and threatened plant and animal species.
2. Biotic communities, vegetative associations, and habitat of plant and animal species that are either one of a kind, or are restricted in distribution on a regional basis.
3. Biotic communities, vegetative associations, and habitat of plant and animal species that are either one of a kind or are restricted in distribution in Los Angeles County.

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[1] The 61 existing SEAs represent the findings of a study that was completed in 1976 by England and Nelson, Environmental Consultants, as amended through the adoption of a revised Los Angeles County General Plan in 1980. The results of an update study to evaluate existing SEAs within unincorporated Los Angeles County is currently being proposed to the Los Angeles County Planning Commission (*Los Angeles County Significant Ecological Area Update Study 2000, Background Report*, PCR Services Corporation). The *Update Study 2000*, which contains existing and proposed SEA boundaries, can be downloaded from the Los Angeles County Department of Planning website at http://planning.co.la.ca.us/drp_revw.html#SEA

4. Habitat that at some point in the life cycle of a species or group of species, serves as a concentrated breeding, feeding, resting, migrating grounds and is limited in availability either regionally or within Los Angeles County.
5. Biotic resources that are of scientific interest because they are either an extreme in physical/geographical limitations, or represent an unusual variation in a population or community.
6. Areas important as game species habitat or as fisheries.
7. Areas that would provide for the preservation of relatively undisturbed examples of natural biotic communities in Los Angeles County.
8. Special areas.[2]

"Significant Natural Area (SNA)" means an area defined by the California Department of Fish and Game (DFG), Significant Natural Areas Program, as an area that contains an important example of California's biological diversity. The most current SNA maps, reports, and descriptions can be downloaded from the DFG website at ftp://maphost.dfg.ca.gov/outgoing/whdab/sna/. These areas are identified using the following biological criteria only, irrespective of any administrative or jurisdictional considerations:

1. Areas supporting extremely rare species or habitats.
2. Areas supporting associations or concentrations of rare species or habitats.
3. Areas exhibiting the best examples of rare species and habitats in the state.

"Site" means the land or water area where any "facility or activity" is physically located or conducted, including adjacent land used in connection with the facility or activity.

"Source Control BMP" means any schedules of activities, prohibitions of practices, maintenance procedures, managerial practices or operational practices that aim to prevent storm water pollution by reducing the potential for contamination at the source of pollution.

"SQMP" means the Los Angeles Countywide Stormwater Quality Management Program.

"State Storm Water Pollution Prevention Plan (State SWPPP)" means a plan, as required by a State General Permit, identifying potential pollutant sources and describing the design, placement and implementation of BMPs, to effectively prevent non-stormwater Discharges and reduce Pollutants in Stormwater Discharges during activities covered by the General Permit.

"Storm Water" means storm water runoff, snow melt runoff, and surface runoff and drainage.

"Storm Water Discharge Associated with Industrial Activity" means industrial discharge as defined in 40 CFR 122.26(b)(14)

"Stormwater Quality Management Program" means the Los Angeles Countywide Stormwater Quality Management Program, which includes descriptions of programs, collectively developed by the Permittees in accordance with provisions of the NPDES Permit, to comply with applicable federal and state law, as the same is amended from time to time.

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[2] These criteria from the 1976 study have been modified in the *Update Study 2000.*

"Structural BMP" means any structural facility designed and constructed to mitigate the adverse impacts of storm water and urban runoff pollution (e.g. canopy, structural enclosure). The category may include both Treatment Control BMPs and Source Control BMPs.

"SUSMP" means the Los Angeles Countywide Standard Urban Stormwater Mitigation Plan. The SUSMP shall address conditions and requirements of new development.

"Total Maximum Daily Load (TMDL)" means the sum of the individual waste load allocations for point sources and load allocations for nonpoint sources and natural background.

"Toxicity Identification Evaluation (TIE)" means a set of procedures to identify the specific chemical(s) responsible for toxicity. These procedures are performed in three phases (characterization, identification, and confirmation) using aquatic organism toxicity tests.

"Toxicity Reduction Evaluation (TRE)" means a study conducted in a step-wise process to identify the causative agents of effluent or ambient toxicity, isolate the sources of toxicity, evaluate the effectiveness of toxicity control options, and then confirm the reduction in toxicity.

"Treatment" means the application of engineered systems that use physical, chemical, or biological processes to remove pollutants. Such processes include, but are not limited to, filtration, gravity settling, media absorption, biodegradation, biological uptake, chemical oxidation and UV radiation.

"Treatment Control BMP" means any engineered system designed to remove pollutants by simple gravity settling of particulate pollutants, filtration, biological uptake, media absorption or any other physical, biological, or chemical process.

"USEPA Phase I Facilities" means facilities in specified industrial categories that are required to obtain an NPDES permit for storm water discharges, as required by 40 CFR 122.26(c). These categories include:

i. facilities subject to storm water effluent limitation guidelines, new source performance standards, or toxic pollutant effluent standards (40 CFR N)
ii. manufacturing facilities
iii. oil and gas/mining facilities
iv. hazardous waste treatment, storage, or disposal facilities
v. landfills, land application sites, and open dumps
vi. recycling facilities
vii. steam electric power generating facilities
viii. transportation facilities
ix. sewage of wastewater treatment works
x. light manufacturing facilities

"Vehicle Maintenance/Material Storage Facilities/Corporation Yards" means any Permittee owned or operated facility or portion thereof that:

i. Conducts industrial activity, operates equipment, handles materials, and provides services similar to Federal Phase I facilities;
ii. Performs fleet vehicle service/maintenance on ten or more vehicles per day including repair, maintenance, washing, and fueling;

iii. Performs maintenance and/or repair of heavy industrial machinery/equipment ; and
iv. Stores chemicals, raw materials, or waste materials in quantities that require a hazardous materials business plan or a Spill Prevention, Control , and Countermeasures (SPCC) plan.

"Water Quality Standards and Water Quality Objectives" means water quality criteria contained in the Basin Plan, the California Ocean Plan, the National Toxics Rule, the California Toxics Rule, and other state or federally approved surface water quality plans. Such plans are used by the Regional Board to regulate all discharges, including storm water discharges.

"Waters of the State" means any surface water or groundwater, including saline waters, within boundaries of the state.

"Waters of the United States" or "Waters of the U.S." means:

a. All waters that are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;
b. All interstate waters, including interstate "wetlands";
c. All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, "wetlands," sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce including any such waters:

    1. Which are or could be used by interstate or foreign travelers for recreational or other purposes;
    2. From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or
    3. Which are used or could be used for industrial purposes by industries in interstate commerce;

d. All impoundments of waters otherwise defined as waters of the United States under this definition;
e. Tributaries of waters identified in paragraphs (a) through (d) of this definition;
f. The territorial sea; and
g. "Wetlands" adjacent to waters (other than waters that are themselves wetlands) identified in paragraph (a) through (f) of this definition.

Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA (other than cooling ponds as defined in 40 CFR 423.22(m), which also meet the criteria of this definition) are not waters of the United States. This exclusion applies only to man-made bodies of water, which neither were originally created in waters of the United States (such as disposal area in wetlands) nor resulted from the impoundment of waters of the United States. Waters of the United States do not include prior converted cropland. Notwithstanding the determination of an area's status as prior converted cropland by any other federal agency, for the purposes of the CWA, the final authority regarding CWA jurisdiction remains with USEPA.

"Wet Season" means the calendar period beginning October 1 through April 15.

Part 6. STANDARD PROVISIONS

A. Standard Requirements

1. Each Permittee shall comply with all provisions and requirements of this permit.
2. Should a Permittee discover a failure to submit any relevant facts or that it submitted incorrect information in a report, it shall promptly submit the missing or correct information.
3. Each Permittee shall report all instances of non-compliance not otherwise reported at the time monitoring reports are submitted.
4. This Order includes the attached Monitoring and Reporting Program, and SUSMP(Regional Board Resolution No. R00-02), which are a part of the permit and must be complied with in the same manner as with the rest of the requirements in the permit.

B. Regional Board Review

Any formal determination or approval made by the Regional Board Executive Officer pursuant to the provisions of this Order may be reviewed by the Regional Board. A Permittee(s) or a member of the public may request such review upon petition within 30 days of the effective date of the notification of such decision to the Permittee(s) and interested parties on file at the Regional Board.

C. Public Review

1. All documents submitted to the Regional Board in compliance with the terms and conditions of this Order shall be made available to members of the public pursuant to the Freedom of Information Act (5 U.S.C. § 552 (as amended) and the Public Records Act (Cal. Government Code § 6250 *et seq.*).
2. All documents submitted to the Regional Board Executive Officer for approval shall be made available to the public for a 30-day period to allow for public comment.

D. Duty to Comply

1. Each Permittee must comply with all of the terms, requirements, and conditions of this Order. Any violation of this order constitutes a violation of the Clean Water Act, its regulations and the California Water Code, and is grounds for enforcement action, Order termination, Order revocation and reissuance, denial of an application for reissuance; or a combination thereof [40 CFR 122.41(a), CWC § 13261, 13263, 13265, 13268, 13300, 13301, 13304, 13340, 13350].
2. A copy of these waste discharge specifications shall be maintained by each Permittee so as to be available during normal business hours to Permittee employees and members of the public.

3. Any discharge of wastes at any point(s) other than specifically described in this Order is prohibited, and constitutes a violation of the Order.

E. Duty to Mitigate [40 CFR 122.41 (d)]

Each Permittee shall take all reasonable steps to minimize or prevent any discharge that has a reasonable likelihood of adversely affecting human health or the environment.

F. Inspection and Entry [40 CFR 122.41(i), CWC § 13267]

The Regional Board, USEPA, and other authorized representatives shall be allowed:

1. Entry upon premises where a regulated facility is located or conducted, or where records are kept under conditions of this Order;
2. Access to copy any records, at reasonable times, that are kept under the conditions of this Order;
3. To inspect at reasonable times any facility, equipment (including monitoring and control equipment), practices, or operations regulated or required under this Order; and,
4. To photograph, sample, and monitor at reasonable times for the purpose of assuring compliance with this Order, or as otherwise authorized by the CWA and the CWC.

G. Proper Operation and Maintenance [40 CFR 122.41 (e), CWC § 13263(f)]

The Permittees shall at all times properly operate and maintain all facilities and systems of treatment (and related appurtenances) that are installed or used by the Permittees to achieve compliance with this Order. Proper operation and maintenance includes adequate laboratory controls and appropriate quality assurance procedures. This provision requires the operation of backup or auxiliary facilities or similar system that are installed by a Permittee only when necessary to achieve compliance with the conditions of this Order.

H. Signatory Requirements [40 CFR 122.41(k) & 122.22]

Except as otherwise provided in this Order, all applications, reports, or information submitted to the Regional Board shall be signed by the Director of Public Works, City Engineer, or authorized designee and certified as set forth in 40 CFR 122.22.

I. Reopener and Modification [40 CFR 122.41(f) & 122.62]

1. This Order may only be modified, revoked, or reissued, prior to the expiration date, by the Regional Board, in accordance with the procedural requirements of the CWC and CCR Title 23 for the issuance of waste

discharge requirements, 40 CFR 122.62, and upon prior notice and hearing, to:

a) Address changed conditions identified in the required reports or other sources deemed significant by the Regional Board;

b) Incorporate applicable requirements or statewide water quality control plans adopted by the State Board or amendments to the Basin Plan;

c) Comply with any applicable requirements, guidelines, and/or regulations issued or approved pursuant to CWA Section 402(p); and/or,

d) Consider any other federal, or state laws or regulations that became effective after adoption of this Order.

2. After notice and opportunity for a hearing, this Order may be terminated or modified for cause, including, but not limited to:

a) Violation of any term or condition contained in this Order;

b) Obtaining this Order by misrepresentation, or failure to disclose all relevant facts; or,

c) A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge.

3. The filing of a request by the Principal Permittee or Permittees for a modification, revocation and re-issuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any condition of this Order.

4. This Order may be modified to make corrections or allowances for changes in the permitted activity listed in this section, following the procedures at 40 CFR 122.63, if processed as a minor modification. Minor modifications may only:

a) Correct typographical errors, or

b) Require more frequent monitoring or reporting by the Permittee.

J. Severability

The provisions of this permit are severable; and if any provision of this permit or the application of any provision of this permit to any circumstance is held invalid, the application of such provision to other circumstances and the remainder of this permit shall not be affected.

K. Duty to Provide Information [40 CFR 122.41(h)]

The Permittees shall furnish, within a reasonable time, any information the Regional Board or USEPA may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this Order. The Permittees shall also furnish to the Regional Board, upon request, copies of records required to be kept by this Order.

L. Twenty-four Hour Reporting [40 CFR 122.41(l)(6)][3]

1. The Permittees shall report to the Regional Board any noncompliance that may endanger health or the environment. Any information shall be provided orally within 24 hours from the time any Permittee becomes aware of the circumstances. A written submission shall also be provided within five days of the time the Permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times and, if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

2. The Regional Board may waive the required written report on a case-by-case basis.

M. Bypass [40 CFR 122.41(m)][4]

Bypass (the intentional diversion of waste streams from any portion of a treatment facility) is prohibited. The Regional Board may take enforcement action against Permittees for bypass unless:

1. Bypass was unavoidable to prevent loss of life, personal injury or severe property damage. (Severe property damage means substantial physical damage to property, damage to the treatment facilities that causes them to become inoperable, or substantial and permanent loss of natural resources that can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.);

2. There were no feasible alternatives to bypass, such as the use of auxiliary treatment facilities, retention of untreated waste, or maintenance during normal periods of equipment down time. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass that could occur during normal periods of equipment downtime or preventive maintenance;

3. The Permittee submitted a notice at least ten days in advance of the need for a bypass to the Regional Board; or,

4. Permittees may allow a bypass to occur that does not cause effluent limitations to be exceeded, but only if it is for essential maintenance to

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[3] This provision applies to incidents where effluent limitations (numerical or narrative) as provided in this Order or in the Los Angeles County SQMP are exceeded, and which endanger public health or the environment.

[4] This provision applies to the operation and maintenance of storm water controls and BMPs as provided in this Order or in the SQMP.

assure efficient operation. In such a case, the above bypass conditions are not applicable. The Permittee shall submit notice of an unanticipated bypass as required.

N. Upset [40 CFR 122.41(n)][5]

Upset means an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

1. A Permittee that wishes to establish the affirmative defense of an upset in an action brought for non compliance shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:

    a) An upset occurred and that the Permittee can identify the cause(s) of the upset;

    b) The permitted facility was being properly operated by the time of the upset;

    c) The Permittee submitted notice of the upset as required; and,

    d) The Permittee complied with any remedial measures required.

2. No determination made before an action for noncompliance, such as during administrative review of claims that non-compliance was caused by an upset, is final administrative action subject to judicial review.

3. In any enforcement proceeding, the Permittee seeking to establish the occurrence of an upset has the burden of proof.

O. Property Rights [40 CFR 122.41(g)]

This Order does not convey any property rights of any sort, or any exclusive privilege.

P. Enforcement

1. Violation of any of the provisions of the NPDES permit or any of the provisions of this Order may subject the violator to any of the penalties described herein, or any combination thereof, at the discretion of the prosecuting authority; except that only one kind of penalties may be applied for each kind of violation. The CWA provides the following:

    a) Criminal Penalties for:

[5] *Supra*. See footnote number 3.

(1) Negligent Violations:

The CWA provides that any person who negligently violates permit conditions implementing § 301, 302, 306, 307, 308, 318, or 405 is subject to a fine of not less than $2,500 nor more than $25,000 per day for each violation, or by imprisonment for not more than 1 year, or both.

(2) Knowing Violations:

The CWA provides that any person who knowingly violates permit conditions implementing § 301, 302, 306, 307, 308, 318, or 405 is subject to a fine of not less than $5,000 nor more than $50,000 per day of violation, or by imprisonment for not more than 3 years, or both.

(3) Knowing Endangerment:

The CWA provides that any person who knowingly violates permit conditions implementing § 301, 302, 307, 308, 318, or 405 and who knows at that time that he is placing another person in imminent danger of death or serious bodily injury is subject to a fine of not more than $250,000, or by imprisonment for not more than 15 years, or both.

(4) False Statement:

The CWA provides that any person who knowingly makes any false material statement, representation, or certification in any application, record, report, plan, or other document filed or required to be maintained under the Act or who knowingly falsifies, tampers with, or renders inaccurate, any monitoring device or method required to be maintained under the Act, shall upon conviction, be punished by a fine of not more than $10,000 or by imprisonment for not more than two years, or by both. If a conviction is for a violation committed after a first conviction of such person under this paragraph, punishment shall be by a fine of not more than $20,000 per day of violation, or by imprisonment of not more than four years, or by both. (See CWA § 309(c)(4))

b) Civil Penalties

The CWA provides that any person who violates a permit condition implementing § 301, 302, 306, 307, 308, 318, or 405 is subject to a civil penalty not to exceed $27,500 per day for each violation.

2. The CWC provides that any person who violates a waste discharge requirement provision of the CWC is subject to civil penalties of up to $5,000 per day, $10,000 per day, or $25,000 per day of violation; or when the violation involves the discharge of pollutants, is subject to civil penalties of up to $10 per gallon per day or $25 per gallon per day of violation; or some combination thereof, depending on the violation or combination of violations.

Q. Need to Halt or Reduce Activity not a Defense [40 CFR 122.41(c)]

It shall not be a defense for a Permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this Order.

R. Rescission

Regional Board Order No. 96-054 is hereby rescinded.

S. Expiration

This Order expires on December 12, 2006. The Permittees must submit a Report of Waste Discharges and a proposed Storm Water Quality Management Program in accordance with CCR Title 23 as application for reissuance of waste discharge requirements no later than June 12, 2006.

I, Dennis A. Dickerson, Regional Board Executive Officer, do hereby certify that the foregoing is a full, true, and correct copy of an order adopted by the California Regional Water Quality Control Board, Los Angeles Region, on December 13, 2001.

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Dennis A. Dickerson
Executive Officer

Protection of Groundwater From Intentional and Nonintentional Stormwater Infiltration

Pitt, R., S. Clark, and K. Parmer. *Protection of Groundwater from Intentional and Nonintentional Stormwater Infiltration*. U.S. Environmental Protection Agency, EPA/600/SR-94/051. PB94-165354AS, Storm and Combined Sewer Program, Cincinnati, Ohio. 187 pgs. May 1994.

CHAPTER 1

SUMMARY AND CONCLUSIONS

Prior to urbanization, groundwater recharge resulted from infiltration of precipitation through pervious surfaces, including grasslands and woods. This infiltrating water was relatively uncontaminated. With urbanization, the permeable soil surface area through which recharge by infiltration could occur was reduced. This resulted in much less groundwater recharge and greatly increased surface runoff. In addition, the waters available for recharge generally carried increased quantities of pollutants. With urbanization, new sources of groundwater recharge also occurred, including recharge from domestic septic tanks, percolation basins and industrial waste injection wells, and from agricultural and residential irrigation. This book addresses potential groundwater problems associated with stormwater toxicants, and describes how conventional stormwater control practices can reduce these problems. This chapter is a summary of the main findings, conclusions, and recommendations contained in the main body of the book, where more detailed and referenced discussions are contained.

Chapter 2 presents a summary of the characteristics of urban runoff, especially from different source areas as monitored in an earlier phase of this EPA funded research. This information is needed to identify critical sources of contaminants that may adversely affect ground and surface receiving waters. These sources can either be controlled, or otherwise diverted from the receiving waters. Chapter 3 is a literature review of potential groundwater impacts associated with pollutants that may be found in stormwater. This information is based on literature describing groundwater problem case studies associated with several classes of stormwater pollutants from different types of source waters, including: stormwater, sanitary wastewater, agriculture operations, and some industrial operations. Appendix A is an annotated bibliography of this literature, including abstracts of the references. The information in chapters 2 and 3 can be used to identify which stormwater pollutants may adversely affect groundwater, and where they may originate. Chapter 4 summarizes the available treatment options for stormwater before discharge. This information can be used to suggest control methods that should be used at critical source areas, or at an outfall, before groundwater discharge. If pretreatment before infiltration is not practicable for a critical area, then other control options may need to be considered, especially pollution prevention or diversion of the runoff away from areas prone to groundwater infiltration.

This book presents information collected as part of a multi-year research project sponsored by the U.S. EPA. The first year of this research project included conducting the literature review and preparation of this book and the design and construction of a treatment device suitable for use at a class of critical source areas, specifically automobile service areas (gas stations, vehicle repair shops, public works maintenance yards, bus barns, etc.), and the installation of several inlet retro-fitted devices to control runoff in residential and commercial areas. As part of this design effort, more than 20 samples were collected from a residential area, a school bus maintenance area, and two public works yards in Stafford, New Jersey. These samples were analyzed for a wide range of conventional and toxic pollutants that could potentially affect groundwater quality (if the water was infiltrated) and the design of the inlet devices and special treatment device. This information was used in the design of the critical area treatment device (the Multi Chambered Treatment Tank, or MCTT) and will be included in an EPA research report.

The second project phase includes monitoring three inlet and the MCTT stormwater treatment device over an extended period of time for many toxicants. Controlled tests for different filtering media are also being conducted during this project phase. These devices can all play a role in the pretreatment of stormwater before discharge to groundwaters. These research activities will result in design manuals for these devices for many U.S. locations. The third project phase is expected to include groundwater monitoring near an existing stormwater infiltrating trench gallery that has been operating in Stafford, New Jersey, for several years.

CHARACTERISTICS OF URBAN RUNOFF

Urban runoff is comprised of many different flow phases. These may include dry-weather base flows, stormwater runoff, combined sewer overflows (CSOs) and snowmelt. The relative magnitudes of these discharges vary considerably, based on a number of factors. Season (such as cold versus warm weather, or dry versus wet weather) and land use have been identified as important factors affecting base flow and stormwater runoff quality.

Land development increases stormwater runoff volumes and pollutant concentrations. Impervious surfaces, such as rooftops, driveways and roads, reduce infiltration of rainfall and runoff into the ground and degrade runoff quality. The most important hydraulic factors affecting urban runoff volume (and therefore the amount of water available for groundwater infiltration) are the quantity of rain and the extent of impervious surfaces directly connected to a stream or drainage system. Directly connected impervious areas include paved streets, driveways, and parking areas draining to curb and gutter drainage systems, and roofs draining directly to a storm or combined sewer pipe.

BOD_5 and nutrient concentrations in stormwater are lower than in raw sanitary wastewater; they are closer in quality to typically treated sanitary wastewaters. However, urban stormwater has relatively high concentrations of bacteria, along with high concentrations of many metallic and some organic toxicants.

Flow Phases

Possibly 25 percent of all separate stormwater outfalls have water flowing in them during dry weather, and as much as 10 percent are grossly contaminated with raw sewage, industrial wastewaters, etc. If stormwater is infiltrated before it enters the drainage system (such as by using French drains, infiltration trenches, grass swales, porous pavements or percolation ponds in upland areas) then the effects of inappropriate contaminated discharges into the drainage system on groundwater will be substantially reduced, compared to outfall infiltration practices. If outfall waters are to be infiltrated in larger regional facilities, then the effects of contaminated dry-weather flows will have to be considered.

Pathogenic Microorganisms

Most of the effort in describing bacteria associated with urban runoff has involved fecal coliform analyses, mainly because of its historical use in water quality standards. However, many researchers have concluded that the fecal coliform test cannot be relied on to accurately assess the pathogenicity of recreational waters receiving urban runoff from uncontaminated storm sewers. Pathogenic bacteria have routinely been found in urban runoff at many locations.

Historically, fecal coliform standards of less than 200 organisms/100 mL have been recommended because the frequency of Salmonella detection has been found to increase sharply at fecal coliform concentrations greater than this value in waters receiving sanitary sewage discharges. The occurrence of Salmonella biotypes in urban runoff is generally low, with their reported densities ranging from less than one, to a high of ten organism/100 mL. However, numerous urban runoff studies have not detected any Salmonella. In addition, Salmonella observations in urban runoff have not correlated well with fecal coliform observations. Salmonella is not usually considered a significant hazard in urban runoff because of the relatively large required infective dose and the low concentrations found in urban runoff.

The evidence of low densities and required high infective doses for Salmonella cannot minimize the health hazard of other pathogens that have been found in urban runoff (such as *P. aeruginosa*, *Shigella*, or enteroviruses) that do not require ingestion, or only require very low infective doses. Shigella species causing bacillary dysentery are one of the primary human enteric disease producing bacteria present in water. Pseudomonas is reported to be the most abundant pathogenic bacteria organism in urban runoff and streams. Several thousand *Pseudomonas aeruginosa* organisms per 100 mL have been commonly found in many urban runoff samples. Relatively small populations of *P. aeruginosa* may be capable of causing water contact health problems ("swimmers ear", and skin infections) and it is resistant to antibiotics. Pathogenic *E. coli* can also be commonly found in urban runoff.

Viruses may also be important pathogens in urban runoff. Very small amounts of a virus are capable of producing infections or diseases, especially when compared to the large numbers of bacteria organisms required for infection. Viruses are usually detected, but at low levels, in urban receiving waters and stormwater.

Toxicants

Nationwide testing has not indicated any significant regional differences in the toxicants detected, or in their concentrations. However, land use (especially residential versus industrial areas) has been found to be a significant factor in toxicant concentrations and yields. Concentrations of many urban runoff toxicants have exceeded the EPA water quality criteria for human health protection by large amounts.

Pesticides (α-BHC, γ-BHC, chlordane and α-Endosulfan) are mostly found in dry-weather flows from residential areas, while heavy metals (As, Cd, Cr, Cu, Pb, and Zn) and other toxic materials (pentachlorophenol, bis (2-ethylhexyl) phthalate, and the PAHs: chrysene, fluoranthene, phenanthrene, and pyrene) are more prevalent in stormwater from industrial areas, although they are also commonly found in runoff from residential and commercial areas. Many of the heavy metals found in industrial area urban runoff were found at high concentrations during both dry-weather and wet-weather conditions.

Sources of Pollutants

High bacteria populations have been found in sidewalk, road, and some bare ground sheetflow samples (collected from locations where dogs would most likely be "walked"). Tables 1 and 2 summarize toxicant concentrations and likely sources or locations having some of the highest concentrations found during an earlier phase of this EPA funded research. The detection frequencies for the heavy metals are all close to 100 percent for all source areas, while the detection frequencies for the organics shown ranged from about 10 to 25 percent. Vehicle service areas had the greatest abundance of observed organics, with landscaped areas having many of the observed organics.

Table 1. Heavy Metal Source Area Observations

Toxicant	**Highest median conc. (µg/L)**	**Source Area**	**Highest conc. (µg/L)**	**Source Area**
Cadmium	8	vehicle service area runoff	220	street runoff
Chromium	100	landscaped area runoff	510	roof runoff
Copper	160	urban receiving water	1250	street runoff
Lead	75	CSO	330	storage area runoff
Nickel	40	parking area runoff	130	landscaped area runoff
Zinc	100	roof runoff	1580	roof runoff

Table 2 Toxic Organic Source Area Observations

Toxicant	**Maximum (µg/L)**	**Detection Frequency (%)**	**Significant Sources**
Benzo (a) anthracene	60	12	gasoline, wood preservative
Benzo (b) fluoranthene	226	17	gasoline, motor oils
Benzo (k) fluoranthene	221	17	gasoline, bitumen, oils
Benzo (a) pyrene	300	17	asphalt, gasoline, oils
Fluoranthene	128	23	oils, gasoline, wood preservative
Naphthalene	296	13	coal tar, gasoline, insecticides
Phenanthrene	69	10	oils, gasoline, coal tar
Pyrene	102	19	oils, gasoline, bitumen, coal tar, wood preservative
Chlordane	2.2	13	insecticide
Butyl benzyl phthalate	128	12	plasticizer
Bis (2-chloroethyl) ether	204	14	fumigant, solvents, insecticides, paints, lacquers, varnishes
Bis (2-chloroisopropyl) ether	217	14	pesticides

1,3-Dichlorobenzene	120	23	pesticides

CONSTITUENTS OF CONCERN

Nutrients

Nitrates are one of the most frequently encountered contaminants in groundwater. Groundwater contamination of phosphorus has not been as widespread, or as severe, as for nitrogen compounds.

Whenever nitrogen-containing compounds come into contact with soil, a potential for nitrate leaching into groundwater exists, especially in rapid-infiltration wastewater basins, stormwater infiltration

devices, and in agricultural areas. Nitrate has leached from fertilizers and affected groundwaters under various turf grasses in urban areas, including golf courses, parks and home lawns. Significant leaching of nitrates occurs during the cool, wet seasons. Cool temperatures reduce denitrification and ammonia volatilization, and limit microbial nitrogen immobilization and plant uptake. The use of slow-release fertilizers is recommended in areas having potential groundwater nitrate problems. The slow-release fertilizers include urea formaldehyde (UF), methylene urea, isobutylidene diurea (IBDU), and sulfur-coated urea.

Residual nitrate concentrations are highly variable in soil due to soil texture, mineralization, rainfall and irrigation patterns, organic matter content, crop yield, nitrogen fertilizer/sludge rate, denitrification, and soil compaction. Nitrate is highly soluble (>1 kg/L) and will stay in solution in the percolation water, after leaving the root zone, until it reaches the groundwater.

Pesticides

Urban pesticide contamination of groundwater can result from municipal and homeowner use of pesticides for pest control and their subsequent collection in stormwater runoff. Pesticides that have been found in urban groundwaters include: 2,4-D, 2,4,5-T, atrazine, chlordane, diazinon, ethion, malathion, methyl trithion, silvex, and simazine. Heavy repetitive use of mobile pesticides on irrigated and sandy soils likely contaminates groundwater. Fungicides and nematocides must be mobile in order to reach the target pest and hence, they generally have the highest contamination potential. Pesticide leaching depends on patterns of use, soil texture, total organic carbon content of the soil, pesticide persistence, and depth to the water table.

The greatest pesticide mobility occurs in areas with coarse-grained or sandy soils without a hardpan layer, having low clay and organic matter content and high permeability. Structural voids, which are generally found in the surface layer of finer-textured soils rich in clay, can transmit pesticides rapidly when the voids are filled with water and the adsorbing surfaces of the soil matrix are bypassed. In general, pesticides with low water solubilities, high octanol-water partitioning coefficients, and high carbon partitioning coefficients are less mobile. The slower moving pesticides have been recommended in areas of groundwater contamination concern. These include the fungicides iprodione and triadimefon, the insecticides isofenphos and chlorpyrifos and the herbicide glyphosate. The most mobile pesticides include:

2,4-D, acenaphthylene, alachlor, atrazine, cyanazine, dacthal, diazinon, dicamba, malathion, and metolachlor.

Pesticides decompose in soil and water, but the total decomposition time can range from days to years. Literature half-lives for pesticides generally apply to surface soils and do not account for the reduced microbial activity found deep in the vadose zone. Pesticides with a thirty-day half life can show considerable leaching. An order-of-magnitude difference in half-life results in a five- to ten-fold difference in percolation loss. Organophosphate pesticides are less persistent than organochlorine pesticides, but they also are not strongly adsorbed by the sediment and are likely to leach into the vadose zone, and the groundwater.

Other Organics

The most commonly occurring organic compounds that have been found in urban groundwaters include phthalate esters (especially bis(2-ethylhexyl)phthalate) and phenolic compounds. Other organics more rarely found, possibly due to losses during sample collection, have included the volatiles: benzene, chloroform, methylene chloride, trichloroethylene, tetrachloroethylene, toluene, and xylene. PAHs (especially benzo(a)anthracene, chrysene, anthracene and benzo(b)fluoroanthenene) have also been found in groundwaters near industrial sites.

Groundwater contamination from organics, like from other pollutants, occurs more readily in areas with sandy soils and where the water table is near the land surface. Removal of organics from the soil and recharge water can occur by one of three methods: volatilization, sorption, and degradation. Volatilization can significantly reduce the concentrations of the most volatile compounds in groundwater, but the rate of gas transfer from the soil to the air is usually limited by the presence of soil water. Hydrophobic sorption onto soil organic matter limits the mobility of less soluble base/neutral and acid extractable compounds through organic soils and the vadose zone. Sorption is not always a permanent removal mechanism, however. Organic re-solubilization can occur during wet periods following dry periods. Many organics can be at least partially degraded by microorganisms, but others cannot. Temperature, pH, moisture content, ion exchange capacity of soil, and air availability may limit the microbial degradation potential for even the most degradable organic.

Pathogenic Microorganisms

Viruses have been detected in groundwater where stormwater recharge basins were located short distances above the aquifer. Enteric viruses are more resistant to environmental factors than enteric bacteria and they exhibit longer survival times in natural waters. They can occur in potable and marine waters in the absence of fecal coliforms. Enteroviruses are also more resistant to commonly used disinfectants than are indicator bacteria, and can occur in groundwater in the absence of indicator bacteria.

The factors that affect the survival of enteric bacteria and viruses in the soil include pH, antagonism from soil microflora, moisture content, temperature, sunlight, and organic matter. The two most important attributes of viruses that permit their long-term survival in the environment are their structure and very small size. These characteristics permit virus occlusion and protection within colloid-size particles. Viral adsorption is promoted by increasing cation concentration, decreasing pH and decreasing soluble organics. Since the movement of viruses through soil to groundwater occurs in the liquid phase and involves water movement and associated suspended virus particles, the distribution of viruses between the adsorbed and liquid phases determines the viral mass available for movement. Once the virus reaches the groundwater, it can travel laterally through the aquifer until it is either adsorbed or inactivated.

The major bacterial removal mechanisms in soil are straining at the soil surface and at intergrain contacts, sedimentation, sorption by soil particles, and inactivation. Because of their larger size than for viruses, most bacteria are therefore retained near the soil surface due to this straining effect. In general, enteric bacteria survive in soil between two and three months, although survival times up to five years have been documented.

<u>Heavy Metals and Other Inorganic Compounds</u>

Heavy metals and other inorganic compounds in stormwater of most environmental concern, from a groundwater pollution standpoint, are aluminum, arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, and zinc. However, the majority of these compounds, with the consistent exception of zinc, are mostly found associated with the particulate solids in stormwaters and are thus relatively easily removed through sedimentation practices. Filterable forms of the metals may also be removed by either sediment adsorption or are organically complexed with other particulates.

In general, studies of recharge basins receiving large metal loads found that most of the heavy metals are removed either in the basin sediment or in the vadose zone. Dissolved metal ions are removed from stormwater during infiltration mostly by adsorption onto the near-surface particles in the vadose zone, while the particulate metals are filtered out at the soil surface. Studies at recharge basins found that lead, zinc, cadmium, and copper accumulated at the soil surface with little downward movement over many years. However, nickel, chromium, and zinc concentrations have exceeded regulatory limits in the soils below a recharge area at a commercial site. Elevated groundwater heavy metal concentrations of aluminum, cadmium, copper, chromium, lead, and zinc have been found below stormwater infiltration devices where the groundwater pH has been acidic. Allowing percolation ponds to go dry between storms can be counterproductive to the removal of lead from the water during recharge. Apparently, the adsorption bonds between the sediment and the metals can be weakened during the drying period.

Similarities in water quality between runoff water and groundwater has shown that there is significant downward movement of copper and iron in sandy and loamy soils. However, arsenic, nickel, and lead did not significantly move downward through the soil to the groundwater. The exception to this was some downward movement of lead with the percolation water in sandy soils beneath stormwater recharge basins. Zinc, which is more soluble than iron, has been found in higher concentrations in groundwater than iron. The order of attenuation in the vadose zone from infiltrating stormwater is: zinc (most mobile) > lead > cadmium > manganese > copper > iron > chromium > nickel > aluminum (least mobile).

<u>Salts</u>

Salt applications for winter traffic safety is a common practice in many northern areas and the sodium and chloride, which are collected in the snowmelt, travel down through the vadose zone to the groundwater with little attenuation. Soil is not very effective at removing salts. Salts that are still in the percolation water after it travels through the vadose zone will contaminate the groundwater. Infiltration of stormwater has led to increases in sodium and chloride concentrations above background concentrations. Fertilizer and pesticide salts also accumulate in urban areas and can leach through the soil to the groundwater.

Studies of depth of pollutant penetration in soil have shown that sulfate and potassium concentrations decrease with depth, while sodium, calcium, bicarbonate, and chloride concentrations increase with depth. Once contamination with salts begin, the movement of salts into the groundwater can be rapid. The salt concentration may not decrease until the source of the salts is removed.

TREATMENT OF STORMWATER

Table 3 summarizes the filterable fraction of toxicants found in stormwater runoff sheet flows from many urban areas found during an earlier phase of this EPA funded research. Pollutants that are mostly in filterable forms have a greater potential of affecting groundwater and are more difficult to control using conventional stormwater control practices that mostly rely on sedimentation and filtration principles. Luckily, most of the toxic organics and metals are associated with the non-filterable (suspended solids) fraction of the wastewaters during wet weather. Likely exceptions include zinc, fluoranthene, pyrene, and 1,3-dichlorobenzene, which may be mostly found in the filtered sample portions. However, dry-weather flows in storm drainage tend to have much more of the toxicants associated with filtered sample fractions.

Table 3. Reported Filterable Fractions of Stormwater Toxicants from Source Areas

Constituent	Filterable Fraction (%)
Cadmium	20 to 50
Chromium	<10
Copper	<20
Iron	small amount
Lead	<20
Nickel	small amount
Zinc	>50
Benzo (a) anthracene	none found in filtered fraction
Fluoranthene	65
Naphthalene	25
Phenanthrene	none found in filtered fraction
Pyrene	95
Chlordane	none found in filtered fraction
Butyl benzyl phthalate	irregular
Bis (2-chloroethyl) ether	irregular
Bis (2-chlrorisopropyl) ether	none found in filtered fraction
1,3-dichlorobenzene	75

Sedimentation is the most common fate and control mechanism for particulate related pollutants. This would be common for most stormwater pollutants, as noted above. Particulate removal can occur in many conventional stormwater control processes, including catchbasins, screens, drainage systems, and detention ponds. Sorption of pollutants onto solids and metal precipitation increase the sedimentation potential of these pollutants and also encourages more efficient bonding of the pollutants in soils, preventing their leaching to groundwaters. Detention ponds are probably the most common management practice for the control of stormwater runoff. If properly designed, constructed, and maintained, wet detention ponds can be very effective in controlling a wide range of pollutants. The monitored performance of wet detention ponds can be more than 90 percent removal of suspended solids, 70 percent for BOD_5 and COD, nutrient removals of about 60 to 70 percent, and heavy metal removals of about 60 to 95 percent. Catchbasins are very small sedimentation devices. Adequate cleaning can help to reduce the total solids and lead urban runoff yields by between 10 and 25 percent, and COD, total Kjeldahl nitrogen, total phosphorus, and zinc by between 5 and 10 percent. Other important fate mechanisms available in wet detention ponds, but which are probably not as important in small sump devices such as catchbasins, include volatilization and photolysis. Biodegradation, biotransformation, and bioaccumulation (into plants and animals) may also occur in ponds.

Upland infiltration devices (such as infiltration trenches, porous pavements, percolation ponds, and grass roadside drainage swales) are located at urban source areas. Infiltration (percolation) ponds are usually located at stormwater outfalls, or at large paved areas. These basins, along with perforated storm sewers, can infiltrate flows and pollutants from all upland sources combined. Infiltration devices can safely deliver large fractions of the surface flows to groundwater, if carefully designed and located. Local conditions that can make stormwater infiltration inappropriate include steep slopes, slowly percolating soils, shallow groundwater, and nearby groundwater uses. Grass filter strips may be quite effective in removing particulate pollutants from overland flows. The filtering effects of grasses, along with increased infiltration/recharge, reduce the particulate sediment load from urban landscaped areas. Grass swales are another type of infiltration device and can be used in place of concrete curb and gutters in most land uses, except possibly strip commercial and high density residential areas. Grass swales allow the recharge of significant amounts of surface flows. Swales can also reduce the concentration of pollutants, due to filtration. Soluble and particulate heavy metal (copper, lead, zinc, and cadmium) concentrations can be reduced by at least 50 percent, COD, nitrate nitrogen, and ammonia nitrogen concentrations can be reduced by about 25 percent, but only very small concentration reductions can be expected for organic nitrogen, phosphorus, and bacteria.

Sorption of pollutants to soils is probably the most significant fate mechanism of toxicants in biofiltration devices. Many of the devices also use sedimentation and filtration to remove the particulate forms of the pollutants from the water. Incorporation of the pollutants onto soil with subsequent biodegradation, with minimal resultant leaching to the groundwater, is desired. Volatilization, photolysis, biotransformation, and bioconcentration may also be significant in grass filter strips and grass swales. Underground French drains and porous pavements offer little biological activity to reduce toxicants.

CONCLUSIONS

Table 4 is a summary of the pollutants found in stormwater that may cause groundwater contamination problems for various reasons. This table does not consider the risk associated with using groundwater contaminated with these pollutants. Causes of concern include high mobility (low sorption potential) in the vadose zone, high abundance (high concentrations and high detection frequencies) in stormwater, and high soluble fractions (small fraction associated with particulates which would have little removal potential using conventional stormwater sedimentation controls) in the stormwater. The contamination potential is the lowest rating of the influencing factors. As an example, if no pretreatment was to be used before percolation through surface soils, the mobility and abundance criteria are most important. If a compound was mobile, but was in low abundance (such as for VOCs), then the groundwater contamination potential would be low. However, if the compound was mobile and was also in high abundance (such as for sodium chloride, in certain conditions), then the groundwater contamination would be high. If sedimentation pretreatment was to be used before infiltration, then some of the pollutants will likely be removed before infiltration. In this case, all three influencing factors

Table 4. Groundwater Contamination Potential for Stormwater Pollutants

	Compounds	Mobility (sandy/low organic soils)	Abundance in storm-water	Fraction filterable	Contamination potential for surface infilt. and no pretreatment	Contamination potential for surface infilt. with sediment-ation	Contamination potential for sub-surface inj. with minimal pretreatment
Nutrients	nitrates	mobile	low/moderate	high	low/moderate	low/moderate	low/moderate
Pesticides	2,4-D	mobile	low	likely low	low	low	low
	γ-BHC (lindane)	intermediate	moderate	likely low	moderate	low	moderate
	malathion	mobile	low	likely low	low	low	low
	atrazine	mobile	low	likely low	low	low	low
	chlordane	intermediate	moderate	very low	moderate	low	moderate
	diazinon	mobile	low	likely low	low	low	low
Other organics	VOCs	mobile	low	very high	low	low	low
	1,3-dichloro-benzene	low	high	high	low	low	high
	anthracene	intermediate	low	moderate	low	low	low
	benzo(a) anthracene	intermediate	moderate	very low	moderate	low	moderate
	bis (2-ethylhexyl) phthalate	intermediate	moderate	likely low	moderate	low?	moderate
	butyl benzyl phthalate	low	low/moderate	moderate	low	low	low/moderate
	fluoranthene	intermediate	high	high	moderate	moderate	high
	fluorene	intermediate	low	likely low	low	low	low
	naphthalene	low/inter.	low	moderate	low	low	low
	penta-chlorophenol	intermediate	moderate	likely low	moderate	low?	moderate
	phenanthrene	intermediate	moderate	very low	moderate	low	moderate
	pyrene	intermediate	high	high	moderate	moderate	high
Pathogens	enteroviruses	mobile	likely present	high	high	high	high
	Shigella	low/inter.	likely present	moderate	low/moderate	low/moderate	high
	Pseudomonas aeruginosa	low/inter.	very high	moderate	low/moderate	low/moderate	high

	protozoa	low/inter.	likely present	moderate	low/moderate	low/moderate	high
Heavy metals	nickel	low	high	low	low	low	high
	cadmium	low	low	moderate	low	low	low
	chromium	inter./very low	moderate	very low	low/moderate	low	moderate
	lead	very low	moderate	very low	low	low	moderate
	zinc	low/very low	high	high	low	low	high
Salts	chloride	mobile	seasonally high	high	high	high	high

(mobility, abundance in stormwater, and soluble fraction) would be considered important. As an example, chlordane would have a low contamination potential with sedimentation pretreatment, while it would have a moderate contamination potential if no pretreatment was used. In addition, if subsurface infiltration/injection was used instead of surface percolation, the compounds would most likely be more mobile, making the abundance criteria the most important, with some regard given to the filterable fraction information for operational considerations.

This table is only appropriate for initial estimates of contamination potential because of the simplifying assumptions made, such as the likely worst case mobility measures for sandy soils having low organic content. If the soil was clayey and had a high organic content, then most of the organic compounds would be less mobile than shown on this table. The abundance and filterable fraction information is generally applicable for warm weather stormwater runoff at residential and commercial area outfalls. The concentrations and detection frequencies would likely be greater for critical source areas (especially vehicle service areas) and critical land uses (especially manufacturing industrial areas).

The stormwater pollutants of most concern (those that may have the greatest adverse impacts on groundwaters) include:

• nutrients: nitrate has a low to moderate groundwater contamination potential for both surface percolation and subsurface infiltration/injection practices because of its relatively low concentrations found in most stormwaters. If the stormwater nitrate concentration was high, then the groundwater contamination potential would likely also be high.

• pesticides: lindane and chlordane have moderate groundwater contamination potentials for surface percolation practices (with no pretreatment) and for subsurface injection (with minimal pretreatment). The groundwater contamination potentials for both of these compounds would likely be substantially reduced with adequate sedimentation pretreatment.

• other organics: 1,3-dichlorobenzene may have a high groundwater contamination potential for subsurface infiltration/injection (with minimal pretreatment). However, it would likely have a lower groundwater contamination potential for most surface percolation practices because of its relatively strong sorption to vadose zone soils. Both pyrene and fluoranthene would also likely have high groundwater contamination potentials for subsurface infiltration/injection practices, but lower contamination potentials for surface percolation practices because of their more limited mobility through the unsaturated zone (vadose zone). Others (including benzo(a)anthracene, bis (2-ethylhexyl) phthalate, pentachlorophenol, and phenanthrene) may also have moderate groundwater contamination potentials, if surface percolation with no pretreatment, or subsurface injection/infiltration is used. These compounds would have low groundwater contamination potentials if surface infiltration was used with sedimentation pretreatment. Volatile organic compounds (VOCs) may also have high groundwater contamination potentials if present in the stormwater (likely for some industrial and commercial facilities and vehicle service establishments).

• pathogens: enteroviruses likely have a high groundwater contamination potential for all percolation practices and subsurface infiltration/injection practices, depending on their presence in stormwater (likely, especially if contaminated with sanitary sewage). Other pathogens, including *Shigella*, *Pseudomonas aeruginosa*, and various protozoa, would also have high groundwater contamination potentials if subsurface infiltration/injection practices are used without disinfection. If disinfection (especially by chlorine or ozone) is used, then disinfection byproducts (such as trihalomethanes or ozonated bromides) would have high groundwater contamination potentials.

• heavy metals: nickel and zinc would likely have high groundwater contamination potentials if subsurface infiltration/injection was used. Chromium and lead would have moderate groundwater contamination potentials for subsurface infiltration/injection practices. All metals would likely have low groundwater contamination potentials if surface infiltration was used with sedimentation pretreatment.

• salts: chloride would likely have a high groundwater contamination potential in northern areas where road salts are used for traffic safety, irrespective of the pretreatment, infiltration or percolation practice used.

Pesticides have been mostly found in urban runoff from residential areas, especially in dry-weather flows associated with landscaping irrigation runoff. The other organics, especially the volatiles, are mostly found in industrial areas. The phthalates are found in all areas. The PAHs are also found in runoff from all areas, but they are in higher concentrations and occur more frequently in industrial areas. Pathogens are most likely associated with sanitary sewage contamination of storm drainage systems, but several bacterial pathogens are commonly found in surface runoff in residential areas. Zinc is mostly found in roof runoff and other areas where galvanized metal comes into contact with rainwater. Salts are at their greatest concentrations in snowmelt and early spring runoff in northern areas.

The control of these compounds will require a varied approach, including source area controls, end-of-pipe controls, and pollution prevention. All dry-weather flows should be diverted from infiltration devices because of their potentially high concentrations of soluble heavy metals, pesticides, and pathogens. Similarly, all runoff from manufacturing industrial areas should also be diverted from infiltration devices because of their relatively high concentrations of soluble toxicants. Combined sewer overflows should also be diverted because of sanitary sewage contamination. In areas of extensive snow and ice, winter snowmelt and early spring runoff should also be diverted from infiltration devices.

All other runoff should include pretreatment using sedimentation processes before infiltration, to both minimize groundwater contamination and to prolong the life of the infiltration device (if needed). This pretreatment can take the form of grass filters, sediment sumps, wet detention ponds, etc., depending on the runoff volume to be treated and other site specific factors. Pollution prevention can also play an important role in minimizing groundwater contamination problems, including reducing the use of galvanized metals, pesticides, and fertilizers in critical areas. The use of specialized treatment devices can also play an important role in treating runoff from critical source areas before these more contaminated flows commingle with cleaner runoff from other areas. Sophisticated treatment schemes, especially the use of chemical processes or disinfection, may not be warranted, except in special cases, especially considering the potential of forming harmful treatment by-products (such as THMs and soluble aluminum).

The use of surface percolation devices (such as grass swales and percolation ponds) that have a substantial depth of underlying soils above the groundwater, is preferable to using subsurface infiltration devices (such as dry wells, trenches or French drains, and especially injection wells), unless the runoff water is known to be relatively free of pollutants. Surface devices are able to take greater advantage of natural soil pollutant removal processes. However, unless all percolation devices are carefully designed and maintained, they may not function properly and may lead to premature hydraulic failure or contamination of the groundwater.

RECOMMENDATIONS

It has been suggested that, with a reasonable degree of site-specific design considerations to compensate for soil characteristics, infiltration can be very effective in controlling both urban runoff quality and quantity problems. This strategy encourages infiltration of urban runoff to replace the natural infiltration capacity lost through urbanization and to use the natural filtering and sorption capacity of soils to remove pollutants. However, potential groundwater contamination through infiltration of some types of urban runoff requires some restrictions. Infiltration of urban runoff having potentially high concentrations of pollutants that may pollute groundwater requires adequate pretreatment, or the diversion of these waters away from infiltration devices. The following general guidelines for the infiltration of stormwater and other storm drainage effluent are recommended in the absence of comprehensive site-specific evaluations:

- Dry-weather storm drainage effluent should be diverted from infiltration devices because of their probable high concentrations of soluble heavy metals, pesticides, and pathogenic microorganisms.

- Combined sewage overflows should be diverted from infiltration devices because of their poor water quality, especially high pathogenic microorganism concentrations, and high clogging potential.

- Snowmelt runoff should also be diverted from infiltration devices because of its potential for having high concentrations of soluble salts.

- Runoff from manufacturing industrial areas should also be diverted from infiltration devices because of its potential for having high concentrations of soluble toxicants.

• Construction site runoff must be diverted from stormwater infiltration devices (especially subsurface devices) because of its high suspended solids concentrations which would quickly clog infiltration devices.

• Runoff from other critical source areas, such as vehicle service facilities and large parking areas, should at least receive adequate pretreatment to eliminate their groundwater contamination potential before infiltration.

• Runoff from residential areas (the largest component of urban runoff from most cities) is generally the least polluted urban runoff flow and should be considered for infiltration. Very little treatment of residential area stormwater runoff should be needed before infiltration, especially if surface infiltration is through the use of grass swales. If subsurface infiltration (French drains, infiltration trenches, dry wells, etc.) is used, then some pretreatment may be needed, such as by using grass filter strips, or other surface filtration devices.

Recommended Stormwater Quality Monitoring to Evaluate Potential Groundwater Contamination

Most past stormwater quality monitoring has not been adequate to completely evaluate groundwater contamination potential. The following list shows the parameters that are recommended to be monitored if stormwater contamination potential needs to be considered, or infiltration devices are to be used. Other analyses are appropriate for additional monitoring objectives (such as evaluating surface water problems). In addition, all phases of urban runoff should be sampled, including stormwater runoff, dry-weather flows, and snowmelt.

- Contamination potential:
    - Nutrients (especially nitrates)
    - Salts (especially chloride)
    - VOCs (if expected in the runoff, such as from manufacturing industrial or vehicle service areas, could screen for VOCs with purgable organic carbon, POC, analyses)
    - Pathogens (especially enteroviruses, if possible, along with other pathogens such as *Pseudomonas aeruginosa*, Shigella, and pathogenic protozoa)
    - Bromide and total organic carbon, TOC (to estimate disinfection by-product generation potential, if disinfection by either chlorination or ozone is being considered)
    - Pesticides, in both filterable and total sample components (especially lindane and chlordane)
    - Other organics, in both filterable and total sample components (especially 1,3 dichlorobenzene, pyrene, fluoranthene, benzo (a) anthracene, bis (2-ethylhexyl) phthalate, pentachlorophenol, and phenanthrene)
    - Heavy metals, in both filterable and total sample components (especially chromium, lead, nickel, and zinc)
- Operational considerations:
    - Sodium, calcium, and magnesium (in order to calculate the sodium adsorption ratio to predict clogging of clay soils)
    - Suspended solids (to determine the need for sedimentation pretreatment to prevent clogging)

CHAPTER 2

CHARACTERISTICS OF URBAN RUNOFF

Unfortunately, some stormwaters from urban areas may be badly polluted. These waters may pose a potential threat to both surface and subsurface receiving waters. In order to protect these receiving water resources, treatment before discharge is likely needed. This chapter summarizes urban runoff quality. Many studies have investigated stormwater quality, with the EPA's Nationwide Urban Runoff Program (NURP) (EPA 1983) providing the largest and best known data base. This water quality data can be compared to the information presented in the following chapter to identify which urban runoff waters need treatment to protect groundwaters.

Urban runoff is comprised of many different flow types. These include dry-weather base flows, stormwater runoff, combined sewer overflows (CSOs) and snowmelt. The relative magnitudes of these discharges vary considerably, based on a number of factors. Season (especially cold versus warm weather) and land use have been identified as important factors affecting base flow and stormwater runoff quality, respectively (Pitt and McLean 1986). This chapter briefly summarizes a number of different observations of runoff quality for these different phases and land uses, along with summaries of observations of source area flows contributing to these combined discharges. This information can be used to identify the best stormwater candidates for infiltration controls, and which ones to avoid.

STORMWATER CHARACTERISTICS

Land development increases stormwater pollutant concentrations and volumes. Impervious surfaces, such as rooftops, driveways and roads, reduce infiltration of rainfall and runoff into the ground and degrade runoff quality. Maintenance of landscaped areas further degrades runoff quality. The average runoff volume from developing subdivisions has been reported to be more than ten times greater than that of typical pre-development agricultural areas (Madison, *et al.* 1979).

Factors affecting runoff water volume (and therefore the amount of water available for groundwater infiltration) include rainfall quantity and intensity, slope, soil permeability, land cover, impervious area and depression storage. Research during the Nationwide Urban Runoff Program (NURP) showed that the most important hydraulic factors affecting urban runoff volume were the quantity of rain and the extent of impervious surfaces directly connected to a stream or drainage system (EPA 1983).

Directly connected impervious areas include paved streets, driveways, and parking areas draining to curb and gutter drainage systems, or roofs draining directly to a storm sewer.

Table 5 presents historical stormwater quality data (APWA 1969) while Table 6 is a summary of the Nationwide Urban Runoff Program stormwater data collected from about 1979 through 1982 (EPA 1983). BOD_5 and nutrient concentrations in stormwater are lower than associated values for raw sanitary wastewater; they are closer in quality to typically treated sanitary wastewaters. However, urban stormwater has relatively high concentrations of bacteria, along with high concentrations of many metallic and some organic toxicants. As will be shown later, land use and source areas (parking areas, rooftops, streets, landscaped areas, etc.) all have important effects on stormwater runoff quality.

Urban Runoff Bacteria and their Associated Public Health Significance

Most of the effort in describing bacteria characteristics of urban runoff has involved fecal coliform analyses, mainly because of its historical use in water quality standards. Fecal coliform bacteria observations have long been used as an indicator of sanitary sewage contamination and therefore has been used as an indicator of possible pathogenic microorganism contamination (Field and O'Shea 1992). Fecal streptococci analyses are also relatively common for urban runoff. Unfortunately, relatively few analyses of specific pathogenic microorganisms have been made for urban runoff.

The fecal coliform test is not specific for any one coliform type, or groups of types, but instead has an excellent positive correlation for coliform bacteria derived from the intestinal tract of warm blooded animals (Geldreich, *et al.* 1968). The fecal coliform test measures *Escherichia coli* as well as all other coliforms that can ferment lactose at 44.5°C and are found in warm blooded fecal discharges. Geldreich (1976) found that the fecal coliform test represents over 96 percent of the coliforms derived from human feces and from 93 to 98 percent of those discharged in feces from other warm blooded animals, including livestock, poultry, cats, dogs, and rodents. In many urban runoff studies, all of the fecal coliforms were *E. coli* (Quresh and Dutka 1979). Field and O'Shea (1992) conclude that the fecal coliform test cannot be relied on to accurately assess the pathogenicity of recreational waters receiving urban runoff from uncontaminated storm sewers. The fecal streptococci test is sensitive to all of the intestinal Streptococci bacteria from warm blooded animal feces (Geldreich and Kenner 1969).

Pathogenic bacteria have been found in urban runoff at many locations and are probably from several different sources (Field, *et al.* 1976; Oliveria, *et al.* 1977; Qureshi and Dutka 1979; Environment Canada 1980; Pitt 1983; Pitt and McLean 1986; and Field and O'Shea 1992). Table 7 summarizes the occurrence of various pathogenic bacteria types found in urban stormwaters at Burlington, Ontario; Milwaukee; and Cincinnati. The observed ranges of concentrations and percent isolations of these biotypes vary significantly from site to site and at the same location for different times. However, it is seen that many of the potentially pathogenic bacteria biotypes can be present in urban stormwater runoff. The occurrence of Salmonella biotypes is generally low and their reported density is usually less than one organism/100 mL. *Pseudomonas aeruginosa* are frequently encountered at densities greater than ten organisms/100 mL.

Some authors do not feel that urban runoff presents a significant health problem. Olivieri, *et al.* (1977) do not believe that urban runoff constitutes a major health problem because of the large numbers of

TABLE 7. PATHOGENIC MICROORGANISMS FOUND IN URBAN STORMWATER (organisms/100mL)

City, Province/ State	catchment/ land-use	*Staphylo-coccus aureus*	*Pseudomonas aeruginosa*	Salmonella	Streptococci	Reference
Burlington, Ontario	Aldershot Plaza		14-3,000	*S. seftenberg* & *S. newport* isolated		Qureshi and Dutka, 1979
	Malvern Road		<1-740	100% negative		Qureshi and Dutka, 1979
Milwaukee, WI	highway runoff	all <1,000	all <1,000	45% positive		Gupta, et al, 1981
Cincinnati, OH	business district				79% positive [1]	Geldreich and Kenner, 1969
	residential area				80% positive [2]	Geldreich and Kenner, 1969
	rural area				87% positive [3]	Geldreich and Kenner, 1969

[1]Strep. bacteria types found: *S. bovis*/*S. equinus* (2%)
Atypical *S. faecalis* (1%)
S. faecalis liquifaciens (18%)

S. thompson: 4,500/100mL

[2]Strep. bacteria types found: *S. bovis*/*S. equinus* (0.5%)
Atypical *S. faecalis* (1%)
S. faecalis liquifaciens (18%)

[3]Strep. bacteria types found: *S. bovis*/*S. equinus* (0.5%)
Atypical *S. faecalis* (0.2%)
S. faecalis liquifaciens (12%)

in urban runoff. For urban runoff, it may be impossible to consume enough bacteria cells to establish the infective dose. The importance of urban runoff in disease transmission in the Ottawa area was also questioned by Gore and Storrie/Proctor and Redfern (1981). They stated that little or no correlation was found between fecal coliform indicator bacteria and pathogenic bacteria in Ottawa stormwater runoff and local receiving waters. They further stated that the currently applied objectives in Ontario for fecal coliforms for body contact recreation are neither universal nor absolute standards relating to disease or infection. They concluded that these numeric objectives should be reviewed for their applicability to the local swimming beaches. However, Field and O'Shea (1992) pointed out that the evidence of low densities and required high infective doses for some pathogens cannot minimize the health hazard of other pathogens that have been found in urban runoff (such as *P. aeruginosa*, *Salmonella typhosa*, *Shigella*, or enteroviruses) that do not require ingestion, or only require very low infective doses.

Urban Runoff Salmonella Observations--

Salmonella has been reported in some, but not all, urban stormwaters. Oureshi and Dutka (1979) frequently detected Salmonella in southern Ontario stormwaters. They did not find any predictable patterns of Salmonella isolations as they were found throughout the various sampling periods. Olivieri, *et al.* (1977) frequently found Salmonella in Baltimore runoff, but at relatively low concentrations. Typical concentrations were from five to 300 Salmonella organisms per ten liters. The concentrations of Salmonella were about ten times higher in the Baltimore stormwater samples than in the urban stream receiving the runoff. They also did not find any marked seasonal variations in Salmonella concentrations. Almost all of the stormwater samples that had fecal coliform concentrations greater that 2000 organisms/100 mL had detectable Salmonella concentrations. However, about 27 percent of the samples having fecal coliform concentrations less than 200 organisms/100 mL had detectable Salmonella.

Quite a few urban runoff studies did not detect Salmonella. Schillinger and Stuart (1978) found that Salmonella isolations were not common in a Montana subdivision study and that the isolations did not correlate well with fecal coliform concentrations. Environment Canada (1980) stated that Salmonella were virtually absent from Ottawa storm drainage samples obtained in 1979. They concluded that Salmonella are seldom present in significant numbers in Ottawa urban runoff. The types of Salmonella found in southern Ontario were *S. thompson* and *S. tvphimurium* var. *copenhagen* (Qureshi and Dutka 1979).

Olivieri, *et al.* (1977) stated that the primary human enteric disease producing Salmonella biotypes associated with the ingestion of water include *S. typhi* (typhoid fever), *S. paratyphi* (paratyphoid fever), and Salmonella species (salmonellosis). These biotypes are all rare, except for Salmonella. The dose of Salmonella required to produce an infection in a healthy adult is quite large (approximately 100,000 organisms). However, more sensitive individuals, such as children and the elderly, are much more susceptible to disease. The salmonellosis health hazard associated with urban streams is believed to be small because of this relatively large infective dose. If two liters of stormwater having typical Salmonella concentrations (ten Salmonella organisms per/ten liters) is ingested, less than 0.001 of the required infective dose would be ingested. If a worse case Salmonella stormwater concentration of 10,000 organisms/ten liters occurred, the ingestion of 20 liters of stormwater would be necessary for an infective dose. They stated that the low concentrations of Salmonella, coupled with the unlikely event of consuming enough stormwater, make the Salmonella health hazard associated with urban runoff small.

Geldreich (1965) recommended a fecal coliform standard of 200 organisms/100 mL because the frequency of Salmonella detection increased sharply at fecal coliform concentrations greater than this value. Setmire and Bradford (1980) stated that the National Academy of Sciences recommended a fecal coliform standard of 70/100 mL in waters with shellfish harvesting to restrict Salmonella concentrations in edible tissues. However, Field, *et al.* (1976) concluded that the use of indicator bacteria to protect Salmonella ingestion is less meaningful in stormwater runoff than in other waters.

Urban Runoff Shigella Observations--

Olivieri, *et al.* (1977) stated that there is circumstantial evidence that Shigella is present in urban runoff and receiving waters and could present a significant health hazard. There have been problems in isolating and quantifying Shigella bacteria. Shigella species causing bacillary dysentery are one of the primary human enteric disease producing bacteria agents present in water. The infective dose of Shigella necessary to cause dysentery is quite low (10 to 100 organisms). Because of this low required infective dose and the assumed presence of Shigella in urban waters, it may be a significant health hazard associated with urban runoff.

Urban Runoff *Pseudomonas aeruginosa* Observations--

Pseudomonas is reported to be the most abundant pathogenic bacteria organism in urban runoff and streams (Olivieri, *et al.* 1977). Pitt and McLean (1986) found *P. aeruginosa* populations of several thousand organisms per 100 mL in many urban runoff samples. No information could be found concerning the problems associated with ingestion of *P. aeruginosa* contaminated drinking waters. However, relatively small populations of *P. aeruginosa* may be capable of causing water contact health problems ("swimmers ear", and skin infections) and it is resistant to antibiotics.

Other Urban Runoff Pathogen Observations--

E. coli and *Vibrio cholerae* are disease producing pathogens associated with the ingestion of water. The cholera pathogen is quite rare, but *E. coli* is more common in urban runoff. The required infective oral dose of both of these pathogens is about 10^8 organisms for healthy adults (Olivieri, *et al.* 1977).

Viruses may also be significant pathogens in urban runoff. Very small amounts of a virus are capable of producing infections or diseases, especially when compared to the large numbers of bacteria organisms required for infection (Berg 1965). Olivieri, *et al.* (1977) stated that viruses are usually detected at low levels in urban receiving waters and storm runoff.

Summary of Urban Runoff Pathogenic Microorganism Observations--

Many potentially pathogenic bacteria biotypes may be present in urban runoff. Because of the low probability of direct ingestion of urban runoff, many of the potential human diseases associated with these biotypes are not likely to occur in normal receiving waters. The pathogenic organisms of most concern in urban runoff (and therefore that have received the most attention) are usually associated with skin infections and body contact in recreation waters. The most significant stormwater biotype causing skin infections would be *Pseudomonas aeruginosa*. This biotype has been detected frequently in most urban runoff studies in concentrations that may cause potential infections. Shigella may be present in urban runoff and receiving waters. This pathogen, when ingested in low numbers, can cause dysentery. A number of other pathogenic microorganisms have been periodically reported in urban runoff.

<u>Significant Stormwater Toxicants</u>

Stormwater research has quantified some inorganic and organic hazardous and toxic substances frequently found in urban runoff. The NURP data (Table 8), collected from mostly residential areas throughout the U.S., did not indicate any significant regional differences in the substances detected, or in their concentrations (EPA 1983). However, the residential and industrial data obtained by Pitt and McLean (1986) in Toronto found significant concentration and yield differences for these two distinct land uses and for dry-weather and wet-weather urban runoff flows.

The concentrations of many of these toxic pollutants exceeded the U.S. EPA water quality criteria for human health protection by large amounts. As an example, typical standards for PAHs in surface waters used as drinking water supplies are 2.8 ng/L (0.0028 μg/L) (EPA 1986). As shown on

Table 8, urban runoff concentrations of chrysene (0.6 to 10 μg/L), fluoranthene (0.3 to 21 μg/L), phenanthrene (0.3 to 10 μg/L) and pyrene (0.3 to 16 μg/L) (four of the most common PAHs found in urban runoff) have been reported to be from 100 to as much as several thousand times greater than this criteria.

TABLE 8. SUMMARY OF NURP PRIORITY POLLUTANT ANALYSES[1]
(Only those compounds found in greater than 10% of outfall samples are shown)

	Frequency of Detection %	Range of Detected Concentrations (μg/L)
Pesticide		
α - BHC	20	0.0027 to 0.1
γ - BHC (lindane)	15	0.007 to 0.1
Chlordane	17	0.01 to 10
α - Endosulfan	19	0.008 to 0.2
Metals and Cyanide		
Antimony	13	2.6 to 23
Arsenic	52	1 to 51
Beryllium	12	1 to 49
Cadmium	48	0.1 to 14
Chromium	58	1 to 190
Copper	91	1 to 100
Cyanides	23	2 to 300
Lead	94	6 to 460
Mercury	10	0.6 to 1.2
Nickel	43	1 to 182
Selenium	11	2 to 77
Zinc	94	10 to 2400
PCBs and Related Compounds		
(none detected in greater than 1% of all samples)		
Halogenated Aliphatics		
Methylene chloride	11	5 to 15
Ethers		
(None detected in any of the samples)		
Monocyclic Aromatics		
(None detected in greater than 6% of all samples)		
Phenols and Cresols		
Phenol	14	1 to 13
Pentachlorophenol	19	1 to 115
4-nitro phenol	10	1 to 37
Phthalate Esters		
bis (2-ethylhexyl) phthalate	22	4 to 62

Polycyclic Aromatic Hydrocarbons		
Chrysene	10	0.6 to 10
Fluoranthene	16	0.3 to 21
Phenanthrene	12	0.3 to 10
Pyrene	15	0.3 to 16

[1]Based on 121 samples from 17 cities

Source: EPA 1983.

Table 9 lists the toxic and hazardous substances that have been found in more than 10 percent of the industrial and residential urban runoff samples analyzed (Galvin and Moore 1982; EPA 1983; and Pitt and McLean 1986). As noted above, available NURP data do not reveal toxic urban runoff conditions significantly different from different parts of the U.S. (EPA 1983). The pesticides shown were mostly found in urban runoff from residential areas, while heavy metals and other hazardous materials were much more prevalent in industrial areas. Urban runoff dry-weather base flows may also be significant contributors of hazardous and toxic pollutants. Lindane (gamma-BHC) and dieldrin may be common in residential dry-weather storm sewer flows, while PCBs may be common in industrial dry-weather storm sewer flows. Many of the heavy metals found in industrial area urban runoff were found at high concentrations during both dry-weather and wet-weather conditions.

COMBINED SEWAGE CHARACTERISTICS

Combined sewage is made up of sanitary wastewater during dry-weather flow conditions, but also includes stormwater during wet-weather flow conditions. Because of the relatively slow sewage flow rates during dry weather, many combined sewage systems experience deposition of solids in the sewerage system. When stormwater enters the system during wet weather, this deposited material is flushed from the system. This "first-flush" therefore typically has greater pollutant concentrations than either separate stormwater or separate sanitary sewage (Moffa 1989). Tables 10 through 14 summarize various aspects of combined sewage. Table 12 compares bacteria densities of combined sewage with separate stormwater in Baltimore (Olivieri, *et al.* 1977). This table shows very little difference in the bacteria densities of these two sample types. Tables 13 and 14 show heavy metal and other toxicant concentrations in combined sewage. Pitt and Barron (1990) found all of the heavy metals investigated in New York City combined sewage samples, but only two of the base-neutral organic compounds were found in more than one of the 20 samples analyzed. None of the base-neutrals were detected (at a detection limit of about 1 μg/L) in the filtered sample portions, but most of the metals were found in the filtered samples.

RELATIVE CONTRIBUTIONS OF URBAN RUNOFF FLOW PHASES

Tables 15 and 16 summarize Toronto residential/commercial and industrial urban runoff characteristics during both warm and cold weather (Pitt and McLean 1986). These tables show the relative importance of wet-weather and dry-weather flows coming from separate stormwater systems. If urban runoff is to be directed to an outfall infiltration device, then the dry-weather flows will also be present at the outfalls. Possibly 25 percent of all separate stormwater outfalls have water flowing in them during dry weather, and as much as 10 percent are grossly contaminated with raw sewage, industrial wastewaters, etc. (Pitt, *et al.* 1993). The EPA's Stormwater Permit program requires municipalities to conduct stormwater outfall surveys to identify, and then correct, inappropriate discharges into separate storm drainage. However, it can be expected that substantial outfall contamination will exist for many years. If stormwater is infiltrated before it enters the drainage system (such as by using French drains, infiltration trenches, grass swales, porous pavements or percolation ponds in upland areas) then the effects of contamination problems in the drainage system on groundwater will be substantially reduced. If outfall waters are to be infiltrated in larger regional facilities, then these periods of dry-weather flows will have to be considered.

TABLE 9. HAZARDOUS AND TOXIC SUBSTANCES FOUND IN URBAN RUNOFF*

	Residential Areas	Industrial Areas
Haloginated Aliphatics		
1,2,-dichlorethene		x
Methylene chloride		x
Tetrachloroethylene		x
Phthalate Esters		
Bis (2-Ethylene) phthalate	x	
Butylbenzyl phthalate	x	x
Diethyl phthalate		x
Di-N-Butyl phthalate	x	x
Polycyclic Aromatic Hydrocarbons		
Phenanthrene		x
Pyrene		x
Other Volatiles		
Benzene	x	x
Chloroform		x
Ethylbenzene		x
N-Nitro-sodimethylamine		x
Toluene		x
Heavy Metals		
Aluminum	x	x
Chromium		x
Copper	x	x
Lead	x	x
Zinc	x	x
Pesticides and Phenols		
BHC	x	
Chlordane	x	
Dieldrin	x	
Endosulfan sulfate	x	
Endrin	x	
Isophorone	x	
Methoxychlor	x	
PCB-1254		x
PCB-1260		x
Pentachlorophenol	x	x
Phenol	x	x

*Substances found in at least 10 percent of the stormwater samples analyzed

TABLE 11. SELECTED COMBINED SEWER OVERFLOW BACTERIA DATA
(organisms/100mL)

City (reference)	Fecal Coliforms	Fecal strep
Ottawa (Ontario Ministry of the Environment 1983)	$5x10^5$-$9x10^6$	---
Toronto (Ontario Ministry of the Environment 1982)	10^6	---
Detroit (Geldreich 1976)	10^6-10^7	10^5
Selected Nationwide Data (Field & Struzeski 1972)	$2x10^4$-$2x10^7$	$2x10^4$-$2x10^6$

TABLE 13. CONCENTRATIONS OF HEAVY METALS IN COMBINED SEWER OVERFLOWS

Land Use Type	Copper (μg/L)		Zinc (μg/L)	Lead (μg/L)
COMBINED SEWER OVERFLOW				
Medium Density Residential[1]	77		191	93
High Density Residential[2]	48		185	84
Residential/Commercial	100		255	135
Light Industrial	58		136	47
Heavy Industrial	98		447	223
Mean for All Land Uses	76	2	242	116

[1]Medium Density Residential — 3 to 8 dwelling units per acre
[2]High Density Residential — 9 and more dwelling units per acre

Source: Johnson 1990

TABLE 14. NEW YORK CITY COMBINED SEWER OVERFLOW QUALITY SUMMARY
(average of observed values)

	total sample		filtered sample[1]		
	mean of observ.	detection frequency	mean of observ.	detection frequency	percent filterable[2]
Microtox toxicity (I_{35}, % light decrease)	59	20 of 20	-	-	-
pH	6.8	20 of 20	-	-	-
Suspended solids (mg/L)	94	20 of 20	-	-	-
Turbidity (NTU)	22	20 of 20	-	-	-
Particle size (median, microns)	50	20 of 20	-	-	-
Base Neutrals (1 µg/L detection limit)					
Nitrobenzene	26.5	1 of 20	nd[3]	0 of 20	0
Isophorone	10.4	1 of 20	nd	0 of 20	0
Bis(2-chloroethyl) ether	15.5	1 of 20	nd	0 of 20	0
1,3-Dichlorobenzene	22	1 of 20	nd	0 of 20	0
Naphthalene	7.7	1 of 20	nd	0 of 20	0
Diethyl phthalate	103	1 of 20	nd	0 of 20	0
Fluorene	9.3	1 of 20	nd	0 of 20	0
Di-n-butyl phthalate	33.2	4 of 20	nd	0 of 20	0
Phenanthrene	33.2	1 of 20	nd	0 of 20	0
Benzyl butyl phthalate	82.3	1 of 20	nd	0 of 20	0
Fluoranthene	6.6	1 of 20	nd	0 of 20	0
Bis(2-ethyl hexyl) phthalate	11500	5 of 20	nd	0 of 20	0
Pyrene	15.3	1 of 20	nd	0 of 20	0
Di-n-octyl phthalate	42.6	1 of 20	nd	0 of 20	0
Benzo(a) anthracene	10.9	1 of 20	nd	0 of 20	0
Chrysene	8.2	1 of 20	nd	0 of 20	0
Pesticides (0.3 µg/L detection limit)					
BHC	0.3	1 of 20	nd	0 of 20	0
DDD	1.2	1 of 20	nd	0 of 20	0
Chlordane	0.5	1 of 20	nd	0 of 20	0
Heavy Metals (1 µg/L detection limit)					
Aluminum (5 µg/L detection limit)	1890	20 of 20	204	14 of 20	11
Cadmium (0.1 µg/L detection limit)	2.8	20 of 20	0.9	20 of 20	32
Chromium	21.7	20 of 20	13.9	9 of 20	64
Copper	93.5	20 of 20	12.8	20 of 20	14
Lead	45.3	20 of 20	3.5	14 of 20	8
Nickel	15.3	20 of 20	8.8	19 of 20	58
Zinc	116	20 of 20	35.5	20 of 20	31

(1) A split sample portion was also filtered through a 0.45µm membrane filter before analysis to determine the filterable pollutant concentrations.

(2) The "percent filterable" is the percentage of the total sample concentration associated with the filtered sample portion: (filtered sample conc./total sample conc.)X100.

(3) nd: not detected

TABLE 15. MEDIAN CONCENTRATIONS OBSERVED AT TORONTO OUTFALLS DURING WARM WEATHER[1]

Constituent (mg/L unless noted)	Warm Weather Baseflow		Warm Weather Stormwater	
	Residential	Industrial	Residential	Industrial
Stormwater volume (m^3/ha/season)	--	--	950	1500
Baseflow volume (m^3/ha/season)	1700	2100	--	--
Total residue	979	554	256	371
Total dissolved solids (TDS)	973	454	230	208
Suspended solids (SS)	<5	43	22	117
Chlorides	281	78	34	17
Total phosphorus	0.09	0.73	0.28	0.75
Phosphates	<0.06	0.12	0.02	0.16
Total Kjeldahl nitrogen (organic N plus NH_3)	0.9	2.4	2.5	2.0
Ammonia nitrogen	<0.1	<0.1	<0.1	<0.1
Chemical oxygen demand (COD)	22	108	55	106
Fecal coliform bacteria (#/100mL)	33,000	7,000	40,000	49,000
Fecal strep. bacteria (#/100mL)	2,300	8,800	20,000	39,000
Pseudo. aeruginosa bacteria (#/100mL)	2,900	2,380	2,700	11,000
Arsenic	<0.03	<0.03	<0.03	<0.03
Cadmium	<0.01	<0.01	<0.01	<0.01
Chromium	<0.06	0.42	<0.06	0.32
Copper	0.02	0.05	0.03	0.06
Lead	<0.04	<0.04	<0.06	0.08
Selenium	<0.03	<0.03	<0.03	<0.03
Zinc	0.04	0.18	0.06	0.19
Phenolics (μg/L)	<1.5	2.0	1.2	5.1
α - BHC (ng/L)	17	<1	1	3.5
γ - BHC (Lindane) (ng/L)	5	<2	<1	<1
Chlordane (ng/L)	4	<2	<2	<2
Dieldrin (ng/L)	4	<5	<2	<2
Polychlorinated biphenols (PCBs) (ng/L)	<20	<20	<20	33
Pentachlorophenol (PCP) (ng/L)	280	50	70	705

(1) Warm weather samples were obtained during the late spring, summer, and early fall months when the air temperatures were above freezing and no snow was present.

Source: Pitt and McLean 1986

TABLE 16. MEDIAN CONCENTRATIONS OBSERVED AT TORONTO OUTFALLS DURING COLD WEATHER[2]

Constituent (mg/L unless noted)	Cold Weather Baseflow		Cold Weather Snowmelt	
	Residential	Industrial	Residential	Industrial
Stormwater volume (m^3/ha/season)	--	--	1800	830
Baseflow volume (m^3/ha/season)	1100	660	--	--
Total residue	2230	1080	1580	1340
Total dissolved solids (TDS)	2210	1020	1530	1240
Suspended solids (SS)	21	50	30	95
Chlorides	1080	470	660	620
Total phosphorus	0.18	0.34	0.23	0.50
Phosphates	<0.05	<0.02	<0.06	0.14
Total Kjeldahl nitrogen (organic N plus NH_3)	1.4	2.0	1.7	2.5
Ammonia nitrogen	<0.1	<0.1	0.2	0.4
Chemical oxygen demand (COD)	48	68	40	94
Fecal coliform bacteria (#/100mL)	9800	400	2320	300
Fecal strep bacteria (#/100mL)	1400	2400	1900	2500
Pseudo. aeruginosa bacteria (#/100mL)	85	55	20	30
Cadmium	<0.01	<0.01	<0.01	0.01
Chromium	<0.01	0.24	<0.01	0.35
Copper	0.02	0.04	0.04	0.07
Lead	<0.06	<0.04	0.09	0.08
Zinc	0.07	0.15	0.12	0.31
Phenolics (mg/L)	2.0	7.3	2.5	15
α - BHC (ng/L)	NA[2]	3	4	5
γ - BHC (Lindane) (ng/L)	NA	NA	2	1
Chlordane (ng/L)	NA	NA	11	2
Dieldrin (ng/L)	NA	NA	2	NA
Pentachlorophenol (PCP) (ng/L)	NA	NA	NA	40

(1) Cold weather samples were obtained during the winter months when the air temperatures were commonly below freezing. Snowmelt samples were obtained during snowmelt episodes and when rain fell on snow.

(2) NA: not analyzed

Source: Pitt and McLean 1986

Similar problems occur in areas having substantial snowfalls. Table 16 summarizes Toronto snowmelt and cold weather baseflow characteristics (Pitt and McLean 1986). The bacteria densities during cold weather are substantially less than during warm weather, but are still relatively high (EPA 1983). However, chloride concentrations and dissolved solids are much higher during cold weather. Early spring stormwater events also contain high dissolved solids concentrations (Bannerman, personal communication, WI DNR). Unfortunately, upland infiltration devices do not work well during cold weather due to freezing soils. Outfall flows occur under ice into receiving waters (including detention ponds) and may enter regional infiltration devices if not specifically diverted.

POLLUTANT CONTRIBUTIONS FROM DIFFERENT URBAN SOURCE AREAS

Limited source area sheetflow quality data is available from several studies conducted in California, Washington, Nevada, Wisconsin, Illinois, Ontario, Colorado, New Hampshire, New York, and Alabama since 1979. A relatively large amount of parking and roof runoff quality data has been obtained from all of these locations, but only a few of these studies evaluated a broad range of source areas or land uses. This information can be used to identify which upland areas can be controlled by direct infiltration, which ones would require significant pretreatment before infiltration, and which ones should not be discharged to the groundwater because of potentially high concentrations of problem pollutants that may not be able to be adequately treated. The major urban source area categories that have been studied include:

- roofs
- paved parking areas
- paved storage areas
- unpaved parking and storage areas
- driveways
- streets
- landscaped areas
- undeveloped areas
- freeway paved lanes and shoulders
- vehicle service areas

Tables 17 through 20, summarize much of the data available describing urban area runoff pollutants from these source areas for different land uses and seasons.

Lead and zinc concentrations are generally the highest in sheetflows from paved parking areas and streets, with some high zinc concentrations also found in roof drainage samples. High bacteria populations have been found in sidewalk, road, and some bare ground sheetflow samples (collected from locations where dogs would most likely be "walked").

Pentachlorophenol was detected (400 to 500 ng/L concentrations) in four of the five industrial source area samples analyzed for priority pollutants in Toronto (Pitt and McLean 1986). These samples were collected from an industrial subdrainage area and from a paved storage yard. Two of the five

TABLE 19. OTTAWA SHEETFLOW BACTERIA CHARACTERISTICS
(August 15 and September 23, 1981 samples)

		rooftop runoff	vacant land and park runoff	parking lot runoff	gutter flow
Fecal Coliforms	geometric mean (#/100mL)	85	5,600	2,900	3,500
	min (#/100mL)	10	360	200	500
	max (#/100mL)	400	79,000	19,000	10,000
	number of observations	4	7	6	7
Fecal Strep.	geometric mean (#/100mL)	170	16,500	11,900	22,600
	min (#/100mL)	20	12,000	1,600	1,800
	max (#/100mL)	3,600	57,000	40,000	1,200,000
	number of observations	4	7	6	7

Source: Pitt 1983

industrial source area priority pollutant sheetflow samples analyzed also had detectable PCBs (80 and 190 ng/L), α-BHC (8 and 10 ng/L), and γ-BHC (2 and 10 ng/L) concentrations.

Some of the sheetflow contributions observed at these locations were not sufficient to explain the concurrent concentrations observed in runoff at outfalls. The low chromium surface sheetflow concentrations and the high outfall concentrations at the Toronto industrial area, as an example, indicated a high likelihood of direct industrial wastewater connections to the storm drainage system. Chromium was rarely detected in any sheetflow samples, but was commonly found in potentially problem concentrations at the industrial outfall. Similarly, most of the fecal coliform populations observed in sheetflows were significantly lower than those observed at the outfall.

The following paragraphs briefly summarize likely sources of important pollutants in urban areas:

Cadmium was commonly detected by Pitt, *et al.* (1995) in almost all stormwater source area runoff samples. They found the highest median concentration (8 μg/L) in vehicle service area runoff, while a street runoff sample had the highest concentration observed (220 μg/L). Durum (1974) stated that concentrations of the carbonate and hydroxide forms of cadmium, with pH values equal to or less than 7, are relatively high, and that waters exceeding the U.S. Public Health Service (USPHS) standard of 10 μ g/L may occur in many stable water systems, including both surface and groundwaters.

Chromium was detected by Pitt, *et al.* (1995) at concentrations above 1 μg/L in almost all of the stormwater source area sheetflow and receiving water samples analyzed. Landscaped area samples had the highest median total chromium concentrations observed (100 μg/L), while a roof runoff sample had the highest sample concentration observed (510 μg/L). Phillips and Russo (1978) stated that in water, trivalent (Cr^{+3}) chromium exists as a complex, colloid or precipitate, depending on pH. The more toxic hexavalent (Cr^{+6}) chromium form is usually present only as an ion and would therefore not be directly removable through filtering or sedimentation practices.

Copper was detected by Pitt, *et al.* (1995) at concentrations greater than 1 μg/L in practically all of the stormwater samples analyzed. Urban creek samples contained the greatest median concentrations (160 μg/L), while a street runoff sample had the highest copper concentration observed (1250 μg/L). Callahan, *et al.* (1979) stated that copper in unpolluted waters occurs mostly as a carbonate complex and in polluted waters forms complexes with organic materials. Pitt and Amy (1973) found that inorganic copper is mostly found with valence states of plus one and plus two in natural water systems near pH 7. The common inorganic copper forms at these pH include copper combined with sulfides, sulfates, oxides, hydroxides, cyanides, and iodide. Phillips and Russo (1978) stated that alkalinity and pH are believed to be the major factors controlling copper speciation. Callahan, *et al.* (1979) stated that copper speciation with organics is most important in polluted waters. Cu^{+2} is especially likely to form complexes with humic materials.

The EPA (1976) stated that the ferrous form of *iron* can persist in waters void of dissolved oxygen, and originates usually from anaerobic groundwaters or from mine drainage. Iron can exist in natural organometallic, humic, and colloidal forms. Black or brown "swamp waters" may contain iron concentrations of several milligrams per liter in the presence or absence of dissolved oxygen, but this iron form has little effect on aquatic life because it is complexed and relatively inactive chemically or physiologically.

Pitt, *et al.* (1995) found *lead* at concentrations greater than 1 μg/L in all of the stormwater runoff and CSO samples analyzed. Vehicle service area samples contained the greatest median concentrations (75 μg/L), while a storage area runoff sample had the highest lead concentration observed (330 μg/L). Lead exists in nature mainly as lead sulfide (Galena) (EPA 1976). Other common natural forms of lead are lead carbonate (Cerussite), lead sulfate (Anglesite) and lead chlorophosphate (Pyromorphite). Stable complexes result from the interaction of lead with organic materials. The toxicity of lead in water is affected by pH, hardness, organic materials and the presence of other metals. Pitt and Amy (1973) reported that most inorganic lead in runoff water systems near pH 7 exist in the plus 2 or plus 4 valence states as lead sulfide, carbonate, sulfate, chromate, hydroxide, or chloride. Rolfe and Reinbold (1977) found that about 46 percent of the total lead input in a test watershed remained airborne. The total input included gaseous and particulate vehicle emissions. About 5 percent of the total lead input to the watershed occurred with rainfall and about 60 percent occurred with atmospheric settleable particulates. The streamflow accounted for the majority of all of the lead discharged from the watershed (about 7 to 8 percent of the total lead input).

Nickel was detected at concentrations greater than 1 μg/L in most of the stormwater samples analyzed by Pitt, *et al.* (1995). Parking area runoff samples contained the greatest median concentrations (40 μg/L), while a landscaped area runoff sample had the highest nickel concentration observed (130 μ g/L).

Zinc was detected by Pitt, *et al.* (1995) at concentrations greater than 1 μg/L in all of the stormwater runoff samples analyzed. Roof runoff samples contained the greatest median concentration (100 μg/L) and the highest concentration observed (1580 μg/L). The EPA (1976) stated that zinc is usually found in nature as the sulfide. It is often associated with the sulfides of other metals, especially lead, copper, cadmium and iron. Callahan, *et al.* (1979) stated that zinc in unpolluted waters is mostly as the hydrated divalent cation (Zn^{+2}) but in polluted waters complexation of zinc predominates. Pitt and Amy (1973) reported that zinc is mostly found as the divalent form, as a sulfide, oxide, sulfate or hydroxide.

The *polycyclic aromatic hydrocarbon* (PAH) compounds found in urban runoff (most commonly anthracene, chrysene, fluoranthene and phenanthrene) are formed by incomplete combustion when organic compounds are burned with insufficient oxygen. Most of the PAHs are associated with suspended solids and humic materials, with little dissolved fractions found in natural waters. There are some studies that have examined the carcinogenic risk associated with the ingestion of PAHs by humans. Many animal studies have established the wide range of carcinogenicity of PAHs by skin contact and ingestion (Varanasi 1989). The concentrations of PAHs needed to produce cancers can be extremely low. As an example, the PAH concentration associated with a cancer risk level of 10^{-6} is only 9.7×10^{-4} μg/L. Tissue damage and systemic toxicity has also been associated with PAH exposure (PHS 1981).

Benzo (a) anthracene, a PAH, was detected at concentrations of about 2 to 60 μg/L in 12 percent of the stormwater samples analyzed by Pitt, *et al.* (1995). The greatest concentration observed was found in an urban creek sample. A major source of benzo (a) anthracene is gasoline, with an emission factor as high as 0.5 mg emitted in the exhaust condensate per liter of gasoline consumed (Verschueren 1983). Wood preservative use may also contribute benzo (a) anthracene. Typical domestic sewage effluent values ranged from 0.2 to more than 1 μg/L (in heavily industrialized areas). During heavy rains, sewage concentrations of benzo (a) anthracene increased substantially to more than 10 μg/L. Benzo (a) anthracene was reported to be both carcinogenic and mutagenic (Verschueren 1983).

Pitt, *et al.* (1995) detected *benzo (b) fluoranthene* in concentrations greater than about 1μg/L in 17 percent of the stormwater samples analyzed. The greatest concentration observed was 226 μg/L, found in a roof runoff sample. Benzo (b) fluoranthene, a PAH, is found in gasoline, in addition to fresh and used motor oils (Verschueren 1983). The automobile emission factor for benzo (b) fluoranthene is about 20 to 50 μg in the exhaust condensate per liter of gasoline consumed. It is also found in bitumen, an ingredient of roofing compounds. Benzo (b) fluoranthene was found in domestic wastewater effluent in concentrations of about 0.04 to 0.2 μg/L. Raw sewage concentrations were as high as 0.9 μg/L in areas of heavy industry. Typical sewage concentrations were about 0.04 μg/L, but increased to about 10 μg/L during heavy rains. The IARC (1979) has found sufficient evidence of carcinogenicity of benzo (b) fluoranthene in animals.

Pitt, *et al.* (1995) detected *benzo (k) fluoranthene* in concentrations greater than 1 μg/L in 17 percent of all stormwater runoff samples analyzed. The greatest concentration observed was 221 μg/L, found in a roof runoff sample. Benzo (k) fluoranthene, a PAH, is found in crude oils, gasoline, and bitumen (Verschueren 1983). Sewage sludges have been found to contain from 100 to 400 μg/L benzo (k) fluoranthene. Domestic sewage effluent can contain from 0.03 to 0.2 μg/L benzo (k) fluoranthene, while sewage in heavily industrialized areas may contain concentrations as great as 0.5 μg/L. During heavy rains, sewage concentrations of benzo (k) fluoranthene increased to more than 4 μg/L.

Benzo (a) pyrene, a PAH, was detected by Pitt, *et al.* (1995) in concentrations greater than about 1 μg/L in 17 percent of the stormwater samples analyzed. The greatest concentration observed was 300 μg/L, found in a roof runoff sample. Benzo (a) pyrene can be synthesized by various bacteria (including *Escherichia coli*) at a rate of about 20 to 60 μg per dry kg of bacterial biomass (Verschueren 1983). It is also a potential leachate of asphalt and is present in oils and gasoline. Benzo (a) pyrene is present in domestic sewage effluents at concentrations of about 0.05 μg/L and in raw sewage sludge at concentrations of about 400 μg/L. Benzo (a) pyrene is a known carcinogen and mutagen.

Fluoranthene, a PAH, was detected in concentrations greater than about 1 μg/L in 23 percent of the stormwater samples analyzed by Pitt, *et al.* (1995). The greatest concentration observed was 128 μ g/L, found in an urban creek sample. Fluoranthene was the only PAH found in an EPA drinking water survey of 110 samples in 1977 (Harris 1982). Fluoranthene is found in crude oils, gasoline, motor oils and wood preservatives (Verschueren 1983). It is found in the exhaust condensate of gasoline engines at a rate of about 1 mg per liter of gasoline consumed. It is found in domestic sewage effluents in concentrations of about 0.01 to 2.5 μg/L, and in raw sewage sludge at concentrations of up to about 1200 μg/L. In one case, sewage effluent had concentrations of fluoranthene of about 0.4 μg/L during dry weather, but increased to about 16 μg/L during heavy rains. Several studies have shown that fluoranthene is a potent carcinogen which substantially increases the carcinogenic potential of other known carcinogens (EPA 1980).

Naphthalene, a PAH, was detected in concentrations greater than about 1 μg/L in 13 percent of the runoff samples analyzed by Pitt, *et al.* (1995). The greatest concentration observed was 296 μg/L, found in an urban creek sample. Naphthalene is the single most abundant component of coal tar, and is present in gasoline and insecticides (especially moth balls). Naphthalene may also originate from natural uncontrolled combustion, such as forest fires, along with house fires in urban areas (Howard 1989). However, vehicle emissions are probably the most significant urban source of naphthalene. Additional major urban naphthalene sources included detergents, solvents, and asphalt (Verschueren 1983). Carcinogenicity and mutagenicity tests were negative for naphthalene (Howard 1989).

Phenanthrene, a PAH, was detected in concentrations greater than about 1 μg/L in 10 percent of the runoff samples analyzed by Pitt, *et al.* (1995). The greatest concentration observed was 69 μg/L, found in an urban creek sample. Phenanthrene is found in crude oil, gasoline, and coal tar. Its emission factor in gasoline engine exhaust condensate is about 2.5 mg per liter of gasoline consumed. Carcinogenicity and mutagenicity tests were negative for phenanthrene (Verschueren 1983).

Pyrene, a PAH, was detected in concentrations greater than about 1 μg/L in 19 percent of the runoff samples analyzed by Pitt, *et al.* (1995). The greatest concentration observed was 102 μg/L, found in an urban creek sample. Pyrene is found in crude oils, gasoline, motor oils, bitumen, coal tar, and wood preservatives (Verschueren 1983). The emission factor of pyrene from gasoline engine exhaust condensates is about 2.5 mg per liter of gasoline consumed. It was degraded in seawater by 85 percent from an initial concentration of 365 μg/L after 12 days. Pyrene is discharged in domestic wastewater effluents at concentrations of about 2 μg/L. In one study, dry-weather raw sewage had pyrene concentrations of about 0.2 μg/L, while pyrene concentrations in raw sewage during a heavy rain increased to about 16 μg/L. Mutagenicity test results of pyrene were negative, but pyrene is considered a human carcinogen (Verschueren 1983).

Pitt, *et al.* (1995) detected *chlordane* in concentrations greater than about 0.3 μg/L in 13 percent of the stormwater samples analyzed. The greatest concentration observed was 2.2 μg/L, found in a roof runoff sample. Chlordane is a non-systemic insecticide and its registered use has been canceled by the EPA. The food chain concentration potential of chlordane is considered high. The EPA has also revoked chlordane residual tolerances in foods (Federal Register, Vol. 51, No. 247, page 46665, Dec. 24, 1986).

Butyl benzyl phthalate (BBP), a phthalate ester, was detected in concentrations greater than about 1 μg/L in 12 percent of the stormwater samples analyzed by Pitt, *et al.* (1995). The greatest concentration observed was 128 μg/L, found in a landscaped area runoff sample. BBP is used chiefly as a plasticizer in polyvinylchlorides (Verschueren 1983). BBP is not tightly bound to the plastic and is readily lost and enters aqueous solutions in contact with the plastic. The typical average concentration of BBP in natural U.S. waters is about 0.4 μg/L, but was reported to be as high as 4.1 μg/L.

Bis (2-chloroethyl) ether (BCEE) was detected in concentrations greater than about 1 μg/L in 14 percent of the stormwater samples analyzed by Pitt, *et al.* (1995). The greatest concentration observed was 204 μg/L, found in an urban creek sample. BCEE is used as a fumigant, and as an ingredient in solvents, insecticides, paints, lacquers and varnishes (Verschueren 1983). It is also formed by the chlorination of waters that contain ethers.

Bis (2-chloroisopropyl) ether (BCIE) was detected by Pitt, *et al.* (1995) in stormwater at concentrations greater than about 1 μg/L in 14 percent of the samples analyzed. The greatest concentration observed was 217 μg/L, found in a parking area runoff sample. BCIE was not found to be carcinogenic during rat tests (HEW 1979).

1,3-Dichlorobenzene (1,3-DCB) was detected in concentrations greater than about 1 μg/L in 23 percent of the stormwater samples analyzed by Pitt, *et al.* (1995). The greatest concentration observed was 120 μg/L, found in an urban creek sample.

CHAPTER 3

POTENTIAL GROUNDWATER CONTAMINATION ASSOCIATED WITH URBAN RUNOFF

This chapter addresses several categories of constituents that are known to affect groundwater quality, or the operation of infiltration or recharge devices, as documented in the groundwater contamination literature. The categories that can adversely affect groundwater quality include nutrients, pesticides, other organics, pathogens, metals, and salts and other dissolved minerals. Suspended solids, dissolved oxygen, and the sodium adsorption ratio (the ratio of monovalent, Na^{+}, to divalent cations, Ca^{+2} and Mg^{+2}) are also important for the operation of recharge and infiltration devices. The intention of this chapter is to identify known stormwater contaminants as to their potential to contaminant groundwater. Many of the references describe groundwater contamination problems with these pollutants from sanitary sewage and agricultural sources, not specifically from stormwater sources. Therefore, care must be taken when assuming that similar problems would occur with stormwater sources. Major differences between stormwater and these other sources which may affect groundwater contamination likely include the rate of pollutant application, intermittent versus continuous applications, and the presence of interfering compounds. However, the information included in this chapter enables the recognition of pollutants which should be considered when investigating stormwater infiltration.

GROUNDWATER CONTAMINATION ASSOCIATED WITH NUTRIENTS

Definition

Primary nutrients are defined as "compounds or constituents that contain nitrogen (N), phosphorus (P) and other elements that are essential for plant growth" (Hampson 1986). Other needed aspects of nutrient use include the organic matter and bacteria that are needed to convert the primary nutrient from its natural form to a form that the organism can use. Nitrogen-containing compounds of interest are primarily from fertilizers and sanitary sewage, with the available nitrogen forms being nitrate, nitrite, ammonium, and urea. The phosphorus containing compounds of interest are generally found in fertilizers, with the available phosphorus form being orthophosphate. Nitrogen and phosphorus are cyclic elements in that the combined forms may be changed and metabolized by decomposition and synthesis (Reichenbaugh 1977).

Examples of Nutrients Contaminating Groundwaters

Nutrients can originate from many different sources, including natural occurrence, sanitary sewage discharges and combined sewage overflows, landscaping/lawn maintenance and other urban sources (including septic tank and sewer system leakage, waste decomposition, and highway runoff) plus agricultural sources. Nitrates are one of the most frequently encountered contaminants in groundwater (AWWA 1990).

Phosphorus compounds of interest are associated with phosphorus containing fertilizers (Lauer 1988a and 1988b) and detergents. Groundwater contamination by phosphorus has not been as widespread, or as severe, as for nitrogen compounds. Nitrogen loadings are usually much greater than phosphorus loadings, especially from nonagricultural sources (Hampson 1986). Spray-irrigation with secondary-treated sanitary wastewater was found to increase both the total nitrogen and nitrate concentrations in a shallow aquifer in Florida, but these, and the total phosphorus concentrations, were significantly reduced within 200 feet of the test site (Brown 1982).

Natural Sources--

Nitrogen occurs naturally both in the atmosphere and in the earth's soils. Natural nitrogen can lead to groundwater contamination by nitrates. As an example, in regions with relatively unweathered sedimentary deposits or loess beneath the root zone, residual exchangeable ammonium in the soil can be readily oxidized to nitrate if exposed to the correct conditions. Leaching of this naturally occurring nitrate caused groundwater contamination (with concentrations greater than 30 μg/L) in non-populated and non-agricultural areas of Montana and North Dakota (Power and Schepers 1989).

Forms of nitrogen from precipitation may be either nitrate or ammonium. Atmospheric nitrate results from combustion, with the highest ambient air concentrations being downwind of power plants, major industrial areas, and major automobile activity. Atmospheric ammonium results from volatilization of ammonia from soils, fertilizers, animal wastes and vegetation (Power and Schepers 1989).

Urban Areas--

Roadway runoff has been documented as the major source of groundwater nitrogen contamination in urban areas of Florida (Hampson 1986; Schiffer 1989; and German 1989). This occurs from both vehicular exhaust onto road surfaces and onto adjacent soils, and from roadside fertilization of landscaped areas. Roadway runoff also contains phosphorus from motor oil use and from other nutrient sources, such as bird droppings and animal remains, that has contaminated groundwaters (Schiffer 1989). Nitrate has leached from fertilizers and affected groundwaters under various turf grasses in urban areas, including at golf courses, parks and home lawns (Petrovic 1990; Ku and Simmons 1986; and Robinson and Snyder 1991).

Leakage from sanitary sewers and septic tanks in urban areas can contribute significantly to nitrate-nitrogen contamination of the soil and groundwater (Power and Schepers 1989). Nitrate contamination of groundwater from sanitary sewage and sludge disposal has been documented in New York (Ku and Simmons 1986; and Smith and Myott 1975), California (Schmidt and Sherman 1987), Narbonne, France (Razack, *et al.* 1988), Florida (Waller, *et al.* 1987) and Delaware (Ritter, *et al.* 1989).

Elevated groundwater nitrate concentrations have been found in the heavily industrialized areas of Birmingham, UK, due to industrial area stormwater infiltration (Lloyd, *et al.* 1988). The deep-well injection of organonitrile and nitrate containing industrial wastes in Florida has also increased the groundwater nitrate concentration in parts of the Floridan aquifer (Ehrlich, *et al.* 1979a and 1979b).

Agriculture Operations--

In the United States, the areas with the greatest nitrate contamination of groundwater include heavily-populated states with large dairy and poultry industries, or states having extensive agricultural irrigation. Extensively irrigated areas of the United States include the corn-growing areas of Delaware, Pennsylvania and Maryland; the vegetable growing areas of New York and the Northeast; the potato growing areas of New Jersey; the tobacco, soybean and corn growing areas of Virginia, Delaware and Maryland (Ritter, *et al.* 1989); the chicken, corn and soybean production areas in New York (Ritter, *et al.* 1991); the western Corn Belt states (Power and Schepers 1989); and the citrus, potato and grape vineyard areas in California (Schmidt and Sherman 1987). Table 21 groups the states according to the percentage of wells in the state which have groundwater nitrate concentrations greater than 3.0 mg/L.

Nitrogen leaching from agricultural fertilizers to irrigation return/drainage waters and eventually to underlying aquifers has been documented in California (Schmidt and Sherman 1987), Arizona and New Mexico (Sabol, *et al.* 1987). Groundwater nitrate contamination has increased in these areas since the 1930s, when large-scale irrigation was instituted (Sabol, *et al.* 1987). Typical nitrate concentrations in shallow vadose-zone water beneath agricultural fields in Nebraska exceed 10 mg/L (Power and Schepers 1989; and Spalding and Kitchen 1988). Irrigation is necessary to leach and reduce salt accumulation in plant root zones in many agricultural areas (Power and Schepers 1989). This leaching generally leads to increased groundwater contamination. Similar processes are likely to occur under irrigated urban landscaped areas, including private homes, parks, and golf courses.

Rates of nitrate concentration increases in groundwater in Nebraska can be from 0.4 to 1.0 mg/L/year (as nitrogen) in well-drained agricultural soils. In areas with fine-textured soils and thick vadose zone sediments, the increase is smaller, from 0.1 to 0.2 mg/L/year, (Spalding and Kitchen 1988).

Leachate from waste decomposition can also contribute nitrogen-containing compounds to groundwater. The urine of grazing animals was the source of groundwater nitrate contamination in New Zealand (Close 1987). Grazing cattle return to the soil between seventy-five and eighty percent of the nitrogen, phosphorus and potassium from their food (Reichenbaugh 1977). Land spreading of animal waste from large-scale, concentrated dairy and poultry industries in the Northeast U.S., the Great Lakes states (Power and Schepers 1989), and Maryland (Ritter, *et al.* 1989) caused the nitrate contamination of groundwater. Poorly managed feed lots can cause enhanced nitrate production from animal wastes which in turn leach through soil during rainfalls and enter the groundwater (Power and Schepers 1989).

Nutrient Leaching and Soil Removal Processes

Whenever nitrogen-containing compounds come into contact with soil, a potential for nitrate leaching into groundwater exists, especially in rapid-infiltration wastewater basins, stormwater infiltration devices, and in agricultural areas. Nitrate is highly soluble (>1 kg/L) and will stay in solution in the percolation water, after leaving the root zone, until it reaches the groundwater. Therefore, vadose-zone sampling can be an effective tool in predicting nonpoint sources that may adversely affect groundwater (Spalding and Kitchen 1988).

TABLE 21. GROUNDWATER NITRATE CONTAMINATION IN THE UNITED STATES

Contaminated Well Percentage - Between 0.0 and 10.0%

Alabama (7.4%)	Alaska (5.2%)
Florida (4.3%)	Georgia (4.8%)
Hawaii (9.1%)	Louisiana (2.4%)
Massachusetts (5.5%)	Michigan (3.9%)
Mississippi (1.8%)	Missouri (8.7%)
Nevada (8.4%)	New Hampshire (4.3%)
North Carolina (5.9%)	North Dakota (9.0%)
Ohio (8.5%)	Oregon (6.6%)
South Carolina (4.1%)	Tennessee (5.5%)
Vermont (6.9%)	Virginia (3.9%)
West Virginia (5.5%)	

Contaminated Well Percentage - Between 10.1 and 20.0%

Arkansas (12.4%)	Connecticut (16.7%)
Idaho (14.6%)	Illinois (14.0%)
Indiana (11.1%)	Iowa (18.4%)
Kentucky (17.2%)	Maine (14.2%)
Montana (11.5%)	New Jersey (11.4%)
New Mexico (12.7%)	South Dakota (14.9%)
Utah (10.4%)	Wisconsin (18.9%)
Wyoming (11.4%)	

Contaminated Well Percentage - Between 20.1 and 30.0%

Colorado (22.9%)	Maryland (28.8%)
Minnesota (20.2%)	Texas (23.5%)
Washington (22.9%)	

Contaminated Well Percentage - Between 30.1 and 40.0%

California (32.6%)	Delaware (34.6%)
Nebraska (32.7%)	Oklahoma (35.9%)
Pennsylvania (30.3%)	Puerto Rico (35.4%)

Contaminated Well Percentage - Between 40.1 and 50.0%

Arizona (49.3%)	New York (40.3%)
Rhode Island (45.1%)	

Contaminated Well Percentage - Greater than 50.0%

Kansas (54.2%)

Source: Power and Schepers 1989.

Urban Areas--

Nitrogen containing compounds in urban stormwater runoff may be carried long distances before infiltration into soil and subsequent contamination of groundwater, affecting South Carolina's approach to golf course stormwater management (Robinson and Snyder 1991). The amount of nitrogen available for leaching is directly related to the impervious cover in the watershed (Butler 1987). Nitrogen infiltration is controlled by soil texture and the rate and timing of water application (either through irrigation or rainfall) (Petrovic 1990; and Boggess 1975). Landfills, especially those that predate the RCRA Subtitle D Regulations, often produce significant nitrogen contamination in nearby groundwater, as demonstrated in Lee County, Florida (Boggess 1975). Studies in Broward County, Florida, found that nitrogen contamination problems can also occur in areas with older septic tanks and sanitary sewer systems (Waller, *et al.* 1987).

Nutrient leachates usually move vertically through the soil and dilute rapidly downgradient from their source. The primary factors affecting leachate movement are the layering of geologic materials, the hydraulic gradients, and the volume of the leachate discharge. Sandy soils show less rapid dilution of the contaminant (mixing of leachate with groundwater), compared to limestone (Waller, *et al.* 1987), silts, clays, and organic-rich sediments (Wilde 1994).

Once the leachate, or the waste liquid from an industrial injection well, is in the soil/groundwater system, decomposition by denitrification can occur, with the primary decomposition product being elemental nitrogen (Hickey and Vecchioli 1986). As an example, deep well injection of organonitriles and nitrates in a limestone aquifer acts like an anaerobic filter with nitrate respiring bacteria being the dominant microorganism. These bacteria caused an eighty percent reduction of the waste within one hundred meters of injection in the Floridan aquifer, near Pensacola (Ehrlich, *et al.* 1979b).

Gold and Groffman (1993) reported groundwater leaching losses from residential lawns to be low for nitrates (typically $<$2mg/L), when using application rates recommended for residential lawn care.

Agricultural Areas--

Nitrogen entry, use and removal in agricultural soils is best described in terms of the nitrogen cycle: plant uptake, atmospheric loss (NH_3 volatilization and denitrification), soil storage, runoff into surface water and/or leaching into groundwater (Petrovic 1990). Nitrogen leaching from soils is common in irrigated agricultural areas. Besides supplying required moisture, irrigation is also needed to prevent the accumulation of salts in the crops' root zone. If salt flushing occurs when there is nitrate in the root zone, the nitrates are leached farther into the soil and potentially into the groundwater (Power and Schepers 1989).

Irrigated areas in the Midwest and Upper Midwest States have a greater potential to leach nitrates to the groundwater than most other areas because: (1) irrigation is concentrated in areas with high soil hydraulic conductivities; (2) irrigated lands generally receive heavy applications of nitrogen fertilizers to increase crop yield to offset the high cost of irrigation; and (3) irrigation accelerates the movement of nitrates, other soluble constituents and percolating water to the groundwater (Mossbarger and Yost 1989). These irrigated areas also have higher water tables than non-irrigated arid areas, further increasing the nitrate leachate potential.

The mass of nitrate leached to groundwater during irrigation is related to the drainage volume (Ritter, *et al.* 1989). Nitrates that are already in the soil or groundwater also travel faster during periods of maximum recharge (when the water table is highest) (Boggess 1975).

Factors that influence the degree of nitrogen leaching in agriculture areas are soil type, irrigation amounts and practices, nitrogen source and application rate, and the season of application. Significant leaching occurs during the cool, wet seasons. Cool temperatures reduce denitrification and ammonia volatilization, and limit microbial nitrogen immobilization and plant uptake; however, they also limit nitrification. The combination of low evapotranspiration and high precipitation means that more water drains out of the root zone into the vadose zone and groundwater (Petrovic 1990). Humid agricultural areas have shown a greater potential for nutrient leaching when compared to arid environments because of the availability of water for leaching during the cool seasons (Close 1987). Land use and soil permeability greatly affect groundwater chemistry, and ultimately its contamination potential, as shown in the Coastal Plains of the East Coast by Ritter, *et al.* (1989) and in California by Schmidt and Sherman (1987).

Although no one has indicated that the potential for nitrate contamination can be prevented, adjustments in fertilizer practices may control the rate of degradation of groundwater (Power and Schepers 1989). Use of slow-release fertilizers is recommended in areas with significant leaching problems, such as coastal golf courses. The slow-release fertilizers include urea formaldehyde (UF), methylene urea, isobutylidene diurea (IBDU), and sulfur-coated urea. The fast-release fertilizers that are not recommended include calcium nitrate, sodium nitrate, ammonium sulfate and urea (Horsley and Moser 1990).

Methods of fertilizer application also affect groundwater contamination. Side-dressing of fertilizers can increase groundwater nitrate concentrations faster than fertigation, the mixing of fertilizers with irrigation water (Ritter, *et al.* 1991). However, other researchers (Saffigna and Keeney 1977) found that side-dressing can reduce leaching, if irrigation is irregular. No difference in the depth of penetration of phosphorus was found between applying the same amount of fertilizer in one application versus the same amount spread over several applications (Lauer 1988a). Frequent fallowing of the soil (leaving unplanted) was found to contribute to nitrate contamination below the root zone. Cultivation (plowing or disking), as part of the planting process, increases aeration and mixes crop residues (which are readily available carbon sources) with soil organisms. A flush of mineralization and nitrification usually occurs after cultivation and results in the accumulation of leachable nitrate in the soil (Power and Schepers 1989). Nitrate contamination, however, appears to be controlled more by denitrification than by preferential flow through the soil (Steenhuis, *et al.* 1988).

Controlled application of wastewater sludge is an effective fertilizer; it has not reduced crop yields where it has been applied and it does not contaminate the groundwater to any greater extent than chemical fertilizer applications. Sludge applications to crop lands are generally controlled by heavy metal accumulations in the soil and plants, not by groundwater contamination of nutrients. Like chemical fertilizers, sludge use in amounts that provide soil with nitrogen in excess of what plants need results in leaching. Liquid sludges mineralize nitrogen faster than composted sludges with the application rate and soil type not affecting the mineralization rate (Chang 1988). The decomposition potential in the groundwater below wastewater irrigation areas is considerable, as the decomposition is controlled by bacteria which are already in the wastewater (Wolff 1988):

$$5\,C + 4\,NO_3 + 2\,H_2O \rightarrow 2\,N_2 + 4\,HCO_3 + CO_2$$

Decomposition of crop waste affects nitrogen leaching potential. Non-legume residues, such as cornstalks, decompose much slower and initially immobilize inorganic nitrogen in the biomass (Power and Schepers 1989). The ammonium cation (NH_4^+) tends to decompose more readily to form ammonia in alkaline soils than in acid soils (White and Dornbush 1988).

General--

During percolation through the soil, some nutrients are removed and the nutrient concentrations affecting the groundwater are significantly reduced. Phosphorus, in the form of soluble orthophosphate, may be either directly precipitated or chemically adsorbed onto soil surfaces through reactions with exposed iron, aluminum or calcium on solid soil surfaces (Crites 1985). Phosphorus fixation is a two-step process, sorption onto the soil solid and then conversion of the sorbed phosphorus into mineraloids or minerals. If the sorption sites are filled either with phosphate anions or another ion, phosphorus sorption will be low. The sorption of phosphorus per unit of percolation liquid decreases with each year of recharge (White and Dornbush 1988).

Downward movement of phosphorus in different soils was found to be directly related to the reactivity index measured for each soil, especially for surface-applied phosphorus fertilizer. In Washington, a difference in depth of penetration was noted, however, between sandy- and clayey-textured soils, with sandy-textured soils showing the greater depth of penetration. If the fertilizer was surface applied, instead of sprinkler applied, and the soil was not inverted, most of the phosphorus remained within the top 5 to 7.5 cm of the surface (Lauer 1988b).

If the nitrogen is not used by the plant, it will leach through the soil toward the groundwater, with some being removed in the soil prior to its reaching the aquifer. Under certain conditions, losses of dissolved nitrate and nitrite could be described by zero-order kinetics (Hampson 1986). In general, however, the process is regulated by so many limiting factors that such a simplified description is not possible (Follet 1989). Residual nitrate concentrations were found to be highly variable in soil due to factors such as soil texture, mineralization, rainfall, irrigation, organic matter content, crop yield, nitrogen fertilizer/sludge rate, denitrification, and soil compaction (Ferguson, *et al.* 1990). Nitrate's flow to groundwater from stormwater infiltration is controlled by the rate and volume of infiltration, horizontal and vertical groundwater flow, the depth to the water table, and the existence of areas/channels of preferential flow. Once the nitrate has reached the groundwater, its concentration may be reduced by dispersion, diffusion, and mixing with uncontaminated groundwater (Wilde 1994). However, on sludge application plots, it was noted that if the soil receives the same annual amount of organic residue, it will accumulate organic nitrogen until the equilibrium concentration is reached. As shown in Riverside, California, once the sludge application is terminated, the organic nitrogen will continue to mineralize for many years and crop yields will continue to be enhanced (Chang, *et al.* 1988). The amount of ammonia volatilization is influenced by the position of the nitrogen in the soil/turf grass after application. This position is highly influenced by rainfall and/or irrigation (Bowman, *et al.* 1987, as reported by Petrovic 1990).

Nitrate concentrations in the vadose zone of an agricultural field generally are highest near the surface, although during irrigation and in times of winter recharge, nitrate can be leached below the zone where it will be taken up by crops or denitrified. In such cases, nitrate will eventually reach groundwater if excess water is added to overlying soil. As nitrogen passes through the soil, NH_4^+ is removed by cation exchange between the NH_4^+ and the H^+ on the soil (Ragone 1977). Nitrogen is also removed by the soil aquifer treatment process through denitrification, a biological process that needs anaerobic conditions and organic carbon for food for the denitrifying bacteria, which in turn produce free nitrogen gas and nitrous oxides (Bouwer 1985).

Phosphorus concentrations generally decrease with depth in agricultural soils because phosphorus is adsorbed to soil minerals and also precipitates readily with calcium, iron, or aluminum (Lauer 1988b and Ragone 1977). The dominant precipitation reactions are pH dependent, forming mostly iron and aluminum phosphates in acid soils and calcium phosphates under alkaline conditions. In neutral soils, the precipitation reactions are strongly rate-limited, so that the apparent solubility of the phosphate compounds is higher than under either acid or alkaline conditions (Bouwer 1985).

Health Problems

Excessive nutrient concentrations can cause both environmental and human health problems.

Environmental Problems--

Nitrogen and phosphorus are fertilizers in aquatic environments, just as they are on land. The continual fertilization of the aquatic environment increases production of less desirable species and alters the aquatic community structure (Nightingale and Bianchi 1977a). Excess agricultural nitrogen applications can reduce both yields and quality of cotton, tomatoes, sugar beets, sugar cane, potatoes, citrus, avocados, peaches, apricots, apples, and grapes (Bouwer 1987). Nitrate ingestion by livestock has been linked to health problems, although livestock can tolerate up to ten times the maximum permissible concentrations allowed for humans with no significant adverse effects (Mossbarger and Yost 1989).

Excess agricultural phosphorus may reduce crop yields because the excess phosphorus reduces the availability to the plants of some micronutrients, such as copper, iron, and zinc. Excess soil phosphorus also increases calcium precipitation (Bouwer 1987).

Human Health Problems--

Excess nitrate concentrations in water (>10 mg/L as N) consumed by infants causes methemoglobinemia, or "blue-baby disease". In infants, nitrate is converted to nitrite which binds to red blood cells at the oxygen binding sites and asphyxiates the child by causing insufficient oxygen adsorption (Crites 1985). Nitrates may also increase the risk of stomach cancer through nitrate reduction to nitrite in the mouth or stomach. The nitrites then react with the amines to form carcinogenic nitrosamines (Bouwer 1989).

GROUNDWATER CONTAMINATION ASSOCIATED WITH PESTICIDES

Definition

Pesticides are generally classified into one of the following three groups, depending on their targets: herbicides, fungicides, or insecticides. Table 22 lists pesticides of potential concern in

TABLE 22. PESTICIDES OF POTENTIAL CONCERN IN GROUNDWATER CONTAMINATION STUDIES

Herbicides	**Major Commercial Use**
Alachlor	Weed control in beans, corn, potatoes and soybeans
Atrazine	Grassy weed control in corn; soil sterilant on non-crop land
Bromoxynil	Weed control in barley, canary seed, corn, flax, oats and seed-producing grasses
2,4-D	Weed control in field crops and on non-crop land; soil sterilant; aquatic weed control (restricted use)
Difenzoquat	Post-emergent wild oat control in barley, canary grass and wheat
Diclofop-methyl	Annual grass control in alfalfa, barley, soybeans, vegetable, wheat, flax and canola
Glyphosate	Non-selective weed control in field crops, non-crop land and turf
MCPA	Weed control in alfalfa, barley, corn, flax, oats, rye, wheat and pastures
Metolachlor	Weed control in corn, soybeans and potatoes
Triallate	Pre-emergent wild oat control in barley, flax, mustard, peas, canola, sugar beets and wheat
Trifluralin	Pre-emergent weed control in field crops, vegetables and ornamentals
Insecticides	**Major Commercial Use**
Carbaryl	Specific insect control in livestock buildings, field crops and fruits and vegetables
Carbofuran	Specific root worm, maggot, beetle and leaf hopper control in vegetables; grasshopper, alfalfa weevil and other insect control in field crops (restricted product)
Chlorpyrifos	Specific insect control in field crops, vegetables and fruits; seed treatment for corn, beans and peas; mosquito control
Diazinon	Specific insect control on fruits, vegetables, turf and non-crop land;

insect control in livestock buildings; seed treatment

(continued)

TABLE 22. (CONTINUED)

Fenitrothion	Specific insect control on fruits, vegetables, turf and non-crop land; insect control in livestock buildings; seed treatment
Fonofos	Specific insect control in corn, onions, potatoes and tobacco
Lindane	Insect control on livestock, lawns, certain grains; seed treatment
Malathion	Specific insect control on livestock and in certain field crops
Phorate	Specific insect control on beans, corn, lettuce and potatoes
Terbufos	Specific worm control in corn and sugar beets; flea beetle control in mustard and canola
Fungicides	**Major Commercial Use**
Captan	Specific fungal disease control on potato seed pieces, flower, fruit, vegetables, turf and tobacco
Chlorothalonil	Fungal disease control on vegetables, potatoes, tomatoes, turf and conifers
Mancozeb	Specific fungal disease control on various fruits, vegetables and corn and potato seeds
Maneb	Specific fungal disease control on certain fruits and vegetables; seed treatment for barley, flax, oats, rye, sugar beets and wheat
Metiram	Specific fungal disease control on potato seed pieces; seed treatment for barley, flax, oats and wheat
Thiram	Specific fungal disease control in turf; seed treatment for vegetables, mustard, canola, barley, wheat, rye, oats, flax, corn, soybeans, alfalfa and fruits

Adapted from Environment Canada/Agriculture Canada (1987) and Pierce and Wong (1988).

groundwater contamination studies and their typical uses from Environment Canada/Agriculture Canada (1987) and Pierce and Wong (1988).

Examples of Pesticide Contamination of Groundwaters

Urban Areas--

Pesticides are used in urban areas, primarily for weed and insect control in houses, along roadsides, in parks, on golf courses, and on private lawns (Racke and Leslie 1993). The pesticide loading in runoff water has been correlated to the amount of impervious cover and to the distance the runoff will travel prior to infiltration or decomposition, as demonstrated by Lager (1977) and confirmed in Austin, Texas by Butler, *et al.* (1987). Urban pesticide contamination of groundwater in central Florida likely resulted from municipal and homeowner use of these chemicals for pest control and their subsequent collection in stormwater runoff. Samples from the upper part of the Floridan aquifer have contained detectable amounts of diazinon, malathion, 2,4-D, ethion, methyl trithion, silvex ,and 2,4,5-T (German 1989). In California, chlordane groundwater contamination has been traced to its application adjacent to residential foundations where it had been used for termite and ant control (Greene 1992). Atrazine and simazine groundwater contamination was related to their use to control weeds along roadways (Domagalski, *et al.* 1992). In Arizona, diazinon, dacthal, and dioxathion were detected in stormwater runoff entering urban dry wells that recharge the aquifer (Wilson, *et al.* 1990). Diazinon (at 30 μg/L) and methyl parathion (at 10 μg/L) were detected in groundwater below municipal waste treatment plants in Florida which used land spreading or well injection of wastes (Pruitt, *et al.* 1985). Gold and Groffman (1993) reported groundwater leaching losses from residential lawns to be low for dicamba and 2,4-D (<1μ g/L), when using application rates recommended for residential lawn care.

In contrast, groundwater below Fresno, California, stormwater recharge basins contained only one of the organophosphorus pesticides, diazinon. None of the ten chlorinated pesticides (aldrin, chlordane, endosulfan I, endosulfan II, endosulfan sulfate, DDD-mixed isomers, DDT-mixed isomers, DDE-mixed isomers, gamma-BHC, and methoxychlor) and none of the chlorophenoxy herbicides were found (Nightingale 1987b; and Salo, *et al.* 1986).

Agricultural Operations--

Groundwater contamination by agricultural use of pesticides has been documented in the United States and Canada. There have been numerous observations of pesticide contamination of groundwater, including: alachlor (Wisconsin), aldicarb (Wisconsin, Arkansas, and California), atrazine (Wisconsin), bromacil (South Carolina, Georgia, and Florida), DBCP (California and South Carolina), EDB (South Carolina, Georgia, and Florida), and metolachlor (Wisconsin) (Krawchuk and Webster 1987). San Joaquin Valley (California) groundwater has been contaminated by atrazine, bromacil, 2, 4-DP, diazinon, DBCP, 1,2-dibromoethane, dicamba, 1,2-dichloropropane, diuron, prometon, prometryn, propazine, and simazine. Atrazine and simazine were detected in 37.5% of the shallow wells sampled (Domagalski and Dubrovsky 1992). In Bakersfield, California, EDB has been found in wells in concentrations of 4 μg/L, or less (Schmidt and Sherman 1987). Sandy soils in the Coastal Plains states in the East and Southeast are also very susceptible to pesticide leaching, primarily because the aquifer is directly below the recharge areas (Ritter, *et al.* 1989). However, tile drain water samples in the southeastern desert valleys of California showed minimal pesticide residue (Schmidt and Sherman 1987).

The EPA has conducted extensive surveys to investigate the potential contamination of drinking water wells by agricultural pesticides (EPA 1990). Forty-six pesticides have been found in groundwater of 35 states. California had 31 pesticides detected, Illinois had 17, Minnesota and New York each had 14 pesticides detected, Wisconsin had 13 detected, and Iowa had 11 detected. Natarajan and Rajagopal (1993) summarized Iowa DNR studies that concluded that hydrology, pesticide chemistry, and time of sampling all affected the observed occurrence of agricultural pesticides in public drinking ground water supplies. One or more pesticides were detected in less than 10 percent of the 865 public drinking water supply wells tested by Iowa DNR (Iowa DNR 1988 and 1990). Atrazine occurred most often and was found in concentrations as high as 21 μg/L. Almost all atrazine was found in concentrations at less than 1 μg/L. Infiltration of soluble pesticides through the soil column was found to be the major route of pesticides to Iowa's shallow ground water, even though the entry of surface runoff through fractures was responsible for relatively high doses of some pesticides.

Pesticide Removal Processes in Soil

Heavy repetitive use of mobile pesticides, such as EDB, on irrigated and sandy soils likely contaminates groundwater. Fungicides and nematocides must be mobile in order to reach the target pest and hence, they generally have the highest contamination potential. Pesticide leaching depends on patterns of use, soil texture, total organic carbon content of the soil, pesticide persistence, and depth to the water table (Shirmohammadi and Knisel 1989). A pesticide leaches to groundwater when its residence time in the soil is less than the time required to remove it, or transform it to an innocuous form by chemical or biological processes. The residence time is controlled by two factors: water applied and chemical adsorption to stationary solid surfaces. Volatilization losses of soil-applied pesticides can be a significant removal mechanism for compounds having large Henry's constants (K_h), such as DBCP or EPTC (Jury, *et al.* 1983). However, for mobile compounds having low K_h values, such as atrazine, metolachlor, or alachlor, it is a negligible loss pathway compared to the leaching mechanism (Alhajjar, *et al.* 1990).

Mobility of Pesticides--

Estimates of pesticide mobility can be made based on the three removal mechanisms affecting organic compounds (volatilization, sorption, and solubility), as shown on Tables 23 through 25 (Armstrong and Llena 1992). Application methods and formulation state can also play a significant role in pesticide mobility. The type of pesticide formulation will affect their loss, with wettable powders exhibiting the greatest losses to the soil (Domagalski, *et al.* 1992). Residues of foliar-applied water soluble pesticides appear in high concentrations in runoff (Pierce and Wong 1988). Pesticide movement can be retarded or enhanced depending upon the soil conditions (Alhajjar, *et al.* 1990). Leaching is enhanced in alluvial soils (Domagalski, *et al.* 1992), but if the vadose zone contains restricting layers, pesticide movement will be slower (Sabol, *et al.* 1987). Leaching is also enhanced by flood-irrigation, in areas needing high recharge rates, and in areas with preferential flow. The greatest pesticide mobility occurs in areas with coarse-grained or sandy soils without a hardpan layer, having low clay and organic matter content and high permeability (Domagalski, *et al.* 1992). Structural voids, which are generally found in the surface layer of finer-textured soils rich in clay, can transmit pesticides rapidly when the voids are filled with water and the adsorbing surfaces of the soil matrix are bypassed. This preferential (bypass) flow is demonstrated in areas where the observed mobility of the pesticide in the soil is greater than the predicted value. This flow occurs in structured, coarse grained soils, or soils with cracks, root holes, or worm holes. It generally does not occur on continuously flooded loam soil. It likely results from

TABLE 23. MOBILITY CLASS DEFINITION

Class	K(d)	M(I)
I - Mobile	<0.1 to 1.0	0.1 to 1.0
II - Intermediate mobility	1.0 to 10.0	0.01 to 0.1
III - Low mobility	10.0 to 100.0	0.001 to 0.01
IV - Very low mobility	>100.0	<0.001

Where K(d) is the soil adsorption coefficient
M(I) is the mobility index (ratio of pollutant's migration velocity to migration velocity of water under saturated flow).

Source: Armstrong and Llena 1992.

TABLE 24. ORGANIC COMPOUND MOBILITY FOR SANDY LOAM SOILS

Mobile (Class I)

Organic Carbon = 0.01%

Dicamba	Cyanazine
Dacthal	Metolachlor
2,4-D	Malathion
Diazinon	Atrazine
Alachlor	Acenaphthylene

Organic Carbon = 0.1%

Dicamba	Dacthal
2,4-D	Diazinon
Alachlor	Atrazine
Cyanazine	Metolachlor

Organic Carbon = 1.0%

Dicamba	2,4-D
Diazinon	Alachlor
Dacthal	

Intermediate Mobility (Class II)

Organic Carbon = 0.01%

2,4'-Dichlorobiphenyl	Pentachlorophenol
Fluorene	Anthracene
Phenanthrene	Chlordane
2,4,4'-Trichlorobiphenyl	Fluoranthene
Pyrene	Benzo(a) anthracene
Methoxychlor	Bis(2-ethylhexyl) phthalate
2,3',4',5-Tetrachlorobiphenyl	2,3,3',4',6-Pentachlorobiphenyl

Organic Carbon = 0.1%

Malathion	Acenaphthylene
2,4'-Dichlorobiphenyl	Pentachlorophenol
Fluorene	

Organic Carbon = 1.0%

Atrazine	Cyanazine
Metolachlor	

(continued)

TABLE 24. (CONTINUED)

Low Mobility (Class III)

Organic Carbon = 0.01%

Chrysene
Benzo(a) pyrene
Benzo(b) fluoranthene
2,2',3,4,4',5,5'- heptachlorobiphenyl
2,2',4,4',5,5'-Hexachlorobiphenyl
Benzo(k) fluoranthene
Benzo(ghi) perylene

Organic Carbon = 0.1%

Anthracene
Chlordane
Fluoranthene
Benzo(a) anthracene
Bis(2-ethylhexyl) phthalate
2,3,3',4',6-Pentachlorobiphenyl
Phenanthrene
2,4,4'-Trichlorobiphenyl
Pyrene
Methoxychlor
2,3',4',5-Tetrachlorobiphenyl

Organic Carbon = 1.0%

Malathion
2,4'-Dichlorobiphenyl
Fluorene
Acenaphthylene
Pentachlorophenol

Very Low Mobility (Class IV)

Organic Carbon = 0.01%

Indeno(1,2,3-cd)Pyrene

Organic Carbon = 0.1%

2,3,3',4',6-Pentachlorobiphenyl
Benzo(a) pyrene
Benzo(b) fluoranthene
2,2',3,4,4',5,5'-Heptachlorobiphenyl
Indeno(1,2,3-cd) pyrene
Chrysene
2,2'4,4',5,5'-hexachlorobiphenyl
Benzo(k) fluoranthene
Benzo(ghi) perylene

Organic Carbon = 1.0%

Anthracene
Chlordane
Fluoranthene
Benzo(a) anthracene
Bis(2-ethylhexyl) phthalate
2,3,3',4',6-Pentachlorobiphenyl
Benzo(a) pyrene
Benzo(b) fluoranthene
2,2',3,4,4',5,5'- heptachlorobiphenyl
Indeno(1,2,3-cd) pyrene
Phenanthrene
2,4,4'-Trichlorobiphenyl
Pyrene
Methoxychlor
2,3',4',5-Tetrachlorobiphenyl
Chrysene
2,2',4,4',5,5'-Hexachlorobiphenyl
Benzo(k) fluoranthene
Benzo(ghi) perylene

Source: Armstrong and Llena 1992.

TABLE 25. ORGANIC COMPOUND MOBILITY CLASSES FOR SILT LOAM SOILS

Mobile (Class I)

Organic Carbon = 0.01%

Dicamba	Cyanazine
Dacthal	Metolachlor
2,4-D	Malathion
Diazinon	Atrazine
Alachlor	Acenaphthylene
2,4'-Dichlorobiphenyl	

Organic Carbon = 0.1%

Dicamba	Dacthal
2,4-D	Diazinon
Alachlor	Atrazine
Cyanazine	Metolachlor

Organic Carbon = 1.0%

Dicamba	2,4-D
Diazinon	Alachlor
Dacthal	

Intermediate Mobility (Class II)

Organic Carbon = 0.01%

Pentachlorophenol	Methoxychlor
Fluorene	Anthracene
Phenanthrene	Chlordane
2,4,4'- trichlorobiphenyl	Fluoranthene
Pyrene	Benzo(a) anthracene
Bis(2-ethylhexyl) phthalate	2,3,3',4',6-Pentachlorobiphenyl
2,3',4',5-tetrachlorobiphenyl	

Organic Carbon = 0.1%

Malathion	Acenaphthylene
2,4'-Dichlorobiphenyl	Pentachlorophenol
Fluorene	Anthracene
Phenanthrene	

Organic Carbon = 1.0%

Atrazine	Cyanazine
Metolachlor	Malathion

(continued)

TABLE 25. (CONTINUED)

Low Mobility (Class III)	
Organic Carbon = 0.01%	
Chrysene	2,2',4,4',5,5'-Hexachlorobiphenyl
Benzo(a) pyrene	Benzo(k) fluoranthene
Benzo(b) fluoranthene	Benzo(ghi) perylene
2,2',3,4,4',5,5'- heptachlorobiphenyl	Indeno(1,2,3-cd) pyrene
Organic Carbon = 0.1%	
Chlordane	2,4,4'-Trichlorobiphenyl
Fluoranthene	Pyrene
Benzo(a)Anthracene	Methoxychlor
Bis(2-ethylhexyl) phthalate	2,3',4',5-Tetrachlorobiphenyl
2,3,3',4',6-Pentachlorobiphenyl	2,2'4,4',5,5'-Hexachlorobiphenyl
Organic Carbon = 1.0%	
Acenaphthylene	Anthracene
2,4'-Dichlorobiphenyl	Pentachlorophenol
Fluorene	Phenanthrene
Very Low Mobility (Class IV)	
Organic Carbon = 0.1%	
Chrysene	2,2'4,4',5,5'-hexachlorobiphenyl
Benzo(a) pyrene	Benzo(k) fluoranthene
Benzo(b) fluoranthene	Benzo(ghi) perylene
2,2',3,4,4',5,5'-Heptachlorobiphenyl	Indeno(1,2,3-cd) pyrene
Organic Carbon = 1.0%	
Chlordane	2,4,4'-Trichlorobiphenyl
Fluoranthene	Pyrene
Benzo(a) anthracene	Methoxychlor
Bis(2-ethylhexyl) phthalate	2,3',4',5-Tetrachlorobiphenyl
2,3,3',4',6-Pentachlorobiphenyl	Chrysene
Benzo(a) pyrene	2,2',4,4',5,5'-Hexachlorobiphenyl
Benzo(b) fluoranthene	Benzo(k) fluoranthene
2,2',3,4,4',5,5'-heptachlorobiphenyl	Benzo(ghi) perylene
Indeno(1,2,3-cd) pyrene	

Reference: Armstrong and Llena 1992.

unsaturated flow processes and is controlled by the mobile and immobile fractions, soil heterogeneity, and soil spatial variability. Preferential flow allows the pesticide to flow easily through the soil and bypass the area with the greatest microbial activity and degradation (Rice, *et al.* 1991; and Steenhuis, *et al.* 1988).

Pesticide transport past the root zone through the unsaturated zone depends on the lipophilic nature and other chemical characteristics of the compound, on how the compound is used in relation to climate and irrigation practices, and on the properties of the soil and aquifer media, including hydraulic conductivity and total organic carbon (Domagalski, *et al.* 1992). Basic (high pH) pesticides, such as atrazine, become more mobile in soils having high pH values. Acidic pesticides ionize, depending on their dissociation constants, to form cationic and anionic species, and under neutral soil conditions (pH of 5 to 9), the anionic form predominates. Since these anions are negatively charged, they do not adsorb onto the negatively charged clay mineral surfaces. Similarly, acidic pesticides tend to be more mobile in neutral soils (Pierce and Wong 1988). Pesticide movement will often slow as the depth increases in the vadose zone, allowing more soil contact time. However, the soil still may not be able to completely remove the pesticide from the water due to reduced biodegradation activity deeper in the soil (Bouwer 1987).

Pesticide mobility comparisons have been performed for atrazine, metolachlor and alachlor in the same soil type and it was found that alachlor mobility > metolachlor >> atrazine (Alhajjar, *et al.* 1990), with faster movement generally occurring in sandy loam soils versus loam soils (Krawchuk and Webster 1987).

Restricted pesticide usage on coastal golf courses has been recommended by regulatory agencies. The slower moving pesticides were recommended provided they were used in accordance with the label's instructions. These included the fungicides Iprodione and Triadimefon, the insecticides Isofenphos and Chlorpyrifos and the herbicide Glyphosate. Others were recommended against, even when used in accordance with the label's instructions. These included the fungicides Anilazine, Benomyl, Chlorothalonil and Maneb and the herbicides Dicamba and Dacthal. No insecticides were on the "banned list" (Horsley and Moser 1990).

Solubility and Sorbtivity of Pesticides--

Leaching of the less water soluble compounds is determined by the sorption ability of the chemicals to the soil particles, especially the colloids. The sorption ability of the pesticide determines whether it will remain in solution until it reaches the groundwater (Pierce and Wong 1988). Adsorption of a pesticide to the soil stops its travel with the percolating water and prevents its contamination of the groundwater (Bouwer 1987). In general, pesticides with low water solubilities, high octanol-water partitioning coefficients, and high carbon partitioning coefficients are less mobile. Also, in general, basic and nonionic water soluble pesticides are lost in greater amounts in surface runoff than acidic and nonionic, low to moderate water soluble, pesticides with less traveling through the soil toward the groundwater (Pierce and Wong 1988).

Adsorption and desorption control the movement of pesticides in groundwater (Sabatini and Austin 1988). Modeling of pesticide movement using physical non-equilibrium expressions for mass transfer and diffusion most closely mimics the actual movement in soil (Pierce and Wong 1988).

Decomposition of Pesticides--

Pesticides decompose in soil and water, but the total decomposition time can range from days to years. Decomposition and dispersion rates in the soil depend upon many factors, including pH, temperature, light, humidity, air movement, compound volatility, soil type, persistence/half-life and microbiological activity (Ku and Simmons 1986).

Historically, pesticides were thought to adsorb to the soil during recharge, with decomposition then occurring from the sorbed sites. The decomposition rates are a function of temperature, moisture, and organic content, with the microbiological community being stable. Decomposition half-lives of many pesticides have been determined. However, literature half-lives generally apply to surface soils and do not account for the reduced microbial activity found deep in the vadose zone (Bouwer 1987).

Pesticides with a thirty-day half life can show considerable leaching. An order of magnitude difference in half-life results in a five to ten-fold difference in percolation loss (Knisel and Leonard 1989). Organophosphate pesticides are less persistent than organochlorine pesticides, but they also are not strongly adsorbed by the sediment and are likely to leach into the vadose zone, and possibly the groundwater (Norberg-King, *et al.* 1991).

As demonstrated in Central Florida and on Long Island, New York, sediment analysis in recharge basins show sediment with significant organic content, indicating that basin storage and recharge may effectively remove a large percentage of the pesticides (Schiffer 1989; and Ku and Simmons 1986). Most organophosphate and carbamate insecticides are regarded as nonpersistent, but they have been found in older, organic soils used for vegetable production and in the surrounding drainage systems (Norberg-King, *et al.* 1991). Studies of recharge basins in Nassau and Suffolk Counties on Long Island, New York, showed that the DDT concentration in each basin correlated well with the basin's age and showed that DDT can survive in recharge basins for many years (Seaburn and Aronson 1974). Residues of atrazine, triallate and trifluralin have carried over from year to year in Canadian field soils (Smith 1982, as reported by Pierce and Wong 1988). Carbofuran has also survived for long periods in soil in Manitoba, Canada, with resulting detection in the groundwater the following year (11.5 to 158.4 µg/L) (Krawchuk and Webster 1987).

Observed chlorothalonil in groundwater (10.1 to 272.6 µg/L) possibly resulted from one of three sources: 1) carryover in the soil from the previous year before leaching to the groundwater (most probable); 2) use in other fields and subsequent movement of the groundwater; and 3) movement of tile drain water through the soil to the area in question. The source water for removing the pesticide from the soil in Manitoba, Canada, the following year was believed to be snow melt water that leached into the ground in the early spring (Krawchuck, *et al.* 1987).

The following pesticides used in the San Joaquin Valley, California, have high leaching potential: alachlor, aldicarb, atrazine, bromacil, carbaryl, carbofuran, carboxin, chlorothalonil, cyanazine, 2,4-D, dalapon, DCPA, diazinon, dicamba, 1,2-dichloropropane, dinoseb, disulfoton, diuron, methomyl, metolachlor, metribuzin, oxamyl, simazine, tebruthiuron, and trifluralin (Domagalski, *et al.* 1992), with some having already been detected in the groundwater. Controlling pesticide leaching to prevent future groundwater contamination requires a reevaluation of current agricultural and residential practices and implementation of the more progressive ones (Lee 1990).

Health Effects

Some pesticides affect only those workers directly working with them, while others affect people or animals near and/or downwind of the application site (Bouwer 1989). Pesticides have been linked to cancer, nervous system disorders, birth defects, and other systemic disorders. DBCP has been linked to male sterility in the manufacturer's employees and to cancer in animals (Sabol, *et al.* 1987). Aldicarb has not been found to be carcinogenic, but it is highly toxic and causes a reversible inhibition of cholinesterase, an enzyme necessary for nerve function (Bouwer 1987). Methyl parathion and carbofuran are the organic toxic agents in the Colusa Basin water in California. Studies of the aquatic toxicity of these compounds found their toxicological effects to be additive when used in mixtures (Norberg-King, *et al.* 1991). Table 26 lists the toxicological data for many common pesticides.

GROUNDWATER CONTAMINATION ASSOCIATED WITH OTHER ORGANIC COMPOUNDS

Definition

Organic compounds are defined as compounds that are comprised mainly of carbon, nitrogen, and hydrogen. The organic compounds discussed in this chapter are generally analyzed using GC/MSD techniques and are divided into several categories, depending on the analytical technique used or the chemical class. The most common organic compounds that have been investigated during groundwater contamination studies are listed in Table 27.

Examples of Organic Compounds Contaminating Groundwater

Many organic compounds are naturally occurring, although many of concern in groundwater contamination investigations are man-made. Sources of organic contaminants include natural sources, landfills, leaky sewerage systems, highway runoff, agricultural runoff, urban stormwater runoff, and other urban and industrial sources and practices.

Natural Occurrence--

Organic compounds occur naturally from decomposing animal wastes, leaf litter, vegetation, and soil organisms (Reichenbaugh, *et al.* 1977). Aerosols in groundwater usually are from precipitation (Seaburn and Aronson 1974).

Urban Areas--

Concentrations of organic compounds in urban runoff are related to land use, geographic location and traffic volume (Hampson 1986). These compounds result from gasoline and oil drippings, tire residuals and vehicular exhaust material (Seaburn and Aronson 1974; Hampson 1986). The primary source is from the use of petroleum products, such as lubrication oils, fuels, and combustion emissions (Schiffer 1989). The organic compounds on many street surfaces consists of: cellulose, tannins, lignins, grease and oil, automobile exhaust hydrocarbons, carbohydrates and animal droppings (Hampson 1986). Toluene and 2,4-dimethyl phenol are also found in urban runoff and are used in making asphalt (German 1992). Polynuclear aromatic hydrocarbons (PAHs) are also commonly found in urban runoff and result from combustion processes, and include fluoranthene, pyrene, anthracene, and chrysene (German 1989; Greene 1992).

TABLE 26. PESTICIDE TOXICOLOGICAL DATA

Pesticide	LD50/Species
Aldicarb	0.93 mg/kg rat
Atrazine	3080 mg/kg rat 200- >5000 mg/kg quail/mallard
Azinphos-methyl	11-20 mg/kg rat
Bromoxynil	190 mg/kg rat >5000 mg/kg quail/mallard
Bromoxynil Octanoate	260 mg/kg rat
Carbaryl	850 mg/kg rat 2290->10000mg/kg quail/mallard
Carbofuran	8.2-14.1 mg/kg rat 0.397-46 mg/kg quail/mallard
Chlorothalonil	>10000 mg/kg rat
Chlorpyrifos	135-163 mg/kg rat 15.9-492 mg/kg quail/mallard
2,4-D	375 mg/kg rat 412- >5000 mg/kg quail/mallard
Decamethrin	128 mg/kg rat
Diazinon	108 mg/kg rat 3.54-101 mg/kg quail/mallard
Dicamba	1040-2900 mg/kg rat
Diclofop-methyl	557-580 mg/kg rat
Difenzoquat	470 mg/kg rat >5000 mg/kg quail/mallard
Disulfoton	2.6-12.5 mg/kg rat
EPTC	1630 mg/kg rat
Fenitrothion	500 mg/kg rat 652-1662 mg/kg quail/mallard

(continued)

TABLE 26. (CONTINUED)

Fonofos	8-17 mg/kg rat 16.9-290 mg/kg quail/mallard
Glyphosate	4320 mg/kg rat >5000 mg/kg quail/mallard
Lindane	76-200 mg/kg rat 490->2000 mg/kg quail/mallard
Malathion	1200 mg/kg rat 1485-2968 mg/kg quail/mallard
Mancozeb	5000 mg/kg rat
MCPA	700 mg/kg rat
Metiram	10000 mg/kg rat
Metolachlor	2750 mg/kg rat
Metribuzin	2200 mg/kg rat
Paraquat	150 mg/kg rat
Phorate	2 mg/kg rat 0.62-575 mg/kg quail/mallard
Propanil	1400 mg/kg rat
Terbufos	4.5-9.0 mg/kg rat 225 mg/kg quail/mallard
Triallate	1675-2166 mg/kg rat
Trifluralin	>10000 mg/kg rat

Source: Krawchuk and Webster 1987; Pierce and Wong 1988.

TABLE 27. ORGANIC COMPOUNDS INVESTIGATED DURING GROUNDWATER CONTAMINATION STUDIES

Volatile Organic Compounds

Benzene	Bromoform
Carbon Tetrachloride	Chlorobenzene
Chlorodibromomethane	Chloroethane
2-Chloroethylvinyl ether	Chloroform
1,2-Trans-dichloroethylene	Diclorobomomethane
Dichlorofluoromethane	1,1-Dichloroethane
1,2-Dichloroethane	1,1-Dichloroethylene
1,2-Dichloropropane	1,3-Dichloropropene
Ethylbenzene	Methyl bromide
1,1,2,2-Tetrachloroethane	Tetrachloroethane
Toluene	1,1,1-Trichloroethane
1,1,2-Trichloroethane	Trichloroethylene
Trichlorofluoromethane	Vinyl Chloride
Dibromochloropropane	

Acid Extractable Organic Compounds

p-Chloro-m-cresol	2-Chlorophenol
2,4-Dichlorophenol	2,4-Dimethylphenol
4,6-Dinitro-o-cresol	2,4-Dinitrophenol
2-Nitrophenol	4-Nitrophenol
Pentachlorophenol	Phenol
2,4,6-Trichlorophenol	2-Ethylphenol
2-Methylphenol	2,6-Dimethylphenol
3-Methylphenol	2,5-Dimethylphenol
3,4-Dimethylphenol	2,3-Dimethylphenol
3,5-Dimethylphenol	2,4,6-Trimethylphenol
2,3,5-Trimethylphenol	2,3,6-Trimethylphenol
2,3,5,6-Tetramethylphenol	2-Napthol

(continued)

TABLE 27. (CONTINUED)

Base-Neutral Extractable Compounds

Acenaphthene	Acenaphthylene
Antracene	Benzidene
Benzo(a)anthracene	Benzo(a)pyrene
Benzo(g,h,i)perylene	Benzo(k)fluoranthene
Benzo(b)fluoranthene	4-Bromophenyl phenyl ether
Butyl benzyl phthalate	Bis(2-chloroethyoxy) methane
Bis(2-chloroethyl)ether	Bis(2-chloroisopropyl)ether
2-Chloronaphthalene	4-Chlorophenyl phenyl ether
Chrysene	Dibenzo(a,h)anthracene
Di-n-butyl phthalate	1,3-Dichlorobenzene
1,4-Dichlorobenzene	1,2-Dichlorobenzene
3,3'-Dichlorobenzidene	Diethyl phthalate
Dimethyl phthalate	2,6-Dinitrotoluene
2,4-Dinitrotoluene	Dioctylphthalate
Bis(2-ethylhexyl)phthalate	Fluoranthene
Hexachlorobenzene	Hexachlorobutadiene
Hexachlorocyclopentadiene	Hexachloroethane
Indeno(1,2,3-cd)pyrene	Isophrone
Naphthalene	Nitrobenzene
N-nitrosodi-n-propylamine	N-nitrosodimethylamine
N-nitrosodiphenylamine	Phenanthrene
Pyrene	1,2,4-Trichlorobenzene
Benzo(b)pyrene	Butyl benzylphthalate

Source: German 1989; Troutman, *et al.* 1984; Wanielista, *et al.* 1991; and Salo, *et al.* 1986.

In Florida, organic compounds found in runoff were attenuated in the soil, with only one priority pollutant being detected in the Floridan aquifer as a result of stormwater runoff. This compound was bis(2-ethylhexyl) phthalate, which is a plasticizer which readily leaches from plastics (German 1989). In Pima County, Arizona, base/neutral compounds appeared in groundwater from residential areas, while phenols in the groundwater were noted only near a commercial site. Groundwater from a commercial site, also in Pima County, has been contaminated with ethylbenzene and toluene. Perched groundwater samples from residential sites showed the presence of toluene, xylene, and phenol (Wilson, *et al.* 1990). On Long Island, New York, benzene (groundwater concentrations of 2 to 3 µg/L); bis(2-ethylhexyl) phthalate (5 to 13 µ g/L); chloroform (2 to 3 µg/L); methylene chloride (stormwater concentration of 230 µg/L and groundwater concentrations of 6 to 20 µg/L); toluene (groundwater concentrations of 3 to 5 µg/L); 1,1,1-trichloroethane (2 to 23 µg/L); p-chloro-m-cresol (79 µg/L); 2,4-dimethyl phenol (96 µg/L); and 4-nitrophenol (58 µg/L) were detected in groundwater beneath stormwater recharge basins (Ku and Simmons 1986).

Organic compounds occasionally found in runoff at three stormwater infiltration sites in Maryland included benzene, trichlorofluoromethane, 1,2-dichloroethane, 1,2-dibromoethylene, toluene, and methylene blue active substances (MBAS). Only MBAS's were found consistently and in elevated concentrations beneath the infiltration devices. The other organic compounds found in runoff were removed either in the device or in the vadose zone. Although specific organic compounds were not detected in the groundwater beneath and downgradient of the infiltration device, the dissolved organic carbon (DOC) concentration in the groundwater affected by infiltration was greater than that in the native groundwater (Wilde 1994).

Leaky sanitary sewerage in the Munich, Germany urban area has caused elevated concentrations in groundwater of total organic carbon, chloroform, trichloroethylene, and tetrachloroethylene (Merkel, *et al.* 1988). Volatile organic compounds (chloroform concentrations of 4.5 to 29 µg/L) were detected in the groundwater below twelve of fifteen municipal wastewater treatment plants throughout Florida (Pruitt, *et al.* 1985).

Organic compounds can leach from municipal waste landfills and other disposal sites, including unlined industrial surface impoundments and older hazardous waste landfills. Municipal waste landfills are sources of phthalate compounds that leach from plastic and detergents. Bis(2-ethylhexyl)phthalate can become airborne during municipal waste incineration, can be leached from plastics in a landfill, and was detected in water samples from the Floridan aquifer (German 1989). Surface impoundments used to contain industrial wastewater at a wood treatment plant showed significant amounts of residual pentachlorophenol (PCP), creosote, and diesel fluids and has led to the phenolic contamination of the groundwater near a wood treatment facility near Pensacola, Florida (Troutman, *et al.* 1984).

Industrial areas contribute heavily to the organic compound load that could potentially leach to the groundwater. Surface impoundments may be used to contain industrial wastes, deep well injection may be used to dispose of water, and stormwater runoff may collect organics as it passes over an industrial site. Phenols and the PAHs benzo(a)anthracene, chrysene, anthracene and benzo(b)fluoroanthenene, have been found in groundwater near an industrial site in Pima County, Arizona. The phenols are primarily used as disinfectants and as wood preservatives and were present in the stormwater runoff, although they were significantly reduced in concentration by the time they reached the groundwater (generally less than 50 μ g/L). At an Arizona recharge site, the groundwater has higher concentrations of trichloroethylene, tetrachloroethylene, and pentachloroanisole, than the inflow water, indicating past industrial contamination (Bouwer *et al.* 1984).

Documented industrial groundwater contamination is not limited to the United States. In Birmingham, UK, groundwater contamination resulted from hydrocarbon oil and volatile chlorinated solvent use. The metals-related industries have contributed significant amounts of trichloroethylene (groundwater concentrations of up to 4.9 mg/L have been noted) to the groundwater in this area, and since trichloroethylene has been replaced by 1,1,1-tri-chloroethane in industry, 1,1,1-tri-chloroethane contamination is beginning to occur. The other organic compound to show up in significant concentrations in Birmingham is perchloroethylene, a solvent used primarily in the dry cleaning laundry industry (Lloyd, *et al.* 1988). On the left bank of the Danube, the petrochemical refinery Slovnaft has contributed to groundwater contamination by leaking oil during tanker loading and unloading (Marton and Mohler 1988).

Soil Removal Processes for Organic Compounds

The appearance in groundwater of organic compounds, along with elevated nitrate concentrations, has been used as an indicator of groundwater contamination (Lloyd 1988). Most organics are reduced in concentration during percolation through the soil, although they may still be detectable in the groundwater. Groundwater contamination from organics, like from other pollutants, occurs readily in areas with pervious soils, such as sand and gravel, and where the water table is near the land surface (Troutman, *et al.* 1984). Based on septic tank effluent studies, sand seems to be more effective than limestone in filtering the organic material (Schneider, *et al.* 1987). In coastal areas and valleys, direct interaction of groundwater and surface water will result in groundwater contamination if the surface water is contaminated (Troutman, *et al.* 1984). Organic removal from the soil and recharge water can occur by one of three methods: volatilization, sorption, and/or degradation (Crites 1985; and Nellor, *et al.* 1985). Estimates of organic compound mobility can be made based on volatilization, sorption, and solubility, as previously shown on Tables 23 through 25 (Armstrong and Llena 1992).

Volatilization of Organics--

The rate of volatilization is controlled by the compound's physical and chemical properties; its concentration; the soil's sorptive characteristics; the soil-water content; air movement; temperature; and the soil's diffusion ability. Volatilization can occur both during application and from soil sites after infiltration. Volatilization during application is controlled by the compound's physical and chemical characteristics, atmospheric conditions, and application method (Crites 1985) and has been measured by observing the reduction in the organic concentration across an infiltration basin.

Volatilization from sorbed sites of soils is a function of: transfer of the organic compound from the soil's sorbed sites to the solution, movement from the solution to the air trapped in the soil and diffusion of the compound in the soil air to the atmosphere. The extent of each of the above reactions depends on the compound's solubility, its concentration gradient in the soil, and proximity of the molecule of interest to the soil surface (Crites 1985).

Volatile organic compounds are rarely found in stormwater recharge basins (<2.4 μg/L), dry wells (<175 μg/L), or the vadose zone or groundwater below the basins (<4 μg/L), as indicated by studies in Fresno, California, by Nightingale (1987b) and in Pima County, Arizona by Wilson, *et al.* (1990).

Sorption of Organic Compounds--

There are at least six different sorption mechanisms: cation exchange, anion exchange, cation-dipole and coordination bonds, hydrogen bonding, van der Waals attraction, and hydrophobic bonding (Crites 1985). Sorption is a function of the following soil-water-compound system characteristics: sorbate shape/configuration (including structure and position of functional groups and presence and degree of molecular saturation); sorbate chemical characteristics (including acidity or basicity; water solubility; charge distribution; polarity and polarizability); and sorbent nature (including mineralogical composition, organic matter content and cation exchange capacity (CEC) (Crites 1985) with the clay and particulate organic matter content controlling the sorption (Bouwer *et al.* 1984).

Hydrophobic sorption onto organic matter were found to limit the mobility of less soluble base/neutral and acid extractable compounds through organic soils and the vadose zone in Orlando, Florida (German 1989). The degree of removal in soil of nonhalogenated organic compounds is greater than that of the halogenated organics (Bouwer, *et al.* 1984). Benzene, toluene and xylene were found in the soils and in the perched water table in Arizona and, as these compounds are relatively soluble, they may percolate easily through the vadose zone. The toluene concentration in the perched-water table was 54 μg/L, while the toluene concentration in the water table was 3.7 μg/L (Wilson, *et al.* 1990).

Sorption is not always a permanent removal mechanism. A study in Florida has shown that organic solubilization can occur for several storms following dry periods. However, extended periods of complete aeration of bottom sediments may be counter-productive when trying to reduce organic compound concentrations (Hampson 1986).

Degradation and Decomposition of Organic Compounds--

The third process for organic compound attenuation is chemical or biological degradation. Examples of chemical degradation processes include hydrolysis and photodegradation. However, most of the trace organic removal is the result of biological degradation (Smith and Myott 1975). Many organics can be degraded by microorganisms, at least partially, but others cannot. Temperature, pH, moisture content, cation exchange capacity, and air availability may limit the microbial degradation potential for even the most degradable organic (Crites 1985). The end products of complete aerobic degradation include carbon dioxide, sulfate, nitrate, phosphate, and water, while the end products under anaerobic conditions include carbon dioxide, nitrogen, hydrogen sulfide, and methane (EPA 1992).

Conditions in the thick, aerobic, unsaturated zone provide a good environment for wastewater detergent concentration reduction through biochemical degradation and adsorption (Smith and Myott 1975). Halogenated one- and two-carbon aliphatic compounds are biotransformed under methanogenic, but not aerobic, conditions (Bouwer, *et al.* 1984). The rate of breakdown of chlorinated hydrocarbons in the soil increases with temperature, water content, and organic matter content (Bouwer 1987). Nonhalogenated hydrocarbons decreased fifty to ninety percent during percolation through the soil, with concentrations in the renovated water being detectable, but near, or below, the detection limit. The halogenated organic compounds generally decreased to a lesser extent during percolation.

The chlorinated aromatics are relatively refractory and mobile in the ground and have lesser concentration decreases than nonchlorinated aromatic hydrocarbons. Significant reductions of TOC concentrations occurred during the first several meters of soil percolation and a gradual decrease in TOC concentration occurred with longer underground travel times at the Phoenix 23rd Ave. recharge project site (Bouwer, *et al.* 1984).

Pretreatment of the recharge water in Arizona by chlorination resulted in higher chloroform concentrations and in the formation of three brominated trihalomethanes (Bouwer, *et al.* 1984). Ponds and lakes affected by stormwater runoff have a high potential for the formation of trihalomethanes (THMs) with chlorination because of the precursor organics existing in the stormwater. Factors which affect THM formation include the chlorine contact time, pH, and temperature. Precursors to THM formation in stormwater include algae, bacteria, and humic substances (Wanielista, *et al.* 1991).

At an injection well site in Florida, organic carbon compounds were microbially converted to carbon dioxide and ammonia within 100 meters of the injection well (Hickey and Vecchioli 1986). In general, deep well injection in Florida showed that organic compounds are being mineralized in the Floridan aquifer (Ehrlich, *et al.* 1979b).

Anaerobic methanogenic bacteria in a surface impoundment located at a wood treatment plant near Pensacola, Florida, reduced the total phenol concentration by forty-five percent. However, the presence of pentachlorophenol inhibits methanogenesis, reducing the removal of some organics in the impoundment (Troutman, *et al.* 1984). In Arizona, partial degradation of the chlorinated benzenes occurs during percolation through the aerobic zone, but the poor overall removal efficiency of chlorinated aromatics probably results from their lack of degradation under anoxic conditions. In general, infiltration and percolation through the soil has the effect of dampening concentration fluctuations and eliminating occasional extreme values (Bouwer, *et al.* 1984).

Health Effects

Some of the organics listed as hazardous to human health include: benzene, ethylenimine, ethylene dibromide, benzidene, carbon tetrachloride, tricresyl phosphate, chloroform, allyl chloride, aroclor 1254, and benzolalpyrene (Crites 1985). Disease outbreaks due to water contamination by organics has been documented for the following compounds: cutting oil, photographic developer fluid (hydroquinone, paramethylamino phenol), ethyl acrylate, fuel oil, leaded gasoline, mixtures of lubricating oil and kerosene, phenol, and polychlorinated biphenyl. In Wisconsin, an accidental phenol spill caused an illness in the area residents that was characterized by diarrhea, mouth sores, burning of the mouth, and dark urine (Craun 1979). Runoff from paved areas in urban Arizona commonly was found to contain the following four suspected carcinogenic PAHs: benzo(a)anthracene, benzo(b)fluoranthene, dibenzo(a,h)anthracene and chrysene (Wilson, *et al.* 1990).

GROUNDWATER CONTAMINATION ASSOCIATED WITH PATHOGENS

Definition

Microorganism pathogens that can be in stormwater and can cause specific human diseases include viruses, protozoa, and bacteria. When evaluating the potential contamination of groundwater, many types of microorganisms are important. Pathogenic microorganisms harmful to human health need to be controlled, while those that are necessary for decomposition of nutrients and contaminants need to be encouraged. Viruses of concern in water are shown in Table 28.

TABLE 28. VIRUSES OF CONCERN IN WATER

Virus Group	**Number Of Types**
Enteroviruses	
Poliovirus	3
Echovirus	34
Coxsackie Virus A	24
Coxsackie Virus B	6
New Enteroviruses	?
Hepatitis Type A (probably an enterovirus)	1
Rotavirus (reovirus family) (gastroenteritis Type B)	2
Reovirus	3
Adenovirus	>30
Parvovirus	3
Adeno-Associated Virus	?

Source: Crites 1985.

Microorganisms that have been studied in urban runoff (both the harmful and the environmentally necessary ones) include: *Shigella, Salmonella, Giardia lamblia, Yersinia Enterocolitica, E. coli, Methanogenic bacteria, Azonmonas, Acinetobacter, Pseudomonas, Bacillus, Flavobacterium, Alcaligenes, Thiobacillus, Leptothrix, Siderocapseceae, Metallogenium, Vibrio, Campylobacter, Leptospira, Streptococci, Beggiotoa, Micrococus, Proteus, Aeromonas, Serratia,* and *Gallionella.*

Examples of Microorganism Contamination of Groundwater

Pathogen sources that potentially contaminate groundwater include waste decomposition, sanitary sewage, agriculture, urban runoff, and natural occurrence.

Natural Occurrence--

Many types of bacteria occur naturally in water. The bacteria groups found in flowing water include sheathed bacteria, iron-manganese bacteria and some of the sulfur oxidizing bacteria (Wanielista, *et al.* 1991). Bacteria that affix to carbon and are water and soil chemoorganotrophs include *Azonmonas, Acinetobacter, Pseudomonas, Bacillus, Flavobacterium* and *Alcaligenes.*

Beggiatoa are filamentous bacteria that produce polysaccharidic sheath-like slimes. They are found at the sulfide/oxic interface of fresh or marine waters or estuaries. *Gallionella* is chemolithotrophic (it oxidizes inorganic ferrous iron and assimilates carbon dioxide). It is characterized by twisted stalks containing the organic material to which the ferric hydrate is bound. *Leptothrix*, if it is the dominant bacteria in water, indicates a high iron and/or manganese concentration in the water. *Metallogenium* are aerobic, chemoorganotroph/parasitic organisms that are found in surface waters near anaerobic sediments, decomposing layers of leaf litter, or bottom deposits of lakes. The *Siderocapsaceae* family of bacteria are non-filamentous, aerobic/anaerobic, facultative/obligate slime-encapsulated bacteria that precipitate iron and manganese. They occur in swamp ditches, stagnant waters, and in the hypolimnion of lakes, and use organic carbon of iron-manganese humates. *Thiobacillus* is an aerobic, non-aggregating bacteria which oxidizes reduced sulfur into sulfate and is found in sulfur-bearing water. *Thiothrix* bacteria are found in sulfide or thiosulfide containing waters and in wastewater treatment plants (Reichenbaugh, *et al.* 1977).

The bacteria found in the aquifer at a recharge site at Bay Park, New York, included obligate aerobes and facultative anaerobes such as *Alcaliganes, Micrococus, Flavobacterium, Acinebacter, Proteurs, Aeromonas*, and *Serratia*. These bacteria used the soluble organic matter in the recharge water as food. Denitrifying strains of *Pseudomonas fluorescens* grow under the anaerobic conditions of the Magothy aquifer by using nitrate as a terminal electron acceptor. Several *Pseudomonas* species, including *P. fluorescens, P. aeruginosa, P. putida, P. alcaligenes,* and *P. pseudoalcaligenes* can sustain themselves under anaerobic conditions by decomposing arginine, an amino acid, through substrate level phosphoration (Ehrlich, *et al.* 1979a).

Urban Areas--

When comparing urban runoff from different land uses on Long Island, New York, low-density residential and nonresidential areas contributed the fewest bacteria to the storm runoff, while medium-density residential and commercial areas contributed the most. The amount of each bacteria species in the runoff varied by season, with the warm seasons having significantly more fecal coliforms and fecal streptococci than the colder seasons. However, total coliform concentrations were not affected by the season (Ku and Simmons 1986). NURP monitoring results also found similar seasonal variations for fecal coliform discharges throughout the U.S. (EPA 1983).

Viruses were detected in groundwater on Long Island at sites where stormwater recharge basins were located less than thirty-five feet above the aquifer (Vaughn, *et al.* 1978). At other locations, viruses are likely removed from the percolation water by either adsorption and/or inactivation.

Rain water infiltration through solid wastes readily carries decomposition products, in addition to bacteria and viruses, downward through the soil to the groundwater. The highest contaminant concentrations occur when the water table is near the land surface (Boggess 1975). Bacterial pathogens found in human and animal feces and the resulting wastewater include *Escherichia coli, Salmonella, Shigella, Yersinia, Vibrio, Campylobacter* and *Leptospira* (Amoros, *et al.* 1989). Leaky sanitary sewerage systems or septic tanks may leach these bacteria into storm drainage systems or directly into groundwater (Pitt, *et al.* 1993).

Shigella is not as common in wastewater as *Salmonella* in developed countries, although it is more prevalent in the tropics and subtropics. *Salmonella* is the most common disease-causing bacteria found in wastewater (Crites 1985).

Agricultural Operations--

Agricultural uses of treated effluent in fertilization can also promote the spread of pathogens to the soil where, during irrigation, they can pass through the soil to the groundwater (Robinson and Snyder 1991). Bacteria also can be returned to humans through vegetables irrigated with inadequately disinfected sewage effluent (Amoros, *et al.* 1989).

Soil Removal Processes for Pathogens

During land application or burial of sewage sludge, pathogens may leach from the sludge and contaminate groundwater, although most are removed in the soil during percolation (Gerba and Haas 1988).

The factors that affect the survival of enteric bacteria and viruses in the soil include pH, antagonism from soil microflora, moisture content, temperature, sunlight, and organic matter. The effect of each of these factors is given in Table 29 (Crites 1985). In general, drying of the soil will kill both bacteria and viruses.

Viruses--

Viral adsorption--Viral adsorption is promoted by increasing cation concentration, decreasing pH and decreasing soluble organics (EPA 1992) and is controlled by both the efficiency of short-term virus retention and the long-term behavior of viruses in the soil (Crites 1985). The effect of each of these factors is given in Table 30 (EPA 1992 and Crites 1985).

The downward movement and distribution of viruses are controlled by convection and hydraulic dispersion mechanisms. Since the movement of viruses through soil to groundwater occurs in the liquid phase and involves water movement and associated suspended virus particles, the distribution of viruses between the adsorbed and liquid phases determines the viral mass available for movement.

The distribution (or sorption) of virus particles in the soil matrix is largely due to electrostatic double layer interactions and Van der Waals forces. Adsorption of viruses in soil is rapid and reversible and can be adequately described by an equilibrium (linear Freundlich isotherm) expression (Tim and Mostaghim 1991). Viral adsorption by the soil does not necessarily result in virus inactivation and has been shown to be reversible after a change in soil conditions, such as the ionic environment (Jansons, *et al.* 1989b; and Vaughn, *et al.* 1978). Also, once the virus reaches the groundwater, it can travel laterally through the aquifer until it is either adsorbed or inactivated (Vaughn, *et al.* 1978).

Viral inactivation--Enterovirus survival in groundwater is highly variable and is influenced by a number of factors, including: virus type, pH, temperature, dissolved oxygen concentration, and microbial antagonism (Jansons, *et al.* 1989b; and Tim and Mostaghim 1991). The two most important attributes of viruses that permit their long-term survival in the environment are their structure and very small size. These characteristics permit virus occlusion and protection within colloid-size particles. Viruses in

TABLE 29. SOIL CHARACTERISTICS AFFECTING PATHOGEN REMOVAL

Factor	Pathogen Type	Remarks
pH	Bacteria	Shorter survival in acid soils (pH = 3 to 5) than in alkaline and neutral soils.
	Viruses	Insufficient data.
Antagonism from soil microflora	Bacteria	Increased survival time in sterile soil.
	Viruses	Insufficient data.
Moisture content	Bacteria and viruses	Longer survival in moist soils and during periods of high rainfall.
Temperature	Bacteria and viruses	Longer survival at low (winter) temperatures.
Sunlight	Bacteria and viruses	Shorter survival at the soil surface.
Organic matter	Bacteria and viruses	Longer survival (regrowth of some bacteria) when sufficient amounts of organic matter are present.

Source: Crites 1985.

TABLE 30. FACTORS THAT INFLUENCE VIRAL MOVEMENT IN SOIL AND TO GROUNDWATER

Soil Type. Fine-textured soils retain viruses more effectively than light-textured soils. Iron oxides increase the adsorptive capacity of soils. Muck soils are poor adsorbents. The higher the clay content of the soil, the greater the expected removal of the virus. Sandy loam soils and other soils containing organic matter are also favorable for virus removal. Soils with a small surface area do not achieve good virus removal.

pH. Generally, adsorption increases when pH decreases. However, the reported trends are not clear due to complicating factors.

Cations. Adsorption increases in the presence of cations (cations help reduce repulsive forces on both virus and soil particles). Rain water may desorb viruses from soil due to its low conductivity.

Soluble organics. Organics generally compete with viruses for adsorption sites. No significant competition at concentrations found in waste water effluents. Humic and fulvic acids reduce virus adsorption to soils.

Virus type. Adsorption to soils varies with virus type and strain. Viruses may have different isoelectric points.

Flow rate. High flow rates reduce virus adsorption to soils.

Saturated vs. unsaturated flow. Virus movement is less under unsaturated flow conditions.

Rainfall. Viruses retained near the soil surface may be eluted after a heavy rainfall because of the establishment of ionic gradients within the soil column.

Sources: EPA 1992; and Crites 1985.

wastewater applied to the soil are integral parts of submicron particles and are small enough to move with the applied water to the groundwater (Wellings 1988).

Dissolved oxygen is a significant factor in loss of virus activity in groundwater, possibly because direct oxidation of components of the virus capsid inactivates the virus or, as with temperature, the level of dissolved oxygen influences the activity of antagonistic microorganisms. At temperatures below 4^{o}C, microorganisms can survive for months or even years, whereas at higher temperatures, inactivation or dieoff occurs rapidly. Decreasing pH promotes virus adsorption and results in shorter survival times, both of the virus and of the antagonistic bacteria. High levels of organic matter appear to shield viruses from adsorption (Treweek 1985). Virus inactivation in the subsurface environment can be described by a first order decay reaction (Tim and Mostaghim 1991). It is difficult to describe a soil that will remove all viruses effectively, as different soil types affect each virus differently (Jansons, *et al.* 1989a).

Enteric viruses are more resistant to environmental factors than enteric bacteria and they exhibit longer survival times in natural waters. They can occur in potable and marine waters in the absence of fecal coliforms. Enteroviruses are more resistant to commonly used disinfectants than are indicator bacteria, and can occur in groundwater in the absence of indicator bacteria (Marzouk, *et al.* 1979).

Removal of bacterial pathogens--

The major bacterial removal mechanisms in soil are straining at the soil surface and at intergrain contacts, sedimentation, sorption by soil particles, and inactivation (Crites 1985). Potable water use requires continuous disinfection to prevent disease outbreaks in the population served (Craun 1979).

Not all bacteria are harmful and need to be removed from the water. For example, methanogenic bacteria are responsible for the decomposition of phenolic compounds in infiltrating water (Troutman, *et al.* 1984).

<u>Bacterial movement</u>--The characteristics of bacterial movement through porous media, such as an aquifer, include the following (Ehrlich, *et al.* 1979a):

- Bacteria travel with the flow of water, not against the hydraulic gradient.
- The rate of bacterial movement through filtering is a function of the nature of the aquifer materials, with silt and soils having high clay content being the best materials for bacterial removal.
- The rate of bacterial removal by filtering can be characterized by the filter efficiency of the aquifer (filterability).
- Typically, the maximum distance that bacteria travel in a porous media ranges from fifty to one hundred feet.
- Under favorable condition, bacteria may survive as long as five years.

Stable populations of bacteria in soil and water may become established due to an increased concentration of adsorbed organics and due to the large surface area of the granules to which they attach themselves (Wanielista, *et al.* 1991).

Bacteria survival--Factors such as temperature, pH, metal concentration, nutrient availability and other environmental characteristics affect the ability of a bacterial colony to survive in the water or soil (Ku and Simmons 1986). Once the microorganisms are retained in the soil, their survival depends upon the sunlight exposure, oxidation rates, desiccation and antagonism from the established soil microbial population (Crites 1985).

Bacteria survive longer in acid soils and when large amounts of organic matter are present. Bacteria and larger organisms in wastewater are usually removed during percolation through a short distance of soil (EPA 1992). When recharging using deep well injection, the logarithm of the coliform bacteria density decreases linearly with distance from the recharge well (Ehrlich 1979).

In general, enteric bacteria survive in soil between two and three months, although survival times up to five years have been documented (Crites 1985). *E. coli* can survive and multiply on trapped organic matter and *Salmonella* and *Shigella* have survived for forty-four days and twenty-four days, respectively, at a recharge site in Israel (Goldschmid 1974).

Significant dieoff can be achieved using intermittent rapid infiltration of wastewater and allowing the recharge basin to dry out (Crites 1985). When the recharge is stopped, the bacteria multiply, using the accumulated organic debris for food. The decomposition of the organic matter starts as an aerobic process. After the oxygen has been consumed, the process turns anaerobic and septic. At this stage, some denitrification and sulfate reduction takes place and the decomposition of the organic matter will lead to a partial reduction in clogging. Pathogenic enterobacteria are unable to multiply under these conditions, but they can survive for a relatively long time. About a hundred days after recharge, the decomposition process ended and no more coliform bacteria were found in the pumped water from the recharged aquifer in Israel (Goldschmid 1974).

Health Effects

Human health can be affected through waterborne diseases transmitted by bacteria, viruses, protozoa, and parasites (Crites 1985). Many microorganism caused diseases may be spread by person-to-person contact, or through contact of infected material (Gerba and Goyal 1988). Health effect research now goes beyond the acute effect of pathogens to the chronic problems associated with carcinogens and mutagens, and the other problems caused by long-term ingestion of low concentrations of these organisms (DeBoer 1983).

The development of clinical illness depends on numerous factors, including the immune status of the host, the age of the host, virulence of the microorganisms, type and strain of the microorganisms, and the route of infection. Mortality rates are affected by many of the same factors that determine the development of clinical illness (Gerba and Haas 1988).

Viruses--

Enteric viruses can survive typical sewage treatment processes, including chlorination, in sufficient numbers to be detectable in the discharged water. Peak concentrations of these viruses occur in the late summer and early autumn. The documented outbreaks of viral diseases from groundwater contamination have been limited primarily to infectious hepatitis (Crites 1985; Craun 1979).

Human enteric viruses of concern, and their diseases or symptoms, are given in Table 31.

TABLE 31. ENTEROVIRUSES AND DISEASES

Virus Group	**Disease or Symptom**
Poliovirus	Paralysis, meningitis, fever, encephalitis, gastroenteritis
Echovirus	Meningitis, respiratory diseases, rash, diarrhea, fever
Coxsackie Virus A	Herpangina, respiratory disease, fever meningitis, myocarditis, diabetes
Coxsackie Virus B	Myocarditis, congenital heart anomalies, rash, fever, meningitis, respiratory disease, pleurodynia, encephalitis
New Enteroviruses	Meningitis, encephalitis, respiratory disease, acute hemorrhagic conjunctivitis, fever, gastroenteritis
Hepatitis Type A	Infectious hepatitis
Rotavirus	Epidemic vomiting and diarrhea, chiefly in children, gastroenteritis
Reovirus	Respiratory infections
Adenovirus	Respiratory disease, eye infections, conjunctivitis, gastroenteritis
Parvovirus	Associated with respiratory diseases in children, but etiology not clearly established
Adeno-associated virus	Associated with respiratory diseases in children, but etiology not clearly established
Norwalk virus	Vomiting, diarrhea, fever, acute gastrointestinal disease
Astrovirus	Gastroenteritis
Renovirus	Not clearly established

Sources: Crites 1985; Tim and Mostaghim 1991.

Bacteria --

Shigella and *Shiga bacillus* are dysentery bacilli and cause mild to acute diarrhea, abdominal pains and blood in the stool. Acute gastroenteritis and typhoid fever result from the *Salmonella* bacteria. Symptoms of *Salmonella* contamination include abdominal cramps, nausea, vomiting and diarrhea (Craun 1979). Most outbreaks of salmonellosis can be traced to transmission of the bacteria via food, milk or direct contact, but its contamination of water supplies, with a resulting disease outbreak, occurred as recently as 1963. The bacteria *Escherichia coli* are responsible for some of the diarrhea diseases, as are *Shigella* and *Salmonella* (Crites 1985). *Azomonas, Acinetobacter, Pseudomonas bacillus* and *Flavobacterium* do not pose an immediate threat to human health, but they are opportunistic pathogens, chlorine resistant and/or suppressers of total coliforms (Wanielista, *et al.* 1991).

Reviews of past disease outbreaks due to water contamination has shown that acute gastrointestinal illnesses were slightly higher in groundwater systems, compared to surface water systems, due to the lack of treatment, or the use of poor treatment practices. For surface water systems, contamination and the resulting outbreaks were caused by contaminated ice or containers, backsiphonage, cross-connections, water main breaks, or accidental contamination of treated storage reservoirs (Craun 1979).

GROUNDWATER CONTAMINATION ASSOCIATED WITH METALS

Even in small concentrations, metals may be a problem when infiltrating stormwater, especially when using a rapid infiltration system (Crites 1985). The heavy metals of most concern include lead, copper, nickel, chromium, and zinc. However, most of these metals have very low solubilities at the pHs found in most natural waters and they are readily removed by either sedimentation or sorption removal processes (Hampson 1986). Many are also filtered, or otherwise sorbed, in the surface layers of soils in infiltrating devices using surface infiltration.

Examples of Metals Contaminating Groundwater

Urban Areas--

Nickel, chromium, and zinc concentrations exceeded the regulatory limits in the soil below a recharge area at an Arizona commercial site. However, only manganese was present at an elevated concentration in the groundwater at a residential site (Wilson, *et al.* 1990).

At a site in Lee County, Florida, groundwater near an unlined landfill had elevated iron concentrations due to landfill leachate. The leachate also may have increased the groundwater manganese concentrations (Boggess 1975). In New York, cesspool leachates have elevated the concentrations of boron and barium in the shallow groundwaters of the Magothy Aquifer (Smith and Myott 1975).

Boron concentrations were found to be high in groundwaters below industrialized areas in Birmingham, UK, as it is used in many metal-related industries. The presence of high concentrations of aluminum, cadmium, manganese, and titanium was also noted in the groundwaters near metals industries in the Birmingham industrial area (Lloyd, *et al.* 1988).

Agricultural Operations--

In the Tulare Lake region of the Central Valley of California, the metals that have adversely affected groundwater quality include: boron, cadmium, chromium, copper, molybdenum, nickel, and selenium. Areas being irrigated had lower groundwater selenium concentrations, but had elevated concentrations of barium, molybdenum, vanadium, and zinc compared to non-irrigated areas (Deason 1989). At other agricultural sites, elevated groundwater concentrations of selenium, molybdenum, chromium, and mercury are of concern (Deason 1987).

Soils below drainage irrigation canals and basins have shown higher concentrations of selenium, arsenic, and uranium than normal for the Western United States (Deason 1989). Selenium groundwater contamination beneath irrigated lands was also documented in Wyoming (Peterson 1988).

Metal Removal Processes in Soils

The interaction of surface water and groundwater has resulted in selenium contamination of groundwater in Wyoming (Peterson 1988). Sandy soils performed minimal removal of boron and nickel while the percolate water had no cobalt (Crites 1985). In general, studies of recharge basins receiving large metal loads show that most of the heavy metals are removed either in the basin sediment or in the vadose zone (Ku and Simmons 1986; and Hampson 1986).

Removal of metals by soil may be accomplished through one of several processes, including: (1) soil surface association, (2) precipitation, (3) occlusion with other precipitates, (4) solid-state diffusion into soil minerals, (5) biologic system or residue incorporation, and (6) complexation and chelation (Crites 1985). Most of these removal processes are pH-dependent, as is the solubility of most metals. In general, the solubility of a metal increases as the solution's pH decreases (Wilde 1994).

Adsorption--

Dissolved metal ions are removed from stormwater mostly by adsorption onto the near-surface particles in the vadose zone, while the particulate metals are filtered out at the soil surface (Ku and Simmons 1986). Studies of dissolved lead ions in recharge ponds in Jacksonville, Florida, found that allowing the ponds to go dry between storms was counterproductive to the removal of lead from the water during recharge (Hampson 1986). Apparently, the adsorption bonds were weakened during the drying period. Studies in Fresno, California, recharge basins found that lead, zinc, cadmium, and copper accumulated at the soil surface with little downward movement over five years. However, the microtopographic features, such as small depressions and basin inlet and outlet locations, influenced the metal's distribution in the soil (Nightingale 1987a).

Similarities in water quality between the runoff water and the groundwater show that there is downward movement of copper and iron in sandy and loamy soils. However, the other metals of concern (arsenic, nickel, and lead) did not significantly move downward through the soil to the groundwater. The exception to this was some downward movement of lead with the percolation water in the sandy soils of Fresno stormwater recharge basins (Nightingale 1987b).

The order of sorption ability (from strongest to weakest) for potential substrates is as follows:

manganese oxides > organic matter > iron oxides > clay minerals.

The order of sorption affinity (from strongest to weakest) for certain metals is as follows:

lead > copper > nickel > cobalt > zinc > cadmium > iron > manganese.

Competition between substrates or between metals will affect the overall adsorption ability of various trace metals (Wilde 1994).

Cation Exchange, Organic Complexation, and Chelation of Metals--

In soils, heavy metals enter into general cation exchange reactions with clay and organic matter and into chelation reactions with organic molecules. As the organic molecules are decomposed, the metals become free to react with iron and aluminum hydroxides, calcium, and other compounds. These new compounds are immobilized in the soil profile. The immobilization reactions are more pronounced at high pH and in an aerobic environment. Boron is adsorbed to iron and aluminum hydroxide coatings on clay minerals, to iron and aluminum oxides, to micaceous clay minerals, and to magnesium hydroxide coatings on weathering surfaces of ferro-magnesium minerals. In sandy soils and quartz, boron is not significantly immobilized (Bouwer 1985). Interactions of certain metals with phosphors can form either soluble or insoluble complexes. The type of clay mineral also affects heavy metal adsorption. However, the higher the cation exchange capacity (CEC) of the soil, the generally greater will be the binding of metallic cations (Nightingale 1987a). A soil's CEC is pH-dependent; therefore, the ion exchange ability of a soil to remove metals from solution is pH-dependent.

Organic complexation of a metal may enhance the metal's ability to move freely to the groundwater. Organic complexes often are stable and uncharged or negatively charged. Because of their negative or neutral charge, they are not attracted to negatively-charged adsorption/ion exchange sites and are not easily removed from solution (Wilde 1994).

Precipitation of Metals--

Selenium in agricultural drainage water is generally in its fully oxidized state, as selenate. Although selenites can be readily precipitated from water, even in the presence of salts, selenate precipitation is inhibited. The precipitation process relies upon the bacteria which occur naturally in the drainage water which convert the inorganic selenate to an organic complex. Part of the selenate is assimilated into the complex, part is reduced to a lower oxidation state, and the rest is reduced to zero valent selenium (Squires, *et al.* 1987). Further testing confirms that selenite can be readily precipitated from drainage water, even in the presence of salts, but selenate precipitation is inhibited in the presence of nitrate and sulfate (Squires, *et al.* 1989).

In central Florida, the dissolved iron concentrations in recharge water is much greater than in the groundwater, indicating that dissolved iron ions are being removed from the recharge water during percolation. The reduction of dissolved iron concentrations resulted from precipitation of iron or complexation into other nonsoluble species (Schiffer 1989). Iron and manganese transformations in groundwater are controlled by both the oxidation-reduction conditions and the acid-alkali balance in the water. The migration and diffusion speed of iron (Fe^{+2}) and oxygen is rather slow in water, but is accelerated by iron bacteria. The amount of iron oxidized by iron bacteria is ten, or even hundreds of times, greater than that oxidized by the chemical reaction alone (Bao-rui 1988). In central Florida, zinc, which is more soluble than iron, was commonly found in higher concentrations in groundwater than iron (Schiffer 1989). Iron and manganese oxidation may lower the pH of a water because the oxidation reactions add acidity (as the H^+ ion) to the water. A lower pH may cause an increase in the dissolved metal concentrations in the water. Concurrent decreases in pH and Eh in the unsaturated zone may have increased the mobility of manganese beneath one stormwater impoundment in Maryland (Wilde 1994).

Dissolved Metal Concentration Increases in Groundwater--

The dissolved iron concentration in the Magothy aquifer was greater after recharge than in the native groundwater and in the recharge water itself. The observed increase in iron concentration from less than 0.5 mg/L to 3 mg/L indicated a constituent of the recharge water reacting with the pyrite and marcasite (FeS_2) in the aquifer (Ragone 1977). For the first twenty feet from the well in the aquifer, the dissolved oxygen in the recharge water reacted with the pyrite to produce ferrous iron, sulfate, and hydrogen ions, according to the following equation:

$$FeS_2 + 7/2\ O_2 + H_2O \dashrightarrow Fe^{+2} + 2\ SO_4^{-2} + 2\ H^+$$

At distances greater than twenty feet, the dissolved oxygen concentration was zero. The reason for the increase in the dissolved iron concentration was unknown (Ragone 1977).

Although the concentrations of many trace metals were reduced through sorption/ion exchange to bottom materials and/or native sediments, elevated concentrations (greater than background) of these metals were found in groundwater beneath and downgradient of three infiltration devices in Maryland. The greater-than-expected metal concentrations could have resulted from fluctuations in pH and/or dissolved oxygen; unfavorable conditions for sorption, oxidation, ion exchange, or precipitation in the pond and/or unsaturated zone; or significantly greater flow rates through the unsaturated zone (Wilde 1994).

Mobility--

In dry recharge wells in Arizona, manganese was the only metal that was mobile in the nearly-neutral vadose zone sediments and was the only metal to show up in the groundwater at elevated concentrations (Wilson, *et al.* 1990).

Aluminum mobility is governed by pH, amount of stormwater infiltration, horizontal and vertical groundwater flow, depth to water table, and existence of channels for preferential flow. Aluminum is soluble above pH 9.0. Cadmium solubility/mobility is governed by pH, redox potential, biological uptake, and solubilities of carbonates and sulfides. If sulfide is present, cadmium is nearly immobile. Cadmium complexes readily with organic and inorganic ligands but preferentially in the following order:

humic acids > carbonate > hydroxides > chlorides > sulfates.

Hydrophilic and negatively-charged, or neutrally-charged, complexes are not likely to be retarded in the vadose zone. Copper is soluble at high pH values (greater pH than zinc or nickel) and its solubility is affected by complexation with iron and other ligands and by coprecipitation by oxides. If chromium entering an infiltration device is negatively charged, or is bound in a stable, negatively-charged compound, it may move easily through the vadose zone (Wilde 1994).

Chromium was detected in groundwater in Maryland beneath stormwater infiltration devices and was not removed from solution by sorption to the sediments in the device, or to the vadose zone sediments. Lead forms compounds with hydroxides, carbonates, sulfides, and sulfates, all of which have a low solubility. Lead also is removed from solution by binding with organic matter, coprecipitating with manganese oxides, and sorbing to organic and inorganic substrates. Zinc mobility is limited by high pH, the partial pressure of carbon dioxide in the solution, and the presence of sulfide. Aqueous zinc can be reduced by coprecipitation with other minerals, cation-exchange, biochemical activities, and complexation and sorption to organic and inorganic substrates (Wilde 1994).

In Maryland, groundwater pH below and downgradient of stormwater infiltration devices was less than 5.0 and tended to keep the metals in solution or solubilize metals attached to particulates. Concentrations of cadmium, chromium, and lead exceeded U.S. Environmental Protection Agency's Maximum Contaminant Levels in some groundwater samples and concentrations of barium, copper, nickel, strontium, and zinc in downgradient groundwater were often greater than their concentrations in native groundwater (Wilde 1994).

Experiments in Orlando, Florida (Harper 1988), concerning metal mobility in soil and its resultant stability have led to the ranking of metals in order of attenuation from recharge water:

> zinc (most mobile) > lead > cadmium > manganese > copper > iron > chromium > nickel > aluminum (least mobile).

Other studies of metal pollutant mobility in soil have led to the generation of mobility classes, as shown in Tables 23 and 32 (Armstrong and Llena 1992).

TABLE 32. METAL MOBILITY

Inorganic Pollutant	Concentration (mg/L)	Mobility Class Sandy Loam	Silt Loam
Arsenic	1.0	III	III
Arsenic	0.01	IV	IV
Cadmium	1.0	III	III
Cadmium	0.01	III	IV
Chromium	1.0	III	II
Chromium	0.01	IV	III
Copper	1.0	IV	IV
Copper	0.01	IV	IV
Lead	1.0	IV	IV
Lead	0.01	IV	IV
Nickel	1.0	III	III
Nickel	0.01	III	III
Zinc	1.0	III	III
Zinc	0.01	III	IV

Source: Armstrong and Llena 1992.

General--

Table 33 summarizes the principal removal mechanisms in the soil for each metal (Crites 1985). The surface water heavy metal concentrations were the most significant variables in predicting the concentrations of the heavy metals in the groundwater (Harper 1988).

Health and Ecological Effects

Metals in groundwater can cause environmental and ecological problems, as well as human health problems. Groundwater contamination will mostly affect human consumers of the groundwater,

TABLE 33. METAL REMOVAL MECHANISMS IN SOIL

Element	Principal Forms in Soil Solution	Principal Removal Mechanisms
Arsenic	AsO_4^{-3}	Strong associations with clay fractions of soil.
Barium	Ba^{+2}	Precipitation and sorption onto metal oxides and hydroxides.
Cadmium	Cd^{+2} complexes chelates	Ion exchange, sorption, and precipitation.
Chromium	Cr^{+3} Cr^{+6} $Cr_2O_9^{-2}$ CrO_4^{-2}	Sorption, precipitation, and ion exchange.
Cobalt	Co^{+2} Co^{+3}	Surface sorption, surface complex ion formation, lattice penetration, ion exchange, chelation, and precipitation.
Copper	Cu^{+2} $Cu(OH)^+$ anionic chelates	Surface sorption, surface complex ion formation, ion exchange, and chelation.
Iron	Fe^{+2} Fe^{+3} polymeric forms	Surface sorption and surface complex ion.
Lead	Pb^{+2}	Surface sorption, ion exchange, chelation, and precipitation.
Manganese	Mn^{+2}	Surface sorption, surface complex ion formation, ion exchange, and chelation, precipitation.
Mercury	Hg^+ HgS $HgCl_3^-$ $HgCl_4^{-2}$ CH_3Hg^+ Hg^{+2}	Volatilization, sorption, and chemical and microbial degradation.

TABLE 33. (CONTINUED)

Element	Principal Forms in Soil Solution	Principal Removal Mechanisms
Nickel	Ni^{+2}	Surface sorption, ion exchange, and chelation.
Selenium	SeO_3^{-2} SeO_4^{-2}	Ferric-oxide selenite complexation.
Silver	Ag^{+}	Precipitation
Zinc	Zn^{+2} complexes chelates	Surface sorption, surface complex ion formation, lattice penetration, ion exchange, chelation, and precipitation.

Source: Crites 1985.

although the discharge of contaminated groundwaters into surface waters can also have deleterious effects on aquatic organisms.

Environmental Problems--

Boron concentrations in sago pondweed from several lakes and reservoirs affected by irrigation water have been found to be large enough to damage sole consumers of that pondweed and is toxic, especially to citrus crops (Bouwer and Idelovitch 1987). In Wyoming, boron and selenium concentrations from local agriculture had concentrated in the wildlife in sufficient quantities to damage bird livers and eggs, to reduce fish reproduction and to kill water fowl (Peterson 1988; Deason 1989). Molybdenum is toxic to animals that forage on plants with high molybdenum concentrations (Bouwer and Idelovitch 1987). Many different heavy metals also affect aquatic organisms, including microinvertebrates, fish, and plants.

Human Health Problems--

Human health problems due to metal poisoning have been linked to water supplies. Iron and manganese removal in most water supplies is primarily for aesthetic reasons (including taste). However, excess concentrations of certain elements, including arsenic, copper, lead and selenium, in the potable water have caused disease outbreaks (Craun 1979). The following list of human health effects is summarized from Craun (1979) and Crites (1985):

- Arsenic is readily adsorbed from the gastrointestinal system and/or the lungs and distributed throughout the body where it can bioaccumulate. Symptoms of mild chronic arsenic poisoning include fatigue and loss of energy, while symptoms of severe poisoning include gastrointestinal mucous membrane inflammation, kidney degeneration, fluid accumulation in the body, polyneuritis and bone marrow injury.

• Barium enters the body through either inhalation or ingestion. Barium ingestion can cause toxic effects on the heart, blood vessels and nerves.

• Cadmium, because of its similarities to zinc, will bind to sites on enzymes intended for zinc. Symptoms of mild chronic poisoning include proteinurea. Continued exposure to cadmium will lead to renal degradation, respiratory disorders such as emphysema, gastric and intestinal dysfunctions, anemiz, and hypertensive heart disease. Exposures to very large quantities of cadmium have caused itai-itai disease, erthyrocyte destruction, and testicular damage, but the necessarily high concentrations are unlikely to occur in groundwater. All disease outbreaks from very large doses of cadmium have resulted from direct industrial exposure.

• Chromium is necessary for glucose tolerance in animals, including man, however, large quantities of hexavalent chromium can cause tumors if inhaled or through skin contact.

• Copper is also essential for animals, and a lack of copper can cause nutritional anemia in infants. Large doses of copper can produce vomiting and liver damage. Disease outbreaks have been traced to copper leaching from plumbing.

• Iron, common in most metal pipes, is not a desired constituent in drinking water due to taste, fixture staining and deposit accumulation.

• Lead enters the body by either inhalation or ingestion and accumulates in the liver, kidney and bones. Chronic high lead exposures can lead to burning in the mouth, severe thirst, vomiting, and diarrhea. Acute toxicity starts with convulsions and anemia, and may proceed to peripheral nerve disease, joint swelling, kidney degeneration, mental confusion, brain damage, and eventually, death.

• Manganese, like iron, is objectionable in drinking water because it affects taste, stains fixtures, spots laundered clothes and collects in distribution systems.

• Mercury damages while it bioaccumulates in the liver, kidney and brain. Chronic exposure results in mouth and gum inflammation, salivary gland swelling, teeth loosening, kidney damage, muscle spasms and personality changes. Acute mercury poisoning causes severe diarrhea, vomiting, kidney damage and death. Mercury also deforms fetuses.

• Chronic selenium poisoning results in red staining of the fingers, teeth and hair; depression; nose and throat irritation; upset stomach; and skin rashes. Acute poisoning is characterized by nervousness, vomiting, convulsions, hypertension, and respiratory failure.

• Silver poisoning results in skin, eye and mucous membrane discoloration and silver is retained in the body tissue indefinitely.

• Zinc, although it is necessary for life, affects the taste of water if in excessive amounts.

GROUNDWATER CONTAMINATION ASSOCIATED WITH SALTS AND OTHER DISSOLVED MINERALS

Definition

The dissolved minerals of concern in groundwater contamination are primarily salts. These salts include compounds containing combinations of calcium, potassium, sodium, chloride, fluoride, sulfate, or bicarbonate.

Examples of Salts Contaminating Groundwater

Increasing chloride concentrations in groundwater have been used as an indicator of early groundwater contamination in Great Britain (Lloyd, *et al.* 1988). When using rapid infiltration for recharge, inorganic dissolved solids are of concern and include chloride, sulfate, and sodium (Crites 1985). Sources of the dissolved solids include naturally occurring salts, landfill leachate, leaky sewerage, cesspool leachate, and other urban and agricultural sources.

Natural Occurrence--

On Long Island, New York, one of the sources of dissolved solids in the recharge water was salt spray from the sea (Seaburn and Aronson 1974). Salt water from an adjacent surface water body can infiltrate into the aquifer if the hydraulic gradient flows in that direction. A brackish lagoon near Narbonne, France has contaminated groundwater (Razack, *et al.* 1988).

Urban Areas--

Salt applications for winter traffic safety is a common practice in many northern areas and the sodium and chloride, which are collected in the snowmelt, travel down through the vadose zone to the groundwater with little attenuation. Fertilizer and pesticide salts also accumulate in urban areas and leach through the soil to the groundwater (Merkel, *et al.* 1988). In Arizona, stormwater infiltration in dry wells dissolves native salts in the vadose zone which are then carried to the groundwater (Wilson, *et al.* 1990).

Investigations of groundwater near a landfill in Lee County, Florida, showed that the concentrations of sulfates, potassium, chloride, and sodium were ten to 100 times greater than in the unaffected aquifer (Boggess 1975). Elevated sulfate concentrations in the groundwater beneath the city center in Narbonne, France, originated from leaking sanitary sewerage. The use of saltpeter (potassium nitrate) in the numerous wine cellars in the area also contaminated the groundwater (Razack, *et al.* 1988). Elevated chloride, sodium, and sulfate groundwater concentrations resulted from cesspool leachate on Long Island, New York, (Smith and Myott 1975) and from septic tank leachate in Florida (Waller, *et al.* 1987).

Agricultural Operations--

Major sources of dissolved solids in groundwaters in agricultural areas include fertilizers and pesticides. Elevated groundwater total dissolved solids concentrations of 200 mg/L and chloride and sulfate concentrations of about 10 mg/L and 20 mg/L, respectively, have been reported on Long Island, New York (Seaburn and Aronson 1974). The concentrations of sodium, chloride, and sulfate vary with the season and are likely related to precipitation and irrigation patterns (Hampson 1986).

In areas of sustained irrigation, some leaching must occur periodically to remove the salts that accumulate in the root zone of the crops (Power and Schepers 1989). Evapotranspiration concentrates the salts in the root zone which, during irrigation, are flushed into the vadose zone and eventually into the groundwater (Schmidt and Sherman 1987). Spray irrigation with secondary treated effluent can increase chloride concentrations and specific conductance in shallow aquifers (Brown 1982). Grazing cattle return seventy-five to eighty percent of the of the potassium in their forage to the soil (Reichenbaugh 1977).

High groundwater salinity has been noted in the San Joaquin Valley, under the agricultural areas near Fresno, California, in irrigated areas of Arizona and New Mexico, where the salinity has been increasing since the 1930s, and in the Corn Belt and Great Lake states (Schmidt and Sherman 1987; Deason 1989; Bouwer 1989; Sabol, *et al.* 1987; and Mossbarger and Yost 1989). Most salts in groundwater below irrigated areas have resulted from the leaching of natural salts from the arid soils. Use of sludge as fertilizer on sandy loam soil in New Jersey increased the total dissolved solids concentration of the groundwater (Higgins 1984). On Long Island, New York, recharge of the groundwater has led to an increase in the sodium and chloride concentrations above the background concentrations (Schneider, *et al.* 1987). Mathematical modeling has led to the conclusion that salt from agricultural return flows is the greatest single contributor (about 40%) of salt to Upper Midwest groundwater (Schmidt and Sherman 1987).

Salt Removal Processes in Soils

Most salts are not attenuated during movement through soil. In fact, salt concentrations typically increase due to leaching of salts out of soils. Groundwater salt concentration decreases may occur with dilution of less saline recharging waters. Use of lower salinity water as recharge water at the Leaky Acres stormwater recharge facility in Fresno, California, was shown to decrease the salt concentrations in the groundwater (Nightingale and Bianchi 1977a). Reduction in the pH of groundwater, such as would result from nitrification and the biodegradation of carbonaceous substances, resulted in the dissolution of soil minerals and subsequent increases in the total dissolved solids concentrations and the hardness of groundwater at the Whittier Narrows site in Los Angeles County, California (Nellor, *et al.* 1985). This effect was noted in Florida during the deep-well injection of acidic, high-oxygen demanding industrial waste. At first, neutralization of the waste occurred through solution of the calcium carbonate in the limestone. Later, the calcium concentration in the aquifer increased and the pH decreased, but the effects have still been confined to the lower strata of the Floridan aquifer (Goolsby 1972).

Leaching of Salts--

Salt leaching is a greater concern in arid areas of the United States because the irrigation requirements for the arid areas are great and the irrigation water collects the salts that have been concentrated in the soil by increased evapotranspiration. Salts that are still in the percolation water after it travels through the vadose zone will contaminate the groundwater (Sabol, *et al.* 1987; and Bouwer 1987). The rate of contaminated water movement in a water-table aquifer is highest when the water table is highest (Boggess 1975).

Nonuniform irrigation and preferential flow allows the percolation water to reach the groundwater much faster and reduces the amount of salt removal that could occur during slower water passage through the soil (Bouwer 1987), especially for the chloride ion, which is not readily adsorbed. Irrigation efficiency and interval significantly affect groundwater chloride concentrations. For example, fields in Arizona and New Mexico that were irrigated at nearly 100% efficiency had much higher chloride concentrations in the root zone of the soil (Sabol, *et al.* 1987). The higher the salt concentration of the soil solution, the higher the soil hydraulic conductivity will be for a given sodium adsorption ratio (SAR) (Bouwer and Idelovitch 1987). Schmidt and Sherman (1987) found a direct relationship between concentrations of groundwater nitrates and salts.

Solubility Equilibrium of Salts--

An equilibrium exists between the recharge water and the high groundwater for calcium and total dissolved solids. For chloride, sodium, and sulfate, reductions in concentrations entering the recharge system are likely accounted for by differences in seasonal precipitation, with a higher loading in the summer than in the winter. Changes in the groundwater concentration reflect these loading differences (Hampson 1986). Potassium exchanges with hydrogen ions on the clay during percolation. Other exchanges cause the calcium and magnesium concentrations to be much greater than had been predicted (Ragone 1977). Deep-well injection waters have shown an increase in alkalinity and bicarbonate concentrations, reflecting the mineralization of the organic compounds. Dissolved calcium and bicarbonate are the primary products of limestone dissolution. Many parameters in natural groundwater systems are controlled, or are influenced, by the calcium carbonate equilibrium system.

Removal of Salts in Soil--

Soil is not very effective at removing most salts. Depth of dissolved mineral penetration in soil has been studied (Close 1987) at a site with a shallow, unconfined aquifer. This study found that sulfate and potassium concentrations decreased with depth, while sodium, calcium, bicarbonate and chloride concentrations increased with depth in the soil. The dissolution of the aquifer material may be the source of many of the chloride, bicarbonate, calcium, and sodium ions. The same increase in salt concentrations with depth was noted in the agricultural (irrigated) areas of Arizona and New Mexico, and may be a result of little water and salt uptake by the plants. On Long Island, New York, it was noted that the heavy metals load was significantly reduced during passage through the soil, while chloride was not reduced significantly. This indicated that the soil does not contain an effective removal process for chloride salts (Ku and Simmons 1986). However, fluorine is removed in soil through sorption and precipitation processes (Crites 1985).

In another study (Waller, *et al.* 1987), it was found that chloride and sulfate concentrations from septic tanks increased with depth below the leach field, but were rapidly diluted downgradient. The primary controls on the leachate movement are the lithology and layering of the geologic materials, hydraulic gradient slopes, and the volume and type of use the septic system receives. Dilution occurs more rapidly in limestone than in sand.

Once contamination with salts begin, the movement of salts into the groundwater can be rapid. The salt concentration may not lessen until the source of the salts is removed. The cations sodium, potassium, calcium, and magnesium appeared in a shallow aquifer three to six months after the source water was applied to the soil (Higgins 1984).

At three stormwater infiltration locations in Maryland, the nearby use of deicing salts and their subsequent infiltration to the groundwater shifted the major-ion chemistry of the groundwater to a chloride-dominated solution. Although deicing occurred only three to eight times a year, increasing chloride concentrations were noted in the groundwater throughout the 3-year study, indicating that groundwater systems are not easily purged of conservative contaminants, even if the groundwater flow rate is relatively high. Sodium and/or calcium concentrations also were constantly elevated in the groundwater beneath and downgradient of the infiltration devices (Wilde 1994).

Control of groundwater salt contamination in agricultural areas should result from maintaining irrigation rates at near the minimum leaching rate (Bouwer 1987). This control, with other crop management practices, will slow the leaching rate of the salt to the groundwater (Lee 1990). Reduction of the dissolved solids concentrations will decrease by dilution through recharge with "cleaner" water (Nightingale, *et al.* 1983).

Health and Other Effects

Besides direct effects, dissolved solids concentrations can also affect the pH of the water. Problems may then be caused by the effect of pH on high concentrations of undesirable elements, such as iron, manganese and aluminum in acid waters, and sodium, carbonates and bicarbonates in alkaline waters (Bouwer 1987).

Human Health Problems--

High total dissolved solids concentrations are objectionable because of possible physiologic effects, mineral taste, and corrosion. High concentrations of chloride ions in water affects its taste and accelerates the corrosion of pipes and household appliances. Excess sodium can cause health problems, especially for people who are on sodium-restricted diets, due either to hypertension, edema from congestive cardiac failure and pregnant women with toxemia. High concentrations of sulfate ions affect the taste of the water and are a laxative to humans (Crites 1985). Although small quantities of fluoride are recommended in water by the American Dental Association, excessive amounts of fluoride can mottle, instead of protect, teeth.

Agricultural Problems--

Sodium can adversely affect crops by causing leaf burn in almonds, avocados and stone fruits. Bicarbonate in spray applied irrigation will leave an unappealing white residue after the water evaporates. Sulfate affects the growth of many plants and can cause leaf burn in still others (Bouwer and Idelovitch 1987).

GROUNDWATER CONTAMINATION ASSOCIATED WITH SUSPENDED SOLIDS

Definition

The term suspended solids is usually defined as the non-filterable portion of a water sample after filtering through a 0.45 μm filter. This definition does not accurately describe the fate of this material.

Depending on specific gravity and particle sizes, the "suspended" material also includes floatable matter, rapidly settleable matter, and matter that could settle out of suspension over highly variable periods of time.

Soil Removal Processes of Suspended Solids

Suspended solids are of concern because of the potential for clogging the infiltration area (Crites 1985). The recharge water should be of low salinity and turbidity (Nightingale and Bianchi 1977b). When the groundwater salinity was reduced by using less salty recharge water in Fresno, California, the turbidity of the groundwater increased. Leaching of poorly crystallized and extremely fine colloids from the soil and into the groundwater had occurred. This effect was only temporary, with the groundwater returning to its original turbidity soon after recharge began and was not observed outside of the recharge basin area. Changes in the recharge water salinity, however, may cause this effect to return (Nightingale and Bianchi 1977b).

Laboratory studies on the movement of fine particulate matter through sand aquifers found that the movement is controlled first by the nature of the particle, second by the cation and anion concentrations of the percolating water, and third by the pore size distribution of the soil to the aquifer (Nightingale and Bianchi 1977b). As water flows through passages formed by the soil particles, suspended and colloidal particles too small to be retained at the surface are thrown off their streamline through hydrodynamic actions, diffusion, impingement, and sedimentation. The particles may then be adsorbed onto stationary soil particles. The degree of trapping and adsorption of suspended solids by soils is a function of the suspended solids concentration and size distribution, soil characteristics, and hydraulic loading (EPA 1992). The soil profile will filter out suspended solids from recharge water and, once the particles are in the soils, biological and chemical degradation may occur. Fine to medium textured soils remove essentially all suspended solids from the wastewater by straining (Bouwer 1985), while coarse textured soils enable deeper penetration of suspended and colloidal particles in the soil (Treweek 1985).

DISSOLVED OXYGEN GROUNDWATER PROBLEMS

Dissolved oxygen (DO) in any water is controlled not only by how much DO exists and how much can be produced by aquatic plants, but also by the oxygen needs of the other organisms and compounds in the water. As groundwater recharging proceeds, dissolved oxygen is depleted due to the proliferation of iron bacteria and *T. thioparus*, which leads to anaerobic conditions in the groundwater (Bao-rui 1988). Increases in both dissolved oxygen and temperature should increase virus inactivation (Jansons, *et al.* 1987b). Groundwater has no natural reaeration process available, so once depleted, groundwater DO will remain very low.

COD levels from injection well wastes were reduced approximately eighty percent within relatively short distances from an injection point near Pensacola, Florida (Ehrlich, *et al.* 1979b). During recharge of the Magothy aquifer at Bay Park, New York, it was found that dissolved oxygen persisted for about twelve feet away from the recharge well. At greater distances, the water is essentially oxygen free. Two occurrences can account for the oxygen loss from the recharge water as it moves through the aquifer. First, oxygen reacts with pyrite in the formation to produce ferrous iron, sulfate and hydrogen. Second, microbial respiration associated with waste stabilization depleted the oxygen supply (Ehrlich, *et al.* 1979a).

CHAPTER 4

TREATMENT BEFORE DISCHARGE OF STORMWATER

One of the best overall urban runoff control strategies may be to encourage infiltration of stormwater to replace the natural infiltration capacity lost through urbanization. This significantly reduces the volume of runoff discharged to surface waters, including pollutants. This strategy also improves groundwater conditions by reducing the lowering rate of urban water tables. Exfiltration from groundwater into local streams during dry periods can also substantially improve receiving water biological conditions. The EPA (1983) concluded, as part of the Nationwide Urban Runoff Program, that stormwater can be safely infiltrated to groundwater, if done carefully. Issues that must be considered include a knowledge of pollutant concentrations from different areas, pollutant removals in the vadose zone, and necessary pretreatment that may be needed before infiltration. This chapter reviews characteristics of urban runoff pollutants that will affect their fates in treatment processes, along with reported performance of stormwater treatment devices.

SOLUBILITIES AND TREATMENT POTENTIALS OF SIGNIFICANT URBAN RUNOFF TOXICANTS

This chapter discusses chemical reactions, solubilities and fates of significant urban runoff pollutants. The information presented here is based upon a review of the urban runoff and environmental chemistry literature and addresses toxic heavy metals and organic pollutants that have been detected in various urban runoff waters. This information can be used to identify the potential removal mechanisms that may be available in stormwater control practices and to identify the potential transport and fate mechanisms of the pollutants in the surface or subsurface receiving waters.

Arsenic

Arsenic Sorption--

Arsenic can be adsorbed onto clays, iron oxides, inorganics (Callahan, *et al.* 1979).

Arsenic Fate/Treatment--

Callahan, *et al.* (1979) stated that many environmental fate mechanisms, except for photolysis, can be important for arsenic. Arsenic can either remain suspended or accumulate in sediments (Callahan, *et al.* 1979). Phillips and Russo (1978) stated that arsenic may be bacterially methylated, much like mercury, to form highly toxic methylarsenic or dimethylarsenic. These methylated forms of arsenic are very volatile and are readily oxidized to less toxic forms.

Cadmium

Cadmium Filterable Fraction, Solubility and Sorption--

Forty to fifty percent of the cadmium in roof, loading docks, and street runoff sampled by Pitt, *et al.* (1995) was found in filtered sample components, while the other stormwater source areas all had less than 20% associated with the filtered sample component. Pitt and Amy (1973) studied the leachability of cadmium from street dirt, along with other metals, and found that in typical urban runoff concentrations, leachable cadmium values of less than 1μg/L occurred in moderately hard water after an exposure of 25 days. This leachable fraction was 14 percent of the total cadmium in the mixture. Wilber and Hunter (1980), in an urban receiving water study in Lodi, New Jersey, found that with most low flows in the Saddle River, the cadmium was mostly dissolved. However, during wet-weather conditions, most of the cadmium was associated with undissolved particulates. Callahan, *et al.* (1979) stated that adsorption of cadmium onto organics, clays, hydrous iron and manganese oxides is important in polluted water.

Chromium

Chromium Filterable Fraction--

Filtered stormwater samples generally contained less than 10 percent of the total chromium detected by Pitt, *et al.* (1995). Pitt and Amy (1973) found that the leachable fraction of chromium associated with street dirt in moderately hard water was about 4 μg/L, or about 0.3 percent of the total chromium in the mixture.

Copper

Copper Filterable Fraction, Sorption, and Solubility--

The filtered stormwater samples analyzed by Pitt, *et al.* (1995) generally had less than 20 percent of the total copper concentrations. Wilber and Hunter (1980), in a study of an urban river in Lodi, New Jersey, found that the readily available copper (at a pH of about 7) was about 13 percent of the street dirt and runoff solids total copper content. Pitt and Amy (1973) found that the leachable fraction of copper associated with street dirt was about 160 μg/L, or about 36 percent of the total copper in the mixture, with moderately hard water conditions. The adsorption of copper can reduce its mobility and enrich suspended and settled sediments (Callahan, *et al.* 1979). Copper is absorbed onto organics, clay minerals, hydrous iron and manganese oxides.

Iron

Iron Filterable Fraction, Sorption, and Solubility--

Pitt and Amy (1973) found that the leachable fraction of iron in street dirt was about 50 μg/L, or much less than 1 percent of the total iron in a mixture with moderately hard water. They also stated that the principal inorganic iron forms, near pH 7, are iron oxide, hydroxide, sulfate, nitrate and carbonate. Phillips and Russo (1978) stated that the soluble ferrous form of iron (Fe^{+2}) is readily oxidized to the insoluble ferric, or trivalent (Fe^{+3}) state in most natural surface waters. A substantial fraction of iron in natural waters is therefore associated with suspended solids.

Lead

Lead Filterable Fraction, Sorption, and Solubility--

The filtered stormwater samples analyzed by Pitt, *et al.* (1995) generally had less than 20 percent of the total lead concentrations. The EPA (1976) stated that most lead salts are of low solubility. The aqueous solubility of lead ranges from 500 μg/L in soft water to 3 μg/L in hard water (EPA 1976). Durum (1974) stated that lead carbonate and lead hydroxide are soluble lead forms at pH values of 6.5, or less, with low alkalinity conditions (less than 30 mg/L alkalinity as $CaCO_3$). The soluble lead concentrations under these conditions can reach 40 to several hundred μg/L. If the alkalinity is greater than 60 mg/L, and if the pH is near 8, however, the dissolved lead would be less than 10 μg/L. Callahan, *et al.* (1979) stated that lead carbonate and lead sulfate control lead solubility under aerobic conditions and normal pH values. Lead sulfide and lead ions, however, control lead solubility in anaerobic conditions. In polluted water, the organic complexes of lead are most important in controlling lead solubility. Phillips and Russo (1978) stated that most lead is probably precipitated in natural waters due to the presence of carbonates and hydroxides.

Pitt and Amy (1973) found that the leachable fraction of lead in a street dirt and water mixture was about 40 μg/L, or about 3 percent of the total lead, in moderately hard water. Wilber and Hunter (1980) found that the readily available fraction of lead was about 20 percent of the total lead in street dirt and runoff solids. They also found that under most low flow river conditions, most of the lead was dissolved, but under wet-weather conditions, most of the lead was insoluble. Solomon and Natusch (1977) also examined the solubilities of lead associated with street dust. They found solubilities ranging from 500 to 5000 μg/L which was 0.03 to 0.3 percent of the initial mixture total lead concentration. However, the test mixture of street dirt with water was very high (1750 mg/L lead). Rolfe and Reinbold (1977) found that about 80 percent of the lead in stream water was insoluble and associated with suspended solids.

Nickel

Nickel Filterable Fraction--

Very few of the filtered stormwater samples analyzed by Pitt, *et al.* (1995) had detectable (>1 μg/L) nickel concentrations. Wilber and Hunter (1980) found that the readily available nickel fraction of street dirt and runoff solids was about 4 percent at close to neutral pH conditions. Pitt and Amy (1973) found that the leachable fraction of nickel associated with street dirt, in a moderately hard water mixture, was about 30 μg/L, or about 7 percent of the total nickel in the mixture.

Mercury

Mercury Fate/Treatment--

Callahan, *et al.* (1979) stated that almost all of the environmental processes are important when determining the fate of mercury in aquatic environments. Phillips and Russo (1978) reported that inorganic mercury concentrations, availability of inorganic mercury, pH, microbial activity and redox potential all affect mercury methylation rates. In general, more methylmercury is produced when more inorganic mercury is present. Chemical agents which precipitate mercury, such as sulfide, reduce the availability of mercury for methylation, but only when present in large quantities. At neutral pH values, the primary product of mercury methylation is monomethylmercury. Methylation can occur under both aerobic and anaerobic conditions, but more mercury is produced when more bacteria are present.

Zinc

Zinc Filtered Fraction, Solubility and Sorption--

Filtered stormwater samples contain most of the total zinc concentrations observed, except for storage area and vehicle service area runoff (Pitt, *et al.* 1995). In contrast to most other heavy metals, the major zinc source in urban areas is probably galvanized metal. Short contact periods of naturally acidic rain water with roof galvanized metal flashings and gutters (or other galvanized metal in the drainage area) results in elevated dissolved zinc concentrations. The flow time for these waters to the outfall is rather short and the zinc generally remains dissolved. In the receiving waters, more time is available to form precipitates or associations with particulates. Other sources of zinc are automobile tire wear and exhaust related which are in particulate forms, which are generally insoluble.

Durum (1974) stated that the solubility of zinc is less than 100 μg/L at pH values greater than 8, and less than 1,000 μg/L for pH values greater than 7, if there is a high concentration of dissolved carbon dioxide. Phillips and Russo (1978) stated that zinc sulfates and halides are soluble in water, but zinc carbonates, oxides and sulfides are insoluble. Wilber and Hunter (1980), in a study of an urban stream near Lodi, New Jersey, found that the readily available zinc in street dirt and runoff solids was about 17 percent of the total zinc. Most of the zinc in the river during low flow conditions was dissolved, while during wet weather it was mostly in the solid form. Pitt and Amy (1973) found that the leachable fraction of zinc was about 170 μg/L, or about 8 percent of the total street dirt zinc, in a moderately hard water mixture.

Phenols and Chlorophenols

Phenols and Chlorophenol Filtered Fraction--

The EPA (1979) stated that the solubility of chlorinated phenols in water solutions is low, but increases when the pH increases. Phenoxide salts are also more soluble than the corresponding phenol in water with neutral pH conditions.

Phenols and Chlorophenol Fate/Treatment--

Phenol may be biochemically hydroxylated to ortho and paradihydroxybenzenes and readily oxidized to the corresponding benzoquinones (EPA 1979). These may in turn react with numerous components of industrial waters, sewerage or other waste streams such as mercaptans, amines, or the -SH, or -NH group of proteins. Phenol has also been shown to be highly reactive to chlorine in dilute solutions over a wide pH range. The chlorination of phenol to toxic chlorophenols has been demonstrated under conditions similar to those used for disinfection of wastewater effluent.

Pentachlorophenol (PCP)

Pentachlorophenol Filtered Fraction--

PCP is slightly soluble in water, while PCP salts are highly soluble in water (EPA 1979).

Pentachlorophenol Fate/Treatment--

PCP can undergo photochemical degradation in solutions in the presence of sunlight, with subsequent formation of several chlorinated benzoquinones (EPA 1979). Sodium-PCP can be decomposed directly by sunlight with the formation of numerous products. Microorganisms have also been reported to metabolize PCP. PCP has also been reported to persist in warm and moist soils for a period of one year.

<u>2,4-Dimethylphenol (2,4-DMP)</u>

2,4-Dimethylphenol Filtered Fraction--

2,4-DMP is slightly soluble in water (EPA 1979).

<u>General Polycyclic Aromatic Hydrocarbons (PAHs)</u>

PAH Filtered Fraction--

PAHs are basically insoluble in water (Callahan, *et al.* 1979).

PAH Fate/Treatment--

These materials will be adsorbed onto suspended particulates and biota. The dissolved portion of these compounds can undergo direct photolysis at a rapid rate. Biodegradation and biotransformation by benthic organisms of PAH contaminated sediments is believed to be their ultimate fate (Callahan, *et al.* 1979). Because of the low solubility of PAHs in water, biological treatment has little benefit. However, because of their attraction to solids, physical solids separation processes can be very effective in reducing PAH concentrations (PHS 1981).

<u>Benzo (a) Anthracene</u>

Benzo (a) Anthracene Filtered Fraction--

No detectable (>1 μg/L) benzo (a) anthracene was found by Pitt, *et al.* (1995) in filtered stormwater sample fractions. The solubility of benzo (a) anthracene in water is about 10 to 45 μg/L (Verschueren 1983).

Benzo (a) Anthracene Fate/Treatment--

More than half of the benzo (a) anthracene was adsorbed onto waterborne particulates (including aggregates of dead plankton and bacteria) after just 3 hours exposure (Verschueren 1983). Physical treatment of sewage can reduce the benzo (a) anthracene concentrations by about 80 percent, while biological treatment can remove almost all of the benzo (a) anthracene, leaving less than 0.1 μg/L in the effluent. Ozonation reduced the benzo (a) anthracene concentrations in sewage effluent by about 95 percent, while chlorination reduced the concentrations by about 50 percent.

<u>Benzo (b) Fluoranthene</u>

Benzo (b) Fluoranthene Fate/Treatment--

Physical sewage treatment processes reduced benzo (b) fluoranthene concentrations by 50 to 80 percent, while biological processes provided almost complete removal (Verschueren 1983). Chlorination alone accounted for about a 33 percent reduction. Water treatment reduced initial 0.15 μg/L benzo (b) fluoranthene concentrations by about 70 percent. Sedimentation in a storage reservoir only slightly reduced the concentrations.

Benzo (k) Fluoranthene

Benzo (k) fluoranthene Fate/Treatment--

Physical sewage treatment reduced concentrations of benzo (k) fluoranthene from 8 to about 2 μg/L (Verschueren 1983). Biological treatment further reduced the concentrations to less than 0.1 μg/L. Chlorination alone reduced the concentrations by about 60 percent, from an initial value of about 70 μg/L.

Benzo (a) Pyrene

Benzo (a) pyrene Filtered Fraction--

Benzo (a) pyrene's solubility is about 3 μg/L (Verschueren 1983).

Benzo (a) pyrene Fate/Treatment--

Benzo (a) pyrene can be degraded in soil that is inoculated with special bacteria, with as much as 80 percent destroyed after eight days (Verschueren 1983). In natural estuarine waters, its degradation rate is only about 2 μg/L destroyed per 1,000 days. Its volatilization half-life is about 1,000 hours (40 days) in waters moving about 1 m/sec with winds of about 2 m/sec. The volatilization half-life extends to about 10,000 hours (400 days) for still water and calm air, and decreases to about 400 hours (20 days) for very violent mixing conditions. About 70 percent of a benzo (a) pyrene mixture, having an initial concentration of 3 μg/L, was adsorbed onto particles after three hours.

From 90 to 99 percent removal of benzo (a) pyrene was found using activated carbon water treatment in waters having initial concentrations of 5 to 50 μg/L (Verschueren 1983). Chlorination (6 mg/L Cl_2) also reduced initial concentrations of 50 μg/L benzo (a) pyrene by 98 percent. Physical wastewater treatment reduced benzo (a) pyrene concentrations by about 65 to 95 percent, and biological treatment further reduced these concentrations by another 50 to 99 percent.

Fluoranthene

Fluoranthene Filtered Fraction--

The observed median filterable portion of fluoranthene in stormwater (in the range of 0.5 to 14 μg/L) was about 85 percent of the total sample concentration (Pitt, *et al.* 1995). The water solubility of fluoranthene is about 200 μg/L (Harris 1982).

Fluoranthene Fate/Treatment--

Harris (1982) reported that sedimentation processes was the most important removal mechanism for fluoranthene, with removals of about 65 percent. Biological treatment increased the removal to about 95 percent. Verschueren (1983) also reported that physical sewage treatment processes reduced initial fluoranthene concentrations of 3 to 45 μg/L by about 60 percent, and biological treatment further reduced the fluoranthene by another 80 percent. Water treatment reduced the raw water fluoranthene concentrations of 0.15 μg/L by about 50 percent using filtration, and by another 50 percent by chlorination. Storage in a reservoir reduced the fluoranthene concentrations by less than 10 percent.

Naphthalene

Naphthalene Solubility and Filtered Fraction--

The observed median filterable portion of naphthalene (in the range of 7 to 82 μg/L) in runoff samples was about 25 percent (Pitt, *et al.* 1995). At about 32 mg/L, the solubility of naphthalene is quite high compared to other PAHs (Howard 1989). Naphthalene is moderately adsorbed by soils and sediments, but at a much less extent than for other PAHs. It is weakly sorbed by sandy soils, and tests have found that less than one percent was sorbed by particulate matter in a variety of surface waters (Howard 1989).

Naphthalene Fate/Treatment--

In rapidly flowing streams, volatilization accounted for about 80 percent and sediment adsorption accounted for about 15 percent of the removal of naphthalene from the water column (Howard 1989). In deeper and slower moving water, biodegradation (having a half-life of about 1 to 9 days) was probably the most important fate mechanism. Adsorption onto sediments is probably only a significant removal mechanism in waters having high solids concentrations and slow moving waters, such as in lakes. Photolysis degrades naphthalene in surface waters with a half-life of about 3 days, but is much less efficient at deeper waters. In 5 meter deep water, the photolysis half-life was about 550 days. The presence of algae can substantially increase the photolysis rate of naphthalene.

Howard (1989) reported that naphthalene in water biodegrades after a short acclimation period. Bacteria can only utilize soluble naphthalene, however. Biodegradation of sediment bound naphthalene is 8 to 20 times faster than in water. In heavily contaminated sediment, the biodegradation half-life is about 5 hours, but can be longer than 3 months in less contaminated sediments. No anaerobic biodegradation of naphthalene in laboratory tests was observed after 11 weeks. The evaporation half-life of naphthalene in surface waters is about 5 hours for moderate current and wind conditions. The expected half-life of naphthalene in surface waters due to evaporation losses is expected to be about 50 hours in rivers and 200 hours in lakes. Microbial degradation rates were about 0.1 μg/L per day. Less than one percent of the naphthalene was sorbed to particles in water after 3 hours exposure. Ion exchange water treatment was close to 100 percent effective and the evaporation half-life of naphthalene was reported to be about 7 hours at a water depth of 1 meter. Naphthalene would be readily removed by physical and biological treatment processes.

Phenanthrene

Phenanthrene Filtered Fraction--

Its solubility in water is relatively high for a PAH, being about 1,000 μg/L (Verschueren 1983). Pitt, *et al.* (1995) did not detect any filterable phenanthrene in stormwater above the detection limit (about 1 μg/L).

Pyrene

Pyrene Filtered Fraction--

The observed median filterable portion of pyrene (about 1 to 19 μg/L) in stormwater samples was about 95 percent (Pitt, *et al.* 1995). Its solubility in water is about 160 μg/L (Verschueren 1983).

Pyrene Fate/Treatment--

Pyrene can be photo-degraded from soils by UV radiation (Verschueren 1983). Chlorination at 6 mg/L chlorine for 6 hours decreased initial pyrene concentrations of 27 μg/L by about 25 percent (Verschueren 1983). Physical wastewater treatment processes decreased pyrene concentrations by about 80 percent, and biological processes further decreased the pyrene concentrations by about 98 percent. Reservoir storage of river water decreased pyrene concentrations by about 25 percent. Filtration further decreased the concentrations by another 40 percent, and chlorination further decreased the pyrene concentrations by another 60 percent.

Chlordane

Chlordane Filtered Fraction--

Chlordane's solubility in water is about 60 μg/L (Verschueren 1983). Pitt, *et al.* (1995) did not find any chlordane, greater than the detection limit of about 0.3 μg/L, in the filtered portion of stormwater samples.

Chlordane Fate/Treatment--

The persistence of chlordane in water in sealed jars exposed to sunlight indicated a 15 percent decrease after 8 weeks. Chlordane was reduced by 75 to 100 percent from soils after 3 to 5 years (Verschueren 1983).

Butyl Benzyl Phthalate

Butyl Benzyl Phthalate Filtered Fraction--

The only observed filterable value of butyl benzyl phthalate (BBP) (16 μg/L) detected my Pitt, *et al.* (1995) in stormwater was 33 percent of the total value. BBP's solubility in water is about 3 mg/L (Verschueren 1983).

Butyl Benzyl Phthalate Fate/Treatment--

BBP does undergo biodegradation with relatively complete removals within one month (Verschueren 1983). Biodegradation using activated sludge from a wastewater treatment plant was reported to be 99 percent effective after 48 hours. Biodegradation in natural river waters was about 80 percent effective after one week of exposure. Photodegradation and chemical degradation (through hydrolysis) of BBP is much less effective, with reported half-lifes of greater than 100 days.

Bis (2-chloroethyl) Ether

Bis (2-chloroethyl) Ether Filtered Fraction--

The two observed filterable fractions of Bis (2-chloroethyl) ether (BCEE) (17 and 23 μg/L) found by Pitt, *et al.* (1995) in stormwater were 19 and 50 percent of the concentrations observed in the unfiltered samples. BCEE solubility in water is about 1 mg/L (Howard 1989). It is also adsorbed at low values onto fine sand, implying that it would be highly mobile in soils and could leach rapidly to groundwaters.

Bis (2-chloroethyl) Ether Fate/Treatment--

Bis (2-chloroethyl) ether (BCEE) may degrade in soils, but acclimation may be necessary (Howard 1989). The volatilization half-life of BCEE in streams was estimated to be about 4 days, while the volatilization half-life of BCEE in lakes was estimated to be about 180 days. Photolysis is not expected to be important, but biodegradation can reduce BCEE concentrations by 50 percent over 35 days. After acclimation, only 9 days were required to remove 50 percent of the BCEE by biodegradation. Conventional water treatment removed about 80 percent of the BCEE, while activated carbon, when added to conventional water treatment processes, removed all of the BCEE (Verschueren 1983).

Bis (2-chloroisopropyl) Ether

Bis (2-chloroisopropyl) Ether Filtered Fraction--

The solubility of bis (2-chloroisopropyl) ether (BCIE) was reported to be 1700 mg/L (Verschueren 1983). No concentrations greater than the detection limit of about 1 μg/L were found by Pitt, *et al.* (1995) in filtered stormwater samples.

Bis (2-chloroisopropyl) Ether Fate/Treatment--

Basu and Bosch (1982), in their summary of the literature concerning bis (2-chloroisopropyl) ether (BCIE), reported that hydrolysis is probably its most significant transformation process in aquatic systems. The overall half-life of BCIE was estimated to vary between 3 and 30 days in rivers and 30 to 300 days in lakes and groundwaters. The evaporation half-life in surface waters was estimated to be similar to the hydrolysis half-life. Leaching of BCIE is expected to be important in soils. They also reported that BCIE is unlikely to be significantly sorbed by plants.

Activated carbon treatment of contaminated water resulted in almost complete removal of BCIE. Conventional water treatment reduced the BCIE water content from 24 μg/L to below detection limits (Verschueren 1983).

1,3-Dichlorobenzene

1,3-Dichlorobenzene Filtered Fraction and Sorption--

The observed median filterable portion of 1,3-DCB (3 to 47 μg/L) found by Pitt, *et al.* (1995) in stormwater was about 75 percent of the unfiltered sample concentrations. The solubility of 1,3-DCB is about 125 mg/L (Verschueren 1983). 1,3-DCB may be moderately to tightly adsorbed to soils, but leaching can occur (Howard 1989).

1,3-Dichlorobenzene Fate/Treatment--

Bacterial degradation disturbed the chemical ring structure of 1,3-Dichlorobenzene (1,3-DCB) within 96 hours (Verschueren 1983). Neal and Basu (1982) reported that biotransformation is the most significant transformation process, with a half-life of about 580 days in a river system. Sedimentation and volatilization processes decrease 1,3-DCB concentrations in half over about 1.5 days in rivers and 50 days in lakes. Biodegradation under aerobic conditions and volatilization from soil may be important (Howard 1989). Adsorption of 1,3-DCB to sediment is a major environmental fate mechanism. 1,3-DCB is also quite volatile from water, with a half-life of about 4 hours in moderately turbulent streams. It may biodegrade under aerobic conditions in water, but is not expected to degrade under anaerobic conditions (such as in polluted sediments). Hydrolysis, oxidation, and direct photolysis are not expected to be important fate mechanisms of 1,3-DCB in the aquatic environment.

Summary

Most of the organics and metals are associated with the non-filterable (suspended solids) fraction of the wastewaters during wet weather. An exception was for stormwater zinc, fluoranthene, pyrene, and 1,3-dichlorobenzene, which were found mostly (>50%) in the filtered sample portions. Dry-weather wastewater flows tended to be much more associated with dissolved sample fractions.

Many processes will affect these pollutants. Sedimentation is the most common fate and control mechanism for particulate related pollutants. This would be common for most stormwater pollutants. Exceptions include the four stormwater constituents noted above which were mostly associated with the filterable sample portions. Particulate removal can occur in many control processes, including catchbasins, screens, drainage systems, and detention ponds. These control processes allow removal of the accumulated polluted sediment for final disposal in an appropriate manner.

Tables 34 and 35 summarize the likely fate mechanisms for these compounds (Callahan, *et al.* 1979). Biological or chemical degradation of the toxicants may occur, but is quite slow for many of the pollutants in anaerobic environments. Degradation of the soluble pollutants in the water column may occur, especially when near the surface in aerated waters. Volatilization is also a mechanism that may affect many of the detected organic toxicants. Increased turbulence and oxygen supplies would encourage these processes that may significantly reduce pollutant concentrations. Sorption of pollutants onto solids and metal precipitation increases the sedimentation potential of the pollutants and also encourages more efficient bonding of the pollutants in soils, preventing their leaching to groundwaters.

OUTFALL PRETREATMENT OPTIONS BEFORE STORMWATER INFILTRATION

Sedimentation Treatment

Wet Detention Ponds--

Detention ponds are probably the most common management practice for the control of stormwater runoff. If properly designed, constructed, and maintained, wet detention ponds can be very effective in controlling a wide range of pollutants and peak runoff flow rates.

There are many kinds of detention ponds, including dry ponds (which typically contain no water between storms), wet ponds (which contain standing water between storms), and combination ponds (which drain slowly after storms and may contain a small permanent pool). In a partial survey of cities in the U.S. and Canada, the American Public Works Association found more than 2,000 wet ponds (about half of which were publicly owned), more than 6,000 dry ponds, more than 3,000 parking lot multi-use detention areas, and more than 500 rooftop storage facilities (Smith 1982).

In selected areas of the U.S., detention ponds have been required for some time and are therefore much more numerous than elsewhere. In Montgomery County, Maryland, as an example, detention ponds were first required in 1971, with more than 100 facilities planned during that first year, and about

Table 34

50 actually constructed. By 1978, more than 500 detention facilities had been constructed in Montgomery County alone (Williams 1982). In DuPage County, Illinois, near Chicago, more than 900 stormwater detention facilities (some natural) receive urban runoff (McComas and Sefton 1985).

The Nationwide Urban Runoff Program (NURP) included full-scale monitoring of nine wet detention ponds (EPA 1983). The Lansing, Michigan, project included two greatly enlarged pipe sections within the storm sewerage system (up-sized pipes) plus a larger detention pond. The project located in Glen Ellyn (west of Chicago) monitored a small lake, the largest detention pond monitored during the NURP program. Ann Arbor, Michigan, monitoring included three detention ponds; Long Island, New York, studied one pond; the Washington, D.C. project included one pond. About 150 storm events were completely monitored at these ponds, and long-term performances ranged from negative removals for the smallest up-sized pipe installation to more than 90 percent removal of suspended solids at the largest wet ponds. The best ponds reported BOD_5 and COD removals of about 70 percent, nutrient removals of about 60 to 70 percent, and heavy metal removals of about 60 to 95 percent.

The Lansing NURP project monitored a wet detention pond (Luzkow *et al.* 1981). The monitored pond was located on a golf course that received urban runoff from an adjacent residential and commercial area. Suspended solids removals were about 70 percent for moderate rains (0.4 to 1-inch rains) while phosphorus removals were usually greater than 50 percent. Total Kjeldahl nitrogen removals ranged from about 30 to 50 percent.

Two wet detention ponds near Toronto, Ontario, were monitored from 1977 through 1979 (Brydges and Robinson 1980). Lake Aquitaine is 4.7 acres in size and receives runoff from a 107-acre urban watershed. Observed pollutant reductions were about 70 to 90 percent for suspended solids, 25 to 60 percent for nitrogen, and about 80 percent for phosphorus. The much smaller Lake Wabukayne (2 acres) received runoff from a much larger urban area (466 acres). Lake Wabukayne experienced much smaller pollutant reductions: about 30 percent for suspended solids, less than 25 percent for nitrogen, and 10 to 30 percent for phosphorus.

Oliver, *et al.* (1981) monitored a small lake detention facility in Rolla, Missouri. Suspended solids yield reductions averaged about 88 percent, with 54 and 60 percent yield reductions for COD and total phosphorus. Organic nitrogen yields were reduced by about 22 percent.

Gietz (1983) studied a 3.3-acre wet detention pond serving a 150-acre urban watershed near Ottawa, Ontario. He compared batch operation (which retains water in the pond without discharge as long as possible) with normal, continuous operation (which has variable but continuous discharges). Batch operation of the pond resulted in substantial pollutant control improvements for particulate solids, bacteria, phosphorus, and nitrate nitrogen. Continuous operation gave slightly better performance for BOD_5 and organic nitrogen. Particulate solid reductions were about 80 to 95 percent, BOD_5 reductions were about 35 to 45 percent, bacteria was reduced by about 50 to 95 percent, phosphorus by about 70 to 85 percent, and organic nitrogen by about 45 to 50 percent.

Yousef (1986) reported long-term nutrient removal information for a wet detention pond in Florida having substantial algal and rooted aquatic plant growths. He found 80 to 90 percent removals of soluble nutrients due to plant uptake. Particulate nutrient removals, however, were quite poor (about ten percent).

Catchbasin, Sewerage, and Street Cleaning--

The mobility of catchbasin sediments was investigated by Pitt (1979) during a research project sponsored by the U.S. EPA's Storm and Combined Sewer Section. This project used particulate fluorescent tracers mixed with catchbasin sediment. It was concluded that the amount of catchbasin and sewerage sediment was very large in comparison with storm runoff yields, but was not very mobile. Cleaning the material from catchbasins would reduce the potential of very large discharges during rare scouring rains.

Further research was conducted in Bellevue, Washington, (Pitt 1984) to investigate the accumulation rate of sediment in storm sewerage and the effects of sewerage cleaning on runoff discharges. The main source of the sediment in the catchbasins and the sewerage was found to be the street surfaces. The catchbasin and sewerage sediment consisted of the largest particles that were washed from the streets. Smaller particles that had washed from the streets during rains had proceeded into receiving waters, leaving behind the larger particles. A few unusual locations were dominated by erosion sediment originating from steep hillsides adjacent to the storm sewer inlets.

Catchbasin sump particulates can be conveniently removed to eliminate this potential source of urban runoff pollutants and to enable the most effective capture of the larger particulates in the storm runoff. Cleaning catchbasins twice a year was found to be most effective. This cleaning schedule was found to reduce the total solids and lead urban runoff yields by between 10 and 25 percent, and COD, total Kjeldahl nitrogen, total phosphorus, and zinc by between 5 and 10 percent (Pitt 1984; Pitt and Shawley 1981).

Street cleaning effectiveness has been monitored at many locations and shows mixed results in removing toxicants from stormwater (Pitt 1979, Pitt and Shawley 1981, Bannerman, *et al.* 1983, and Pitt 1984, for example). Street cleaning has been shown to be very effective in removing the largest particulates on streets (especially those greater than about 200 microns). Unfortunately, street cleaning generally removes only a very small fraction of the small particles that are readily washed-off streets by rains (Pitt 1987). Many of the street cleaning demonstration projects monitored a wide variety of available street cleaning equipment types, including mechanical broom sweepers, vacuum cleaners, and regenerative-air cleaners. Pitt (1984) also monitored a special prototype regenerative-air cleaner specifically modified to increase the removal of small particles. Many types of cleaner operations were investigated in some of these projects, including multiple passes using broom sweepers followed by vacuum cleaners, cleaning frequencies as often as two passes per day, full-street-width street cleaning, etc. Many demonstration projects only monitored relatively small changes in the street cleaning programs, however, and dramatic results could not have been expected.

In arid areas of the west, Pitt (1979) and Pitt and Shawley (1981) found that street cleaning could be beneficial in improving the stormwater quality associated with early fall rains following long dry summers. The dry summers allowed very large street dirt loadings to accumulate (if no street cleaning was used). If frequent street cleaning was used in the late summer (about weekly cleaning during September and October, for example), moderate heavy metal removals (25 to 50%) from the stormwater are likely. In most areas of the U.S., frequent rains would be more successful in keeping the streets clean than intensive street cleaning (Pitt 1984), resulting in very limited benefits.

Street runoff has also been over-emphasized as a source of runoff pollutants for many areas. In most locations, streets contribute only a small portion of the total annual runoff loading, even though they are very important pollutant sources for the smallest rains (Pitt 1987). Therefore, even absolute cleanliness of streets would only result in limited overall stormwater quality improvement. In general, recommended street cleaning programs (cleaning about every three months in residential and commercial areas, and monthly in industrial areas, intensive spring cleaning after snowmelt in northern areas, rapid leaf removal in the fall, and intensive late summer cleaning in the arid west) using any type of street cleaning equipment available would result in optimal, but limited, stormwater quality improvements. Other stormwater control options are usually found to be more cost-effective in removing pollutants from stormwater than street cleaning (Pitt 1986).

Fate Mechanisms in Sedimentation Devices--

The major fate mechanism in wet detention ponds and in smaller sumps, such as catchbasins, is sedimentation. Pollutants mostly associated with particulate matter will be much better removed than pollutants mostly in filterable forms. Unfortunately, sedimentation can result in the development of polluted sediments. These sediments can be anaerobic, with associated chemical and biochemical transformations. Resulting toxic chemical releases from heavily polluted sediments, plus the potential problems associated with the disposal of toxicant contaminated dredging spoils during required maintenance, can present problems.

Other important fate mechanisms available in wet detention ponds, but which are probably not important in small sump devices, include volatilization and photolysis. Biodegradation, biotransformation, and bioaccumulation (into plants and animals) may also occur in ponds. Most wet detention ponds are completely flushed by moderate rains (probably every several weeks), depending on their design. Much of the runoff during moderate and large rains passes through the ponds during several hours during and immediately after rains. Sediments may reside in ponds for several to many years. Therefore, the time available for these other removal or transformation processes can vary greatly for detention ponds. The residence time in small sedimentation devices is just a few minutes and significant biological activity may not be present, except in the anaerobic sediments in catchbasin sumps and in the culverts of sewerage.

Most sedimentation devices (especially ponds) are designed to provide effective sedimentation and sufficient sacrificial storage for the long-term maintenance of accumulated sediment. The removal of many toxicants by other processes can possibly be increased by aerating the water and increasing the associated oxygen content and biological activity in ponds (Pitt, *et al.* 1995).

LOCAL PRETREATMENT OPTIONS BEFORE SOURCE AREA STORMWATER INFILTRATION

Biofiltration Devices

General Infiltration--

All infiltration devices redirect surface runoff waters to the groundwater. They are recharge devices that can be used at many local areas in a watershed area. They must be carefully designed, especially using appropriate pretreatment as needed, to enable long-term operation and to protect groundwater quality.

Upland infiltration devices (such as infiltration trenches, porous pavements, percolation ponds, and grass roadside drainage swales) are located at urban source areas. Infiltration (percolation) ponds are usually located at stormwater outfalls, or at large paved areas. These ponds, along with perforated storm sewerage, can infiltrate flows and pollutants from all upland sources combined.

Several Nationwide Urban Runoff Program projects investigated infiltration devices (EPA 1983). They found that infiltration devices can safely deliver large fractions of the surface flows to groundwater, if carefully designed and located. Local conditions that can make localized stormwater infiltration inappropriate include steep slopes, slowly percolating soils, high groundwater, and nearby important groundwater uses.

The Lake Tahoe (California/Nevada) Regional Planning Agency has developed a set of design guidelines for infiltration devices in an area that has severe winters (Lake Tahoe 1978). They recommend the use of infiltration trenches to collect and infiltrate runoff from impervious surfaces, such as driveways, roofs, and parking lots. The Ontario Ministry of the Environment (1984) also included infiltration devices in its general stormwater management plan. The states of Florida, Maryland, and Delaware all extensively use infiltration as an important stormwater management and to recharge shallow groundwaters adversely affected by development. However, serious operational problems are very common with infiltration trenches and percolation ponds due to poor maintenance, poor construction practices, and poor placement (Lindsey, *et al.* 1992).

The Long Island, New York, and metropolitan Washington, D.C. NURP projects (EPA 1983) examined the performance of several types of infiltration devices. The Long Island project studied a series of interconnected percolating catchbasins, which were found to recharge more than 99 percent of the stormwater discharges. The Washington, D.C. study found that porous pavement recharged 85 to 95 percent of the pavement runoff flows, while an infiltration trench recharged about 50 percent of the surface flows. The EPA (1983) concluded that, with a reasonable degree of site-specific design considerations to compensate for soil characteristics, infiltration devices can be very effective in controlling urban runoff through recharging groundwaters.

Grass Filter Strips--

Grass filter strips may be quite effective in removing pollutants from overland flows. The filtering effects of grasses, along with increased infiltration/recharge, reduce the pollutant load from urban landscaped areas. Filter strips are extensively used in contour strip cropping systems in agricultural areas to reduce erosion yields associated with grain crop production. Grass filters can be used at urban runoff source areas to reduce the particulate pollutant yields to the storm drainage system. Specific situations may include directing roof runoff to grassed areas instead of pavement, planting grass between eroding slopes and the storm drainage system, and planting grass between paved or unpaved parking or storage areas and the drainage system.

Novotny and Chesters (1981) reviewed several publications describing research on the effectiveness of grass filter strips. Grass filtering occurs during shallow flows, requiring the depth of flow to be less than the vegetation height. The critical length is defined as the minimum water flow length within which almost 100 percent of the particles of concern are removed. This length (and removal efficiency) varies for different particle sizes, grass density, flow depth and flow velocity. For Bermuda grass, the critical length was found to be about 10 feet for sand, about 50 feet for silt, and about 400 feet for clay (Wilson 1967).

Grass Swales--

Grass swale drainages are a type of infiltration device and can be used in place of concrete curb and gutter drainages in most land uses, except possibly strip commercial and high density residential areas. Grass swales allow the recharge of significant amounts of surface flows.

Several large-scale urban runoff monitoring programs have included test sites that were drained by grass swales. Bannerman, *et al.* (1979), as part of the International Joint Commission (IJC) monitoring program to characterize urban runoff inputs to the Great Lakes, monitored a residential area served by swales and a similar residential area served by concrete curb and gutters in the Menomonee River watershed in the Milwaukee area. This monitoring program included extensive flow and pollutant concentration measurements during a variety of rains. They found that the swale-drained area, even though it had soils characterized as poorly drained, had significantly lower surface flows (up to 95 percent lower) compared to the curb and gutter area.

The ability of grass swales to infiltrate source area sheetflows was also monitored in Durham, New Hampshire (EPA 1983). A special swale was constructed to treat runoff from a commercial parking lot. Flow measurements were not available to directly measure infiltration, but significant pollutant concentration reductions were found, apparently due to filtration. Soluble and particulate heavy metal (copper, lead, zinc, and cadmium) concentrations were reduced by about 50 percent. COD, nitrate nitrogen, and ammonia nitrogen concentrations were reduced by about 25 percent, while no significant concentration reductions were found for organic nitrogen, phosphorus, and bacteria.

Wang, *et al.* (1980) monitored the effectiveness of grass swales at several freeway sites in the State of Washington. Lead was more consistently and effectively trapped in the swale soils than the other metals, possibly because of its greater association with particulates in the runoff. Particulate filtering was therefore an important process during these tests. Lead concentrations were typically reduced by 80 percent or more, while copper was reduced by about 60 percent, and zinc by about 70 percent. Because of the particulate filtering action, they concluded that it may be necessary to remove the contaminated soils and replant the grass periodically to prevent dislodging the deposited polluted sediment. Part of the swales monitored by Wang, *et al.* (1980) were bare earth lined. Pollutant concentrations were not found to be effectively reduced in these sections, and the earth lining was not contaminated.

A project to specifically study the effects of grass swale drainages was also conducted in Brevard County, Florida, by Kercher, *et al.* (1983). Two adjacent low density residential areas, with about 14 acres and 50 homes each, were selected for study. One area had conventional concrete curbs and gutters, while the other had grass swales for roadside drainage. The two areas had very similar characteristics (soils, percentage imperviousness, slopes, vegetation, etc.). Thirteen storm events were monitored in the areas for flow and several selected pollutants. The curb and gutter area produced runoff flows during all 13 events, while the grass swale area produced runoff during only three events. The grass swale system also cost about one-half as much as the curb and gutter system.

In another large-scale urban runoff monitoring project, Pitt and McLean (1985) monitored a residential area in Toronto that was served about evenly by swales and concrete curbs and gutters. The pollutant concentrations in both types of drainage systems were similar, but the area had annual flows about 25 percent less than if the area were served solely by curbs and gutters. For small but frequent rains (less than about 0.5 inch), very little surface runoff was observed, with almost all of the flows being infiltrated to the groundwater.

Porous Pavements--

Porous pavement is a "hard" surface that can support a certain amount of activity, while still allowing water to pass through to recharge the underlying groundwaters. Porous pavement is generally used in areas of low traffic, such as service roads, storage areas, and parking lots. Several different types of porous pavement exist. Open mixes of asphalt appear similar to regular asphalt, but use only a specific size range of rocks in the hot mix. The porosity of the finished asphalt is much higher than regular asphalt, if properly designed and constructed. Concrete grids have open holes up to several inches wide filled with sand or gravel. It is possible to plant grass in the holes, if traffic is very light and if light and moisture conditions are adequate. They can be designed to recharge all of the runoff water from paved areas. The percolation rate of the pavement base is usually the limiting condition in porous pavement installations (Cedergren 1974).

Porous pavements do not provide any direct water quality treatment for the infiltrating water, but they do allow the water to pass through soil before reaching the groundwater. The organic content of the soil and associated sorption capacity of the soils may be limited below porous pavements because of the pavement construction operations.

Porous pavements may be effectively used in areas having soils with adequate percolation characteristics, if carefully designed and maintained. The percolation requirements for porous pavements are not as demanding as they are for other infiltration devices, unless runoff from other areas is directed towards the paved area. The percolation of the soils underlying the porous pavement installation need only to exceed the rain intensity directly. In most cases, several inches of storage is available in the asphalt base to absorb short periods of very high rain intensities. Diniz (1980) states that the entire area contributing to the porous pavement can be removed from the surface hydrologic regime (and therefore be used for groundwater recharge).

Gburek and Urban (1983) studied a porous pavement parking lot in Pennsylvania. They found that percolation below the pavement occurred soon after the start of rain. For small rains (less than 0.25 inches), no percolation under the pavement was observed, with all of the rain being contained in the pavement base. Percolation during large rains was equal to about 70 to 90 percent of the rainfall. The differences between the rain amounts and the observed percolation quantities were caused by flash evaporation (not estimated) and storage in the asphalt base material.

Goforth *et al.* (1983 and 1984) evaluated a porous pavement parking lot in Austin, Texas, over several years and under heavy traffic conditions. Infiltration rates through the pavement averaged about

1800 inches per hour, while the two-inch pavement base had an infiltration rate of about 70,000 inches per hour. Day (1980) conducted a series of laboratory tests using several different types of concrete grid pavements. The geometry of the grid was more important than the percentage of open space in determining the ability of the grid to absorb and detain rainwater. The runoff coefficients from the grids ranged from 0.06 to 0.26 (resulting in recharge rates from 75 to 95 percent) depending on the rain intensity, ground slope, and subsoil type.

Fate Mechanisms in Biofiltration Devices--

Sorption of pollutants to soils is probably the most important fate mechanism of toxicants in biofiltration devices. Many of the devices also use sedimentation and filtration to remove the particulate forms of the pollutants from the water. Incorporation of the pollutants onto soil with subsequent biodegradation and minimal leaching to the groundwater is desired. Volatilization, photolysis, biotransformation, and bioconcentration may also be important in grass filter strips and grass swales. Underground French drains and porous pavements offer little biological activity to reduce toxicants.

REFERENCES

Alhajjar, B.J., G.V. Simsiman and G. Chesters. "Fate and Transport of Alachlor, Metolachlor and Atrazine in Large Columns." *Water Science and Technology*. Volume 22, number 6, pp. 87-94. 1990.

Amoros, I., J.L. Alonso and I. Peris. "Study of Microbial Quality and Toxicity of Effluents from Two Treatment Plants Used for Irrigation." *Water Science and Technology*. Volume 21, number 3, pp. 243-246. 1989.

APWA (American Public Works Assoc.). *Water Pollution Aspects of Urban Runoff.* Water Pollution Control Research Series WP-20-15, Federal Water Pollution Control Administration, January 1969.

Armstrong, David E. and Reynaldo Llena. *Stormwater Infiltration: Potential for Pollutant Removal.* Report prepared for the Wisconsin Department of Natural Resources (Madison) and the U.S. Environmental Protection Agency, Chicago. February 1992.

Aronson, D.A. and G.E. Seaburn. *Appraisal of Operating Efficiency of Recharge Basins on Long Island, New York*. U.S. Geological Survey Water-Supply Paper 2001-D. USGS, Washington, D.C., 1974.

AWWA (American Water Works Association). "Fertilizer Contaminates Nebraska Groundwater." *AWWA Mainstream.* Volume 34, number 4, p. 6. April 1990.

Bannerman, R., K. Baun, M. Bohn, P.E. Hughes, and D.A. Graczyk. *Evaluation of Urban Nonpoint Source Pollution Management in Milwaukee County, Wisconsin*, Vol. I. Grant No. P005432-01-5, PB 84-114164. US Environmental Protection Agency, Water Planning Division, November 1983.

Bannerman, R., J.G. Konrad, and D. Becker. *The IJC Menomonee River Watershed Study.* EPA-905/4-79-029. US Environmental Protection Agency. Chicago Illinois. 1979.

Bao-rui, Yan. "Investigation into Mechanisms of Microbial Effects on Iron and Manganese Transformations in Artificially Recharged Groundwater." *Water Science and Technology*. Volume 20, number 3, pp. 47-53. 1988.

Basu, D. and S.J. Bosch. Bis-(2-Chloroisopropyl) Ether Reportable Quantity (RQ) Ranking Based on Chronic Toxicity. Environmental Criteria and Assessment Office. U.S. Environmental Protection Agency, Contract No. 68-03-3112. Cincinnati, Ohio. July 1982.

Berg, G. editor. *Transmission of Viruses by the Water Route*. Interscience Publishers, New York. 1965.

Boggess, D.H. *Effects of a Landfill On Ground-Water Quality*. United States Department of the Interior Geological Survey, Open File Report 75-594. Prepared in cooperation with the City of Fort Myers. U.S. Government Printing Office, Washington, D.C. 1975.

Bouwer, Edward J., Perry L. McCarty, Herman Bouwer and Robert C. Rice. "Organic Contaminant Behavior During Rapid Infiltration of Secondary Wastewater at the Phoenix 23rd Avenue Project." *Water Resources*. Volume 18, number 4, pp. 463-472. 1984.

Bouwer, Herman. "Renovation of Wastewater with Rapid-Infiltration Land Treatment Systems." In: *Artificial Recharge of Groundwater*. Edited by Takashi Asano. Butterworth Publishers, Boston, pp. 249-282. 1985.

Bouwer, Herman. "Effect of Irrigated Agriculture on Groundwater." *Journal of Irrigation and Drainage Engineering, ASCE*. Volume 113, number 1, pp. 4-15. February 1987.

Bouwer, Herman and Emamuel Idelovitch. "Quality Requirements for Irrigation with Sewage Water." *Journal of Irrigation and Drainage*. Volume 113, number 4, pp. 516-535. November 1987.

Bouwer, Herman. "Agricultural Contamination: Problems and Solutions." *Water Environment and Technology*. Volume 1, number 2, pp. 292-297. October 1989.

Bowman, D.C., J.L. Paul, W.B. Davis, and S.H. Nelson. "Reducing Ammonia Volatilization from Kentucky Bluegrass by Irrigation." *Horticulture Science*. Vol. 22, pp. 84-87. 1987.

Brown, David P. *Effects of Effluent Spray Irrigation on Groundwater at a Test Site near Tarpon Springs, Florida*. United States Department of the Interior Geological Survey Open File Report 81-1197. Prepared in cooperation with Pinellas County, Florida. USGS, Denver, Colorado. 1982.

Brydges, T. and G. Robinson. "Two Examples of Urban Stormwater Impoundment for Aesthetics and for Protection of Receiving Waters." In: *Restoration of Lakes and Inland Waters: International Symposium on Inland Waters and Lake Restoration*. Portland, Main, September 1980. Proceedings published by the U.S. Environmental Protection Agency, Washington, D.C. 1986.

Butler, Kent S. "Urban Growth Management and Groundwater Protection: Austin, Texas." *Planning for Groundwater Protection*. Academic Press, Inc. New York. pp. 261-287. 1987.

Callahan, M.A., M.W. Slimak, N.W. Gabel, I.P. May, C.F. Fowler, J.R. Freed, P. Jennings, R.L. Durfee, F.C. Whitmore, B. Maestri, W.R. Mabey, B.R. Holt, and C. Gould. *Water Related Environmental Fates of 129 Priority Pollutants*. U.S. Environmental Protection Agency, Monitoring and Data Support Division, EPA-4-79-029a and b. Washington D.C., 1979.

Cedergren, H.R. *Drainage of Highway and Airfield Pavements*. John-Wiley and Sons, New York, 1974.

Chang, A.C., A.L. Page, P.F. Pratt and J.E. Warneke. "Leaching of Nitrate from Freely Drained-Irrigated Fields Treated with Municipal Sludge." *Planning Now for Irrigation and Drainage in the 21st Century: Proceedings of a Conference Sponsored by the Irrigation and Drainage Division of the American Society of Civil Engineers*. Lincoln, Nebraska, pp. 455-467. ASCE, New York. July 18-21 1988.

Chase, William L. "Reclaiming Wastewater in Phoenix, Arizona." *Irrigation Systems for the 21st Century - Proceedings of a Conference Sponsored by the Irrigation and Drainage Division of the American Society of Civil Engineers*. Portland, Oregon, July 28-30, 1987. ASCE, New York. pp. 336-343. 1987.

Close, M.E. "Effects of Irrigation on Water Quality of a Shallow Unconfined Aquifer." *Water Resources Bulletin*. Volume 23, number 5, pp. 793-802. October 1987.

Craun, Gunther F. "Waterborne Disease -- A Status Report Emphasizing Outbreaks in Ground-Water Systems." *Groundwater*. Volume 17, number 2, pp. 183-191. March-April 1979.

Crites, Ronald W. "Micropollutant Removal in Rapid Infiltration." In: *Artificial Recharge of Groundwater*. Edited by Takashi Asano. Butterworth Publishers, Boston, pp. 579-608. 1985.

Dalrymple, R.J., S.L. Hodd, and D.C. Morin. *Physical and Settling Characteristics of Particulates in Storm and Sanitary Wastewaters*. EPA-670/2-75-011. U.S. Environmental Protection Agency, Cincinnati, Ohio, 1975.

Day, G.E. "Investigation of Concrete Grid Pavements." In *Proceedings - National Conference on Urban Erosion and Sediment Control: Institutions and Technology*, EPA-905/9-80-002, U.S. Environmental Protection Agency, Chicago, Ill., January 1980.

Deason, Jonathan P. "Selenium: It's Not Just in California." *Irrigation Systems for the 21st Century - Proceeding of a Conference.* Sponsored by the Irrigation and Drainage Division of the American Society of Civil Engineers, New York. pp. 475-482. 1987.

Deason, Jonathan P. "Irrigation-Induced Contamination: How Real a Problem?" *Journal of Irrigation and Drainage Engineering, ASCE*. Volume 115, number 1, pp. 9-20. February 1989.

DeBoer, Jon G. "Wastewater Reuse: A Resource or a Nuisance?" *Journal of the American Water Works Association*. Volume 75, pp. 348-356. July 1983.

Diniz, E.V. *Porous Pavement; Phase I, Design and Operational Criteria*. EPA-600/2-80-135. U.S. Environmental Protection Agency, Cincinnati, Ohio, August 1980.

Domagalski, Joseph L. and Neil M. Dubrovsky, Neil M. "Pesticide Residues in Groundwater of the San Joaquin Valley, California." *Journal of Hydrology*. Volume 130, number 1-4, pp. 299-338. January 1992.

Durum, W. H. Occurrence of Some Trace Metals in Surface Waters and Groundwaters. In Proceeding of the Sixteenth Water Quality Conference, Am. Water Works Assoc., *et al.* Univ. of Illinois Bull., 71(108), Urbana, Illinois. 1974.

Ehrlich, Garry G., Henry F.H. Ku, John Vecchioli and Theodore A. Ehlke. *Microbiological Effects of Recharging the Magothy Aquifer, Bay Park, New York, with Tertiary-Treated Sewage.* Geological Survey Professional Paper 751-E. Prepared in cooperation with the Nassau County Department of Public Works. USGS, Washington, D.C. 1979a.

Ehrlich, G.G., E.M. Godsy, C.A. Pascale and John Vecchioli. "Chemical Changes in an Industrial Waste Liquid during Post-Injection Movement in a Limestone Aquifer, Pensacola, Florida." *Groundwater*. Volume 17, number 6, November-December, pp. 562-573. 1979b.

Environment Canada. Rideau River Water Quality and Stormwater Monitoring Study. MS Report OR-29, Ontario Ministry of the Environment. Feb. 1980.

Environment Canada/Agriculture Canada. *Pesticide Registrant Survey; 1986 Report.* Prepared by the Commercial Chemicals Branch. Conservation and Protection. Environment Canada. January, 1987

EPA. *Areawide Assessment Manual.* Three Volumes. Municipal Envir. Research Lab., Cincinnati, Ohio, July 1976.

EPA. *Results of the Nationwide Urban Runoff Program.* Water Planning Division, PB 84-185552, Washington, D.C., December 1983.

EPA. *Quality Criteria for Water.* U.S. Environmental Protection Agency. EPA 440/5-86-001. Wash., D.C., May 1986.

EPA (U.S. Environmental Protection Agency). *National Pesticide Survey: Summary results of EPA's national survey of pesticides in drinking water wells.* EPA Office of Pesticides and Toxic Substances. U.S. Government Printing Office, Washington, D.C. 1990.

EPA (U.S. Environmental Protection Agency). *Manual: Guidelines for Water Reuse.* EPA Document No. EPA/625/R-92/004. U.S. Government Printing Office, Washington, D.C. September, 1992.

Ferguson, Bruce K. "Role of the Long-Term Water Balance in Management of Stormwater Infiltration." *Journal of Environmental Management.* Volume 30, number 3, pp. 221-233. April 1990.

Ferguson, R.B., D.E. Eisenbauer, T.L. Bockstadter, D.H. Krull and G. Buttermore. "Water and Nitrogen Management in Central Platte Valley of Nebraska." *Journal of Irrigation and Drainage*. Volume 116, number 4, pp. 557-565. July/August 1990.

Field, R., E. J. Struzeski, Jr., H. E. Masters and A. N. Tafuri. Water Pollution and Associated Effects from Street Salting. EPA-R2-73-257, U.S. Environmental Protection Agency, Cincinnati, Ohio. May 1973.

Field, R. and M.L. O'Shea. "The Detection of Pathogens in Storm-Generated Flows." *Water Environment Federation 65th Annual Conference and Exposition*. New Orleans. September, 1992.

Galvin, D.V. and R.K. Moore. *Toxicants in Urban Runoff. Toxicant Control Planning Section, Municipality of Metropolitan Seattle*, Contract # P-16101, U.S. Environmental Protection Agency, Lacy, Washington, Dec. 1982.

Gburek, W.J. and J.B. Urban. "Storm Water Detention and Groundwater Recharge Using Porous Asphalt - Initial Results." *1983 International Symposium on Urban Hydrology, Hydraulics and Sediment Control*, University of Kentucky, Lexington, Kentucky, July 1983.

Gerba, Charles P. and Sagar M. Goyal. "Pathogen Removal from Wastewater during Groundwater Recharge." In: *Artificial Recharge of Groundwater*. Edited by Takashi Asano. Butterworth Publishers, Boston. pp. 283-317. 1988.

Gerba, Charles P. and Charles N. Haas. "Assessment of Risks Associated with Enteric Viruses in Contaminated Drinking Water." *Chemical and Biological Characterization of Sludges, Sediments, Drudge Spoils and Drilling Muds, ASTM STP 976*. American Society for Testing and Materials, Philadelphia, Pennsylvania. pp. 489-494. 1988.

Geldreich, E.E. and B.A. Kenner. Concepts of Fecal Streptococci in Stream Pollution. Journal WPCF, Vol. 41, No. 8, pp. R336-R352. Aug. 1969.

German, Edward R. *Quantity and Quality of Stormwater Runoff Recharged to the Floridan Aquifer System Through Two Drainage Wells in the Orlando, Florida Area*. U.S. Geological Survey - Water Supply Paper 2344. Prepared in cooperation with the Florida Department of Environmental Regulation. USGS, Denver, Colorado. 1989.

Gietz, R.J. *Urban Runoff Treatment in the Kennedy-Burnett Settling Pond*. For the Rideau River Stormwater Management Study, Pollution Control Division, Works Department, Regional Municipality of Ottawa-Carleton, Ottawa, Ontario, March 1983.

Goforth, G.F., E.V. Diniz, and J.B. Rauhut. *Stormwater Hydrological Characteristics of Porous and Conventional Paving Systems*. EPA-600/2-83-106, U.S. Environmental Protection Agency, Cincinnati, Ohio, February 1984 (also dated October 1983).

Gold, A.J. and P.M. Groffman. "Leaching of Agrichemicals from Suburban Areas." In: *Pesticides in Urban Environments - Fate and Significance*. Racke, K.D. and A.R. Leslie, editors. ACS Symposium Series No. 522. American Chemical Society, Washington, D.C. 1993.

Goldshmid, J. "Water-Quality Aspects of Ground-Water Recharge in Israel." *Journal of the American Water Works Association*. Volume 66, number 3, pp. 163-166. March 1974.

Goolsby, Donald A. "Geochemical Effects and Movement of Injected Industrial Waste in a Limestone Aquifer." *Underground Waste Management and Environmental Implications (Reprint)*. The American Association of Petroleum Geologists, Memoir No. 18. 1972.

Gore & Storrie Ltd./Proctor & Redfern Ltd. Executive Summary Report on Rideau River Stormwater Management Study, Phase 1, Rideau River Stormwater Management Study, Ottawa and the Ontario Ministry of the Environment, Kingston, Ontario. 1981.

Greene, Gerald E. "Ozone Disinfection and Treatment of Urban Storm Drain Dry-Weather Flows: A Pilot Treatment Plant - Demonstration Project on the Kenter Canyon Storm Drain System in Santa Monica." *Santa Monica Bay Restoration Project.* Office of the City Engineer, Santa Monica, California. June 1992.

Hampson, Paul S. *Effects of Detention on Water Quality of two Stormwater Detention Ponds Receiving Highway Surface Runoff in Jacksonville, Florida.* U.S. Geological Survey Water-Resources Investigations Report 86-4151. Prepared in cooperation with the Florida Department of Transportation. USGS, Denver, Colorado. 1986.

Harper, Harvey H. *Effects of Stormwater Management Systems on Groundwater Quality*. Final Report for DER Project WM190. Florida Department of Environmental Regulation. September 1988.

Harris, B. Fluoranthene: Reportable Quantity (RQ) Ranking Based on Chronic Toxicity. U.S. Environmental Protection Agency. Contract No. 68-03-3112. Cincinnati, Ohio, July 1982.

HEW (U.S. Dept. of Health, Education, and Welfare). Bioassay of Technical Grade Bis (2-Chloro-1-Methylethyl) Ether for Possible Carcinogenicity. CAS No. 108-60-1, NCI-CG-TR-191. Bethesda, Maryland, 1979.

Hickey, John J. and John Vecchioli. *Subsurface Injection of Liquid Waste with Emphasis on Injection Practices in Florida*. U.S. Geological Survey Water-Supply Paper 2281. USGS, Denver, Colorado. 1986.

Higgins, Andrew J. "Impacts on Groundwater due to Land Application of Sewage Sludge." *Water Resources Bulletin*. Volume 20, number 3, pp. 425-434. June 1984.

Horsley, Scott W. and John A. Moser. "Monitoring Groundwater for Pesticides at a Golf Course -- A Case Study on Cape Cod, Massachusetts." *Groundwater Monitoring Review*. Volume 10, pp. 101-108. Winter 1990.

Howard, P.H. Handbook of Environmental Fate and Exposure Data for Organic Chemicals, Volume 1, Large Production and Priority Pollutants. Lewis Publishers. Chelsea, Mich. 1989.

IARC. Chemicals and Industrial Processes Associated with Cancer in Humans. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans, Supplement 1. World Health Organization. Lyon, France, 1979.

Iowa DNR. *Pesticide and Synthetic Organic Compound Survey*. Iowa Department of Natural Resources. 1988.

Iowa DNR. *The Iowa State-Wide Rural Well-Water Survey Water Quality Data: Initial Analysis*. Iowa Department of Natural Resources. 1990.

Jansons, Janis, Lindsay W. Edmonds, Brent Speight and Marion R. Bucens. "Movement of Viruses after Artificial Recharge." *Water Research*. Volume 23, number 3, pp. 293-299. 1989a.

Jansons, Janis, Lindsay W. Edmonds, Brent Speight and Marion R. Bucens. "Survival of Viruses in Groundwater." *Water Research*. Volume 23, number 3, pp. 301-306. 1989b.

Johnson, C.R. "A New Look at Sewer Separation for CSO Control." *WPCF Specialty Conference Series: Control of Combined Sewer Overflows*, Boston. April 8-11, 1990.

Jury, W.A., W.F. Spencer, and W.J. Farmer. "Model for Assessing Behavior of Pesticides and other Trace Organics using Benchmark Properties. I. Description of Model". *J. Environmental Quality*. No. 12. pp. 558-564. 1983.

Kercher, W.C., J.C. Landon and R. Massarelli. "Grassy Swales Prove Cost-Effective for Water Pollution Control." *Public Works*, April 1983.

Knisel, W.G. and R.A. Leonard. "Irrigation Impact on Groundwater: Model Study in Humid Region." *Journal of Irrigation and Drainage, ASCE*. Volume 115, number 5, pp. 823-838. October 1989.

Krawchuk, Bert P. and G.R. Barrie Webster. "Movement of Pesticides to Groundwater in an Irrigated Soil." *Water Pollution Research Journal of Canada*. Volume 22, pp. 129-146. number 1, 1987.

Ku, Henry F.H., John Vecchioli and Stephen E. Ragone. "Changes in Concentration of Certain Constituents of Treated Waste Water during Movement through the Magothy Aquifer, Bay Park, New York." *Journal Research U.S. Geological Survey*. Volume 3, number 1, pp. 89-92. January-February 1975.

Ku, Henry F. H. and Dale L. Simmons. *Effect of Urban Stormwater Runoff on Groundwater beneath Recharge Basins on Long Island, New York*. U.S. Geological Survey Water-Resources Investigations Report 85-4088. Prepared in cooperation with Long Island Regional Planning Board, Syosset, New York. USGS, Denver, Colorado. 1986.

Ku, Henry H.F., Nathan W. Hagelin and Herbert T. Buxton. "Effects of Urban Storm-Runoff Control on Ground-Water Recharge in Nassau County, New York." *Groundwater*. Volume 30, number 4, pp. 507-514. July-August 1992.

Lager, J.A. *Urban Stormwater Management and Technology: Update and User's Guide*. Rep No. EPA-600/8-77-014. U.S. Environmental Protection Agency. Cincinnati, Ohio. pp. 90-92. 1977.

Lake Tahoe Regional Planning Agency. *Lake Tahoe Basin Water Quality Management Plan, Volume II, Handbook of Best Management Practices*. Lake Tahoe, California, January 1978.

Lauer, D.A. "Vertical Distribution in Soil of Sprinkler-Applied Phosphorus." *Soil Science Society of America Journal.* Volume 52, number 3, pp. 862-868. May/June 1988a.

Lauer, D.A. "Vertical Distribution in Soil of Unincorporated Surface-Applied Phosphorus under Sprinkler Irrigation." *Soil Science Society of America Journal.* Volume 52, number 6, pp. 1685-1692. November/December 1988b.

Lee, Edwin W. "Chapter 21: Drainage Water Treatment and Disposal Options." In: *Agricultural Salinity Assessment and Management.* Edited by Kenneth K. Tanji. American Society of Civil Engineers, New York. pp. 450-468. 1990.

Linsey, G., L. Roberts and W. Page. "Inspection and Maintenance of Infiltration Facilities." *Journal of Soil and Water Conservation*. Vol. 47, No. 6, pp. 481-486, November/December 1992.

Lloyd, J.W., D.N. Lerner, M.O. Rivett and M. Ford. "Quantity and Quality of Groundwater beneath an Industrial Conurbation -- Birmingham, UK." In: *Proceedings of the Conference -- Hydrological Processes and Water Management in Urban Areas*. Duisburg, Federal Republic of Germany. International Hydrological Programme, UNESCO, pp. 445-452. April 24-29, 1988.

Loague, K.M. and R.A. Freeze. "A Comparison of Rainfall-Runoff Modeling Techniques on Small Upland Catchments", *Water Resources Research*, Vol. 21, No. 2, pp 229-248, February 1985.

Luzkow, S.M., D.A. Scherger, and J.A. Davis. "Effectiveness of Two In-Line Urban Stormwater Best Management Practices (BMP's)." *1981 International Symposium on Urban Hydrology, Hydraulics, and Sediment Control*, University of Kentucky, Lexington, Kentucky, July 1981.

Madison, F., J. Arts, S. Berkowitz, E. Salmon, and B. Hagman. *Washington County Project.* EPA 905/9-80-003, U.S. Environmental Protection Agency, Chicago, Ill., 1979.

Marton, J. and I. Mohler. "The Influence of Urbanization on the Quality of Groundwater." In: *Proceedings of the Conference -- Hydrological Processes and Water Management in Urban Areas*. Duisburg, Federal Republic of Germany. International Hydrological Programme, UNESCO, pp. 453-460. April 24-29, 1988.

Marzouk, Yosef, Sagar M. Goyal and Charles P. Gerba. "Prevalence of Enteroviruses in Groundwater of Israel." *Groundwater*. Volume 17, number 5, pp. 487-491. September-October 1979.

McComas, S.R. and D.F. Sefton. "Comparison of Stormwater Runoff Impacts on Sedimentation and Sediment Trace Metals for Two Urban Impoundments." In: *Lake and Reservoir Management: Practical Applications*, proceedings of the Fourth Annual Conference and International Symposium, October, 1984, North American Lake Management Society, McAfee, New Jersey, 1985.

Merkel, B., J. Grossman and P. Udluft. "Effect of Urbanization on a Shallow Quarternary Aquifer." *Proceedings of the Conference -- Hydrological Processes and Water Management in Urban Areas*. Duisburg, Federal Republic of Germany. International Hydrological Programme, UNESCO, pp. 461-468. April 24-29, 1988.

Moffa, P.E. *Control and Treatment of Combined Sewer Overflows*. Van Nostrand Reinhold. New York. 1989

Mossbarger, W.A. and R.W. Yost. "Effects of Irrigated Agriculture on Groundwater Quality in Corn Belt and Lake States." *Journal of Irrigation and Drainage Engineering, ASCE*. Volume 115, number 5, pp. 773-790. October 1989.

Natarajan, U. and R. Rajagopal. "Surveying The Situation." *Environmental Testing and Analysis*. pp. 40 - 50. Jan/Feb. 1993.

Nellor, Margaret H., Rodger B. Baird and John R. Smyth. "Health Aspects of Groundwater Recharge." In: *Artificial Recharge of Groundwater*. Edited by Takashi Asano. Butterworth Publishers, Boston, pp. 329-356. 1985.

Nightingale, Harry I. and William C. Bianchi. "Ground-Water Chemical Quality Management by Artificial Recharge." *Groundwater*. Volume 15, number 1, pp. 15-22. January-February 1977a.

Nightingale, Harry I. and William C. Bianchi. "Ground-Water Turbidity Resulting from Artificial Recharge." *Groundwater*. Volume 15, number 2, pp. 146-152. March-April 1977b.

Nightingale, H.I., J.E. Ayars, R.L. McCormick and D.C. Cehrs. "Leaky Acres Recharge Facility: A Ten-Year Evaluation." *Water Resources Bulletin*. Volume 19, number 3, pp. 429-437. June 1983.

Nightingale, Harry I. "Water Quality beneath Urban Runoff Water Management Basins." *Water Resources Bulletin*. Volume 23, number 2, pp. 197-205. April 1987a.

Nightingale, Harry I. "Accumulation of As, Ni, Cu and Pb in Retention and Recharge Basins Soils from Urban Runoff." *Water Resources Bulletin*. Volume 23, number 4, pp. 663-672. August 1987b.

Norberg-King, Teresa J., Elizabeth J. Durhan, Gerald T. Ankley and Eric Robert. "Application of Toxicity Identification Evaluation Procedures to the Ambient Waters of the Colusa Basin Drain, California." *Environmental Toxicology and Chemistry*. Volume 10, pp. 891-900. 1991.

Novotny, V. and G. Chesters. *Handbook of Nonpoint Pollution*. VanNostrand Reinhold, New York, 1981.

Oliver, L.J. and S.G. Grigoropoulis. "Control of Storm-Generated Pollution Using a Small Urban Lake." *Journal Water Pollution Control Federation*, Vol 53, No. 5, May 1981.

Olivieri, V.P., C.W. Kurse, and K. Kawata. Selected Pathogenic Microorganisms Contributed from Urban Watersheds. In: Watershed Research in Eastern North America, Vol. II, D.L. Correll. NTIS No. PB-279 920/3SL. 1977a.

Olivieri, V.P., C.W. Kurse, and K. Kawata. Microorganisms in Urban Stormwater, U.S. Environmental Protection Agency, EPA-600/2-77-087. July 1977b.

Ontario Ministry of the Environment. *Rideau River Stormwater Management Study*. Kingston, Ontario, 1983.

Ontario (Province of). *Urban Drainage Design Guidelines* (Draft). Urban Drainage Policy Implementation Committee, Technical Sub-Committee No. 3. March 1984.

Ontario Ministry of the Environment. *Humber River Water Quality Management Plan*, Toronto Area Watershed Management Strategy. Toronto, Ontario, 1986.

Peterson, David A. "Selenium in the Kendrick Reclamation Project, Wyoming." *Planning Now for Irrigation and Drainage in the 21st Century*. Proceedings of a conference sponsored by the Irrigation and Drainage Division of the American Society of Civil Engineers, Lincoln, Nebraska, pp. 678-685. ASCE, New York. July 18-21, 1988.

Petrovic, A. Martin. "The Fate of Nitrogenous Fertilizers Applied to Turfgrass." *Journal of Environmental Quality*. Volume 19, number 1, pp. 1-14. January-March 1990.

Phillips, G. R., and R. C. Russo. Metal Bioaccumulation in Fishes and Aquatic Invertebrates: A Literature Review. EPA-600-3-78-103, U.S. Environmental Protection Agency, Duluth, Minnesota. December 1978.

PHS (U.S. Public Health Service). Second Annual Report on Carcinogens. U.S. Dept. of Health and Human Services. Dec. 1981.

Pierce, Ronald C. and Michael P. Wong. "Pesticides in Agricultural Waters: The Role of Water Quality Guidelines." *Canadian Water Resources Journal.* Volume 13, number 3, pp. 33-49. July, 1988.

Pitt, R. and G. Amy. *Toxic Materials Analysis of Street Surface Contaminants*. EPA-R2-73-283, U.S. Environmental Protection Agency, Washington, D.C., August 1973.

Pitt, R. *Demonstration of Nonpoint Pollution Abatement Through Improved Street Cleaning Practices*. EPA-600/2-79-161, U.S. Environmental Protection Agency, Cincinnati, Ohio, August 1979.

Pitt, R. and G. Shawley. *A Demonstration of Non-Point Source Pollution Management on Castro Valley Creek*. Alameda County Flood Control and Water Conservation District (Hayward, CA) for the Nationwide Urban Runoff Program, U.S. Environmental Protection Agency, Water Planning Division, Washington, D.C., June 1982.

Pitt, R. *Urban Bacteria Sources and Control by Street Cleaning in the Lower Rideau River Watershed, Ottawa, Ontario*. Rideau River Stormwater Management Study, Ontario Ministry of the Environment, Ottawa, Ontario, 1983.

Pitt, R. *Characterization, Sources, and Control of Urban Runoff by Street and Sewerage Cleaning*. Contract No. R-80597012, U.S. Environmental Protection Agency, Office of Research and Development, Cincinnati, Ohio, 1984.

Pitt, R. and P. Bissonnette. *Bellevue Urban Runoff Program, Summary Report*. U.S. Environmental Protection Agency and the Storm and Surface Water Utility, Bellevue, Washington, 1984.

Pitt, R. "Runoff Controls in Wisconsin's Priority Watersheds." *Conference on Urban Runoff Impact and Quality Enhancement Technology. Henniker, NH.* Edited by B. Urbonas and L.A. Roesner, Proceedings published by the American Society of Civil Engineering. New York, NY. June 1986.

Pitt, R. and J. McLean. *Toronto Area Watershed Management Strategy Study: Humber River Pilot Watershed Project.* Ontario Ministry of the Environment, Toronto, Ontario, 1986.

Pitt, R. *Small Storm Urban Flow and Particulate Washoff Contributions to Outfall Discharges*. Ph.D. dissertation. Dept. of Civil and Environmental Engineering, University of Wisconsin - Madison. October 1987.

Pitt, R., and P. Barron. *Assessment of Urban and Industrial Stormwater Runoff Toxicity and the Evaluation/Development of Treatment for Runoff Toxicity Abatement - Phase I.* U.S. Environmental Protection Agency, Office of Research and Development, Edison, New Jersey, 1990.

Pitt, R. M. Lalor, R. Field, D.D. Adrian, and D. Barbe'. *Investigation of Inappropriate Pollutant Entries into Storm Drainage Systems*. EPA/600/R-92/238. U. S. Environmental Protection Agency. Office of Research and Development, Cincinnati, Ohio, 1993.

Pitt, R.E., R. Field, M. Lalor, and M. Brown. "Urban Stormwater Toxic Pollutants: Assessment, Sources, and Treatability." *Water Environment Research*. Vol. 67, No. 3, pp. 260-275. May/June 1995.

Power, J.F. and J.S. Schepers. "Nitrate Contamination of Groundwater in North America." *Agriculture, Ecosystems and Environment.* Volume 26, pp. 165-187. number 3-4 1989.

Pruitt, Janet B., David A. Troutman and G.A. Irwin. *Reconnaissance of Selected Organic Contaminants in Effluent and Groundwater at Fifteen Municipal Wastewater Treatment Plants in Florida, 1983-84*. U.S. Geological Survey Water-Resources Investigation Report 85-4167. Prepared in cooperation with the Florida Department of Environmental Regulation. USGS. Denver, Colorado. 1985.

Quresh, A.A. and B.J. Dutka. Microbiological Studies on the Quality of Urban Stormwater Runoff in Southern Ontario, Canada. Water Research, Vol. 13, pp. 977-985. 1979.

Racke, K.D. and A.R. Leslie, editors. *Pesticides in Urban Environments - Fate and Significance.* ACS Symposium Series No. 522. American Chemical Society, Washington, D.C. 1993.

Ragone, Stephen E. *Geochemical Effects of Recharging the Magothy Aquifer, Bay Park, New York, with Tertiary-Treated Sewage.* Geological Survey Professional Paper 751-D. Prepared in cooperation with the Nassau County Department of Public Works. USGS, Washington, D.C. 1977.

Razack, M., C. Drogue and M'Baitelem. "Impact of an Urban Area on the Hydrochemistry of a Shallow Groundwater (Alluvial Reservoir) Town of Narbonne, France." *Proceeding of the Conference -- Hydrological Processes and Water Management in Urban Areas*. International Hydrological Programme, UNESCO, pp.487-494. Duisburg, Federal Republic of Germany, April 24-29, 1988.

Reichenbaugh, R.C. *Effects on Ground-Water Quality from Irrigating Pasture with Sewage Effluent Near Lakeland, Florida.* U.S. Geological Survey Water-Resources Investigations Report 76-108. Prepared in cooperation with Southwest Florida Water Management District. USGS, Denver, Colorado. April 1977.

Rice, R.C., D.B. Jaynes and R.S. Bowman. "Preferential Flow of Solutes and Herbicide under Irrigated Fields." *Transactions of the American Society of Agricultural Engineers*. Volume 34, number 3, pp. 914-918. May-June 1991.

Ritter, W.F., F.J. Humenik and R.W. Skaggs. "Irrigated Agriculture and Water Quality in East." *Journal of Irrigation and Drainage Engineering, ASCE.* Volume 115, number 5, pp. 807-821. October 1989.

Ritter, W.F., R.W. Scarborough and A.E.M. Chirnside. "Nitrate Leaching under Irrigation on Coastal Plain Soil." *Journal of Irrigation and Drainage Engineering, ASCE.* Volume 117, number 4, pp. 490-502. July/August 1991.

Robinson, J. Heyward and H. Stephen Snyder. "Golf Course Development Concerns in Coastal Zone Management." *Coastal Zone '91: Proceedings of the Seventh Symposium on Coastal and Ocean Management.* Long Beach, California, pp. 431-443. ASCE, New York. July 8-12, 1991.

Rolfe, G.L. and K.A. Reinhold. Vol. I: *Introduction and Summary. Environmental Contamination by Lead and Other Heavy Metals.* Institute for Environmental Studies, University of Illinois, Champaign-Urbana, Illinois, July 1977.

Sabatini, David A. and T. Al Austin. "Adsorption, Desorption and Transport of Pesticides in Groundwater: A Critical Review." *Planning Now for Irrigation and Drainage in the 21st Century.* Proceedings of a Conference Sponsored by the Irrigation and Drainage Division of the American Society of Civil Engineers, Lincoln, Nebraska, pp. 571-579. ASCE, New York. July 18-21, 1988.

Sabol, George V., Herman Bouwer and Peter J. Wierenga. "Irrigation Effects in Arizona and New Mexico." *Journal of Irrigation and Drainage Engineering, ASCE.* Volume 113, number 1, pp. 30-57. February 1987.

Saffigna, P.G. and D.R. Keeney. "Nitrate and Chloride in Groundwater under Irrigated Agriculture in Central Wisconsin." *Ground Water.* Vol. 15, no. 2. pp. 170-177. 1977

Salo, John E., Doug Harrison and Elaine M. Archibald. "Removing Contaminants by Groundwater Recharge Basins." *Journal of the American Water Works Association.* Volume 78, number 9, pp. 76-81. September 1986.

Schiffer, Donna M. *Effects of Three Highway-Runoff Detention Methods on Water Quality of the Surficial Aquifer System in Central Florida.* U.S. Geological Survey Water-Resources Investigations Report 88-4170. Prepared in cooperation with the Florida Department of Transportation. USGS, Denver, Colorado. 1989.

Schillinger, J.E. and D.G. Stuart. *Quantification of Non-Point Water Pollutants from Logging, Cattle Grazing, Mining, and Subdivision Activities.* U. S. Environmental Protection Agency. PB 80-174063. 1978

Schmidt, Kenneth D. and Irving Sherman. "Effect of Irrigation on Groundwater Quality in California." *Journal of Irrigation and Drainage Engineering, ASCE.* Volume 113, number 1, pp. 16-29. February 1987.

Schneider, Brian J., Henry F.H. Ku and Edward T. Oaksford. *Hydrologic Effects of Artificial-Recharge Experiments with Reclaimed Water at East Meadow, Long Island, New York.* U.S. Geological Survey Water-Resources Investigations Report 85-4323. Prepared in cooperation with the Nassau County Department of Public Works, Syosset, New York. USGS, Denver, Colorado. 1987.

Seaburn, G.E. and D.A. Aronson. *Influence of Recharge Basins on the Hydrology of Nassau and Suffolk Counties, Long Island, New York.* U.S. Geological Survey Water-Supply Paper 2031. USGS, Washington, D.C. 1974.

Setmire, J.G. and W.L. Bradford. "Quality of Urban Runoff, Tecolote Creek Drainage Area, San Diego County, CA. U.S. Geological Survey. PB81-159451. Menlo Park, CA. 1980

Shirmohammadi, A. and W.G. Knisel. "Irrigated Agriculture and Water Quality in the South." *Journal of Irrigation and Drainage Engineering, ASCE.* Volume 115, number 5, pp. 791-806. October 1989.

Smith, A.E. "Herbicides and the Soil Environment in Canada." *Canadian Journal of Soil Science.* Volume 62. pp. 433-460. 1982.

Smith, Sheldon O. and Donald H. Myott. "Effects of Cesspool Discharge on Ground-Water Quality on Long Island, N.Y." *Journal of the American Water Works Association.* Volume 67, number 8, pp. 456-458. August 1975.

Smith, W.G. "Water Quality Enhancement through Stormwater Detention." *Proceedings of the Conference on Stormwater Detention Facilities, Planning, Design, Operation, and Maintenance*, Henniker, New Hampshire, Edited by W. DeGroot, published by the American Society of Civil Engineers, New York, August 1982.

Solomon, R. L., and D. F. S. Natusch. Vol:III: Distribution and Characterization of Urban Dists. In: Environmental Contamination by Lead and Other Heavy Metals, G. L. Rolfe and K. G. Reinbold, eds. Institute for Environmental Studies, Univ. of Illinois, Urbana-Champaign, Illinois. July 1977.

Spalding, Roy F. and Lisa A. Kitchen. "Nitrate in the Intermediate Vadose Zone Beneath Irrigated Cropland." *Groundwater Monitoring Review.* Volume 8, number 2, pp. 89-95. Spring 1988.

Squires, Rodney C. and William R. Johnston. "Selenium Removal - Can We Afford It? *Irrigation_ Systems for the 21st Century - Proceeding of a Conference.* Sponsored by the Irrigation and Drainage Division of the American Society of Civil Engineers. New York, New York, pp. 455-466. 1987.

Squires, Rodney C., G. Raymond Groves and William R. Johnston. "Economics of Selenium Removal from Drainage Water." *Journal of Irrigation and Drainage Engineering.* Volume 115, number 1, pp. 48-57. February 1989.

Steenhuis, Tammo, Robert Paulsen, Tom Richard, Ward Staubitz, Marc Andreini and Jan Surface. "Pesticide and Nitrate Movement under Conservation and Conventional Tilled Plots." *Planning Now for Irrigation and Drainage in the 21st Century.* Proceedings of a conference sponsored by the Irrigation and Drainage Division of the American Society of Civil Engineers, Lincoln, Nebraska, pp. 587-595. ASCE, New York. July 18-21, 1988.

Tetra Tech. *Detention and Retention Effects on Groundwater, A Literature Review.* Contract No. 68-C9-0013. U.S. Environmental Protection Agency. Watershed Management Unit. Water Division. Region V. Chicago. Ill. February 1991.

Tim, Udoyara S. and Saied Mostaghim. "Model for Predicting Virus Movement through Soil." *Groundwater.* Volume 29, number 2, pp. 251-259. March-April 1991.

Treweek, Gordon P. "Pretreatment Processes for Groundwater Recharge." In: *Artificial Recharge of Groundwater.* Edited by Takashi Asano. Butterworth Publishers, Boston, pp. 205-248. 1985.

Troutman, D.E., E.M. Godsy, D.F. Goerlitz and G.G. Ehrlich. *Phenolic Contamination in the Sand-and-Gravel Aquifer from a Surface Impoundment of Wood Treatment Wastewaters, Pensacola, Florida.* U.S. Geological Survey Water-Resources Investigations Report 84-4230. Prepared in cooperation with the Florida Department of Environmental Regulation. USGS, Denver, Colorado. 1984.

Varanasi, U. (ed.). Metabolism of Polycyclic Aromatic Hydrocarbons in the Aquatic Environment. CRC Press. Boca Raton, Florida, 1989.

Verschueren, K. Handbook of Environmental Data on Organic Chemic als. Second Edition, Van Nostrand Reinhold. New York, 1989.

Vaughn, J.M., E.F. Landry, L.J. Baranosky, C.A. Beckwith, M.C. Dahl and N.C. Delihas. "Survey of Human Virus Occurrence in Wastewater Recharged Groundwater on Long Island." *Applied and Environmental Microbiology.* Volume 36, number 1, pp. 47-51. July, 1978.

Verschueren, K. *Handbook of Environmental Data on Organic Chemicals.* Second Edition, Van Nostrand Reinhold. New York, 1983.

Waller, Bradley, Barbara Howie and Carmen R. Causaras. *Effluent Migration from Septic Tank Systems in Two Different Lithologies, Broward County, Florida.* U.S. Geological Survey Water Resources Investigations Report 87-4075. Prepared in cooperation with Broward County. USGS, Denver, Colorado. 1987.

Wang, T.S., D.E. Spyridakis, B.W. Mar, and R.R. Horner. *Transport Deposition and Control of Heavy Metals in Highway Runoff.* WA-RD-39.10, U.S. Dept. of Transportation and Washington State Department of Transportation, Seattle, January 1980.

Wanielista, M.P., Y.A. Yousef and H.H. Harper. "Hydrology/Hydraulics of Swales", *Open Channel Hydraulics Workshop*, by the University of Central Florida and American Society of Civil Engineers, Florida Section, Orlando, Sept. 1983.

Wanielista, Martin P., Julius Charba, John Dietz, Richard S. Lott and Bryon Russell. *Evaluation of the Stormwater Treatment Facilities at the Lake Angel Detention Pond, Orange County, Florida*. State of Florida Department of Transportation Environmental Research Paper FL-ER-49-91. National Technical Information Service, Springfield, VA. 1991.

Wellings, F.M. "Perspective on Risk of Waterborne Enteric Virus Infection." *Chemical and Biological Characterization of Sludges, Sediments, Dredge Spoils, and Drilling Muds.* ASTM STP 976. American Society for Testing and Materials, Philadelphia, Pennsylvania, pp. 257-264. 1988.

White, Everett M. and James M. Dornbush. "Soil Change Caused by Municipal Waste Water Applications in Eastern South Dakota." *Water Resources Bulletin*. Volume 24, number 2, pp. 269-273. April 1988.

Wilber, W.G. and J.V. Hunter. *The Influence of Urbanization on the Transport of Heavy Metals in New Jersey Streams*. Water Resources Research Institute, Rutgers University, New Brunswick, New Jersey, February 1980.

Wilde, F. D. *Geochemistry and Factors Affecting Ground-Water Quality at Three Storm-Water-Management Sites in Maryland*: *Report of Investigations No. 59*. Department of Natural Resources, Maryland Geological Survey, Baltimore, Maryland. (Prepared in Cooperation with the U.S. Department of the Interior Geological Survey, The Maryland Department of the Environment, and The Governor's Commission on Chesapeake Bay Initiatives). 1994.

Williams, L.H. "Effectiveness of Stormwater Detention." *Proceedings of the Conference on Stormwater Detention Facilities, Planning, Design, Operation, and Maintenance*, Henniker, New Hampshire, Edited by W. DeGroot, published by the American Society of Civil Engineers, New York, August 1982.

Wilson, L.G. "Sediment Removal from Flood Water." *Transactions American Society of Agricultural Engineers* 10(1):35-37, 1967.

Wilson, L.G., M.D. Osborn, K.L. Olson, S.M. Maida and L.T. Katz. "The Groundwater Recharge and Pollution Potential of Dry Wells in Pima County, Arizona." *Groundwater Monitoring Review*. Volume 10, pp. 114-121. Summer 1990.

Wolff, J., J. Ebeling, and A. Muller. "Waste Water Irrigation Suited to the Environment as Shown by the Example of 'Abwasserverband Wolfsburg.'" *Hydrological Processes and Water Management in Urban Areas - Proceedings of the Conference*, International Hydrological Programme, UNESCO. pp. 599-607. Duisburg, Federal Republic of Germany. April 24-29 1988.

Yousef, Y.A., M.P. Wanielista, and H.H. Harper. "Design and Effectiveness of Urban Retention Basins." *Engineering Foundation Conference: Urban Runoff Quality - Impact and Quality Enhancement Technology*, Henniker, New Hampshire, edited by B. Urbonas and L. A. Roesner, published by the American Society of Civil Engineers, New York, June 1986.

APPENDIX A

ANNOTATED BIBLIOGRAPHY OF GROUNDWATER CONTAMINATION

A bibliography of all of the literature sources used in the preparation of Chapter 3 of this report (Potential Groundwater Contamination Associated with Urban Runoff) was assembled and is included in this appendix. This bibliography contains the abstracts of the various sources, as published in the original documents. A matrix of information (Table A-1) was also prepared. This matrix includes the author and the date of the reference in the same format that is used in the report. The matrix also notes the source water considered in the reference (stormwater, sanitary wastewater, industrial wastewater, or agricultural runoff), the location of the research (where applicable), and the contaminants discussed. The contaminants are organized in the same manner as in Chapter 3: Nutrients, Pesticides, Organics, Pathogens, Metals, Dissolved Solids, Suspended Solids and Dissolved Oxygen. If a contaminant was addressed in the literature source, an "X" was placed in the appropriate column on Table A-1.

Alhajjar, B. J., G. V. Simsiman and G. Chesters. "Fate And Transport Of Alachlor, Metolachlor And Atrazine In Large Columns." ***Water Science And Technology: A Journal Of The International Association Of Water Pollution Research.*** **V. 22, n. 6. pp. 87-94. 1990.**

Abstract. ^{14}C ring-labeled atrazine, alachlor, and metolachlor were surface-applied at 3.14 kg a.i./ha in greenhouse lysimeters containing two soils in an ongoing experiment. Bromide (Br) --a conservative tracer-- at 6.93 kg/ha as KBr and nitrate-nitrogen (NO_3-N) at 112 kg/ha as KNO_3 were mixed with each herbicide and surface-applied. Growth of Red top (*Agrostis alba*) was established in each column (105 cm long and 29.4 cm i.d.). The experiment consisted of 12 columns (2 soils x 3 herbicides x 2 replicates) each fitted with four sampling ports for leachates, a volatilization chamber, and an aeration and irrigation system. Volatile materials are being trapped directly in solvents. One column replicate was dismantled for soil and plant analyses. Columns of Plainfield sand and Plano silt loam treated with alachlor and metolachlor were sampled after 23 and 28 weeks, respectively; the atrazine columns after 35 weeks. Herbicide residues are determined by liquid scintillation counting, extracted and separated by thin-layer chromatography using autoradiographic detection. Volatilization was $\leq 0.01\%$ of the amount of herbicide applied. The order of herbicide mobility was alachlor > metolachlor >> atrazine. As many as 8 to 12 alachlor metabolites and 2 to 6 metolachlor metabolites were separated in leachates. .

American Water Works Association. "Fertilizer Contaminates Nebraska Groundwater." ***AWWA Mainstream.*** **V. 34, n. 4. pp. 6. 1990.**

Abstract. Nitrates and nitrogen from commercial fertilizers, manure, and other sources are increasingly contaminating large areas of groundwater in Nebraska. Nitrate was by far Nebraska's most frequently encountered contaminant. Most of the contamination stems from nonpoint sources such as rainwater runoff and erosion, not from spills or other accidents.

Amoros, I., J. L. Alonso and I. Peris. "Study Of Microbial Quality And Toxicity Of Effluents From Two Treatment Plants Used For Irrigation." ***Water Science And Technology: A Journal Of The International Association On Water Pollution Research.*** **V. 21, n. 3. pp. 243-246. 1989.**

Abstract. The use of treated wastewater for agriculture is currently practiced in many countries. The benefits of recycling wastewater are based upon its constituents, particularly nitrogen, phosphorus and potassium, which are of value as fertilizers for many crops. There are, however, potential health risks associated with wastewater reuse. A number of bacterial pathogens excreted in the faeces of humans and animals are found in wastewater. The most significant pathogens, such as enteropathogenic *Escherichia coli*, Salmonella, Shigella, Yersinia, Vibrio, Campylobacter and Leptospira, can be transmitted via sewage-irrigated vegetables. Populations of bacterial pathogens in wastewater may be quite high, although variable, and may depend on the effectiveness of wastewater treatment. In addition, toxic substances, such as heavy metals and some organic compounds, may be found.

In the province of Alicante, there are some arid agricultural areas designated for grape cultivation but which have water resource problems. The use of treated wastewater from secondary treatment plants is one solution to this problem. Some reservoirs have been constructed to store wastewater destined for irrigation.

A study of the health risks associated with wastewater reuse (especially important since grapes are destined for human consumption and are normally eaten raw, and not peeled) was carried out. The

presence in water and on fruit of total coliforms, faecal coliforms and faecal streptococci, and pathogens such as Salmonella and *Vibrio cholerae*(only in wastewater) was investigated. Total and faecal coliforms and faecal streptococci were considered as indicator bacteria for the evaluation of the faecal pollution. Salmonella species were investigated because they are one of the pathogenic organisms most frequently found in sewage and they have been isolated from effluent samples after secondary treatment and disinfection with chlorine dioxide and ozone. *V. cholerae* is also transmitted via contaminated water and some studies have reported prolonged survival of this micro-organism in sewage with increased resistance to chlorine. Microbial toxicity tests to detect the potential toxicity of the wastewaters were conducted.

Armstrong, D. E. and R. Llena. ***Stormwater Infiltration: Potential For Pollutant Removal.*** **Project Report To The U.S. Environmental Protection Agency. Wisconsin Department Of Natural Resources, Water Chemistry Program. 1992.**

Abstract. The potential mobility of pollutants during infiltration of urban stormwater through soil was investigated. Groups of 32 organic and seven inorganic chemicals were evaluated. The framework for evaluating mobility was that of a conservative (non-sorbed) chemical. The main parameter controlling relative leaching rate was the pollutant K_d for sorption by the soil. For organic chemicals, K_d values were calculated based on predicted sorption to soil organic and inorganic components. Values were estimated for each compound in two soils at three organic matter contents. Soil organic matter was the dominant component controlling K_d, even in low organic matter soils. Among compounds, K_d increased with increasing hydrophobicity (octanol-water partition coefficient). For inorganic pollutants, published K_d values for two "typical" soils were used.

A mobility index (M_I = velocity of chemical/velocity of water under saturated flow) was used to classify pollutant leaching mobility. M_I values were calculated for each organic compound in two soils at three levels of organic concentrations. For organic chemicals, mobility was controlled by a combination of pollutant and soil properties. Organic matter content was the main soil property controlling mobility. In a low organic matter sandy loam soil (organic carbon = 0.01% by weight), ten compounds were classified as mobile (M_I =0.1 to 1.0), while one was in the very low mobility group (M_I < 0.001). When soil organic carbon was increased to 1%, only five compounds remained in the high mobility group, and nineteen were in the very low mobility group. Hydrophobicity was the main organic chemical property controlling mobility. Pollutants remaining in the mobile and intermediate mobility groups even when soil organic matter was relatively high (1%) were characterized by octanol-water partition coefficients below 10^3.

The potential mobility of the inorganic pollutant group (mostly trace metals) was generally lower than for the organic chemical group. A non- linear sorption model resulted in a predicted increase in mobility with concentration. At low concentration (0.01 mg/L), calculated mobilities were in the low (M_I = 0.001 to 0.01) or very low (M_I < 0.001) ranges.

Estimated residence times for leaching through the soil to the water table were estimated for a 1.0 meter soil layer and a water infiltration rate of about 60 meters/year. Residence times were influenced by pollutant mobility and infiltration site characteristics. Under the site conditions assumed, predicted residence times per meter were less than one year for mobile pollutants and less than 10 years for most low mobility pollutants. Predicted residence times would increase directly with increasing soil depth or decreasing water loading rate. Residence times were calculated for a set of six pollutants at a hypothetical infiltration site in the Milwaukee, WI area.

Aronson, D. A. and G. E. Seaburn. ***Appraisal Of Operating Efficiency Of Recharge Basins On Long Island, New York, In 1969.*** **Geological Survey Water-Supply Paper 2001-D. U.S.**

Government Printing Office, Washington, D.C. 1974.

Abstract. Recharge basins on Long Island are unlined pits of various shapes and sizes excavated in surficial deposits of mainly glacial origin. Of the 2,124 recharge basins on Long Island in 1969, approximately 9 percent (194) contain water 5 or more days after a 1-inch rainfall. Basins on Long Island contain water because (1) they intersect the regional water table or a perched water table, (2) they are excavated in material of low hydraulic conductivity, (3) layers of sediment and debris of low hydraulic conductivity accumulate on the basin floor, or (4) a combination of these factors exists.

Data obtained as part of this study show that (1) 22 basins contain water because they interest the regional water table, (2) a larger percentage of the basins excavated in the Harbor Hill and the Ronkonkoma morainal deposits contain water than basins excavated in the outwash deposits, (3) a larger percentage of basins that drain industrial and commercial areas contain water than basins that drain highways and residential areas, (4) storm runoff from commercial and industrial areas and highways generally contains high concentrations of asphalt, grease, oil, tar, and rubber particles, whereas runoff from residential areas mainly contains leaves, grass cuttings, and other plant material, and (5) differences in composition of the soils within the drainage areas of the basins on Long Island apparently are not major factors in causing water retention.

Water-containing basins dispose of an undetermined amount of storm runoff primarily by the slow infiltration of water through the bottoms and the sides of the basins. The low average specific conductance of water in most such basins suggests that evaporation does not significantly concentrate the chemical constituents and, therefore, that evaporation is not a major mechanism of water disposal from these basins.

Asano, T. "Irrigation With Reclaimed Wastewater - Recent Trends." ***Irrigation Systems For The 21st Century, Portland, Oregon, 1987.*** **(American Society Of Civil Engineers, New York, New York, pp. 735-742). 1987.**

Abstract. Land application of municipal wastewater is a well established practice in California. Since approximately 33 million acre-feet (4×10^{10} m^3) of water, or about 85 percent of the total water used in the State are applied annually to approximately 9 million acres (36,400 km^2) of irrigated cropland (Calif. State Water Resources Control Board, 1981), irrigation with reclaimed wastewater has become a logical and important component of total water resources planning and development.

Much of the reclaimed municipal wastewater (57%) in California is used for irrigation of fodder, fiber and seed crops (a use not requiring a high degree of wastewater treatment), and about 7% is used for irrigation of orchard, vine, and other food crops. An important use in recent years (about 14%) is irrigation of golf courses, other turfgrass, and landscape areas. According to a survey (Crook, 1985) conducted by California Department of Health Services, approximately 220,000 (271×10^6 m^3) feet of wastewater is reclaimed by 240 municipal wastewater treatment plants that supply reclaimed water to more than 380 use areas. Data from the 1984 survey on the types of reuse and numbers of use areas are listed.

Bao-rui, Y. "Investigation Into Mechanisms Of Microbial Effects On Iron And Manganese Transformations In Artificially Recharged Groundwater." ***Water Science And Technology: A Journal Of The International Association On Water Pollution Research.*** **V. 20, n. 3. pp. 47-53. 1988.**

Abstract. After artificial recharging of groundwater some problems occurred, such as changes in groundwater quality, the silting up of recharge (injection) wells, etc. Therefore, the mechanisms of microbial effects on groundwater quality after artificial recharging were studied in Shanghai and the district of Changzhou. These problems were approached on the basis of the amounts of biochemical reaction products generated by the metabolism of iron bacteria, sulphate-reducing bacteria, *Thiobacillus thioparus*, and *Thiobacillus denitrificans*. The experiments showed that in the transformations occurring and the siltation of recharge wells, microorganisms play an important role, due to the various chemical and biochemical activities. A water-rock-microorganisms system is proposed, and some methods for the prevention and treatment of these effects are given.

Barraclough, J. T. "Waste Injection Into A Deep Limestone In Northwestern Florida." ***Ground Water.*** **V. 3, n. 1. pp. 22-24. 1966.**

Abstract. During a three-month trial period, 70 million gallons of industrial wastes were successfully injected at moderate pressures into a deep limestone in the westernmost part of Florida. The movement of these wastes is expected to be predominantly southward toward the natural discharge area which is presumed to be far out in the Gulf of Mexico. The limestone lies between two thick beds of clay (aquicludes) and contains 13, 000 parts per million salty water. A series of aquifers and aquicludes appear capable of preventing contamination of the overlying fresh-water aquifers.

Boggess, D. H. ***Effects Of A Landfill On Ground Water Quality.*** **Geological Survey Open File Report 75-594. U.S. Geological Survey, Tallahassee, Florida. 1975.**

Abstract. Chemical analyses of water from 11 wells were adequate to show definite effects on ground-water quality in the vicinity of a landfill site in Lee County, Florida, operated by the city of Fort Myers. These effects were observed as far as 1,200 feet (320 metres) down gradient. When compared to the average concentrations of chemical constituents determined in comparable wells used as controls, water from the well with the greatest effect had sulfate 72 times greater, potassium 43 times greater, ammonia nitrogen 20 times greater, sodium and chloride 12 times greater, and most other chemical constituents 2 to 8 times greater.

The leachate was transported downgradient in the water- table aquifer in the general direction of ground-water movement. A subsurface clay barrier and paths of higher permeability apparently caused some local variation in the direction of leachate movement. The leachate probably is transported more rapidly during high stages of the water table due to higher hydraulic gradients and increased transmissivity.

Because of the high water table,, which is at or near the land surface during periods of maximum recharge from rainfall, extensive modification of the waste-disposal procedures would be required to reduce or eliminate the effect of the leachate.

Bouchard, A. B. "Virus Inactivation Studies For A California Wastewater Reclamation Plant." ***Water Environment Federation 65th Annual Conference & Exposition, New Orleans, Louisiana, 1992.*** **(Water Environment Federation, Alexandria, Virginia). 1992.**

Abstract. Engineering-Science, Inc. (ES) was retained by Thetford Systems, Inc. to develop, implement and supervise a virus inactivation study program for the Thetford Cycle-Let Wastewater Reclamation System. Thetford has installed a Cycle-Let system at the Water Garden Development Project in Santa Monica, California, to treat the collected municipal sewage from the project's office buildings and facilities. The Water Garden Cycle-Let system will produce reclaimed water for use as landscape irrigation for the development's property, and as make-up water for an on-site decorative lake. Phase II of the Water Garden Project proposes to use the reclaimed water as a source of toilet flush water in the office buildings. The State of California has established treatment process criteria required for certain types of reclaimed water use. Specifically, the California Administrative Code Title 22 identifies the processes required to treat municipal wastewater prior to reuse. Title 22 stipulates the following treatment processes to use reclaimed water as landscape irrigation -- oxidation, clarification, coagulation, filtration and disinfection using chlorination. The Thetford Cycle-Let extended aeration activated sludge with biological nitrification, followed by ultramembrane filtration, granular activated carbon adsorption, and ultraviolet light disinfection. As such, the California Department of Health Services (DOHS) has the requirements of Title 22. These requirements stipulate that the median number of coliform organisms in the plant effluent does not exceed 2.2 MPN per 100 milliliters and that the effluent must be essentially pathogen free. ES was retained by Thetford to develop a DOHS approved testing protocol, to implement the test program, to supervise the test program, and to prepare an engineering report to be submitted to the DOHS that demonstrates the adequacy of the extensive seeded virus inactivation study, followed by an in-situ virus study, and the necessary bacteriological analyses. Since the Water Garden Project is still under construction and no wastewater is being currently generated, the study was conducted at a similar facility that serves an office park in Princeton, New Jersey. The effluent from the Cycle-Let system at this plant is used for toilet flush water in the office complex. By conducting the study at this plant, ES was able to test the Cycle-Let system's adequacy of meeting Title 22 and the possibility of using reclaimed water as toilet flush water for the Water Garden Project.

Bouwer, E. J., P. L. McCarty, H. Bouwer and R. C. Rice. "Organic Contaminant Behavior During Rapid Infiltration Of Secondary Wastewater At The Phoenix 23rd Avenue Project." ***Water Resource.*** **V. 18, n. 4. pp. 463-472. 1984.**

Abstract. Movement of trace organic pollutants during rapid infiltration of secondary wastewater for groundwater recharge was studied at the 23rd Avenue Rapid Infiltration Project in Phoenix, Arizona. Samples of the wastewater applied to the spreading basins and of renovated water taken from monitoring wells were characterized for priority pollutants and other specific organic compounds using gas chromatography/mass spectrometry. The concentrations of organic constituents were affected by volatilization, biodegradation and sorption processes. Nonhalogenated aliphatics and aromatic hydrocarbons exhibited concentration decreases of 50-99% during soil percolation. Halogenated organic compounds were generally removed to a lesser extent. Concentrations of trichloroethylene, tetrachloroethylene, and pentachloroanisole appeared to be significantly higher in the renovated water than in the basin water; reasons for this behavior remain unclear. Many organic contaminants were detected in the groundwater indicating such systems should be designed to localize contamination of the aquifer. Chlorination of the wastewater had no significant effect on concentrations and types of trace organic compounds.

Bouwer, H. "Agricultural Contamination: Problems And Solutions." ***Water Environment And Technology*****. V. 1, n. 2. pp. 292-297. 1989.**

Abstract. Salts from irrigation water concentrate in the deep percolation water and can pollute groundwater, especially in dry climates where there is little natural dilution. Under certain geologic conditions, selenium and other trace elements may leach from the root and vadose zones into the groundwater. Salt and trace element contamination is a direct result of agricultural activities, but neither is caused by anthropogenic chemicals, such as nitrate and pesticides, which can cause severe groundwater contamination.

Not long ago, it was thought that pesticides would not migrate to groundwater except, perhaps, under situations of very coarse or cracked soils, shallow groundwater tables, high pesticide application rates, or accidental spills. In the mid- to late-1970s, more and more cases of pesticide contamination were reported as well testing increased and more sensitive analytical equipment was used. The problem is now widespread. Many pesticides have been detected in groundwater, and thousands of wells have been closed.

Nitrogen-containing fertilizers also threaten groundwater quality because they produce nitrate in the soil. Nitrate moves readily with deep percolation through the vadose zone to groundwater. Thus, nitrogen not used by crops or denitrified in the soil and volatilized eventually appears as nitrate in groundwater. Nitrate concentrations in vadose-zone water beneath agricultural fields typically range from 5 to 100 mg/L and are often 20 to 40 mg/L -- 10 to 30 mg/L greater than the maximum drinking water limit.

Growing concern over groundwater contamination caused by fertilizer and pesticide use has triggered an increase in legislative and regulatory activity. However, more research, including that on health effects and acceptable risks, is needed to establish sound regulations. Contaminant migration must also be better understood so that pesticide transport can be more accurately predicted. Preventing contamination is more effective than cleaning polluted aquifers and, for this purpose, best management practices (BMPs) must be developed. Realistic regulatory policies and management practices that will protect public health while ensuring viable and sustainable agriculture must be implemented.

Bouwer, H. "Effect Of Irrigated Agriculture On Groundwater." ***Journal of Irrigation and Drainage Engineering*****. V. 113, n. 1. pp. 4-15. 1987.**

Abstract. The time it takes for deep percolation water from irrigated fields to reach underlying groundwater increases with decreasing particle size of the vadose zone material and increasing depth to groundwater. For average deep percolation rates, decades may be required before the water joins the groundwater. Due to nonuniform irrigation applications and preferential flow, some deep percolation water will reach the groundwater much faster. Dissolved salts, nitrate, and pesticides are the chemicals in deep percolation water of main concern in groundwater pollution. Movement of pesticides may be retarded in the vadose zone, but biodegradation may also be slowed due to reduced organic carbon content and microbial activity at greater depths. Because of the large area of irrigated land in the world and the real potential for groundwater pollution, more research is necessary on downward movement of water and chemicals in the vadose zone.

Bouwer, H. and E. Idelovitch. "Quality Requirements For Irrigation With Sewage Water ." *Journal of Irrigation and Drainage Engineering*. V. 113, n. 4. pp. 516-535. 1987.

Abstract. Irrigation is an excellent use for sewage effluent because it is mostly water with nutrients. For small flows, the effluent can be used on special, well-supervised "sewage farms," where forage, fiber, or seed crops are grown that can be irrigated with standard primary or secondary effluent. Large-scale use of the effluent requires special treatment so that it meets the public health, agronomic, and aesthetic requirements for unrestricted use (no adverse effects on crops, soils, humans, and animals). Crops in the unrestricted-use category include those that are consumed raw or brought raw into the kitchen. Most state or government standards deal only with public health aspects, and prescribe the treatment processes or the quality parameter that the effluent must meet before it can be used to irrigate a certain category of crops. However, agronomic aspects related to crops and soils must also be taken into account. Quality parameters to be considered include bacteria, viruses, and other pathogens; total salt content and sodium adsorption ratio of the water (soil as well as crop effects); nitrogen; phosphorus; chloride and chlorine; bicarbonate; heavy metals, boron, and other trace elements; pH; and synthetic organics (including pesticides).

Brown, D. P. *Effects Of Effluent Spray Irrigation On Ground Water At A Test Site Near Tarpon Springs, Florida.* Geological Survey Open-File Report 81-1197. U.S. Geological Survey, Tallahassee, Florida. 1982.

Abstract. Secondary-treated effluent was applied to a 7.2-acre test site for about 1 year at an average rate of 0.06 million gallons per day and 3 years at 0.11 million gallons per day. Chemical fertilizer was applied periodically to the test site and adjacent areas. Mounding of the water table occurred due to effluent irrigation, inducing radial flow from the test site.

Ground water in the surficial aquifer at the test site and adjacent areas showed substantial increases in most chemical and physical parameters (including chloride, specific conductance, pH, total nitrogen, and total carbon) above the range of values observed in nearby areas that were irrigated with water from the Floridan aquifer and periodically fertilized.

In the surficial aquifer, about 200 feet downgradient from the test site, physical, geochemical, and biochemical processes effectively reduced total nitrogen concentration 90 percent and total phosphorus concentration more than 95 percent from that of the applied effluent. In the effluent, total nitrogen averaged 26 milligrams per liter and total phosphorus averaged 7.3 milligrams per liter. Downgradient, total nitrogen averaged 2.4 milligrams per liter and total phosphorus averaged 0.17 milligrams per liter. Increases in total phosphorus concentration were observed where the pH of ground water increased.

Microbiological data did not indicate fecal contamination in the surficial aquifer. Fecal coliform bacteria were generally less than 25 colonies per 100 milliliters at the test site and were not detected downgradient or near the test site. Fecal streptococcal bacteria were generally less than 100 colonies per 100 milliliters at the test site and on three occasions were detected adjacent to the test site. In the Floridan aquifer, total and fecal coliform bacteria were detected in 50 percent of the samples. Total coliform bacteria were generally less than 100 colonies per 100 milliliters and fecal coliform bacteria were generally less than 10 colonies per 100 milliliters. .

Butler, K. S. "Urban Growth Management And Groundwater Protection: Austin, Texas." ***Planning For Groundwater Protection.*** **Academic Press, New York, New York. pp. 261-287. 1987.**

Abstract. Austin, Texas has recognized that the greatest opportunity to prevent declining groundwater quality is through proper location, design, construction, and maintenance of new urban development and its associated drainage systems. Increasing development in the environmentally sensitive watersheds south and west of Austin resulted in the promulgation of a series of innovative watershed development ordinances in the early 1980s (Butler, 1983). These regulations are designed to protect the water quality of the Edwards Aquifer, a unique karstic limestone system. This process of planning for the protection of groundwater is the subject of this report.

Specifically, this report concerns the effects that the ordinances for several watersheds and the associated aquifer will have on suburban land development and water quality protection for the Edwards Aquifer. These ordinances are salient examples of a new, largely untested venture into urban runoff pollution control using a combination of engineering and land use management techniques. The immediate motivation for adopting these 4 techniques is protecting groundwater and spring discharges from degradation and contamination with nontoxic chemicals. Austin also recognized that toxic contaminants may become a threat to groundwater. The combination of engineering and land use management techniques as adopted in Austin's ordinances should protect the groundwater from organic and inorganic microcontaminants as well as more common pollutants associated with urban storm runoff.

This report addresses three key questions: Why is the Edwards Aquifer are so deserving of special protection in the face of urban expansion? How do these development standards affect the planning of new subdivisions and site developments? And how do groundwater quality protection standards operate in the broader context of growth management in this rapidly urbanizing region of central Texas?

Cavanaugh, J. E., H. S. Weinberg, A. Gold, R. Sangalah, D. Marbury, W. H. Glaze, T. W. Collette, S. D. Richardson and A. D. Thruston Jr. "Ozonation Byproducts: Identification Of Bromohydrins From The Ozonation Of Natural Water With Enhanced Bromide Levels." ***Environmental Science & Technology.*** **V. 26, n. 8. pp. 1658-1662. 1992.**

Abstract. When ozone is used in the treatment of drinking water, it reacts with both inorganic and organic compounds to form byproducts. If bromide is present, it may be oxidized to hypobromous acid, which may then react with natural organic matter (NOM) to form brominated organic compounds. The formation of bromoform has been well documented and more recently, other byproducts, such as bromoacetic acids, bromopicrin, cyanogen bromide, bromoacetones, and bromate, have been identified. The purpose of this communication is to report the identification of bromohydrins, a new group of labile brominated organic byproducts from the ozonation of a natural water in the presence of enhanced levels of bromide.

Chang, A. C., A. L. Page, P. F. Pratt and J. E. Warneke. "Leaching Of Nitrate From Freely Drained-Irrigated Fields Treated With Municipal Sludges." ***Planning Now For Irrigation And Drainage In The 21st Century, Lincoln, Nebraska, 1988.*** **(American Society Of Civil Engineers, New York, New York, pp. 455-467). 1988.**

Abstract. A municipal sludge land application experiment was initiated in 1975 near Riverside, California. From 1975 to 1983 sludges from the Los Angeles Metropolitan Area were applied on

experimental plots where crops were grown annually. Results indicated that (1) crop yields were not affected by the sludge application and the total biomass harvested was a function of total N input, (2) the extent and the rate of N mineralization of liquid sludges were consistently higher than composted sludges and the sludge application rate and the soil type did not affect mineralization of N, and (3) nitrogen application exceeding N requirements for crop growth always results in leaching and accumulation of nitrate in the soil profile.

Chase, W. L. J. "Reclaiming Wastewater In Phoenix, Arizona." ***Irrigation Systems For The 21st Century, Portland, Oregon, 1987.*** **(American Society Of Civil Engineers, New York, New York, pp. 336-343). 1987.**

Abstract. This paper examines the role of wastewater effluent reuse in the future water resource management of the City of Phoenix. The paper seeks to explain why a proposal to renovate effluent through rapid infiltration land treatment and to recycle that renovated water for agricultural irrigation has still not been implemented 20 years after the first serious studies of this project were initiated by the Salt River Project and the U.S. Department of Agriculture's Water Conservation Laboratory in Phoenix. While answering the technical questions concerning the safety of using renovated wastewater effluent for unrestricted agricultural irrigation accounted for a little of over half of that time, the primary problems since 1982 have been economic, legal and institutional.

Cisic, S., D. Marske, B. Sheikh, B. Smith and F. Grant. "City Of Los Angeles Effluent - Today's Waste, Tomorrow's Resource." ***Water Environment Federation 65th Annual Conference & Exposition, New Orleans, Louisiana, 1992.*** **(Water Environment Federation, Alexandria, Virginia). 1992.**

Abstract. The City Of Los Angeles (City) receives water from three sources. In an average year, 70 percent of the water used to come from the Eastern Sierra Nevada via the Los Angeles Aqueduct; wells in the San Fernando Valley and other local groundwater basins supplied 16 percent; and purchases from the Metropolitan Water District of Southern California (Metropolitan) provided the remaining 14 percent. Faced with the fifth consecutive year of drought and supply cut from all three present sources, the City is planning to tap into a fourth -- its wastewater.

Close, M. E. "Effects Of Irrigation On Water Quality Of A Shallow Unconfined Aquifer." ***Water Resources Bulletin*****. V. 23, n. 5. pp. 793-802. 1987.**

Abstract. The ground water quality of a shallow unconfined aquifer was monitored before and after implementation of a border strip irrigation scheme, by taking monthly samples from an array of 13 shallow wells. Two 30 m deep wells were sampled to obtain vertical concentration profiles. Marked vertical, temporal, and spatial variabilities were recorded. The monthly data were analyzed for step and linear trends using nonparametric tests that were adjusted for the effects of serial correlation. Average nitrate concentrations increased in the preirrigation period and decreased after irrigation began. This was attributed to wetter years in 1978-1979 than 1976-1977 which increased leaching, and to disturbance of the topsoil during land contouring before irrigation, followed by excessive drainage after irrigation. Few significant trends were recorded for other determinants, possibly because of shorter data records.

Nitrate, sulphate, and potassium concentrations decreased with depth, whereas sodium, calcium, bicarbonate, and chloride concentrations increased. These trends allowed an estimation to be made of the depth of ground water affected by percolating drainage. This depth increased during the irrigation season

and after periods of winter recharge. Furthermore, an overall increase in the depth of drainage-affected ground waster occurred with time, which paralleled the development of the irrigation scheme.

Clothier, B. E. and T. J. Sauer. "Nitrogen Transport During Drip Fertigation With Urea." *Soil Science Society Of America Journal.* V. 52, n. 2. pp. 345-349. 1988.

Abstract. Urea added to drip irrigation water will be rapidly hydrolyzed in the soil to ammonium and then oxidized to nitrate. An approximate theory is presented for the unsteady, three- dimensional transport of water and N through unsaturated soil around a dripper discharging a urea solution. The results were compared with measurements from laboratory experiments with repacked silt loam. Water and solute movement in the course of the irrigation cycle and during the subsequent redistribution are considered. The theory successfully located the penetration of both the inert nitrate and reactive ammonium derived from the applied urea. It was possible to predict the direction, and approximated the magnitude of pH changes proximal to the emitter.

Craun, G. F. "Waterborne Disease - A Status Report Emphasizing Outbreaks In Ground-Water Systems." *Ground Water.* V. 17, n. 2. pp. 183-191. 1979.

Abstract. A total of 192 outbreaks of waterborne disease affecting 36,757 persons were reported in the United States during the period 1971-1977. More outbreaks occurred in nonmunicipal-water systems (70 %) than municipal-water systems; however, more illness (67 %) resulted from outbreaks in municipal systems. Almost half of the outbreaks (49 %) and illness (42 %) were caused by either the use of untreated or inadequately treated ground water. An unusually large number of waterborne outbreaks affected travelers, campers, visitors to recreational areas, and restaurant patrons during the months of May-August and involved nonmunicipal-water systems which primarily depend on ground-water sources. The major causes of outbreaks in municipal systems were contaminations of the distribution systems and treatment deficiencies which accounted for 68 % of the outbreaks and 75% of the illness that occurred in municipal systems. Use of untreated ground water was responsible for only 10% of the municipal system outbreaks and 1% of the illness. The major cause of the outbreaks in nonmunicipal systems was used of untreated ground water which accounted for 44% of the outbreaks and 44% of the illness in these systems. Treatment deficiencies, primarily inadequate and interrupted chlorination of ground- water sources, were responsible for 34% of the outbreaks and 50% of the illness in nonmunicipal-water systems.

Crites, R. W. "Micropollutant Removal In Rapid Infiltration." *Artificial Recharge Of Groundwater.* Butterworth Publishers, Boston. pp. 579-608. 1985.

Abstract. In a rapid-infiltration land treatment system, wastewater is treated as it percolates through the soil. The wastewater is applied to moderately and highly permeable soils (such as sands) by surface spreading in level basins or by sprinkling. Treatment is accomplished by biologic, physical and chemical means within the soil.

The need for definitive information on the extent of soil treatment during rapid infiltration has been recognized. Rapid infiltration is effective in removing many wastewater constituents such as suspended solids, BOD_5, ammonium-nitrogen, phosphorus, bacteria, and virus and is less effective in removing other constituents such as nitrate-nitrogen, trace organics, and trace minerals.

The constituents addressed in this report include trace organics, inorganics (those covered by drinking water standards), and microorganisms. For these three classes of constituents, the health effects, removal mechanisms and removals in existing rapid infiltration systems are discussed.

Crook, J., T. Asano and M. Nellor. "Groundwater Recharge With Reclaimed Water In California." ***Water Environment & Technology*. V. 2, n. 8. pp. 42-49. 1990.**

Abstract. In California, increasing demands for water have given rise to surface water development and large-scale projects for water importation. Economic and environmental concerns associated with these projects have expanded interest in reclaiming municipal wastewater to supplement existing water supplies. Groundwater recharge represents a large potential use of reclaimed water in the state. For example, several projects have been identified in the Los Angeles area that could use up to 150 X 10^6 m^3/a (120,000 ac-ft/yr) of reclaimed water for groundwater recharge. Recharging groundwater with reclaimed wastewater has several purposes: to prevent saltwater intrusion into freshwater aquifers, to store the reclaimed water for future use, to control or prevent ground subsidence, and to augment nonpotable or potable groundwater aquifers. Recharge can be accomplished by surface spreading or direct injection.

With surface spreading, reclaimed water percolates from spreading basins through an unsaturated zone to the groundwater. Direct injection entails pumping reclaimed water directly into the groundwater, usually into a confined aquifer. In coastal areas, direct injection effectively creates barriers that prevent saltwater intrusion. In other areas, direct injection may be preferred where groundwater is deep or where the topography or existing land use makes surface spreading impractical or too expensive. While only two large-scale, planned operations for groundwater recharge are using reclaimed water in California, incidental or unplanned recharge is widespread.

The constraints of groundwater recharge with reclaimed water include water quality, the potential for health hazards, economic feasibility, physical limitations, legal restriction, and the availability of reclaimed water. Of these concerns, the health concerns are by far the most important, as they pervade all potential recharge projects. Health authorities emphasize that indirect potable reuse of reclaimed wastewater through groundwater recharge encompasses a much broader range of potential risks to the public's health than nonpotable uses of reclaimed water. Because the reclaimed water eventually becomes drinking water and is consumed, health effects associated with prolonged exposure to low levels of contaminants and acute health effects from pathogens or toxic substances must be considered. Particular attention must be given to organic and inorganic substances that may elicit adverse health responses in humans after many years of exposure.

Deason, J. P. "Irrigation-Induced Contamination: How Real A Problem?" ***Journal of Irrigation and Drainage Engineering*. V. 115, n. 1. pp. 9-20. 1989.**

Abstract. The U.S. Department of the Interior has embarked on a series of reconnaissance-level investigations throughout the western states to identify, evaluate, and respond to irrigation-induced water quality problems. A series of water, sediment, and biological samples are being analyzed for 17 inorganic constituents and a number of pesticides. 19 studies in 13 states have been undertaken. Seven have been completed to date. Results of the seven studies that have been completed are presented and compared to baselines, standards, criteria, and other guidelines helpful for assessing the potential of observed constituent concentrations in water, bottom sediment, and biota, to result in physiological harm to fish, wildlife, or humans. These initial results indicate that a new environmental problem of major

proportions does not exit, but that some localized problems of significant magnitude do exist and should be addressed.

Deason, J. P. "Selenium: It's Not Just In California." ***Irrigation Systems For The 21st Century, Portland, Oregon, 1987.*** **(American Society Of Civil Engineers, New York, New York, pp. 475-482). 1987.**

Abstract. The U.S. Department of the Interior has embarked on a series of reconnaissance level investigations throughout the western states to identify and assess potential irrigation-induced water quality problems. A series of water, sediment and biological samples are being analyzed for selenium and 16 other trace elements, as well as a number of pesticides. Nine studies in seven states are underway currently and 10 additional locations for study have been identified.

DeBoer, J. G. "Wastewater Reuse: A Resource Or A Nuisance?" ***Journal of the American Water Works Association.*** **V. 75, . pp. 348-356. 1983.**

Abstract. As demand for good quality water increases, some areas in the United States find that traditional finite sources cannot meet all needs. although many utilities draw potable supplies from water that has previously been used upstream, the direct reuse of treated water for potable supplies is limited by unknowns concerning health effects and by costs. Planned reuse options, however, are feasible water conservation techniques, especially for industrial and agricultural uses. Reclaimed wastewater can also be used to recharge groundwater, thereby augmenting potable supplies.

Domagalski, J. L. and N. M. Dubrovsky. "Pesticide Residues In Ground Water Of The San Joaquin Valley, California." ***Journal Of Hydrology.*** **V. 130, n. 1-4. pp. 299-338. 1992.**

Abstract. A regional assessment of non-point-source contamination of pesticide residues in ground water was made of the San Joaquin Valley, an intensively farmed and irrigated structural trough in central California. About 10% of the total pesticide use in the USA is in the San Joaquin Valley. Pesticides detected include atrazine, bromacil, 2,4-DP, diazinon, dibromochloropropane, 1,2- dibromoethane, dicamba, 1,2-dichloropropane, diuron, prometon, prometryn, propazine and simazine. All are soil applied except diazinon.

Pesticide leaching is dependent on use patterns, soil texture, total organic carbon in soil, pesticide half-life and depth to water table. Leaching is enhanced by flood-irrigation methods except where the pesticides is foliar applied such as diazinon. Soils in the western San Joaquin Valley are fine grained and are derived primarily from marine shales of the Coast Ranges. Although shallow ground water is present, the fewest number of pesticides were detected in this region. The fine- grained soil inhibits pesticide leaching because of either low vertical permeability or high surface area; both enhance adsorption on to solid phases. Soils in the eastern part of the valley are coarse grained with low total organic carbon and are derived from Sierra Nevada granites. Most pesticide leaching is in these alluvial soil, particularly in areas where depth to ground water is less than 30 m. The areas currently most susceptible to pesticide leaching are eastern Fresno and Tulare Counties.

Tritium in water molecules is an indicator of aquifer recharge with water of recent origin. Pesticide residues transported as dissolved species were not detected in non- tritiated water. Although pesticides were not detected in all samples containing high tritium, these samples are indicative of the presence of recharge water that interacted with agricultural soils.

Ehrlich, G. G., E. M. Godsy, C. A. Pascale and J. Vecchioli. "Chemical Changes In An Industrial Waste Liquid During Post- Injection Movement In A Limestone Aquifer, Pensacola, Florida." ***Ground Water.*** **V. 17, n. 6. pp. 562-573. 1979a.**

Abstract. An industrial waste liquid containing organonitrile compounds and nitrate ion has been injected into the lower limestone of Floridan aquifer near Pensacola, Florida since June 1975. Chemical analyses of water from monitor wells and backflow from the injection well indicate that organic carbon compounds are converted to CO_2 and nitrate is converted to N_2. These transformations are caused by bacteria immediately after injection, and are virtually completed within 100 m of the injection well. The zone near the injection well behaves like an anaerobic filter with nitrate respiring bacteria dominating the microbial flora in this zone.

Sodium thiocyanate contained in the waste is unaltered during passage through the injection zone and is used to detect the degree of mixing of injected waste liquid with native water at a monitor well 312 m (712 ft) from the injection well. The dispersivity of the injection zone was calculated to be 10 m (33 ft). Analyses of samples from the monitor well indicate 80 percent reduction in chemical oxygen demand and virtually complete loss of organonitriles and nitrate from the waste liquid during passage from the injection well to the monitor well. Bacteria densities were much lower at the monitor well than in backflow from the injection well.

Ehrlich, G. G., H. F. H. Ku, J. Vecchioli and T. A. Ehlke. ***Microbiological Effects Of Recharging The Magothy Aquifer, Bay Park, New York, With Tertiary-Treated Sewage.*** **Geological Survey Professional Paper 751-E. U.S. Government Printing Office, Washington, D.C. 1979b.**

Abstract. Injection of highly treated sewage (reclaimed water) into a sand aquifer on Long Island, N.Y., stimulated microbial growth near the well screen. Chlorination of the injectant to 2.5 milligrams per liter suppressed microbial growth to the extent that it did not contribute significantly to head buildup during injection. In the absence of chlorine, microbial growth caused extensive well clogging in a zone immediately adjacent to the well screen.

During a resting period of several days between injection and well redevelopment, the inhibitory effect of chlorine dissipated and microbial growth ensued. The clogging mat at the well/ aquifer interface was loosened during this period, probably as a result of microbial activity.

Little microbial activity was noted in the aquifer beyond 20 feet from the well screen; this activity probably resulted from small amounts of biotransformable substances not completely filtered out of the injectant by the aquifer materials.

Movement of bacteria from the injection well into the aquifer was not extensive. In one test, in which injected water had substantial total-coliform, fecal-coliform, and fecal-streptococcal densities , no fecal- coliform or fecal - streptococcal bacteria, and only nominal total-coliform bacteria, were found in water from an observation well 20 feet from the point of injection.

Elder, J. F., J. D. Hunn and C. W. Calhoun. ***Wastewater Application By Spray Irrigation On A Field Southeast Of Tallahassee, Florida: Effects On Ground-Water Quality And Quantity.*** **Geological Survey Water-Resources Investigations Report 85-4006. U.S. Geological Survey, Tallahassee, Florida. 1985.**

Abstract. An 1,840-acre agriculture field southeast of Tallahassee, Florida, which has been used for land application of wastewater by spray irrigation, is the site of a long-term, ground-water monitoring study. The purpose of the study is to determine effects of wastewater application on water-table elevations and ground-water quality. The study was conducted in cooperation with the City of Tallahassee. This report summarizes the findings for the period 1980-82.

Wastewater used for spray irrigation has high concentrations, relative to those in ground water, of chloride, nitrogen, phosphorus, organic carbon, coliform bacteria, sodium, and potassium. At most locations, percolation through the soil has been quite effective in attenuation of these substances before they can impact the ground water. However, increases in chloride and nitrate-nitrogen were evident in ground water in some of the monitoring wells during the study, especially those wells which are within the sprayed areas. Chloride concentrations, for example, increased from approximately 3 milligrams per liter to 15 to 20 milligrams per liter in some wells and nitrate-nitrogen concentrations increased less than 0.5 milligrams per liter to 4 milligrams per liter or more.

Ground-water levels in the area of the spray field fluctuated over a range of several feet. These fluctuations were affected somewhat by spray irrigation, but the primary control on water levels was rainfall.

As of December 1982, constituents introduced to the system by spray irrigation of effluent had not exceeded drinking water standards in the ground water. The system has not yet stabilized, however, and more changes in ground-water quality may be expected.

Eren, J. "Changes In Wastewater Quality During Long Term Storage." pp. 1291-1300.

Abstract. The rainfall in Israel is in the winter months November-April and the irrigation period is during the summer months May-October. Cotton which is the main crop irrigated by reused wastewater requires irrigation during 3 months (June- August) only.

Therefore wastewater reuse projects require facilities to store the winter effluents for summer utilization.

It is either underground storage in sandy aquifers as in the Dan Region reclamation project or storage in deep wastewater reservoirs which are used in all the other projects. The largest of these reservoirs is the Maale Kishon (Upper Kishon) Reservoir which is part of the Kishon Project that reuses wastewater from the Haifa Metropolitan Region.

The storage duration is few weeks up to several months and during this period there is intense biological activity which causes significant changes in water quality in the reservoirs. In a preliminary study in a small reservoir (1) prior to the construction of the Maale Kishon Reservoir it was observed that 6 weeks storage improved considerably the water quality. The purpose of this investigation was to determine the changes that occur in relative large water body and how those affect those parameters which are important for agricultural irrigation.

Ferguson, B. K. "Role Of The Long-term Water Balance In Management of Stormwater Infiltration." ***Journal Of Environmental Management.*** **V. 30, n. 3. pp. 221-233. 1990.**

Abstract. Artificial infiltration of urban stormwater can potentially recharge ground water and sustain stream base flows while improving stormwater quality and contributing to flood control. It involves capturing stormwater in basins where it is stored while infiltrating the surrounding soil. This paper suggests that management of these basins with design-storm approaches needs to be supplemented by the long-term water balance incorporates continuous low-level background flows, in contrast to the design storm, which is an isolated, rare and brief event. Background flows can accumulate in basins with no regular surface outlets, potentially reducing basin capacity and causing nuisances associated with standing water. A model is described for routing monthly average flows through infiltration basins. Using this model, 12 infiltration basins representing different construction methods and management objectives were designed for a hypothetical catchment in the Atlanta area. The effects of these basins in terms of cost, presence of standing water, capture of flood flows and average annual disposition of water were evaluated. The results show that background flows cannot be disregarded in infiltration management, since the performance of basins designed without considering background flows can be considerably hampered by their presence. The results also invite discussion of alternative basin geometries, materials and hydroperiods as ways of meeting site-specific objectives for water resources and urban amenities.

Ferguson, R. B., D. E. Eisenhauer, T. L. Bockstadter, D. H. Krull and G. Buttermore. "Water And Nitrogen Management In Central Platte Valley Of Nebraska." ***Journal Of Irrigation And Drainage Engineering*****. V. 116, n. 4. pp. 557-565. 1990.**

Abstract. Contamination of ground water by nitrogen leached from fertilizer on irrigated soils is related to the quantity of nitrate-N (NO_3^--N) present, the leaching potential based on soil texture and percent depletion of available soil water in the root zone, and the amount of water entering the soil profile. Research and demonstration projects in the central Platte valley of Nebraska have shown that NO_3^--N leaching is influenced by both irrigation and fertilizer-nitrogen (N) management in corn production. Scheduling irrigation according to available soil-water depletion can reduce deep percolation to a certain extent. Additional reduction in deep percolation can be achieved by improving efficiency of water application, particularly on furrow irrigated fields. Testing for NO_3^--N in irrigation water and soil can provide for substantial reductions in fertilizer N application, if residual levels in the soil are high, or if considerable NO_3^--N will be applied with irrigation water. Grain yields were not appreciably affected by the use of these management practices, while in most cases input costs for fertilizer nitrogen and irrigation water were reduced.

Gerba, C. P. and S. M. Goyal. "Pathogen Removal From Wastewater During Groundwater Recharge." ***Artificial Recharge Of Groundwater.*** **Butterworth Publishers, Boston. pp. 283-317. 1985.**

Abstract. Groundwater contamination by pathogenic microorganisms has not received as much attention as surface water pollution because it is generally assumed that groundwater has a good microbiologic quality and is free of pathogenic microorganisms. A number of well-documented disease outbreaks have, however, been traced to contaminated groundwater. A total of 673 waterborne outbreaks affecting 150,268 persons occurred in the United States from 1946 to 1980. Of these, 295 (44%) involving 65,173 cases were attributed to contamination of groundwater.

Currently, 20 percent of the total water consumed in the United States is drawn from groundwater sources and it estimated that this usage will increase to 33 percent in the year 2000. According to Duboise

et al. over 60 million people in the United States are served by public water supplies using groundwater, and about 54 percent of rural population and 2 percent of the urban population obtain their water from individual well. Since groundwater is often used for human consumption without any treatment, it is imperative to understand the fate of pathogenic microorganisms during land application of wastewater.

The sources of fecal contamination may include septic tanks, leaky sewer lines, lagoons and leaching ponds, sanitary landfills for solid wastes, and sewage oxidation ponds. Additional sources of pathogens in groundwater may involve artificial recharge of groundwater aquifers with renovated wastewater including deep well injection, spray irrigation of crops and landscape, basin recharge, and land application of sewage effluent and sludges. Leakage of sewage into the groundwater from septic tanks, treatment lagoons and leaky sewers is estimated to be over a trillion gallons a year in the United States.

It should be realized that, as opposed to surface water pollution, contamination of groundwater is much more persistent and is difficult to eradicate. Because restoration of groundwater quality is difficult, time-consuming, and expensive, efforts should be made for the protection of groundwater quality rather than only for its restoration after degradation.

Gerba, C. P. and C. N. Haas. "Assessment Of Risks Associated With Enteric Viruses In Contaminated Drinking Water." ***Chemical And Biological Characterization Of Sludges, Sediments, Dredge Spoils, And Drilling Muds. ASTM STP 976.*** **American Society For Testing And Materials, Philadelphia, Pennsylvania. pp. 489-494. 1988.**

Abstract. It is now well established that enteric viruses, such as hepatitis A, Norwalk, rotavirus, and so forth, can be transmitted by sewage-contaminated water and food. Standards for viruses in water have been suggested by the World Health Organization and several other organizations. Few attempts have been made to assess the risks associated with exposure to low numbers of enteric viruses in the environment.

To determine the risks that may be associated with exposure to human enteric viruses, the literature on minimum infectious dose, incidence of clinical illness, and mortality was reviewed. This information was then used to assess the probability of infection, illness, and mortality for individuals consuming drinking water containing various concentrations of enteric viruses. Risks were determined on a daily, annual, and lifetime basis. This analysis suggested that significant risks of illness($>1:10^6$) may arise from the exposure to low levels of the enteric virus.

German, E. R. ***Quantity And Quality Of Stormwater Runoff Recharged To The Floridan Aquifer System Through Two Drainage Wells In The Orlando, Florida, Area.*** **Geological Survey Water Supply Paper 2344. U.S. Government Printing Office, Washington, D.C. 1989.**

Abstract. Quantity and quality of inflow to two drainage wells in the Orlando, Fla. ,area were determined for the period April 1982 through March 1983. The wells, located at Lake Midget and at Park Lake, are used to control the lake levels during rainy periods. The lakes receive stormwater runoff from mixed residential-commercial areas of about 64 acres (Lake Midget) and 96 acres (Park Lake) and would frequently flood adjacent areas if the wells did not drain the excess stormwater. These lakes and wells are typical of stormwater drainage systems in the area.

Lake stages were monitored and used to estimate quantities of drainage-well inflow. Estimated inflow for April 1982 through March 1983 was 62.4 acre-feet at Lake Midget and 84.0 acre-feet at Park Lake. Inflow to the drainage wells was sampled periodically. The quality of water prior to inflow to the

drainage wells was estimated from samples of stormwater runoff to the lakes. The quality of formation water near the wells was estimated from samples pumped from the two drainage wells. a reconnaissance sampling of inflow at seven other drainage wells in the Orlando area was done, once at each well, to broaden the areal coverage of the investigation. The laboratory analyses included determinations of selected nutrients, bacteria, major constituents, trace elements, and numerous organic compounds , including many designated priority pollutants by the U.S. Environmental Protection Agency.

Comparison of quality of drainage-well inflow with State criteria for drinking water supply indicated that color and bacteria were excessively high, and pH excessively low, in some samples. Constituents that exceeded the criteria were iron, in 10 to 21 inflow samples, manganese, in 1 sample, and lead, in 1 sample.

The priority pollutant dibenzo(a,h)anthracene was present in one of two sample pumped from the Lake Midget drainage well (concentration of 370 micrograms per liter). The presence of this compound in that high a concentration is puzzling because it was not detected in any samples of stormwater runoff or drainage-well inflow.

Pesticides, especially diazinon, malathion, and 2,4-D, were the most frequently detected organic compounds in stormwater runoff, drainage-well inflow, and Floridan aquifer system water samples. The priority pollutant bis(2-ethylhexyl)phthalate was detected in seven samples from five sites, probably because of widespread use of the compound in plastic products. Polynuclear aromatic compounds (fluoranthene, pyrene, anthracene, and chrysene) were found in stormwater runoff or inflow to drainage wells at Lake Midget or Park Lake and may be associated with runoff containing petroleum products.

Estimated annual loads to the Floridan aquifer system through drainage-well inflow in the Orlando area, in pounds, are dissolved solids, 32,000,000; total nitrogen, 100, 000; total phosphorus, 13,000; total recoverable lead, 2,300; and total recoverable zinc, 3,700.

Goldschmid, J. "Water-Quality Aspects Of Ground-Water Recharge In Israel." ***Journal Of The American Water Works Association.*** **V. 66, n. 3. pp. 163-166. 1974.**

Abstract. Because of the difference in rainfall and water needs in northern and southern Israel, a method of recharging ground water and transporting it from the north to the south was needed. This article details the new system, including problems encounter and overcome.

Goolsby, D. A. ***Geochemical Effects And Movement Of Injected Industrial Waste In A Limestone Aquifer.*** **Memoir No. 18. American Association Of Petroleum Geologists. 1972.**

Abstract. Since 1963, more than 6 billion gal of acidic industrial waste has been injected into a limestone aquifer near Pensacola, Florida. The industrial waste, an aqueous solution containing nitric acid, inorganic salts, and numerous organic compounds, is injected through two wells into the aquifer between depths of 1, 400 and 1,700 ft (425-520 m). The aquifer receiving the waste is overlain by an extensive clay confining layer which, at the injection site, is about 200 ft (60 m) thick.

Industrial waste is presently (late 1971) being injected at a rate of about 2,100 gal per minute. Wellhead injection pressures are about 175 psi. Calculations indicate that pressure effects in the receiving aquifer extend out more than 30 mi (48 km). No apparent change in pressure has been detected in the aquifer directly above the clay confining layer. Geochemical effects were detected at a monitor well in the receiving aquifer 0.25 mi (0.4 km) from the injection wells about 10 months after injection began. The

geochemical effects included increases in calcium-ion concentration and total alkalinity and formation of large quantities of nitrogen and methane gas.

Geochemical effects have not been detected at monitor wells in the receiving aquifer 1.9 mi (3.0 km) north and 1.5 mi (2.4 km) south of the injection wells, nor have effects been detected in a monitor well at the injection site open to the aquifer directly overlying the clay confining layer. Tests made at the injection wells early in 1968 indicated that rapid denitrification and neutralization of the waste occurred near the injection wells. Denitrification may have accounted for more than half neutralization, and solution of calcium carbonate accounted for the rest. Denitrification has not been observed since mid-1968, when the pH of the injected waste was lowered from 5.5 to 3.

Greene, G. E. *Ozone Disinfection And Treatment Of Urban Storm Drain Dry-Weather Flows: A Pilot Treatment Plant Demonstration Project On The Kenter Canyon Storm Drain System In Santa Monica.* The Santa Monica Bay Restoration Project, Monterey Park, CA. 1992.

Abstract. The Pico-Kenter Canyon storm drain has become the archetype for assessing the problems and possible solutions that can be associated with many of the urban storm drains in the Santa Monica Bay region. While known events of chemical contamination are few, the drain has long been known to be contaminated with indicator bacteria such as Total and Fecal Coliforms. More recently, the consistent identification of Human Enteric Viruses, F-male Specific Coliphage, and high densities of Enterococcus bacteria have indicated that a potentially serious public health threat exists. The City Of Santa Monica, with the assistance of the Santa Monica Bay Restoration Project (SMBRP), the United States Environmental Protection Agency (EPA), and the UCLA Laboratory of Biomedical and Environmental Sciences (LBES), recently completed an evaluation of ozone for the treatment of dry-weather storm drain flows. The primary goals of this study were to establish if ozone could be used to disinfect the water that typically flows from the Pico-Kenter storm drain and determine if some known hazardous chemical contaminants were present at significant levels.

Recently, ozone has become renowned in the drinking water industry as an alternative to chlorine that rapidly disinfects water while forming few halogenated by-products. This study demonstrated that ozone was an effective disinfectant, reducing bacterial and viral populations by 3-5 log (99.9 to 99.999% of the microbes killed or inactivated). In many of the 438 effluent samples, coliform concentrations were sufficiently reduced to qualify the water for reclamation projects such as landscape irrigation along the Santa Monica Freeway, suggesting a possible useful role for the treated effluent. Ozonation by-products (aldehydes) were detected in the plant effluent at low (<100 PPB) concentrations. No significant increase in halogenated by-products, or mutagenicity, were observed following ozone disinfection. During a test of the ozonation process, twelve organic chemicals were added to the influent water and the effluent monitored. While some refractory compounds passed through the pilot facility intact, the concentrations of most were reduced.

In comparison to the State Ocean Plan Water Quality Objectives and Federal Drinking Water Maximum Contaminant Levels, the primary hazardous chemical constituents in the influent storm drain water were metals (primarily copper and lead) and polynuclear aromatic hydrocarbons (PAHs). While lead levels were significantly above both standards, the concentration of copper was well under drinking water standards. The mean observed level of six major PAHs were approximately equal to their proposed phase V drinking water MCL standard (100-400 ng/L or PPTr). Isolated samples were found to contain organic contaminants, such as ortho-xylene and the pesticide chlordane. This did not appear to be a pervasive problem and can be attributed to isolated events that cannot be anticipated and will only be prevented through an informed and concerned public.

While the metal content of the water cannot be reduced using ozone, this study found that high concentrations of some organics, including PAHs, can be reduced during the ozonation process. This remediation probably occurs by oxidation and hydroxylation to less hazardous forms. Irregardless of further ozonation investigations, additional more sensitive and definitive PAH analyses are warranted in future studies of the storm drain water and sediments.

Based on the results of this investigation, the City Of Santa Monica is investigating construction of a disinfection facility that would reclaim high quality water for landscape irrigation, use low quality for sewer flushing, and disinfect the remainder prior to releasing it into the Santa Monica Bay. Construction of the proposed facility would be encouraged by the support of the Santa Monica Bay Restoration Project in goal definition and consensus building among the member and non-member agencies.

Summary Conclusions

1) Ozone at moderate doses (10-20 mg/L) was an extremely effective disinfectant of dry-weather storm drain flows.
2) Bacterial and viral levels were reduced 3-5 log (99.9 to 99.999% of the microbes killed or deactivated).
3) Much of the effluent was sufficiently disinfected to meet the landscape irrigation standard of 23 coliforms per 100 ml.
4) Based on California Ocean Plan Water Quality Objectives, heavy metals and polynuclear aromatic hydrocarbons appear to be the primary contaminants of concern in the pilot plant effluent.
5) While ozone disinfection by-products were detected (aldehydes), their concentration was low and, in contrast to what would be expected from disinfection by chlorination, no increase in mutagenicity was observed following ozonation.

Summary Recommendations

1) The SMBRP should encourage further evaluation of the ozone disinfection process, by promoting the City of Santa Monica in its effort to design and construct a full scale facility.
2) Since construction and operation of the proposed facility will require interagency consent and permitting, the City of Santa Monica solicits the continued assistance of the SMBRP in consensus building, policy direction, and technical support.
3) Further investigations into the use of the ozone technology should include provisions for the evaluation of Advanced Oxidation Processes (AOPs), using hydrogen peroxide and ozone, for the control of organic pollutants such as PAHs.

Hampson, P. S. *Effects Of Detention On Water Quality Of Two Stormwater Detention Ponds Receiving Highway Surface Runoff In Jacksonville, Florida.* Geological Survey Water-Resources Investigations Report 86-4151. U.S. Geological Survey, Tallahassee, Florida. 1986.

Abstract. Water and sediment samples were analyzed for major chemical constituents, nutrients, and heavy metals following 10 storm events at a stormwater detention ponds that receive highway surface runoff in the Jacksonville, Florida, metropolitan area. The purpose of the sampling program was to detect changes in constituent concentration with time of detention within the pond system. Statistical inference of a relation with total rainfall was found on the initial concentrations of 11 constituents and with antecedent dry period for the initial concentrations of 3 constituents. Based on graphical examination and factor analysis, constituent behavior with time could be grouped into five relatively independent processes for one of the ponds. The processes were (1) interaction with shallow ground-water systems, (2) solubilization of bottom materials , (3) nutrient uptake, (4) seasonal changes in precipitation, and (5) sedimentation. Most of the observed water-quality changes in the ponds were virtually complete within 3 days following the storm event.

Harper, H. H. *Effects Of Stormwater Management Systems On Groundwater Quality*. DER Project WM190. Florida Department Of Environmental Regulation, Orlando, Florida. 1988.

Abstract. It has long been recognized that nonpoint sources of pollution contribute significantly to receiving water loadings of both nutrients and toxic elements such as heavy metals (Harper, 1983; Sartor, *et al.*, 1974). As a means of protecting Florida surface waters from the effects of nonpoint source pollution, the Florida Department of Environmental Regulation has established regulations which require new developments or projects to retain or detain specified volumes of runoff water on-site. In most cases runoff is collected in shallow ponds which infiltrate all or part of the retained or detained volumes into groundwaters.

When stormwater management facilities receive inputs of stormwater containing nutrients, heavy metals and other pollutants, processes such as precipitation, coagulation, settling and biological uptake deposit a large percentage of the input mass into the sediments. Recently, concern has been expressed that this continual accumulation of pollutants in the sediments of stormwater management ponds may begin to present a toxicity or pollution potential to underlying groundwaters. Specifically, do these pollutant accumulations cause physical and chemical changes to occur within the sediments of stormwater management facilities which mobilize certain pollutant species from the sediment phase into the water phase.

Hickey, J. J. "Subsurface Injection Of Treated Sewage Into A Saline-Water Aquifer At St. Petersburg, Florida-Aquifer Pressure Buildup." *Ground Water*. V. 22, n. 1. pp. 48-55. 1984.

Abstract. The city of St. Petersburg has been testing subsurface injection of treated sewage into the Floridan aquifer as a means of eliminating discharge of sewage to surface waters and as a means of storing treated sewage for future nonpotable reuse. The injection zone originally contained native saline ground water that was similar in composition to sea water. The zone has a transmissivity of about 1.2 X 10^6 feet squared per day (ft^2/ d) and is within the lower part of the Floridan aquifer.

Treated sewage that had a mean chloride concentration of 170 milligrams per liter (mg/l) was injected through a single well for 12 months at a mean rate of 4.7 X 10^5 cubic feet per day (ft^3/d). The volume of water injected during the year was 1.7 X 10^8 cubic feet.

Pressure buildup at the end of one year ranged from less than 0.1 to as much as 2.4 pounds per square inch (lb/ in^2) in observation wells at the site. Pressure buildup in wells open to the upper part of the injection zone was related to buoyant lift acting on the mixed water in the injection zone in addition to subsurface injection through the injection well.

Calculations of the vertical component of pore velocity in the semiconfining bed underlying the shallowest permeable zone of the Floridan aquifer indicate upward movement of native water. This is consistent with the 200-to 600-mg/l increase in chloride concentration observed in water from the shallowest permeable zone during the test.

Hickey, J. J. and J. Vecchioli. *Subsurface Injection of Liquid Waste With Emphasis on Injection Practices in Florida*. Geological Survey Water-Supply Paper 2281. United States Government

Printing Office, Washington D.C. 1986.

Abstract. Subsurface injection of liquid waste is used as a disposal method in many parts of the country. It is used particularly when other methods for managing liquid waste are either not possible or too costly. Interest in subsurface injection as a waste-disposal method stems partly from recognition that surface disposal of liquid waste may establish a potential for degrading freshwater resources. Where hydrogeologic conditions are suitable and where surface disposal may cause contamination, subsurface injection is considered an attractive alternative for waste disposal. Decisions to use subsurface injection need to be made with care because, where hydrogeologic conditions are not suitable for injection, the risk to water resources, particularly ground water, could be great. Selection of subsurface injection as a waste-disposal method requires thoughtful deliberation and, in some instances, extensive data collection and analyses.

Subsurface injection is a good geological method of waste disposal. Therefore, many State and local governmental officials and environmentally concerned citizens who make decisions about waste-disposal alternatives may know little about it. This report serves as an elementary guide to subsurface injection and presents subsurface injection practices in Florida as an example of how one State is managing injection.

Hickey, J. J. and W. E. Wilson. ***Results Of Deep-Well Injection Testing At Mulberry, Florida.*** **Geological Survey Water-Resources Investigations Report 81-75. U.S. Geological Survey, Tallahassee, Florida. 1982.**

Abstract. At the Kaiser Aluminum and Chemical Corporation plant, Mulberry, Florida, high-chloride, acidic liquid wastes are injected into a dolomite section at depths below about 4,000 feet below land surface. Sonar caliper logs made in April 1976 revealed a solution chamber that is about 100 feet in height and has a maximum diameter of 23 feet in the injection zone.

Results of two injection tests in 1972 were inconclusive because of complex conditions and the lack of an observation well that was open to the injection zone. In 1975, a satellite monitor well was drilled 2,291 feet from the injection well and completed open to the injection zone. In April 1975 and September 1976, a series of three injection tests were performed. Duration of the tests ranged from 240 to 10,020 minutes and injection rates ranged from 110 to 230 gallons per minute. Based on an evaluation of the factors that affect hydraulic response, water-level data suitable for interpretation of hydraulic characteristics of the injection zone were identified to occur from 200 to 1,000 minutes during the 10,020-minute test. Test results indicate that leakage through confining beds is occurring.

Transmissivity of the injection zone was computed to be within the range from 700 to 1, 000 feet squared per day and storage coefficient of the injection zone was computed to be within the range from $4x10^{-5}$ to $6x10^{-5}$. The confining bed accepting most of the leakage appears to be the underlying bed. Also, it appears that the overlying beds are probably relatively impermeable and significantly retard the vertical movement of neutralized waste effluent.

Higgins, A. J. "Impacts On Groundwater Due To Land Application Of Sewage Sludge." ***Water Resources Bulletin.*** **V. 20, n. 3. pp. 425-434. 1984.**

Abstract. The project was designed to demonstrate the potential benefits of utilizing sewage sludge as a soil conditioner and fertilizer on Sassafras sandy loam soil. Aerobically digested, liquid sewage sludge was applied to the soil at rates of 0, 22.4 and 44.8 Mg of dry solids/ha for three consecutive years

between 1978 and 1981. Groundwater, soil, and crop contamination levels were monitored to establish the maximum sewage solids loading rate that could be applied without causing environmental deterioration. The results indicate that application of 22.4 Mg of dry solids/ha of sludge is the upper limit to ensure protection of the groundwater quality on the site studied. Application rates at or slightly below 22.4 Mg of dry solids/ha are sufficient for providing plant nutrients for the dent corn and rye cropping system utilized in the study.

Horsley, S. W. and J. A. Moser. "Monitoring Ground Water For Pesticides At A Golf Course - A Case Study On Cape Cod, Massachusetts." ***Ground Water Monitoring Review.*** **V. 10. pp. 101-108. 1990.**

Abstract. The town of Yarmouth, Massachusetts, proposed to locate a new municipal golf course within a delineated area of recharge to public water-supply wells. Two concerns of town officials were (1) hydrologic impacts upon downgradient wells; and (2) water- quantity impacts from fertilizers and pesticides. In response to these concerns, a thorough hydrogeologic investigation was made, fertilizer and pesticides management programs were recommended, and a ground water monitoring program was developed.

The golf course parcel was determined to be underlain by a sand and gravel aquifer composed primarily of glacial outwash. Water-table maps confirmed that ground water flow was in the direction of several public water-supply wells. A three-dimensional finite-difference flow model was used to determine the optimum location and pumping rates for irrigation wells. Potential nitrate-nitrogen concentration in the ground water were predicted to range from 5.0 to 7.9 milligrams per liter so slow-release fertilizers were recommended.

With the assistance of the EPA Office of Pesticide Programs, the list of proposed pesticides was reviewed and sorted into three categories based on the known leachability, mobility, and toxicity characteristics of each compound. Specific recommendations were made as to pesticide selection and application rate using that classification.

A monitoring program was developed to provide an on-going assessment of any effects on water quality related to the application of fertilizer or pesticide. The elements of the monitoring program include (1) specifications for monitoring wells and lysimeters, (2) a schedule for sampling and analysis, (3) specific concentrations of nitrates or pesticide compounds that require resampling and analysis, restriction of usage, or remedial action, and (4) regular reports to the Yarmouth Water Quality Advisory Committee and to the Yarmouth Water Department. In a effort to ensure the implementation of this program, a table of responsibilities was prepared, and a Memorandum of Understanding adopting the program was signed by the town agencies interested in water-supply protection and the golf course operation.

The monitoring facilities were installed with minimal problems as part of the golf course construction tasks. However, implementation of the sampling and analysis part of the program was accomplished only after some difficulty and delay. The assistance of the State Pesticide Bureau, the University of Massachusetts Department of Entymology, and the Massachusetts Pesticide Laboratory was enlisted when budgetary problems threatened to prevent implementation. It is apparent from Yarmouth's experience that the mere preparation of a plan is not sufficient by itself. Consultants who prepare the plan should make every possible effort to include implementation in their scope of services.

Hull, R. W. and M. C. Yurewicz. ***Quality Of Storm Runoff To Drainage Wells In Live Oak, Florida, April 4, 1979.*** **Geological Survey Open-File Report 79-1073. U.S. Government Printing**

Office, Washington, D.C. 1979.

Abstract. Water-quality samples of storm runoff to drainage wells were collected during a storm event on April 4, 1979. Two sites in commercial areas and two in residential areas of Live Oak, Florida, were sampled. A composite rainfall sample was collected from these sites, and rainfall quantity data were obtained from two additional sites.

Samples of storm runoff were analyzed for those constituents important to the potability of water. The analyses generally included filtered and unfiltered nutrients, bacteria, trace elements, and organics. Several of the analyses had constituent values which equaled or exceeded maximum containment levels for State primary drinking water standards and Federal proposed secondary drinking water standards.

Ishizaki, K. "Control Of Surface Runoff By Subsurface Infiltration Of Stormwater: A Case Study In Japan." ***Artificial Recharge Of Groundwater.*** **Butterworth Publishers, Boston. pp. 565-575. 1985.**

Abstract. Even though the annual rainfall in Japan is about 1,800 mm, which is twice as much as the average rainfall worldwide, water shortages often occur during the summer months. This is because a large amount of surface water is diverted to flood rice fields and, as a result, river flow is reduced to the minimum.

There have been various long-term national programs for the development and management of water resources. Groundwater provides approximately 16 percent of the water resources requirements in Japan. In some areas, however, the groundwater levels have been lowered by excessive pumping and such problems as land subsidence and seawater intrusion have occurred. There have been many cases, particularly in the coastal regions, where salinity of groundwater has become too high for any significant beneficial uses. In addition, due to the urbanization of river drainage basins in many parts of Japan, the decrease of soil infiltration has caused excessive surface runoff, leading to several serious flooding incidences in the surrounding areas.

To reduce excessive surface runoff and to promote groundwater recharge of stormwater, a number of groundwater recharge methods have been investigated at the Japan Ministry Of Construction's Public Works Research Institute. This report describes the subsurface infiltration of stormwater through culverts and also discusses the effects of the stormwater infiltration experiment at an apartment complex in Tokyo, Japan.

Jansons, J., L. W. Edmonds, B. Speight and M. R. Bucens. "Movement Of Viruses After Artificial Recharge." ***Water Research.*** **V. 23, n. 3. pp. 293-299. 1989a.**

Abstract. Results of human enteric virus movement through soil and groundwater aquifers after artificial recharge using wastewater are presented. The penetration through the recharge soil of indigenous viruses from treatment plant effluent was found to be much greater than that of a seeded vaccine poliovirus. Echovirus type 11 from wastewater was detected at a depth of 9.0 m in groundwater from a bore located 14 m from the recharge basin whereas seed poliovirus was not isolated beyond a depth of 1.5m below the recharge basin. It was concluded that data on enteric virus survival in groundwater were required if safe abstraction distances were to be determined.

Jansons, J., L. W. Edmonds, B. Speight and M. R. Bucens. "Survival Of Viruses In Groundwater." ***Water Research.*** **V. 23, n. 3. pp. 301-306. 1989b.**

Abstract. Survival in groundwater of echovirus types 6, 11 and 24, coxsackievirus type B5 and poliovirus type 1 was determined. Enterovirus survival in groundwater was found to be variable and appeared to be influenced by a number of factors: temperature, dissolved oxygen concentration and possibly the presence of microorganisms. Dissolved oxygen concentration was the most significant factor in loss of virus in groundwater. Poliovirus type 1 incubated in groundwater with a mean dissolved oxygen concentration of 2.0 mg/l decreased in infectivity by 100-fold in 50 days compared with 20 days for a decreases of the same magnitude when incubated in groundwater with a mean dissolved oxygen concentration of 5.4 mg/l. Echovirus type 6 was found to be least stable, and poliovirus type 1 was found to be most stable, although virus stability may have been due to conditions existing in individual groundwater bores.

Johnson, R. B. "The Reclaimed Water Delivery System And Reuse Program For Tucson, Arizona." ***Irrigation Systems For The 21st Century, Portland, Oregon, 1987.*** **(American Society Of Civil Engineers, New York, New York, pp. 344-351). 1987.**

Abstract. The City of Tucson has implemented a reclaimed water reuse program in a community-wide effort to preserve high quality groundwater for potable and other priority uses. presently, the system consists of an 8.2 million gallons per day (mgd) pressure filtration plant (expandable to 25 mgd), a 3 million gallon reservoir, a 12 mgd booster facility, and a significant network of large capacity distribution lines which supply major turf irrigation uses throughout the community. An additional element of the system is a 1.0 mgd aquifer recharge facility which provides cost effective seasonal storage of reclaimed water for subsequent recovery and use during the peak demand season.

The initial system was made operational in February, 1984 with the first deliveries of reclaimed water for turf irrigation. By the end of fiscal year 1986-87, Tucson Water will be providing nearly 5,000 acre feet per year of reclaimed water with the expanding reclaimed water system. It is projected that by 1995, Tucson's reclaimed water delivery system will be serving 35,000 acre feet for turf irrigation, cooling tower and gravel washing uses throughout the metropolitan area. The program has reduced peak demands on the potable water system and represents a major step toward the efficient management of the water resources available to our growing community.

Karkal, S. S. and D. L. Stringfield. "Wastewater Reclamation And Small Communities: A Case History." ***Water Environment Federation 65th Annual Conference & Exposition, New Orleans, Louisiana, 1992.*** **(Water Environment Federation, Alexandria, Virginia, pp. 419-425). 1992.**

Abstract. In California's Central Valley, regulatory requirements and concerns of the local community have led to a unique wastewater reclamation project. The City of Orange Cove owns and operates a 3,785.4 M^3/day(1.0 mgd) treatment plant that uses tertiary treatment to produce a high quality reclaimed water that meets the California Code of Regulations (CCR) Title 22 requirements for unrestricted irrigation use. The water is supplied to the independently own and operated Orange Cove Irrigation District (OCID). This facility is in stark contrast to many reclaimed wastewater irrigation facilities in the Central Valley that use primary or secondary effluents for irrigation. The objective of this paper is to discuss the regulatory requirements leading to this project, and the factors involved in the selection of the treatment processes used to meet these requirements. .

Katopodes, N. D. and J. H. Tang. "Self-Adaptive Control Of Surface Irrigation Advance." ***Journal Of Irrigation And Drainage Engineering*. V. 116, n. 5. pp. 696-713. 1990.**

Abstract. The controllability of surface irrigation is examined by analytical means and numerical tests based on the linearized zero- inertia model. First, the inflow hydrograph is proved to be identifiable from advance data. Then, it is shown that it is possible to control the advance rate by adjustment of the inflow rate. Field parameter heterogeneities are automatically taken into account, so a predetermined advance trajectory is obtained under arbitrary field conditions. The model utilizes a tentative time increment, during which a trial value for inflow is adopted. The resulting wave advance is simulated by the zero- inertia model. Discrepancies between the actual and desired advance rate are then used to construct an objective function, whose minimization leads to a correction of the inflow rate for the next time increment of inflow. Finally, examples of self- adaptive control are presented, in which an irrigation stream is led into a field of unknown parameters. The model uses real-time information for the identification of the parameters and simultaneous control of the inflow rate to achieve a desired advance rate.

Kaufman, M. I. "Subsurface Wastewater Injection, Florida." ***Journal Of Irrigation And Drainage Engineering*. V. 99, n. 1. pp. 53-70. 1973.**

Abstract. The Secretary of the Interior directed the U.S. Geological Survey in December, 1969 to begin a research program to evaluate the 'effects of underground waste disposal on the Nation's subsurface environment, with particular attention to ground-water supplies.' The directive noted the complexity of the subsurface environment and emphasized the need to begin collecting pertinent environmental data.

As a direct result, the Survey is engaged in an investigative and research program to develop a scientific basis for assessing the long-term environmental impact of subsurface waste injection. Prediction of movement, chemical interaction, and ultimate fate of injected liquid waste is difficult. As noted by Piper: "Uncritical acceptance (of deep well injection) would be ill advised." The complexity of both the waste and the subsurface environment preclude making generalizations; with the present state of knowledge, a thorough regional and localized study must be made for each proposed waste-injection system.

Extensive areas in Florida are underlain by deep permeable saline-aquifer systems that are separated from overlying freshwater aquifers by low- permeability confining materials consisting of clay, evaporites, or dense carbonate rocks.

To resolve problems of waste disposal and to alleviate deterioration of fresh and estuarine waters, approaches such as deep-well injection of industrial and municipal effluents into these saline-aquifer systems are being actively explored.

The hydrologic and geochemical characteristics of these saline-aquifer systems and their response to waste injection are the subject of current research by the Survey. This information would assist planning-management and regulatory agencies in their evaluation of subsurface injection of liquid wastes, including its potential applicability to regional water and waste management systems.

This paper contains both a summary of data and present status of subsurface waste injection in Florida, including observed hydraulic and geochemical effects and a descriptive regional portrayal of the lithology and hydrogeochemistry of the saline-aquifer system.

Knisel, W. G. and R. A. Leonard. "Irrigation Impact On Groundwater: Model Study In Humid Region ." *Journal Of Irrigation And Drainage Engineering*. V. 115, n. 5. pp. 823-839. 1989.

Abstract. The Groundwater Loading Effects of Agricultural Management Systems (GLEAMS) model was applied to estimate the effects of: (1) Soil; (2) planting date; (3) irrigation level; and (4) pesticide characteristic on pesticide leaching below the root zone of representative coarse-grained soils. Climate/application/pesticide-characteristic interactions are shown to significantly affect pesticide losses, whereas irrigation practice has little effect. Persistent and mobile compounds exhibit the highest losses.

Krawchuk, B. P. and B. G. R. Webster. "Movement Of Pesticides To Ground Water In An Irrigated Soil." *Water Pollution Research Journal Of Canada*. V. 22, n. 1. pp. 129-146. 1987.

Abstract. The movement of pesticide residues to ground water was studied on a commercial farm southwest of Portage la Prairie, Manitoba. The site had sandy soil with low organic matter content, a high water table, a tile drain system and an irrigation system using river water. Records were available from the beginning of commercial operation in 1979 describing pesticide usage on a field by field basis. A total of 21 different pesticide formulations were used in the 5 years of operation.

An initial (1981) random sampling of the tile drain water did not detect any pesticide residues in the outflow at the 0.02 ug/L level. A subsequent extensive sampling (1982) detected residues of chlorothalonil on eight occasions ranging from 0.06 to 3.66 ug/L in the tile drain outflow. Ground water from one of two wells in the northwest quarter was found to contain chlorothalonil at a level of 10.1 to 272.2 ug/L in 1982 and 0.4 to 9.0 ug/L in 1983, carbofuran at a level of 11.5 to 158.4 ug/L in 1982 and <0.5 to 1.0 ug/L in 1983, and carbofuran phenol (not quantified) in 1982 and 1983.

RP-HPLC K_{OW} data indicated that a number of the pesticides used on the farm could be as mobile or more mobile than chlorothalonil which had been detected in the ground water in two consecutive years; however, of the other pesticides only carbofuran was detected in the ground water. With a K_{OW} lower than that of chlorothalonil, carbofuran was expected to be more mobile than chlorothalonil, and to appear in the water sooner, but this was not observed in the field samples.

Ku, H. F. H., N. W. Hagelin and H. T. Buxton. "Effects Of Urban Storm-Runoff Control On Ground-Water Recharge In Nassau County, New York." *Ground Water*. V. 30, n. 4. pp. 507-513. 1992.

Abstract. Before urban development, most ground-water recharge on Long Island, New York, occurred during the dormant season, when evapotranspiration is low. The use of recharge basins for collection and disposal of urban storm runoff in Nassau County has enabled ground-water recharge to occur also during the growing season. In contrast, the use of storm sewers to route storm runoff to streams and coastal waters has resulted in a decrease in ground-water recharge during the dormant season. The net result of the these two forms of urban storm-runoff control has been an increase in annual recharge of about 12 percent in areas served by recharge basins and a decrease of about 10 percent in areas where runoff is routed to streams and tidewater. On a countrywide basis, annual ground-water recharge has remained nearly the same as under predeveloped conditions, but its distribution pattern has changed. Redistribution resulted in increased recharge in the eastern and central parts of the county, and decreased recharge in the western and near shore areas. Model simulation of recharge indicates that the water- table altitude has increased by as much as 5 feet above predevelopment levels in areas served by recharge basins and declined by as much as 3 feet in areas where stormwater is discharged to streams and tidewater.

Ku, H. F. H. and D. L. Simmons. ***Effect Of Urban Stormwater Runoff On Ground Water Beneath Recharge Basins On Long Island, New York.*** **Geological Survey Water-Resources Investigations Report 85-4088. U.S. Geological Survey, Syosset, New York. 1986.**

Abstract. Urban stormwater runoff was monitored during 1980-82 to investigate the source, type, quantity, and fate of contaminants routed to the more than 3,000 recharge basins on Long Island and to determine whether this runoff might be a significant source of contamination to the ground-water reservoir. Forty-six storms were monitored at five recharge basins in representative land-use areas (strip commercial, shopping-mall parking lot, major highway, low-density residential, medium-density residential).

Runoff/precipitation ratios indicate that all storm runoff is derived from precipitation on impervious surfaces in the drainage area except during storms of high intensity or long duration, when additional runoff can be derived from precipitation on permeable surfaces.

Concentrations of most measured constituents in individual stormwater samples were within Federal and State drinking-water standards. The few exceptions are related to specific land uses and seasonal effects. Lead was present in highway runoff in concentrations up to 3,300 micrograms per liter (ug/L), and chloride was found in parking-lot runoff in concentrations up to 1,100 milligrams per liter (mg/L) during winter, when salt is used for deicing.

The load of heavy metals was largely removed during movement through the unsaturated zone, but chloride was not removed. Total nitrogen was commonly found in greater concentrations in ground water than in stormwater; this is attributed to seepage from cesspools and septic tanks and to the use of lawn fertilizers.

In the five composite stormwater samples and nine ground-water grab samples that were analyzed for 113 U.S. Environmental Protection Agency-designated "priority pollutants," four constituents were detected in concentrations exceeding New York State guidelines of 50 ug/L for an individual organic compound in drinking water: p-chloro-m-cresol (79 ug/L in ground water at the highway basin); 2,4-dimethylphenol (96 ug/ L in ground water at the highway basin); 4-nitrophenol (58 ug/L in ground water at the parking-lot basin); and methylene chloride (230 ug/L in stormwater at the highway basin). One stormwater sample and two ground-water samples exceeded New York State guidelines for total organic compounds in drinking water (100 ug/ L). The presence of these constituents is attributed to contamination from point sources rather than to quality of runoff from urban areas.

The median number of indicator bacteria in stormwater ranged from 10^8 to 10^{10} MPN/100 mL (most probable number per 100 milliliter). Fecal coliforms and fecal streptococci increased buy 1 to 2 orders of magnitude during the warm season. Total coliforms concentrations showed no significant seasonal differences.

Low-density residential and nonresidential (highway and parking lot) areas contributed the fewest bacteria to stormwater; medium-density residential and strip commercial areas contributed the most. No bacteria were detected in the ground water beneath any of the recharge basins.

The use of recharge basins to dispose of storm runoff does not appear to have significant adverse effects on ground-water quality in terms of the chemical and microbiological stormwater constituents studied.

Ku, H. F. H., J. Vecchioli and S. E. Ragone. "Changes In Concentration Of Certain Constituents Of Treated Waste Water During Movement Through The Magothy Aquifer, Bay Park, New York." ***Journal Research U.S. Geology Survey.*** **V. 3, n. 1. pp. 89-92. 1975.**

Abstract. Approximately 7 million gallons (27 million litres) of tertiary- treated sewage (reclaimed water) was injected by well into the Magothy aquifer and was subsequently pumped out. As the reclaimed water moved through the aquifer, concentrations of certain dissolved constituents decreased as follows: Total nitrogen, 7 percent; methylene blue active substances, 49 percent; chemical oxygen demand, 50 percent; and phosphate, more than 93 percent.

Lauer, D. A. "Vertical Distribution In Soil Of Sprinkler-Applied Phosphorus." ***Soil Science Society Of America Journal.*** **V. 52, n. 3. pp. 862-868. 1988a.**

Abstract. Soil-immobile plant nutrients, such as P, accumulate near the soil surface in conservation cropping systems where tillage leaves crop residues on or near the soil surface and limits soil mixing. The objective was to determine, in field and laboratory experiments, the vertical distribution in soil of P applied in sprinkler irrigation water. Following P applications, distribution was determined from depth increment (1 or 2 cm) sampling on a Warden silt loam (coarse-silty, mixed, mesic, Xerollic Camborthids) and a Quincy sand (mixed, mesic, Xeric Torripsamments). The fertilizer materials applied in 10-mm irrigations were: monoammonium phosphate (227g P kg^{-1}), urea phosphate (192g P kg^{-1}), commercial white phosphoric acid (238g P kg^{-1}), and ammonium polyphosphate (149g P kg^{-1}) containing 61g P kg^{-1} as polyphosphate. Application rates ranged from 50 to 400 kg P ha^{-1}. Movement of P was about the same for all P fertilizer materials except ammonium polyphosphate, from which P moved only 60 to 70% of the depth of the other materials. Postapplication irrigation totals up to 160 mm at 10 m dl, which was applied without drying cycles, distributed P more uniformly with depth. The overall mean depths of P penetration across all treatments were 10.4 cm (SD = 4.04 cm) on the Quincy sand and 7.3 cm (SD = 4.93 cm) on the Warden silt loam. Theses depths of penetration and vertical distribution of sprinkler-applied P are probably sufficient to supply the P needs of crop plants under sprinkler irrigation. .

Lauer, D. A. "Vertical Distribution In Soil Of Unincorporated Surface-Applied Phosphorus Under Sprinkler Irrigation." ***Soil Science Society Of America Journal.*** **V. 52, n. 6. pp. 1685-1692. 1988b.**

Abstract. Determining vertical distribution of P is important in irrigated conservation cropping systems for evaluation of P fertilization because soil-immobile phosphorus accumulates near the soil surface where limited tillage reduces soil mixing. The objective was to determine in field and laboratory experiments the vertical distribution of P from surface -applied monoammonium phosphate (MAP; 227 g P kg^{-1}), triple superphosphate (TSP; 197 g P kg^{-1}) and ammonium polyphosphate (APP; 149g P kg^{-1}). Following P application, vertical distribution was determined from 2-cm depth increment samples in a Quincy sand (mixed, mesic, Xeric Torripsamments), a Warden silt loam (coarse-silty, mixed, Xerollic Camborthids), and a calcareous subsoil of the Warden. There was little effect on P distribution from antecedent moisture; fertilizer rates at 30, 60, 120, or 240 kg P ha^{-1}; or from preirrigation reaction times of 1, 4, or 16 d. Continuous postapplication irrigation totals of 40 or 160 mm at 10 mm d^{-1} moved P somewhat deeper into the soil, principally at 160 mm on the Quincy sand. Overall mean penetration depths of P were as follows: (i) APP moved the farthest in the Quincy sand (mean = 6.1; SD = 1.05 cm); (ii) penetrations were practically the same for MAP or TSP on the Quincy sand (mean = 5.5; SD = 1.25 cm); (iii) depth of penetration was intermediate for APP on the noncalcareous Warden (mean = 4.0; SD = 0.98 cm); and (iv) downward movement in calcareous Warden of P from all fertilizer P materials was much more restricted (MAP/TSP: mean = 3.1; SD = 0.10 cm and APP: mean = 3.3; SD = 0.52) than on the two noncalcareous soils. Overall, the most apparent conclusion from this study is that the reactivity of P fertilizer material with the soil is the dominant and overriding determinate of the vertical distribution of surface-applied P.

Lee, E. W. "Drainage Water Treatment And Disposal Options." ***Agricultural Salinity Assessment And Management.*** **American Society Of Civil Engineers. pp. 450-468. 1990.**

Abstract. Treating and disposing of subsurface drainage water from irrigated agricultural lands presents unique technical challenges. A review of the literature reveals limited experiences in the management of such waters. The challenge is made more difficult by the complex chemical characteristics of most drainage water. Drainage usually contains a heavy salt load -- a perennial cause for concern -- and residual pesticides, herbicides, fungicides, fertilizers and toxic trace elements -- a more recent cause for concern. While crop management practices and conventional treatment processes can control salt and residuals to some degree, a new treatment technology needs to be developed to control toxic trace elements. Conventional methods appear to be ineffective in meeting the requirements set by many regulatory agencies.

In this report, the treatment and disposal of subsurface drainage from irrigated lands will be covered, disposal options will be presented, the technology of drainage water treatment and disposal options will be reviewed, and current research on treatment technology will be discussed.

Lloyd, J. W., D. N. Lerner, M. O. Rivett and M. Ford. "Quantity And Quality Of Groundwater Beneath An Industrial Conurbation - Birmingham, UK." ***Hydrological Processes And Water Management In Urban Areas, Duisburg, Federal Republic Of Germany, 1988.*** **(International Hydrological Programme, UNESCO, pp. 445-453). 1988.**

Abstract. Since the 1960's groundwater heads have been rising noticeably beneath Birmingham, principally due to reducing abstraction. Despite the almost complete urbanisation of the aquifer surface, potential recharge is at least as high as it was before the city was built. There is sufficient leakage from water mains and sewers to make up for the reduced infiltration at the surface. The marked change in groundwater conditions has prompted interest in groundwater quality and both inorganic and organic quality of the groundwater are currently being studied. First indications are of widespread worsening inorganic quality, with high nitrates, chlorides and certain trace elements. Chlorinated organic solvents (e.g. trichloroethylene) are widespread, but there is little evidence to date of other organic pollutants.

Loh, P. C., R. S. Fujioka and W. M. Hirano. "Thermal Inactivation Of Human Enteric Viruses In Sewage Sludge And Virus Detection By Nitrose Cellulose-Enzyme Immunoassay." ***Chemical And Biological Characterization Of Sludges, Sediments, Dredge Spoils, And Drilling Muds. ASTM STP 976.*** **American Society For Testing And Materials, Philadelphia, Pennsylvania. pp. 273-281. 1988.**

Abstract. The Zimpro Thermal Sludge Treatment Process installed at the Sand Island Wastewater Treatment Plant, Honolulu, HI, was evaluated for its reliability in disinfecting human enteric viruses and fecal bacteria in the treated sludge. The principle of this process involves grinding the sludge particles to a small size(<4.8 mm) and heating the ground sludge to 193'C under 330 psi pressure for 30 min. Such thermally treated sludge yielded no human enteric viruses and little or no fecal bacteria(<2 to 24 MPN/100g), thus rendering the sludge safe for reuse. In corollary studies, the nitrocelluose-enzyme immunoassay was evaluated as an alternate cost-effective method to augment infectivity assays for the detection of human enteric viruses. The method was found to be rapid, highly sensitive (it can detect picogram quantities), and specific for the detection of human enteric viruses.

Malik, A., M. Stone, F. R. Martinez and R. Paul. "First Wastewater Desalting Plant In Central Coast, California." ***Water Environment Federation 65th Annual Conference & Exposition, New Orleans, Louisiana, 1992.*** **(Water Environment Federation, Alexandria, Virginia, pp. 395-406). 1992.**

Abstract. This paper describes a 144.6 liter/second (L/s) (3.0 million gallon per day (mgd)) water reclamation plant and a 35 L/s (0.8 mgd) reverse osmosis plant (RO). The water reclamation plant treats secondary treated discharged from the Goleta Sanitary District wastewater treatment plant. The RO plant further processes a portion of the effluent that will be produced at the water reclamation plant. RO treatment is needed to : (1) lower the chloride content of the tertiary effluent to less than 300 milligrams per liter (mg/l), for protection of golf course greens and sensitive plants; and (2) to provide water with reduced concentrations of chlorides, sodium, sulfates, and other constituents to agricultural growers.

The installed RO Plant will produce 35 L/s (0.8 mgd) of desalted water. The facility will discharge 9.6 L/s (0.22 mgd) desalted water to the agricultural growers and discharge 25.4 L/s (0.58 mgd) to reclaimed water storage tanks for blending with effluent from the water reclamation plant. 115.7 L/s (2.64 mgd) of blended effluent will be available to distribute to all other reclaimed water users.

Mancini, J. L. and A. H. Plummer Jr. "A Method For Develping Wet Weather Water Quality Criteria for Toxics." ***Water Environment Federation 65th Annual Conference & Exposition, New Orleans, Louisiana, 1992.*** **(Water Environment Federation, Alexandria, Virginia, pp. 15-26). 1992.**

Abstract. Current federal and state water quality programs are focusing on control of toxics and on impacts from diffuse sources. These two elements of regulatory programs can be expected to come together in the future. Regulations will begin to address the effects of toxics from diffuse sources.

Diffuse sources of contaminants such as runoff from urban, industrial, and agricultural sites are associated with wet-weather events. The inputs of toxic materials from these sources are intermittent, and may not occur during all runoff events. Exposure of aquatic organisms to toxicants, from these sources, are often of short duration separated by extended periods which provide opportunities for organism

recovery. The concentrations and exposure patterns of toxicants, which cause impacts on resident aquatic organisms are different, for diffuse wet-weather dischargers and continuous point source inputs.

The potential cost for control of toxics in discharges from diffuse sources is large. Therefore, it is important that water quality criteria properly represents the level of protection needed to address contaminants introduced by diffuse sources. The application of technologically-based modifications to existing water quality criteria which account for the characteristics of diffuse sources (e.g. wet-weather inputs) could produce environmental protection at lower costs.

This paper presents technology which could be used to modify existing EPA numerical criteria for toxics to consider the effects of the variability of concentrations and exposure patterns associated with wet-weather inputs. Illustrations of criteria development, site-specific use of criteria and compliance monitoring are included. The technology can also be used to estimate the impacts of wet-weather discharges on aquatic organisms.

Markwood, I. M. "Waterborne Disease -- Historical Lesson." ***Ground Water.*** **V. 17, n. 2. pp. 197-198. 1979.**

Abstract. While it is true that waterborne diseases are still with us, and probably always will be, we cannot classify them as a current threat in the sense that they were 100 years ago. The discovery that chlorine would disinfect water supplies removed these diseases from a "current threat" to a "historical lesson" category. We are not faced with unknown which we are unable to attack. We have only to look at what others have done to protect themselves and follow the same or improved practices.

If the record of waterborne outbreaks in public water supplies in this country from the end of World War II up to the present is examined, it will be found that all are caused by breakdowns in disinfection procedures or carelessness. The record is replete with statements such as "improper disinfection after repair," "breakdown or lack of disinfecting equipment," "back siphonage," and other similar statements all pointing to failure to follow practices which the history of water treatment has shown to be necessary for protection against waterborne disease. Carelessness allows recurrence of disease outbreaks. If the lessons of history were followed, the conquest of waterborne disease transmission by public water systems could be complete.

Marton J. and Mohler I. "The Influence Of Urbanization On The Quality Of Groundwater." ***Hydrological Processes And Water Management In Urban Areas, Duisburg, Federal Republic Of Germany, 1988.*** **(International Hydrological Programme, UNESCO, pp. 452- 461). 1988.**

Abstract. On the example of the described antropogeneous activities in an urbanized basin we have manifested their influence upon quantitative and qualitative regime of groundwater on the territory of Bratislava and the consequential measures taken to suppress or liquidate their negative effect as well.

Marzouk, Y., S. M. Goyal and C. P. Gerba. "Prevalence Of Enteroviruses In Ground Water Of Israel." ***Ground Water.*** **V. 17, n. 5. pp. 487-491. 1979.**

Abstract. Few studies have been performed on the occurrence of enterovirus contamination of ground water. In this study, 99 ground-water samples were examined for the presence of enteroviruses, total bacteria, fecal coliforms, and fecal streptococci by standard methods. Enteroviruses were isolated from 20% of the samples. Viruses were isolated from 12 samples which contained no detectable fecal

organisms per 100 ml. No statistical correlation between presence of virus and bacteriological indicators could be determined. The widespread failure of current bacteriological standards to indicated the presence of potentially pathogenic enteroviruses in ground water is an area of concern that requires more study.

Merkel, B., J. Grossmann and P. Udluft. "Effect Of Urbanization On A Shallow Quarternary Aquifer." ***Hydrological Processes And Water Management In Urban Areas, Duisburg, Federal Republic Of Germany, 1988.*** **(International Hydrological Programme, UNESCO, pp. 461-469). 1988.**

Abstract. Quantity and quality of groundwater renewal is mainly determined by physico-chemical processes within the soil and the unsaturated zone. Pollution of groundwater from urbanization were brought to light and exemplary pointed out by deposits from precipitation, sodium chloride spreading and leakage from sewerage.

Mossbarger, W. A. Jr. and R. W. Yost. "Effects Of Irrigated Agriculture On Groundwater Quality In Corn Belt And Lake States." ***Journal of Irrigation and Drainage Engineering.*** **V. 115, n. 5. pp. 773-789. 1990.**

Abstract. The impact of irrigation on groundwater quality is influenced by climate, topography, geology, soils, geohydrology, crops, and agricultural practices. Since the early 1950s, the irrigated crop acreage in the Corn Belt and Lake States has increased markedly. Irrigation in these regions is concentrated in areas underlain by sandy soils with low moisture-holding capacities, where supplemental moisture and relatively heavy applications of agrichemicals are needed to achieve economically viable crop yields. Due to the high hydraulic conductivities and low attenuation capacities of sandy soils, shallow aquifers underlying these areas are particularly susceptible to contamination with nitrates and stable, soluble pesticides. Present and potential problems associated with irrigation in these states are illustrated by available case studies from the Central Sand Plain of Wisconsin.

Nellor, M. H., R. B. Baird and J. R. Smyth. "Health Aspects Of Groundwater Recharge." ***Artificial Recharge Of Groundwater.*** **Butterworth Publishers, Boston. pp. 329-355. 1985.**

Abstract. Southern California, like many semiarid regions of the United States, does not receive sufficient water from local sources to support the considerable population of the area. Almost two thirds of the water supply is imported 200 to 500 miles from the point of use. The remainder is derived from local groundwater basins. In some areas, the occurrence of overdraft conditions and saltwater intrusion has led to the adjudication of groundwater extractions and/or the implementation of artificial groundwater replenishment. Water sources used for groundwater replenishment include storm runoff, imported water, and, in some cases, treated wastewater (reclaimed water).

There is considerable uncertainty at this time regarding the sufficiency of water supplies for future water needs of the area. Population growth projections coupled with reductions in imported water deliveries indicate that, by the mid-1990s water needs may exceed available supplies. These water shortage predictions have stimulated regional planning activities aimed at optimizing available water supplies through conservation efforts and developing new local sources of supply through conjunctive groundwater storage and water reclamation. Foremost among these planning efforts is the Orange and Los Angeles Counties Water Reuse Study, which has identified the most viable water reclamation projects within the South Coast Region and has developed a financial and institutional scheme for their

implementation. Of all the reclamation projects under consideration, groundwater recharge represents the largest and most economical use of reclaimed water.

Despite these economic incentives, implementation of proposed groundwater recharge projects is constrained by concerns over the potential health impacts of indirect reuse for potable purposes. Health issues associated with groundwater recharge include the acute and chronic effects of trace metals, minerals, pathogens, and organic compounds that, if present in reclaimed water, may ultimately become part of a potable water supply. Available information on existing groundwater recharge projects has never shown any evidence of impaired water quality or health. Yet, it is recognized that this information is insufficient for rigorous evaluation of the possible long-term health implications associated with indirect potable reuse.

The existing groundwater recharge projects in Los Angeles and Orange Counties provided an opportunity to gather the data needed to evaluate the health significance of water reuse by groundwater recharge. Foremost among these is the Whittier Narrows groundwater recharge project located in the Montebello Forebay area of Los Angeles County where planned replenishment using reclaimed water has been practiced since 1962. A work plan was developed by the Los Angeles County Sanitation Districts, which incorporated multidisciplinary research recommendations proposed by a "blue ribbon" panel of experts convened by the California State Water Resources Control Board, the Department of Water Resources, and the Department of Health Services. The work plan formed the basis for the Health Effects Study that formally began in November 1978 and was completed in March 1984.

Nightingale, H. I., J. E. Ayars, R. L. McCormick and D. C. Cehrs. "Leaky Acres Recharge Facility: A Ten-Year Evaluation." *Water Resources Bulletin*. V. 19, n. 3. pp. 429-437. 1983.

Abstract. From 1971-1980, studies were conducted at Fresno, California, to identify and quantity, where possible, the soil and water chemistry, subsurface geologic, hydrologic, biologic, and operational factors that determine the long term (10 year) effectiveness of basin type artificial ground water recharge through alluvial soils This paper updates previous findings and refers to publication that describe the geology beneath the basins and regional geology that determine the transmission and storage properties for local ground water management and chemical quality enhancement. High quality irrigation water from the Kings River was used for recharge. Construction and land costs for the present expanded facility 83 ha (205.2 ac) using three parcels of land were $1,457,100. The nine-year annual mean costs for only canal water , maintenance, and operation were $110.42/ ha*m ($13.62/ac*ft) based on an average recharge rate of 1338 ha*m/yr (10,848 ac*ft/yr) at 86 percent facility efficiency. The measured end of season recharge rate averaged 14.97 $\pm$ 0.24 cm/ day. The 10-year mean actual recharge rate based on actual water delivered, total ponded area, and total days of recharge was 12.1 cm/day.

Nightingale, H. I. "Accumulation Of As, Ni, Cu, And Pb In Retention And Recharge Basins Soils From Urban Runoff." *Water Resources Bulletin*. V. 23, n. 4. pp. 663-672. 1987a.

Abstract. The accumulation of arsenic, nickel, copper, and lead in the soil profile was determined beneath five urban storm-water retention/ recharge basins used by the Fresno Metropolitan Flood Control District, California. Soils were sampled from the surface to the first zone of saturation and compared with soils from an adjacent uncontaminated control site. These elements were found to be accumulating in the first few centimeters of basin soil and are important to the effectiveness of a specific best management practice, i.e., the retention and recharge of urban storm water. Study basins in use since 1962, 1965, and 1969 had lead contents in the 0-2 cm soil depth interval of 570, 670, and 1400 mg Pb/kg soil, respectively. The median indigenous soil lead concentration was 4.6 mg/kg soil. The practice of

removing excess flood runoff water from two basins by pumping apparently is a factor in reducing the accumulation rate of these elements in the surface soils of the basins.

Nightingale, H. I. "Water Quality Beneath Urban Runoff Management Basins." ***Water Resources Bulletin*****. V. 23, n. 2. pp. 197-205. 1987b.**

Abstract. The chemical impact of urban runoff water on water quality beneath five retention/recharge basins was investigated as part of the US EPA's Nationwide Urban Runoff Program in Fresno, California. Soil water percolating through alluvium soils and the ground water at the top of the water table were sampled with ceramic/Teflon vacuum water extractors of depths up to 26m during the two-year investigation. Inorganic and organic pollutants are present in the runoff water delivered to the basins. No significant contamination of percolating soil water or ground water underlying any of the five retention/recharge basins has occurred for constituents monitored in the study. The oldest basins was constructed in 1962. The concentration of selected trace elements in the ground water samples was similar to the levels reported in the regional ground water. None of the pesticides or other organic priority pollutants, for which water samples were analyzed, was detected except diazinon which was found in trace counts (0.3 ug/L or less) in only three soil water samples. These results are important to the continued conservation of storm water and the development of a best management practice for storm-water management using retention/ recharge basins in a semi-arid climate.

Nightingale, H. I. and W. C. Bianchi. "Ground-Water Chemical Quality Management By Artificial Recharge ." ***Ground Water*****. V. 15, n. 1. pp. 15-22. 1977a.**

Abstract. The effectiveness of basin ground-water recharge at the Leaky Acres Facility in Fresno, California for improving the regional ground-water quality was studied as 65,815,000 m^3 of high-quality surface water was recharged from 1971 through 1975. Observation wells at the facility showed some variability in chemical parameters associated with each recharge period. The long-term decrease in salinity could be described by decay curve fitted by regression analysis.

Without a special network of observation wells outside the facility, scientific evaluation of the enclave of recharged water is not possible. A practical evaluation of water-quality changes is possible from producing water wells around the facility. However, the pumping well discharge-time variations, well depth, aquifer sequence, and prior use of surrounding land must be considered, since all of these factors affect the pumped-water quality and its seasonal variability. Recharge at Leaky Acres had noticeably decreased the ground-water salinity for a distance of up to 1.6 km in the regional ground-water movement.

Nightingale, H. I. and W. C. Bianchi. "Ground-Water Turbidity Resulting From Artificial Recharge." ***Ground Water*****. V. 15, n. 2. pp. 146-152. 1977b.**

Abstract. Turbid ground water is rarely observed in domestic or public supply aquifers. At the Leaky Acres Recharge Facility at Fresno, California, water of low salinity(<50 umhos/cm) and turbidity (<5 FTU, Formazin turbidity units) is recharged in the spreading basins. Six months after the start of the third (1973) recharge period, the groundwater salinity was decreased to about 100 umhos/cm from the initial mean of 147 umhos/cm and the ground water became visibly turbid (>5 FTU)/ Two months later, some peripheral domestic wells also began to become turbid. After two more recharge periods (1974 and 1975), turbidity at 10 observation wells beneath Leaky Acres averaged 18 FTU and salinity averaged 74 umhos/cm. By this time, ground-water turbidity in peripheral wells near Leaky Acres had decreased to <0.5 FTU. This turbidity was traced to poorly-crystallized and extremely fine colloids, which have leached

from the surface soils because of the low salinity of the recharge water. Laboratory and field studies showed that gypsum application will reverse the phenomena, but such treatment is uneconomical. This phenomenon is a transient one, and now turbidity outside the recharge area is insignificant from a water quality viewpoint. However, the magnitude of the mass of material is transit through the profile if stabilized through flocculation or sieving in soil pore space, could greatly change the water transmission and so recharge project performance. However, we have not yet noted this effect at Leaky Acres.

Norberg-King, T. J., E. J. Durhan, G. T. Ankley and E. Robert. "Application Of Toxicity Identification Evaluation Procedures To The Ambient Waters Of The Colusa Basin Drain, California." ***Environmental Toxicology And Chemistry.*** **V. 10. pp. 891-900. 1991.**

Abstract. Pesticides are applied to the rice fields in the Sacramento Valley to prevent the growth of plants, algae and insects that reduce rice yields. Following the pesticide application, field water is released into agricultural drains that in turn discharge into the Sacramento River and delta. Rice irrigation is the largest single use of irrigation water in the Sacramento Valley, and because the irrigation water (or rice return) flows are the primary source of drain effluent during the spring and summer (up to 33% of the total flow), these discharges can significantly affect drain water quality and resident aquatic organisms. Acute and chronic toxicity to freshwater organisms (*Ceriodaphnia dubia*) was observed in the drain water during the period that coincides with the initial draining of the fields in 1986, 1987 and 1988. In 1988, a toxicity identification evaluation (TIE) was conducted using *Ceriodaphnia dubia* in an effort to identify the cause of toxicity. Both methyl parathion and carbofuran were identified as possible toxicants. Mixture tests and chronic toxicity tests indicated that the concentrations of methyl parathion and carbofuran in the water sample account for the toxicity observed in *Ceriodaphnia dubia*.

Pahren, H. R. "EPA's Research Program On Health Effects Of Wastewater Reuse For Potable Purposes." ***Artificial Recharge Of Groundwater.*** **Butterworth Publishers, Boston. pp. 319-328. 1985.**

Abstract. One of the many objectives of the Office of Research and Development of the U.S. Environmental Protection Agency (EPA) has been to carry out a relatively small research program on the potential health effects associated with the reuse of renovated wastewater for potable purposes. This report reviews the research tasks conducted and the results obtained to date.

Research on potable reuse was initiated in 1974 and the federal program funding averaged about $400,000 annually through 1978. Following the 1977 amendments to the Safe Water Drinking Act, which called for special studies on the health implications involved in the reclamation, recycling, and reuse of wastewaters for drinking, funds for reuse research increased. However, the separate program on wastewater reuse was discontinued in 1981. Any activity in the future will be continued as part of the regular drinking water base research program.

Peterson, D. A. "Selenium In The Kendrick Reclamation Project, Wyoming." ***Planning Now For Irrigation And Drainage In The 21st Century, Lincoln, Nebraska, 1988.*** **(American Society Of Civil Engineers, New York, New York, pp. 678-685). 1988.**

Abstract. Elevated concentrations of selenium in water, bottom sediment, and biota were noted during a reconnaissance investigation of the Kendrick Reclamation Project in central Wyoming. Dissolved-selenium concentrations in 11 of 24 samples of surface or ground water exceeded the national drinking-water standard of 10 micrograms per liter. Bottom-sediment samples contained concentrations of several

elements, including selenium, that were greater than baseline concentrations in soils of western States. Samples of biota from several trophic levels at four wetlands contained selenium at concentrations associated with physiological problems and abnormalities as reported in laboratory studies and previously published literature.

Petrovic, A. M. "The Fate Of Nitrogenous Fertilizers Applied To Turfgrass." ***Journal Of Environmental Quality*****. V. 19, n. 1. pp. 1-14. 1990.**

Abstract. Maintaining high quality surface and groundwater supplies is a national concern. Nitrate is a widespread contaminant of groundwater. Nitrogenous fertilizer applied to turfgrass could pose a threat to groundwater quality. However, a review of the fate of N applied to turfgrass is lacking, but needed in developing management systems to minimize groundwater contamination. The discussion of the fate of N applied to turfgrass is developed around plant uptake, atmospheric loss, soil storage, leaching, and runoff. The proportion of the fertilizer N that is taken up by the turfgrass plant varied from 5 to 74% of applied N. Uptake was a function of N release rate N rate and species of grass. Atmospheric loss, by either NH_3 volatilization or denitrification, varied from 0 to 93% of applied N. Volatilization was generally <36% of applied N and can be reduced substantially by irrigation after application. Denitrification was only found to be significant (93% of applied N) on fine-textured, saturated, warm soils. The amount of fertilizer N found in the soil plus thatch pool varied as a function of N source, release rate, age of site, and clipping management. With a soluble N source, fertilizer N found in the soil and thatch was 15 to 21% and 21 to 26% of applied N, respectively, with the higher values reflecting clippings being returned. Leaching losses for fertilizer N were highly influenced by fertilizer management practices (N rate, source, and timing), soil texture, and irrigation. Highest leaching losses were reported at 53% of applied N, but generally were far less than 10%. Runoff of N applied to turfgrass has been studied to a limited degree and has been found seldom to occur at concentrations above the federal drinking water standard for NO_3^-. Where turfgrass fertilization poses a threat to groundwater quality, management strategies can allow the turfgrass manager to minimize or eliminate NO_3^- leaching.

Phelps, G. G. ***Effects Of Surface Runoff And Treated Wastewater Recharge On Quality Of Water In The Floridan Aquifer System, Gainesville Area, Alachua County, Florida*** **. Geological Survey Water-Resources Investigations Report 87-4099. U.S. Geological Survey, Tallahassee, Florida. 1987.**

Abstract. Rates of recharge to the Floridan aquifer system at four sites in Alachua County were estimated and water samples were analyzed to determine if the recharge water had any effects on the water quality of the aquifer. A total of about 33 million gallons per day recharges the upper part of the aquifer system at Haile Sink, Alachua Sink, and drainage wells near Lake Alice . At the Kanapaha Wastewater Treatment Plant, injection wells recharge an average of 6.1 million gallons per day into the lower zone of the system.

The samples of water entering the aquifer system collected at the four sites generally conformed to the drinking water standards recommended by the U.S. Environmental Protection Agency in 1983. Bacteria and nutrient concentrations were more variable in the recharge water than were other constituents. Organic compounds such as diazinon, lindane, and malathion were occasionally detected in all recharge water, but concentrations never exceeded recommended limits.

Bacteria were detected in most wells sampled near the Gainesville recharge sites. The highest counts were from wells near Alachua Sink. At only one site was there a significant difference between the quality of the recharge water and water from the wells sampled, although the recharge water tended

to be lower in calcium and iron than water from the Floridan aquifer system. A sample from a well about 150 feet downgradient of a drainage well near Lake Alice consisted of turbid water with a total phosphorus concentration of 75 milligrams per liter and a total nitrogen concentration of 57 milligrams per liter. Water flowing into the drainage well from the lake had a total nitrogen concentration of 1.6 milligrams per liter. Apparently, nutrient-rich suspended sediment in inflow to the drainage well settles out of the water and accumulates in the cavities in the limestone.

Estimated loads entering the aquifer include 3,500 kilograms day of chloride, less than 0.43 kilogram per day lead, 310 kilograms per day of nitrogen, and 150 kilograms per day of phosphorus. The effects of the loads were not detected in most monitor wells. Apparently, some of the constituents may settle out, some may be absorbed by the aquifer materials, and the remainder diluted and dispersed by the extremely large volume of water in the aquifer.

Pierce, R. C. and M. P. Wong. "Pesticides In Agricultural Waters: The Role of Water Quality Guidelines." ***Canadian Water Resources Journal.*** **V. 13, n. 3. pp. 33-49. 1988.**

Abstract. Water of good quality is of primary importance to modern agriculture in determining the productivity of crops and the health and marketability of livestock. The quality of water used in agricultural operations can be affected by numerous factors, including pesticide usage. This paper focuses on the relationship between the use of pesticides in Canadian agriculture and the hazards associated with the quality of agricultural waters used in irrigation and livestock watering. The extent and complexity of this problem is assessed initially by examining the overlap between pesticide use and agricultural water use in Canada. The inherent properties of selected pesticides used in Canadian agriculture are highlighted and related to their potential for release to agricultural water supplies. Field and laboratory investigators as related to agricultural water uses are reviewed and a discussion of pesticide water quality guidelines to ensure protection of agricultural water supplies is provided.

Pitt, W. A. J. Jr. ***Effects Of Septic Tank Effluent On Ground- Water Quality, Dade County, Florida: An Interim Report.*** **Geological Survey Open File Report 74010. U.S. Geological Survey, Tallahassee, Florida. 1974.**

Abstract. At each of five sites in Dade County, where individual (residence) septic tanks have been in operation for at least 15 years and where septic tank concentration is less than 5 per acre, a drainfield site was selected for investigation to determine the effects of septic tank effluent on the quality of the water in the Biscayne Aquifer.

At each site two sets of multiple depth wells were drilled. The upgradient wells adjacent to the drainfields in most places, were constructed in such a way that the aquifer could be sampled at 10, 20, 30, 40, and 60 feet below land surface. The down-gradient wells at each site area 35 feet or more from the up-gradient wells in the direction of ground-water flow, and allow the aquifer to be sampled at various depths.

Except at one site, no fecal coliforms were found below the 10-foot depth. Total coliforms exceeded a count of one colony per ml at the 60-fool depth at two sites. At one site a fecal streptococci count of 53 colonies per ml was found at the 60-foot depth and at another a count of seven colonies was found at the 40-foot depth. The three types of bacteria occur in higher concentration in the northern areas of the county than in the south. Bacteria concentrations were also higher where the septic tanks were more concentrated.

Pitt, W. A. J. Jr., H. C. Mattraw and H. Klein. ***Ground-Water Quality In Selected Areas Serviced By Septic Tanks, Dade County, Florida.*** **Geological Survey Open File Report 75-607. U.S. Geological Survey, Tallahassee, Florida. 1975.**

Abstract. During 1971-74, the U.S. Geological Survey investigated the chemical, physical, bacteriological, and virological characteristics of the ground water in five selected areas serviced by septic tanks in Dade county, Florida. Periodic water samples were collected from multiple-depth groups of monitor wells ranging in depth from 10 to 60 ft at each of the five areas. Analyses of ground water from base-line water-quality wells in inland areas remote from urban development indicated that the ground water is naturally high in organic nitrogen, ammonia, organic carbon and chemical oxygen demand. Some enrichment of ground water with sodium provided a possible key to differentiating septic-tank effluent from other urban ground- water contaminant sources. High ammonia nitrogen, phosphorus, and the repetitive detection of fecal coliform bacteria were characteristic of two 10-foot monitor wells that consistently indicated the presence of septic-tank effluent in ground water. Dispersion, dilution, and various chemical processes have presumably prevented accumulation of septic-tank effluent at depths greater than 20 ft, as indicated by the 65 types of water analyses used in the investigation. Fecal coliform bacteria were present on one or two occasions in many monitor wells but the highest concentration, 1,600 colonies/100 ml, was related to storm-water infiltration rather than septic-tank discharge.

Areal variations in the composition and the hydraulic conductivity of the sand and limestone aquifer had the most noticeable influence on the overall ground-water quality. The ground water in the more permeable limestone in south Dade County near Homestead contained low concentrations of septic-tank related constituents, but higher concentrations of dissolved sulfate and nitrate. The ground water in north Dade County, where the aquifer is less permeable, contained the highest dissolved iron, manganese, COD, and organic carbon.

Power, J. F. and J. S. Schepers. "Nitrate Contamination Of Groundwater In North America." ***Agriculture, Ecosystems and Environment.*** **V. 26, n. 3-4. pp. 165-187. 1989.**

Abstract. Groundwater serves as the primary domestic water supply for over 90% of the rural population and 50% of the total population of North America. Consequently, protection of groundwater from contamination is of major concern. This paper reviews the problem of controlling nitrate pollution of groundwater in North America. Nitrates in groundwater originate from a number of non-point sources, including geological origins, septic tanks, improper use of animal manures, cultivation (especially fallowing) precipitation , and fertilizers. Accumulation of nitrate N in groundwater is probably attributed to different regions. Major areas of nitrate pollution often occur under irrigation because leaching is required to control salt accumulation in the root zone. In the last few decades, areas under irrigation and the use of N fertilizers have increased greatly, and both of these have probably contributed to groundwater nitrate problems. Use of known best management practices (irrigation scheduling; fertilization based on calibrated soil tests; conservation tillage; acceptable cropping practices; recommended manuring rates) has been demonstrates to be highly effective in controlling leaching of nitrates. Government policies are needed that will encourage and reward the use of the best management practices that help control nitrate accumulations in groundwater.

Pruitt, J. B., D. E. Troutman and G. A. Irwin. ***Reconnaissance Of Selected Organic Contaminants In Effluent And Ground Water At Fifteen Municipal Wastewater Treatment Plants In Florida.*** **Geological Survey Water-Resources Investigations Report 85-4167. U.S. Geological Survey, Tallahassee, Florida. 1985.**

Abstract. Results of a 1983-84 reconnaissance of 15 municipal wastewater treatment plants in Florida indicated that effluent form most of the plants contains trace concentrations of volatile organic compounds. Chloroform was detected in the effluent at 11 of the 15 plants and its common occurrence was likely the result of chlorination. The maximum concentration of chloroform detected in the effluent sampled was 120 micrograms per liter. Detectable concentrations of selected organophosphorus insecticides were also common. For example, diazinon was detected in the effluent at 12 of the 15 plants with a maximum concentration of 1.5 micrograms per liter. Organochlorine insecticides, primarily lindane, were detected in the effluent at 8 of the 15 plants with a maximum concentration of 1.0 micrograms per liter.

Volatile compounds, primarily chloroform, were detected in water from monitor wells at four plants and organophosphorus insecticides, primarily diazinon, were present in the ground water at three treatment plants. Organochlorine insecticides were not detected in any samples from monitor wells. Based on the limited data available, this cursory reconnaissance suggests that the organic contaminants commonly occurring in the effluent of many of the treatment plants are not transported into the local ground water.

Ragone, S. E. ***Geochemical Effects Of Recharging The Magothy Aquifer, Bay Park, New York, With Tertiary-Treated Sewage.*** **Geological Survey Professional Paper 751-D. U.S. Government Printing Office, Washington, D.C. 1977.**

Abstract. A ground-water deficit of 93.5 to 123 million gallons per day (4.10 to 5.39 cubic meters per second) has been predicted for Nassau County, N.Y., by the year 2000 in a State report. Because of the predicted deficit, the U.S. Geological Survey, in cooperation with the Nassau County Department of Public Works, began an experimental deep-well recharge program in 1968. Thirteen recharge tests using tertiary-treated sewage (reclaimed water) and six tests using water from the domestic supply (city Water) were completed between 1968 and 1973. Recharge was through an 18-inch (46-centimeter) diameter recharge well screened in the Magothy aquifer between depths of 418 and 480 feet (127 and 146 meters) below land surface. Recharge rates ranged from about 200 to 400 gallons per minute (13 to 25 liters per second). In the longest test, reclaimed water was injected during 84.5 days of a 199-day period.

Although the iron concentration of native water in the recharge zone and reclaimed water is less than 0.5 milligrams per liter, the iron concentration of samples collected from observation wells 20, 100, and 200 feet (6.1, 30, and 61 meters) from the recharge well, and screened in the zone of recharge, approached 3 milligrams per liter at times. Iron mass-balance calculations indicate that dissolution of pyrite and marcasite (FeS_2) in the aquifer are the only known sources of iron that could explain the observed increase. Within a 20-foot (6.1-meter) radius of the recharge well, dissolved oxygen in the reclaimed water oxidizes pyrite and release Fe^{+2} (ferrous iron) to solution. However, the amount of iron in water continues to increase with distance from the recharge well even though dissolved oxygen is no longer present in water reaching the 20-foot (6.1 meter) radius; the mechanism by which iron continues to be dissolved in not quantitatively understood.

Some cation exchange also occurs during recharge. Loss of ammonium and potassium cations in the water was balanced by an increase in H^+, which at times caused pH to decrease by more than 1 pH unit.

Tertiary treatment removes 90 to 98 percent of the phosphate, MBAS (methylene blue active substances), and COD (chemical oxygen demand), leaving an average of 0.17, 0.07, and 9 milligrams per liter, respectively. During recharge, phosphate concentrations remain at native-water levels at the 20-, 100-, and 200-foot (6.1-, 30-, and 61-meter) observation wells, which indicates phosphate retention by the aquifer. Some MBAS and COD are retained at the 100-and 200- foot (30-and 61-meter) wells, presumably by adsorption reactions.

Ragone, S. E., H. F. H. Ku and J. Vecchioli. "Mobilization Of Iron In Water In The Magothy Aquifer During Long-Term Recharge With Tertiary-Treated Sewage, Bay Park, New York." ***Journal Research U.S. Geological Survey*****. V. 3, n. 1. pp. 93-98. 1975.**

Abstract. Tertiary-treated sewage (reclaimed water) has been recharged by well into the Magothy aquifer qt Bay Park, N.Y., intermittently since 1968. The longest of 13 recharge tests, the subject of this report, lasted 84.5 days. This was sufficient time for the reclaimed water to reach an observation well 200 ft (61 m) from the recharge well. Although the iron concentrations of the reclaimed water and the native water were less than 0.4 mg/l, the iron concentrations of samples from observation wells 20,000, and 200 ft (6,30, and 61 m) from the recharge well at times approached 3 mg/l. Source of the iron is pyrite that is native to the aquifer.

Ragone, S. E. and J. Vecchioli. "Chemical Interaction During Deep Well Recharge Bay Park, New York." ***Ground Water*****. V. 13 , n. 1. Reprint. 1975.**

Abstract. The U.S. Geological Survey, in cooperation with the Nassau County Department of Public Works, recharged tertia ry-treated sewage (reclaimed water) into the Magothy aquifer in 13 recharge experiments between 1968 and 1973. The recharge resulted in a degradation in water quality with respect to iron concentration and pH. Iron concentration increased from the range 0.14 to 0.30 milligrams per litre to as much as 3 milligrams per litre at the 20-, 100-, and 200-foot or 6.1-, 30-, and 61-metre observation wells as the reclaimed water displaced native water. The increase was presumably a result of pyrite dissolution. The pH of the water decreased from the range 5.22 to 5.72 to a low of about 4.50, predominantly as a result of cation-exchange reactions.

Ramsey, R. H. III, J. Borreli and C. B. Fedler. "The Lubbock, Texas, Land Treatment System." ***Irrigation Systems For The 21st Century, Portland, Oregon, 1987*****. (American Society Of Civil Engineers,** New York, New York, pp. 352-361). 1987.

Abstract. The land treatment system at Lubbock, Texas provides an excellent model for studying the response of a system to growth. It also provides insights and justification for current criteria used to design slow-rate land treatment systems. During the 62 years of operation, the Lubbock Land Treatment System responded to a substantial increase in the volume of the effluent and changes in environmental concern for groundwater pollution. While certain problems persist, they have demonstrated that shortcomings in the system design can be turned into positive assets. Groundwater from beneath the treatment farms is used to provide flat water recreation and for irrigation of city parks and cemeteries.

Razack, M., C. Drogue and M. Baitelem. "Impact Of An Urban Area On The Hydrochemistry Of A Shallow Groundwater (Alluvial Reservoir) Town Of Narbonne, France." ***Hydrological Processes And Water Management In Urban Areas, Duisburg, Federal Republic Of Germany, 1988.*** **(International Hydrological Programme, UNESCO, pp. 487-494). 1988.**

Abstract. The Roman founded urban area of Narbonne in Southern France is built upon a shallow groundwater. This reservoir which thickness ranges from 10 to 30 meters is composed by the packing of varied materials and by quaternary deposits. A hydrochemical survey carried out during the Summer 1984 and the Winter 1985, showed an important impact of the urban activity on the groundwater quality. This impact is expressed through the superimposition beneath the city of a chemistry of exogeneous elements issued from urban activity (SO_4,NO_3) and of a natural chemistry (Na, Cl), both displaying different aerial patterns.

Rea, A. H. and J. D. Istok. "Groundwater Vulnerability To Contamination: A Literature Review." ***Irrigation Systems For The 21st Century, Portland, Oregon, 1987.*** **(American Society Of Civil Engineers, New York, New York, pp. 362-367). 1987.**

Abstract. Methods are needed to allow regulatory agencies and resource managers to predict, from readily available data, the potential for groundwater contamination problems. Regional maps developed from these methods can aid in planning and allocation of resources. The literature was searched for methods capable of filling this need. Six methods were selected and compared using hypothetical hydrogeologic settings. Based on the results obtained, which varied considerably between methods, none of the methods is completely satisfactory. Of the reviewed methods, "DRASTIC" seemed to be most suitable.

Reichenbaugh, R. C. ***Effects On Ground-Water Quality From Irrigating Pasture With Sewage Effluent Near Lakeland, Florida.*** **Geological Survey Water-Resources Investigations 76-108. U.S. Geological Survey, Tallahassee, Florida. 1977.**

Abstract. Since 1969, on the average, 25,000 gallons (94,600 liters per day) of domestic secondary-treated effluent has been used each day to supplement irrigation of 30 acres (12 hectares) of grazed pasture north of Lakeland, in west-central Florida. The U.S. Geological Survey began a study of the site several months after sprinkler application of the effluent to the Myakka sands (well- sorted, fine, acid) was started. The site, on the south shore of Lake Gibson, is underlain by as much as 60 feet (18 meters) of sand, sandy clay, and clay, containing the water-table aquifer, and two relatively unimportant confined aquifers, which in turn are underlain by the confined Floridan aquifer.

Monitor-wells were constructed to various depths in clusters near the effluent- irrigated pasture. The water table in the surficial aquifer varied from 1 to 3.3 feet (0.3 to 1.0 meters) below the land surface. Ground-water quality was evaluated by analysis of water samples collected three times over a 1-year period.

Ground-water beneath the irrigated pasture showed slight increases in cations and anions which are attributed to irrigation with the effluent. The concentration of total nitrogen (predominantly ammonia and organic nitrogen) was reduced to less than 20 percent of that in the upper 8 feet (2.4 meters) of pasture soils, and there was no increase in concentration below 20 feet (6.1 meters), or in downgradient ground water. There was no evidence of phosphorus or carbon contamination of ground water at the site. Though small numbers of bacteria were noted in some samples from nine wells, most were of the coliform

group. Only four wells yielded samples containing bacteria of probable fecal origin--one colony per 100 milliliters in each sample.

There was no detected accumulation of solids at the soil surface. Organic carbon, pH, and Kjeldahl nitrogen concentrations of the soil in the irrigated pasture were only slightly higher when compared to soil outside the pasture. As of 1972, the low-rate application of the effluent to the pasture apparently has had little effect on the soil and ground water.

Reichenbaugh, R. C., D. P. Brown and C. L. Goetz. *Results Of Testing Landspreading Of Treated Municipal Wastewater At St. Petersburg, Florida.* Geological Survey Water-Resources Investigations Report 78-110. U.S. Geological Survey, Tallahassee, Florida. 1979.

Abstract. Chlorinated secondary-treated effluent was used to irrigate a grassed 4-acre site at rates of 2 and 4 inches per week for periods of 11 and 14 weeks, respectively. Part of the site was drained by tile lines 5 feet below land surface. Chemical and bacteriological changes in the acidic ground water in the shallow and aquifer and in the effluent from the drains were studied.

Irrigation of the drained plot resulted in rapid passage of the applied wastewater through the soil and, consequently, poor nitrogen removal. The rapid percolation permitted nitrification but prevented denitrification. Thus, the effluent from the drains contained as much as 5.2 milligrams per liter nitrate-nitrogen. Irrigation of the undrained plot resulted in more extensive nitrogen removal.

Total phosphorus in the shallow ground water at the site increased from a maximum of 1.4 milligrams per liter before irrigation to as much as 5 milligrams per liter in the ground water 5 feet below land surface.

Concentrations of nitrogen and phosphorus did not increase in ground water downgradient from the site, although increased chloride concentrations demonstrated downgradient migration of the applied wastewater.

Prior to irrigation, total coliform bacteria were not detected in ground water at the site. After irrigation, total and fecal coliforms were detected in the ground water at the site and downgradient. The nitrifying bacteria *Nitrosomonas* and *Nitrobacter* at the irrigated site were most abundant at the soil surface; their numbers decreased with depth.

Rein, D. A., G. M. Jamesson and R. A. Monteith. "Toxicity Effects Of Alternative Disinfection Processes." *Water Environment Federation 65th Annual Conference & Exposition, New Orleans, Louisiana, 1992.* (Water Environment Federation, Alexandria, Virginia, pp. 461-470). 1992.

Abstract. Chlorination/dechlorination, ultraviolet irradiation, and ozonation were evaluated in side-by-side pilot/bench scale tests at the Akron, Ohio Water Pollution Control Station. The objective of the evaluation was to investigate the effect of these disinfection Processes on final effluent toxicity.

Six sets of chronic and two sets of acute whole effluent toxicity tests were conducted using *P. promelas* and *C. dubia*. After the first two sets of tests, it became apparent that differences between the processes could only be seen in 100 percent effluent samples. The test protocol was then modified to compare the relative toxic response in terms of survival and reproduction of *C. dubia* in 100 percent effluent samples.

Although very little statistically estimated toxicity was found in any of the process effluents, the chlorination/ dechlorination process effluent consistently produced a greater relative toxic response than either ultraviolet irradiation or ozonation. The chlorination/ dechlorination process produced the greatest relative toxic response for offspring produced and/or survival of *C. dubia* in seven of eight tests sets using 100 percent effluent samples.

Rice, R. C., D. B. Jaynes and R. S. Bowman. "Preferential Flow Of Solutes And Herbicide Under Irrigated Fields." ***Transactions Of The American Society Of Agricultural Engineers*. V. 34, n. 2. pp. 914-918. 1991.**

Abstract. Over the past several years, there has been an increasing concern of groundwater contamination from agricultural chemicals. Until recently it was generally believed that pesticides would not move to the groundwater. Starting in the mid-seventies more cases of pesticide contamination were reported. This article discusses recent experiments where accelerated leaching of solutes and a herbicide were observed under intermittent flood and sprinkler irrigation. Preferential flow phenomena resulted in solute and herbicide velocities of 1.6 to 2.5 times faster than calculated by traditional water balance methods and piston flow model. Little preferential flow was observed under continuously flooded conditions on a loam soil. Generally, preferential flow is thought to occur in coarse grained soils , cracked soils or in macro-pores such as root or worm holes. The bypass that we observed was in sandy loam and sandy soils with little or no structure. Understanding the preferential flow phenomena is necessary when predictive flow models are used.

Ritter, W. F., F. J. Humenik and R. W. Skaggs. "Irrigated Agriculture And Water Quality In East." ***Journal of Irrigation and Drainage Engineering*. V. 115, n. 5. pp. 807-821. 1989.**

Abstract. The northeastern and Appalachian states have a diverse array of geology, soils, and climate. Irrigation is concentrated in a few states, with the largest irrigation area in the Coastal Plain soils. Most of these soils are sandy and very susceptible to leaching. The groundwater recharge area in the Coastal Plain is directly above the aquifer. Most of the increase in irrigation has been to irrigate corn in Delaware, Maryland, and Virginia. Groundwater studies have been conducted in Delaware, Maryland, and New York in irrigated regions. Nitrate and aldicarb leaching has occurred on Long Island, New York, where potatoes are grown. Poultry manure is the largest source of nitrate contamination of the water table aquifer on the Delmarva Peninsula in Maryland. Both pesticide and nitrate leaching under irrigation have been studied in Delaware. A total water management system that can be used for both drainage and subsurface irrigation has been developed in North Carolina. The system will increase crop yields and has the potential for reducing nitrates by water table control.

Ritter, W. F., R. W. Scarborough and E. M. Chirnside. "Nitrate Leaching Under Irrigation On Coastal Plain Soil." ***Journal of Irrigation and Drainage Engineering*. V. 117, n. 4. pp. 490-502. 1991.**

Abstract. The effect of irrigation and nitrogen management on ground-water quality was evaluated for four years on a Sassafras sandy loam Coastal Plain soil. Applying the greatest portion of the nitrogen by side-dressing and by fertigation were compared. Maintaining optimum soil moisture and partial irrigation (applying one half the water as optimum irrigation) were the water management practices investigated. Nitrate concentrations increased in the ground water for all nitrogen and irrigation-management practices. The mass of the nitrate leached was related to the drainage volume. In all but one year the largest mass of nitrate was leached during the fall and winter months, when the largest amount of

recharge occurs. Very little nitrate was leached during the growing season for any nitrogen or irrigation management practice except for one year when 30 cm of rainfall occurred in August. The mass of nitrate leached during that growing season ranged from 33.9 kg/ha for partial irrigation to 139.0 kg/ha for full irrigation.

Robinson, J. H. and H. S. Snyder. "Golf Course Development Concerns In Coastal Zone Management." ***Coastal Zone '91: Proceedings Of The Seventh Symposium On Coastal And Ocean Management, Long Beach, California, 1991.*** **(American Society Of Civil Engineers, New York, New York, pp. 431-442). 1991.**

Abstract. The rapid growth of golf course development in South Carolina's coastal zone presents new challenges in protecting coastal water and wetlands. While filling or dredging of wetland resources for golf courses development is a practice of the past, golf course designers make every effort to minimize their proximity to wetland resource areas. Coastal zone management concerns associated with golf course development include the protection of adjacent wetland resources from (1) nutrient and chemical laden storm water runoff, (2) aerosol from "fertigation," a mixture of fertilizer and irrigation water, and treated effluent irrigation systems, and (3) physical impacts associated with wetland crossings, play-through areas, and player intrusion. This paper first provides a brief overview of current literature associated with the use of chemicals on golf courses and their impacts on man and the coastal environment. This paper then focuses on best management practices which can be utilized in the physical design and management of golf courses to minimize impacts on coastal resources, drawing upon examples from golf courses recently constructed or currently under development in coastal South Carolina.

Rosenshein, J. S. and J. J. Hickey. "Storage Of Treated Sewage Effluent And Storm Water In A Saline Aquifer Pinellas Peninsula, Florida." ***Ground Water.*** **V. 15, n. 4. pp. 284-293. 1977.**

Abstract. The Pinellas Peninsula, an area of 750 square kilometres (290 square miles) in coastal west-central Florida, is a small hydrogeologic replica of Florida. Most of the Peninsula's water supply is imported from wells fields as much as 65 kilometres (40 miles) inland. Stresses on the hydrologic environment of the Peninsula and on adjacent water bodies, resulting from intensive water-resources development and waste discharge, have resulted in marked interest in subsurface storage of waste water (treated effluent and untreated storm water) and in future retrieval of stored water for nonpotable use. If subsurface storage is approved by regulatory agencies, as much as 265 megalitres per day (70 million gallons a day) of waste water could be stored underground within a few years, and more than 565 megalitres per day (150 million gallons a day) could be stored in about 25 years. This storage would constitute a large resource of nearly fresh water in the saline aquifers underlying about 250 square kilometres (200 square miles) of the Peninsula.

The upper 1,060 metres (3,480 feet) of the rock column underlying four test sites on the Pinellas Peninsula have been explored. The rocks consist chiefly of limestone and dolomite. Three moderately to highly transmissive zones, separated by leaky confining beds, (low permeability limestone) from about 225 to 380 metres (740 to 1,250 feet) below mean sea level, have been identified in the lower part of the Floridan aquifer in the Avon Park Limestone. Results of withdrawal and injection tests in Pinellas County indicate that the middle transmissive zone has the highest estimated transmissivity -- about 10 times other reported values. The chloride concentration of water in this zone, as well as in the Avon Park Limestone in Pinellas Peninsula, is about 19,000 milligrams per litre. If subsurface storage is approved and implemented, this middle zone probably would be used for storage of the waste water and the one would become the most extensively used in Florida for this purpose.

Sabatini, D. A. and T. A. Austin. "Adsorption, Desorption And Transport Of Pesticides In Groundwater: A Critical Review." ***Planning Now For Irrigation And Drainage In The 21st Century, Lincoln, Nebraska, 1988.*** **(American Society Of Civil Engineers, New York, New York, pp. 571-579). 1988.**

Abstract. Adsorption and desorption are major mechanisms affecting the transport and fate of pesticides in groundwater. Equilibrium, chemical nonequilibrium and physical nonequilibrium adsorption relationships for predicting pesticide transport are reviewed. Hysteresis of desorption and relationships for predicting linear equilibrium coefficients are discussed.

Sabol, G. V., H. Bouwer and P. J. Wierenga. "Irrigation Effects In Arizona And New Mexico." ***Journal of Irrigation and Drainage Engineering*****. V. 113, n. 1. pp. 30-57. 1987.**

Abstract. Irrigated agriculture accounts for about 90% of all water consumption in both Arizona and New Mexico. More than 50% of this water is pumped from groundwater sources. Some portion of the applied irrigation water is returned to the groundwater supply through deep percolation. Several field studies have been conducted in these states to measure the quantity and quality of water that is recharging the aquifer. These studies indicate that groundwater quality in Arizona and New Mexico has been deleteriously affected in deep supplies. The magnitude and time rate of groundwater quality changes is a function of irrigation management practice, fertilizer and pesticide applications, quality of irrigation water, rate of groundwater level decline, presence of perched zones that intercept percolating water, proximity to surface water supplies, leakage through and along well casings, and soil salinity.

Salo, J. E., D. Harrison and E. M. Archibald. "Removing Contaminants By Groundwater Recharge Basins." ***Journal Of The American Water Works Association*****. V. 78, n. 9. pp. 76-81. 1986.**

Abstract. The effects of urban runoff used to recharge groundwater basins in the Fresno, Calif., area are discussed. The study, which was part of the US Environmental Protection Agency's nationwide urban runoff program, was undertaken to determine the environmental effects on groundwater quality and to identify management practices that would mitigate adverse effects. No deterioration of groundwater quality because of recharge with runoff was found, although the authors recommend a more thorough investigation of effects of recharge with runoff from industrial sites.

Schiffer, D. M. ***Effects Of Three Highway-Runoff Detention Methods On Water Quality Of the Surficial Aquifer System In Central Florida.*** **Geological Survey Water-Resources Investigations Report 88-4170. U.S. Geological Survey, Tallahassee, Florida. 1989.**

Abstract. Water quality of the surficial aquifer system was evaluated at one exfiltration pipe, two ponds (detention and retention), and two swales in central Florida, representing three runoff detention methods, to detect any effects from infiltrating highway runoff. Concentrations of major ions, metals, and nutrients were measured in ground water and bottom sediments form 1984 through 1986.

At each study area, concentrations in ground water near the structure were compared to concentrations in ground water from an upgradient control site. Ground-water quality data also were pooled by detention method and statistically compared to detect any significant differences between methods.

Analysis of variance of the rank-converted water-quality data at the exfiltration pipe indicated that mean concentration s of 14 to 26 water-quality variables are significantly different among sampling locations (the pipe, unsaturated zone, saturated zone, and the control well). Most of these differences are between the unsaturated zone and other locations. Only phosphorus is significantly higher in ground water near the pipe than in ground water at the control well.

Analysis of variance of rank- converted water-quality data at the retention pond indicated significantly differences in 14 to 25 water-quality variables among sampling locations (surficial aquifer system, intermediate aquifer, pond, and the control well), but mean concentrations in ground water below the pond were never significantly higher than in ground water from the control well. Analysis of variance results at other study areas indicated few significant differences in water quality among sampling locations.

Values of water-quality variables measured in ground water at all study areas generally were within drinking water standards. the few exceptions included pH (frequently lower than the limit of 6.5 at one pond and both swales), and iron, which frequently exceeded 300 micrograms per liter in ground water at one swale and the detention pond.

Large concentrations of polyaromatic hydrocarbons were measured in sediments at the retention pond, but qualitative analysis of organic compounds in ground water from three wells indicated concentrations of only 1 to 5 micrograms per liter at on site, and below detection level (1 microgram per liter) at the other two sites. This may be an indication of immobilization of organic compounds in sediments.

Significant differences for most variables were indicated among ground-water quality data pooled by detention method. Nitrate nitrogen and phosphorus concentrations were highest in ground water near swales and exfiltration pipe, the Kjeldahl nitrogen was highest near ponds. Chromium, copper, and lead concentrations in ground water were frequently below detection levels at all study areas, and no significant differences among detention methods were detected for any metal concentration with the exception of iron. High iron concentrations in ground water near the detention pond and one swale most likely were naturally occurring and unrelated to highway runoff.

Results of the study indicate that natural processes occurring in soils attenuate inorganic constituents in runoff prior to reaching the receiving ground water. However, organic compounds detected in sediments at the retention pond indicate a potential problem that may eventually affect the quality of the receiving ground water.

Schmidt, K. D. and I. Sherman. "Effect Of Irrigation On Groundwater Quality In California." ***Journal Of Irrigation And Drainage Engineering*. V. 113, n. 1. pp. 16-29. 1987.**

Abstract. Deep percolation of irrigation return flow is a major source of recharge beneath most irrigated areas in California. Tile drainage, soils, water in the vadose zone, and shallow groundwater have been studied. Nitrate, salinity, and several pesticide have received the most attention. Numerous parts of the San Joaquin Valley have been investigated, as well as parts of the Sacramento Valley, Imperial Valley, Los Angeles Basin, and several other valleys. The results of the studies indicate that irrigation return flow usually exerts a substantial impact on groundwater quality. High nitrate contents in groundwater beneath irrigated areas are often a result of irrigation. In addition, extensive pollution of shallow groundwater in parts of the San Joaquin Valley have been caused by use of the pesticide DBCP.

Schneider, B. J., H. F. H. Ku and E. T. Oaksford. ***Hydrologic Effects Of Artificial-Recharge Experiments With Reclaimed Water At East Meadow, Long Island, New York.*** **Geological Survey Water Resources Investigations Report 85-4323. U.S. Geological Survey, Denver, Colorado. 1987.**

Abstract. Artificial-recharge experiments were conducted at East meadow from October 1982 through January 1984 to evaluate the degree of ground-water mounding and the chemical effects of artificially replenishing the ground-water system with tertiary-treated wastewater. More than 800 million gallons of treated effluent was returned to the upper glacial aquifer through recharge basins and injection wells in the 15-month period.

Reclaimed water was provided by the Cedar Creek advanced wastewater-treatment facility in Wantagh, 6 miles away. The chlorinated effluent was pumped to the recharge facility, where it was fed to basins by gravity flow and to injection wells by pumps. An observation- well network was installed at the recharge facility to monitor both physical and chemical effects of reclaimed water on the ground-water system.

Observations during the recharge tests indicate that the two most significant factors in limiting the rate of infiltration through the basins floor were the recharge- test duration and quality of reclaimed water. Head buildup in the aquifer beneath the basins ranged from 4.3 to 6.7 feet, depending on the quantity and duration of water application. Head buildup near the injection wells within the aquifer ranged from 0.3 to 1.2 feet. The head buildup in the injection wells is attributed to biological, physical, and chemical actions, which can operate separately or together. Recharge basins provided a more effective means of moving large quantities of reclaimed water into the aquifer than injection wells.

Two basins equipped with central observation manholes permit the acquisition of data on the physical and chemical processes that occur within the unsaturated zone during recharge. Results of 3-day and 176-day ponding tests in basins 3 and 2, respectively, indicate that reclaimed water is relatively unchanged chemically by percolation through the unsaturated zone because (1) the sand and gravel of the upper glacial aquifer is unreactive, (2) the water moves to the water table rapidly, and (3) the water is highly treated before recharge.

The quality of water in the aquifer zones affected by recharge improved, on the whole. Ground-water concentrations of nitrate nitrogen and several low-molecular- weight hydrocarbons, although significantly above drinking-water standards before recharge, decrease to well within drinking-water standards as a direct result of recharge. Sodium and chloride concentrations increased above background levels as a result of recharge but remained well within drinking-water standards and the New York State effluent standards established for this ground-water-recharge study.

Seaburn, G. E. and D. A. Aronson. ***Influence Of Recharge Basins On The Hydrology Of Nassau And Suffolk Counties, Long Island, New York.*** **Geological Survey Water Supply Paper 2031. U.S. Government Printing Office, Washington, D.C. 1974.**

Abstract. An investigation of recharge basins on Long Island was made by the U.S. Geological Survey in cooperation with the New York State Department of Environmental Conservation, Nassau County Department of Public Works, Suffolk County Water Authority. The major objectives of the study were to (1) catalog basic physical data on the recharge basins in use on Long Island, (2) measure quality and quantity of precipitation and inflow, (3) measure infiltration rates at selected recharge basins, and (4)

evaluate regional effects of recharge basins on the hydrologic system of Long Island. The area of study consists of Nassau and Suffolk Counties-about 1,370 square miles -in eastern Long Island, N.Y.

Recharge basins, numbering more than 2,100 on Long Island in 1969, are open pits on moderately to highly permeable sand and gravel deposits. These pits are used to dispose of storm runoff from residential, industrial, and commercial areas, and from highways, by infiltration of the water through the bottom and sides of the basins.

The hydrology of three recharge basins on Long Island -- Westbury, Syosset, and Deer Park basins- was studied. The precipitation-inflow relation showed that the average percentage of precipitation flowing into each basin were roughly equivalent to the average percentage of impervious areas in the total drainage areas of the basins. Average percentages of precipitation flowing into the basins as direct runoff were 12 percent at the Westbury basin, 10 percent at the Syosset basin, and 7 percent at the Deer Park basin. Numerous open-bottomed storm-water catch basins at Syosset and Deer Park reduced the proportion of inflow to those basins, as compared with the Westbury basin, which has only a few open-bottomed catch basins.

Inflow hydrographs for each basin typify the usual urban runoff hydrograph- steeply rising and falling limbs, sharp peaks, and short time bases. Unit hydrographs for the Westbury and the Syosset basins are not expected to change; however, the unit hydrograph for the Deer Park basin is expected to broaden somewhat as a result of additional future house construction within the drainage area.

Infiltration rates averaged 0.9 fph (feet per hour) for 63 storms between July 1967 and May 1970 at the Westbury recharge basin, 0.8 fph for 22 storms from July 1969 to September 1970 at the Syosset recharge basin, and 0.2 fph for 24 storms from March to September 1970 at the Deer Park recharge basin. Low infiltration rates at Deer Park resulted mainly from (1) a high percentage of eroded silt, clay, and organic debris washed in from construction sites in the drainage area, which partly filled the interstices of the natural deposits, and (2) a lack of well-developed plant-root system on the younger basin, which would have kept the soil zone more permeable.

The apparent rate of movement of storm water through the unsaturated zone below the unsaturated zone below each basin averaged 5.5 fph at Westbury, 3.7 fph at Syosset, and 3.1 fph at Deer Park. The rates of movement for storms during the warm months (April through October) were slightly higher than average, probably because the recharging water was warmer than it was during the rest of the year, and therefore, was slightly less viscous.

On the average, a 1-inch rainfall resulted in a peak rise of the water table directly below each basin of 0.5 fool; a 2-inch rainfall resulted in a peak rise of about 2 feet. The mound commonly dissipated within 1 to 4 days at Westbury, 7 days to more than 15 days at Syosset, and 1 to 3 days at Deer Park, depending on the magnitude of the peak buildup.

Average annual ground-water recharge was estimated to be 6.4 acre-feet at the Westbury recharge basin, 10.3 acre-feet at the Syosset recharge basin, and 29.6 acre-feet at the Deer Park recharge basin.

Chemical composition of precipitation at Westbury, Syosset, and Deer Park drainage areas was similar: hardness of water ranged from 6 to 56 mg/l (milligrams per liter as calcium and magnesium hardness), dissolved-solids content ranged from 21 to 124 mg/l, and pH ranged from 5.9 to 6.6. Calcium was the predominant cation, and sulfate and bicarbonate were the predominant anions. Atmospheric dust and gaseous sulfur compounds associated with the Northeast urban environment mainly account for this combination of ions in precipitation.

Chemical composition of the inflow to the basins was also similar in each of the three basins. In general, hardness of the water samples collected at Westbury, Syosset, and Deer Park recharge basins in 1970 was less than 50 mg/l (as calcium and magnesium hardness), and dissolved-solids content was less than 100 mg/l. The pH ranged from 6.1 to 7.4. The concentrations of most constituents in inflow were greater than those in precipitation; precipitation contributed 70 to 88 percent of the loads of dissolved constituents in the inflow.

Only three of 11 pesticides sought by chemical analysis were detected. A maximum DDT concentration of 0.08 ug/l (micrograms per liter) was determined for an inflow sample to Westbury recharge basin. Concentrations of other pesticides were 0.02 ug/ l or less.

Total concentration of pesticides detected in the soil layers on the floors of each basin generally ranged from 0.4 to 40 mg/l. The greater organic content of the soil layers, compared with that of the underlying natural deposits, suggests that pesticides as well as other organic material are effectively reduced or removed from the infiltrating water in the soil layer.

Ground-water recharge from precipitation through the total area (73,000 acres) drained by 2,124 recharge basins in operation in 1969 was estimated to be 166,000 acre-feet per year, or about 148 million gallons per day. Ground-water recharge in the areas where recharge basins are used is probably equivalent to or may slightly exceed recharge under natural conditions.

Shirmohammadi, A. and W. G. Knisel. "Irrigated Agriculture And Water Quality In South." ***Journal of Irrigation and Drainage Engineering*****. V. 115, n. 5. pp. 791-806. 1989.**

Abstract. Irrigated agriculture in the humid region has resulted in more intensive management including crop production and associated increase in fertilizer and pesticide use. Multiple cropping in most of the southeast (Alabama, Florida, Georgia, and South Carolina)and Delta (Arkansas, Louisiana, and Mississippi) states increases the demand for water and agricultural chemicals. Pesticide usage in the 48 states and the District of Columbia totaled 299,892,159 kg of active ingredient (AI) by 1982. Agricultural chemicals may percolate to aquifers in some soils and geologic formations resulting in groundwater contamination. Groundwater fluctuations are related to irrigation. Groundwater quality data are used to show the trend in quality related to irrigated agriculture and cropping systems. Areas with specific groundwater problems such as salt-water intrusion and pesticide levels are identified. A total of 17 pesticides have been reported in groundwater in the United States and four of these were found in the southeast and Delta states. Data show that less than 1% of wells sampled in the southeast and Delta states had nitrate concentrations exceeding 10 mg/'L (drinking water standard). Degradation of surface water quality relative to irrigation is discussed.

Smith, S. O. and D. H. Myott. "Effects Of Cesspool Discharge On Ground-Water Quality On Long Island, N.Y." ***Journal Of The American Water Works Association*****. V. 67, n. 8. pp. 456-458. 1975.**

Abstract. Large amounts of household wastes, discharged through cesspools, have resulted in deterioration of groundwater quality on Long Island. Although nitrate pollution poses the greatest threat to the Island's water supplies, other constituents derived from cesspool leachings are increasing. Municipal sewering projects which have been undertaken as a solution are discussed in the following.

Spalding, R. F. and L. A. Kitchen. "Nitrate In The Intermediate Vadose Zone Beneath Irrigated Cropland." ***Ground Water Monitoring Review.*** **V. 8, n. 2. pp. 89-95. 1988.**

Abstract. More than 1000 feet of fine-textured, unsaturated zone core beneath nitrogen-fertilized and irrigated farmland was collected, leached and analyzed for nitrate-nitrogen. Fertility plots treated with 200, 300 and 400 lbs N/acre/yr accumulated significant quantities of nitrate-nitrogen in those vadose zone below the crop rooting zone. The average nitrate-nitrogen concentration approximately doubled with each 100 lbs. N/acre/ yr increment above the 100 lbs. N/acre/yr treatment. Nitrate loading estimates for the plots treated with 400 lbs./N/acre/yr indicate that over 1200 lbs. N/acre was in the vadose zone beneath the crop rooting zone. In 15 years, the nitrate moved vertically at least 60 feet through these fine-textured, unsaturated sediments. As much as 600 lbs. N/acre have accumulated in the vadose zone under independent corn producer's fields.

Vadose zone sampling is effective in predicting future non-point nitrate-contaminated areas.

Squires, R. C., G. R. Groves and W. R. Johnston. "Economics Of Selenium Removal From Drainage Water." ***Journal of Irrigation and Drainage Engineering*****. V. 115, n. 1. pp. 48-57. 1989.**

Abstract. A treatment system consisting of biological reactors and microfiltration has been developed to remove soluble selenium species from agricultural drainage water. The process was evaluated over a two-year period, and the reactor configurations and specific removal rates of nitrate and selenium were optimized. Trials on the operation of a pilot solar salt works to concentrate the detoxified water after treatment to recover salts were also carried out. The treatment process reduced the selenium concentration of the drainage water from over 500 ug/L to 10-50 ug/L as Se. Boron in the drainage water was reduced from 6-8 mg/L to 0.5 mg/L by an ion exchange post-treatment. This resin also removed residual selenium to below 10 ug/L. Trials on high-salinity drainage waters, similar to those found in evaporation ponds, were successful and gave enhanced specific selenium removal rates. The costs of removing selenium or selenium and boron from the drainage water were estimated to be \$0.038-0.052/m^3 and \$0.050-0.071/m^3, respectively, after allowance for by-product recovery (boric acid and sodium sulfate) credits.

Squires, R. C. and R. Johnston. "Selenium Removal -- Can We Afford It?" ***Irrigation Systems For The 21st Century, Portland, Oregon, 1987.*** **(American Society Of Civil Engineers, New York, New York, pp. 455-467). 1987.**

Abstract. The process of biologically removing the element selenium from agricultural drainage water is discussed and an economic evaluation of the process is presented.

Steenhuis, T., R. Paulsen, T. Richard, W. Staubitz, M. Andreini and J. Surface. "Pesticide And Nitrate Movement Under Conservation And Conventional Tilled Plots." ***Planning Now For Irrigation And Drainage In The 21st Century, Lincoln, Nebraska, 1988.*** **(American Society Of Civil Engineers, New York, New York, pp. 587-595). 1988.**

Abstract. Carbofuran, alachlor, atrazine, nitrate and bromide (a tracer) wee applied to plots with conventional and conservation tillage. Conventional tillage consisted of plowing, disking and harrowing. In the conservation tilled plots, the sod was killed with "Roundup" and the corn seeded without any further tillage.

During the early part of the growing season the conservation tilled plots had a higher tile discharge than those under conventional tillage due to dead sod cover that suppressed evapotranspiration. Low concentrations of atrazine and carbofuran were found below the rootzone in the conservation tilled plots starting one month after application. In the conventional tillage it was not until late fall that some atrazine was detected below the rootzone. Dye studies indicated that in the plowed layer of the conventional tilled plots water and solutes were in intimate contact with the soil matrix promoting adsorption of the pesticides. The bromide tracer was not adsorbed and the bromide distribution with depth was similar for both tillage practices. Bromide was, therefore, a poor indicator for predicting potential pesticide losses under different tillage practices. Nitrate was only found in the zone that was never saturated.

Strutynski, B., R. E. Finger, S. Le and M. Lundt. "Pilot Scale Testing Of Alternative Technologies For Meeting Effluent Reuse Criteria." ***Water Environment Federation 65th Annual Conference & Exposition, New Orleans, Louisiana, 1992.*** **(Water Environment Federation, Alexandria, Virginia, pp. 69-79). 1992.**

Abstract. The Municipality of Metropolitan Seattle (Metro) has been investigating the potential for reuse of the effluent from its treatment plant at Renton for the last several years. The City of Seattle's Water Department, a major water supplier for the area, joined with Metro in 1991 in the evaluation and development of reuse options. These options include both nonconsumptive reuse such as heating and cooling and consumptive reuse such as irrigation.

A pilot program was instituted in 1991 to identify a range of technologies capable of producing reuse quality water from secondary effluent. Technologies investigated included additional chlorination of the existing secondary effluent as well as filtration, ultraviolet disinfection without and with prior filtration. All process streams were monitored for variety of parameters in addition to coliform levels. This paper presents the results of this testing.

Tim, U. S. and S. Mostaghimi. "Model For Predicting Virus Movement Through Soils." ***Ground Water.*** **V. 29, n. 2. pp. 251- 259. 1991.**

Abstract. A numerical model, VIROTRANS, is developed for simulating the vertical movement of water and virus through soils treated with waste-water effluents and sewage sludges. The expression describing transient flow of water is coupled with the convective-dispersive equation for subsurface solute transport. The resulting methodology is a coupled set of partial differential equations that describe the transient flow of water and suspended virus particle movement through variably saturated media. Solutions to the partial differential equations are accomplished by a Galerkin finite element method. Several example problems are used to provide a quantitative verification and validation of the model. The model simulations are compared to an analytical solution and to experimental measurements of soil moisture content and poliovirus 1 transport. The comparisons show reasonable agreement between model simulations and measured data. Sensitivity of the model's prediction to variations in pertinent input parameters are also analyzed.

Townley, J. A., S. Swanback and D. Andres. ***Recharging A Potable Water Supply Aquifer With Reclaimed Wastewater In Cambria, California.*** **John Carollo Engineers, Walnut Creek, CA. 1992.**

Abstract. A proposed project in Cambria, a small unincorporated community in San Luis Obispo County, involves recharging one of the community's domestic supply aquifers with reclaimed

wastewater. This paper describes the advance treatment system, regulatory involvement, and public acceptance issues.

Treweek, G. P. "Pretreatment Processes For Groundwater Recharge." ***Artificial Recharge Of Groundwater.*** **Butterworth Publishers, Boston. pp. 205-248. 1985.**

Abstract. Unplanned, indirect wastewater reuse through effluent discharge to streams and groundwater basins for subsequent downstream use by a wide variety of interests -- agricultural, industrial, or domestic -- has been a long-accepted practice throughout the world. Many communities at the end of major waterways, such as New Orleans and London, ingest water that already has been used as many as five times by repeated river withdrawal and discharge. Similarly, rivers or percolation basins may recharge underlying groundwater aquifers with reclaimed wastewater, which is in turn withdrawn by subsequent communities. For example, the effluent from over 140 wastewater treatment plants partially replenishes the groundwater tapped by the water supply system for London. This means effluent disposal, known as unplanned, indirect reuse, has become a generally accepted practice.

Planned, direct reuse is practiced on a smaller scale for a limited number of purposes, primarily agricultural and industrial. The terms 'unplanned' and 'planned' refer to whether the subsequent reuse was an unintentional byproduct of effluent discharge, or was designed as a conscious act following effluent discharge. The planned reuse schemes discussed in this report incorporated wastewater reclamation processes designed to meet not only effluent discharge standards, but also reuse standards promulgated by health authorities.

Troutman, D. E., E. M. Godsy, D. F. Goerlitz and G. G. Ehrlich. ***Phenolic Contamination In The Sand-And-Gravel Aquifer From A Surface Impoundment Of Wood Treatment Wastewaters, Pensacola, Florida.*** **Geological Survey Water-Resources Investigations Report 84-4230. U.S. Geological Survey, Tallahassee, Florida. 1984.**

Abstract. The discharge of creosote and pentachlorophenol wastewaters to unlined surface impoundments has resulted in ground-water contamination in the vicinity of a wood-treatment plant near Pensacola, Florida. Total phenol concentrations of 36,000 micrograms per liter have been detected at a depth 40 feet below land surface in a test hole 100 feet south of overflow impoundment. Phenol concentrations in this same test hole were lest than 10 micrograms per liter at a depth of 90 feet below land surface. Samples collected in test holes 1,350 feet downgradient from the surface impoundments and 100 feet north of Pensacola Bay, above and immediately below a clay lens, indicate that phenol contaminated ground water may not be discharging directly into Pensacola Bay. Phenol concentrations exceeding 20 micrograms per liter were detected in samples from a drainage ditch discharging directly into Bayou Chico.

Microbiological data collected near the wood-treatment site suggest that anaerobic methanogenic ecosystem contributes to reduction in phenol concentrations in ground water. A laboratory study using bacteria isolated from the study site indicates that phenol, 2- methylphenol, and 3-methylphenol are significantly degraded and that methanogenesis reduces total phenol concentrations in laboratory digestors by 45 percent. Pentachlorophenol may inhibit methanogenesis at concentration exceeding 0.45 milligrams per liter.

Data on wastewater migration in ground water from American Creosote Works indicate that the sand-and-gravel aquifer is highly susceptible to contamination from unlined surface impoundments and other surface sources. Groundwater contamination occurs readily in pervious sands and gravel within the

aquifer where the water table is near land surface. Coastal areas and valleys tend to be areas of ground-water discharge, and contamination of ground water in these areas may result in surface-water contamination.

U.S. Environmental Protection Agency Office Of Water, Office of Wastewater Enforcement and Compliance, and Office of Research and Development, Office of Technology Transfer and Regulatory Support. ***Manual: Guidelines For Water Reuse.*** **EPA/625/R-92/004. U.S. Environmental Protection Agency, Washington, D.C. 1992.**

Abstract. With many communities throughout the world approaching or reaching the limits of their available water supplies, water reclamation and reuse has become an attractive option for conserving and extending available water supplies. Water reuse may also present communities an opportunity for pollution abatement when it replaces effluent discharge to sensitive surface waters.

Water reclamation and nonpotable reuse only require conventional water and wastewater treatment technology that is widely practiced and readily available in countries throughout the world. Furthermore, because properly implemented nonpotable reuse does not entail significant health risks, it has generally been accepted and endorsed by the public in the urban and agricultural areas where it has been introduced.

Water reclamation for nonpotable reuse has been adopted in the United States and elsewhere without the benefit of national or international guidelines or standards. However, in recent years, many states in the U.S. have adopted standards or guidelines, and the World Health Organization (WHO) has published guidelines for reuse for agricultural irrigation. The primary purpose of this document is to present guidelines, with supporting information, for utilities and regulatory agencies in the U.S. In states where standards do not exist or are being revised or expanded, the Guidelines can assist in developing reuse programs or appropriate regulations. The Guidelines will also be useful to consulting engineers and others involved in the evaluation, planning, design, operation, or management of water reclamation and reuse facilities. In addition, a section on reuse internationally is offered to provide background and discuss relevant issues for authorities in other countries where reuse is being considered. The document does not propose standards by either the U.S. Environmental Protection Agency (EPA) or the U.S. Agency for International Development (AID). In the U.S., water reclamation and reuse standards are the responsibility of state agencies.

These guidelines primarily address water reclamation for nonpotable urban, industrial, and agricultural reuse, about which little controversy exists. Also, attention is give to augmentation of potable water supplies by indirect reuse. Because direct potable reuse is not currently practiced in the U.S., only a brief overview is provided.

Varuntanya, C. P. and D. R. Shafer. "Techniques For Fluoride Removal In Industrial Wastewaters." ***Water Environment Federation 65th Annual Conference & Exposition, New Orleans, Louisiana, 1992.*** **(Water Environment Federation, Alexandria, Virginia, pp. 159-170). 1992.**

Abstract. This paper will present data from several laboratory scale treatability studies for fluoride removal from two industrial plant wastewaters. Additionally, limited plant data will be presented from one facility. Production at each facility involves the manufacture of zirconium tubes and the manufacture of semiconductors. The zirconium tube manufacturing plant wastewater contains approximately 15-20 mg/L fluoride before treatment while the semiconductor facility contains

approximately 25 mg/L fluoride. The results of the studies show that fluoride can be reduced to as low as 1 mg/L. The paper will also discuss the effluent concentrations achievable from each treatment scheme, as well as the chemical dosages required, and the process equipment necessary in each scheme. The advantages and disadvantages of the treatment processes will also be evaluated in this paper. The objective of the paper will provide insight for defluoridation of wastewaters for given effluent limitations.

Vaughn, J. M., E. F. Landry, L. J. Baranosky, C. A. Beckwith, M. C. Dahl and N. C. Delihas . "Survey Of Human Virus Occurrence In Wastewater-Recharged Groundwater On Long Island." ***Applied And Environmental Microbiology.*** **V. 36, n. 1. pp. 47-51. 1978.**

Abstract. Treated wastewater effluents and groundwater observation wells from three sewage recharge installations located on Long Island were assayed on a monthly basis for indigenous human enteroviruses and coliform bacteria for a period of 1 year. Viruses were detected in groundwater at sites where recharge basins were located less than 35 feet (ca. 10.6 m) above the aquifer. Results from one of the sites indicated the horizontal transfer of viable viruses through the groundwater aquifer.

Vecchioli, J., G. G. Ehrlich, E. M. Godsy and C. A. Pascale. "Alterations In The Chemistry Of An Industrial Waste Liquid Injected Into Limestone Near Pensacola, Florida." ***Hydrogeology Of Karstic Terrains: Case Histories.*** **International Association Of Hydrogeologists, UNESCO, V. 1. pp. 217-220. 1984.**

Abstract. An industrial waste liquid containing organonitrile compounds and nitrate ions has been injected since June 1975 into the lower limestone of the Floridan aquifer at a site near Pensacola, Florida. Data from inorganic and organic chemicals, dissolved gas, and microbiological analyses of liquid backflowed from the injection well and of liquid sample from a nearby monitor well indicated that the injected waste liquid undergoes substantial chemical changes in the subsurface.

Verdin, J., G. Lyford and L. Sims. ***Application Of Satellite Remote Sensing For Identification Of Irrigated Lands In The Newlands Project.*** **1987.**

Abstract. As one element of Operating Criteria and procedures for the Newlands project in west-central Nevada, the Bureau of Reclamation has compiled an irrigation water rights spatial data base. In 1984, color infrared aerial photography was obtained and used to identify irrigated lands in the project. The photo interpretations were digitized to integrate them with water right maps for the project, which had similarly been digitized. Bench and bottom land designations, a soil type distinction of consequence for legal water entitlements, were recorded from maps as well. The data base was used to calculate and summarize the tables, on a section-by-section basis, acreages of irrigated lands with water rights, irrigated lands without water rights, and non-irrigated water-righted land. For the 1985 and 1986 growing seasons, multispectral digital imagery of the project acquired by the Thermatic Mapper instrument on Landsat-5 was used to update the irrigated lands theme of the data base. Scenes from May and August dates of those seasons, chosen after consideration of the phenologies of the major crops in the project, were co-registered and used to derive multidate vegetation index (Kauth - Thomas "greenness") images. These derivative images were then interpreted at an interactive video display providing a variety of enhancement capabilities, such as zooming and contrast stretching, to identify lands whose irrigation status had changed. Revisions to the irrigation theme of the spatial data base were then made accordingly, as were modifications to the water rights coverage due to transfers between parcels of land. New acreage tabulation s were prepared by digitally overlaying the revised coverages. In 1986, the SPOT-1 satellite was launched, and the higher resolution imagery available from this remote sensing satellite is currently being

evaluated for use in the Newlands Project. Multitemporal greenness images are being processed for crop type identification, and multispectral images are being digitally merged with 10-meter resolution panchromatic images for improved interpretability.

Waller, B. G., B. Howie and C. R. Causaras. *Effluent Migration From Septic Tank Systems In Two Different Lithologies, Broward County, Florida.* Geological Survey Water-Resources Investigations Report 87-4075. U.S. Geological Survey, Tallahassee, Florida. 1987.

Abstract. Two septic tank test sites, one in sand and one in limestone, in Broward County, Florida, were analyzed for effluent migration. Ground water from shallow wells, both in background areas and hydraulically downgradient of the septic tank system, was sampled during a 16-month period from April 1983 through August 1984. Water-quality indicators were used to determine the effluent affected zone near the septic tank systems.

Specific conductance levels and concentrations of chloride, sulfate, ammonium, and nitrate indicated effluent movement primarily in a vertical direction with abrupt dilution as it moved downgradient. Effluent was detected in the sand to a depth more than 20 feet below the septic tank outlet, but was diluted to near background conditions 50 feet downgradient from the tank. Effluent in the limestone was detected in all three observation wells to depths exceeding 25 feet below the septic tank outlet and was diluted, but still detectable, 40 feet downgradient.

The primary controls on effluent movement from septic tank systems in Broward County are the lithology and layering of the geologic materials, hydraulic gradients, and the volume and type of use the system receives.

Wanielista, M., J. Charba, J. Dietz, R. S. Lott and B. Russell. *Evaluation Of The Stormwater Treatment Facilities At The Lake Angel Detention Pond Orange County, Florida.* Report No. FL-ER- 49-91. Florida Department Of Transportation Environmental Office, Tallahassee, Florida. 1991.

Abstract. This is the final report on the use of Granulated Active Carbon (GAC) beds of Filtrasorb 400 in series to reduce the Trihalomethane Formation Potential (THMFP) concentrations at the Lake Angel detention pond, Orange County, Florida. The detention pond accepts runoff from an interstate highway and a commercial area. Breakthrough time was estimated from laboratory analyses and used to design two beds in series at the detention pond. Breakthrough occurred in the first bed after treating 138,000 liters of water. Exhaustion of the first bed was reached after treating 1270 bed volumes with a sorption zone length of 1.70 feet. The TOC adsorbed per gram of GAC was 6.3 mg. The liquid flow rate averaged 0.0011 cfs. Similar breakthrough curves for Total Organic Carbon (TOC) and color were also reported. The used GAC can be disposed of by substituting it for sand in concrete mixes.

An economic evaluation of the GAC system at Lake Angel demonstrated an annual cost of $4.39/1000 gallons to treat the stormwater runoff after detention and before discharge into a drainage well. This cost could be further reduced by using the stormwater to irrigate right-of-way sections of the watershed. An alternative method of pumping to another drainage basin was estimated to be more expensive.

The underdrain network for GAC system initially became clogged with the iron-and sulfur-precipitating bacteria *Leptotrix*, *Gallionella* and *Thiothrix*. These bacteria were substantially reduced by altering the influent GAC system pipeline to take water directly from the lake. An alternate pipe system used a clay layer to reduce ground water inputs and did not exhibit substantial bacterial growth.

Wellings, F. M. "Perspective On Risk Of Waterborne Enteric Virus Infections." ***Chemical And Biological Characterization Of Sludges, Sediments, Dredge Spoils, And Drilling Muds. ASTM STP 976.*** **American Society For Testing And Materials, Philadelphia, Pennsylvania. pp. 257-264. 1988.**

Abstract. A valid perspective on the risk of waterborne enteric virus infections related to land disposal of sludge must incorporate various parameters. It is not enough to accept at face value the predominantly negative findings from the relatively few scientific studies that have purportedly been done to determine the fate of viruses introduced into the environment with the deposition of sludge. Rather, it is incumbent upon interested parties, whether they are regulatory or scientific, to evaluate the whole through a careful examination of the parts. This paper attempts to bring into focus the presently available data on four major virological issues. These are the characteristics of enteric viruses which enable them to survive wastewater treatment processes, problems associated with the accumulation and interpretation of data related to viral contamination of groundwater by sludge disposal practices, problems associated with transfer to the real world of data derived from laboratory- seeded experiments, and problems related to the establishment of the role of enteric viruses in waterborne disease outbreaks. Present data are insufficient for establishing the quantitative risk of waterborne disease because of the land disposal of sludge. However, there is some probability of groundwater contamination sufficient to warrant a cautious approach to land disposal of sludge.

White, E. M. and J. N. Dornbush. "Soil Changes Caused By Municipal Wastewater Applications In Eastern South Dakota." ***Water Resources Bulletin.*** **V. 24, n. 2. pp. 269-273. 1988.**

Abstract. Wastewater from a municipal treatment plant was applied in rapid infiltration basins for four years to determine a poorly drained soils effectiveness in removing influent N and P and the soil changes that might limit their removal. About half the total PO_4-P lost from the influent was sorbed in the upper 91 cm of the soil and the other half was sorbed by the soil below the perforated pipe, which was used to drain the basins and collect the effluent for analysis. Drying of the basin soils converted more sorbed PO_4-P to Ca phosphates but the total sorbed was about the same. The influent N decreased , probably by volatilization, because the two basins with surface soil lost soil N rather than gained soil N. The soil total Ca, Mg, and K contents did not change significantly but Na increased slightly. Changes in the characteristics of the soils were slight and would have little effect on the longevity of a rapid infiltration basin.

Wilde, F. D. ***Geochemistry and Factors Affecting Ground-Water Quality at Three Storm-Water-Management Sites in Maryland: Report of Investigations No. 59.*** **Department of Natural Resources, Maryland Geological Survey, Baltimore, Maryland. (Prepared in Cooperation with the U.S. Department of the Interior Geological Survey, The Maryland Department of the Environment, and The Governor's Commission on Chesapeake Bay Initiatives). 1994.**

Abstract. The effects of infiltration of storm runoff on ground-water chemistry and quality were examined at three suburban storm-water-management impoundments at sites in Annapolis, Greenmount, and Prince Frederick, Maryland. Geochemical and hydrologic data were collected from December 1985 through June 1989. The Annapolis and Prince Frederick sites are in the Coastal Plain physiographic province, and the Greenmount site is in the Piedmont physiographic province. This study

was a cooperative effort of the U.S. Geological Survey, the Maryland Geological Survey, the Maryland Department of the Environment, and the Governor's Council on Chesapeake Bay Initiatives.

The objectives of the study were to determine whether the chemical composition of ground water beneath the impoundments changed as a result of storm-water infiltration, whether ground-water quality was adversely affected, and whether contaminants being sequestered in impoundments could be potentially mobilized to ground water.

Native geographic materials collected from drill cores at each site and bottom materials collected each September from the Annapolis and Greenmount ponds were analyzed for particle size, selected chemical constituents, and the predominant mineralogy. Aqueous solutions were analyzed for major ions, a large suite of trace elements, and volatile and polyaromatic organic compounds; pH, dissolved oxygen, alkalinity, chloride, and specific conductance were measured in the field. Samples of runoff, impoundment water, unsaturated-zone water, and ground water were collected triannually for extensive chemical analyses and at least monthly for field measurements. The results were compared for the two sites with storm-water ponds (Annapolis and Greenmount) and porous-pavement site with a subsurface impoundment (Prince Frederick).

Either primary or secondary maximum contaminant levels established by the U.S. Environmental Protection Agency (USEPA) for aluminum, cadmium, chloride, chromium, and lead in drinking water were exceeded from time to time in ground-water samples collected beneath and downgradient from the impoundments. In addition, uncharacteristically high concentrations of barium, copper, molybdenum, nickel, strontium, vanadium, and zinc occasionally were reported in ground water beneath the impoundments, and median concentrations of barium, cadmium, chloride, copper, nickel, and zinc were elevated in some ground-water samples beneath the study sites. Chromium and lead were rarely detected in ground water. Low concentrations of arsenic were detected sporadically in storm water and ground water. Concentrations of volatile organic compounds were usually below or near detection in storm-water and ground-water samples; small concentrations of polyaromatic organic compounds were detected only in pond-bottom materials.

Pond-bottom materials generally were effective scavengers of trace metals introduced to storm-water impoundments in the runoff. Between 1986 through 1988, concentrations of lead increased from below detection levels to 28 parts per million (ppm), and zinc concentrations increased from 54 to 344 ppm in bottom materials collected from the Annapolis impoundment. In addition, copper concentrations increased from 3.5 to 40 ppm and nickel concentrations increased from 6 to 16 ppm in bottom materials at the Annapolis site. For the same period at the Greenmount impoundment, concentrations of lead increased from 20 to 90 ppm; zinc concentrations increased from 59 to 469 ppm; and nickel concentrations increased from 35 to 48 ppm (there was a net decrease in the copper concentration). Despite this accumulation of metals in bottom materials, concentrations of these and other metals were considerably elevated in ground water beneath and downgradient from the impoundments. Cadmium concentrations did not increase in bottom materials, although cadmium was a common constituent in storm water and sorbed readily to the bottom materials in laboratory tests. Ground-water samples collected from the control wells at each site had concentrations of cadmium that were below or near detection, whereas concentrations were as high as 27, 26, and 8.4 μg/L (micrograms per liter) beneath the impoundments at Annapolis, Greenmount, and Prince Frederick, respectively.

Storm water was the primary source of most contaminants that were found at elevated concentrations in ground-water samples collected beneath impoundments. Contaminants entered ground water as a result of several variables, including direct storm-water infiltration; impoundment-related modifications of pH and redox that periodically favored metal mobilization from pond-bottom or aquifer materials; and formation of anionic or neutral complexes.

Metal mobility in the impoundments was mitigated by ion exchange, sorption, and mineral precipitation; storm water was aerobic and usually had neutral or higher pH that generally did not favor the presence of soluble species of most metals. Nevertheless, cadmium sorption in the impoundments may have been excluded by competing cations. Moreover, conditions for complexing of cadmium with organic compounds and chloride was favorable in impoundments and could have enhanced cadmium transport to ground water.

Algal photosynthesis modified the pond-water chemistry at Annapolis and Greenmount, increasing pH to 9.0 or greater, whereas algal respiration and rainwater dilution decreased pH to 6.5. Algal mediation of the pond-water pH at Greenmount resulted in a median pH of 9.2. Because aluminum solubility increases exponentially at about pH 9.0, aluminum concentrations in pond water at this site exceeded the U.S. Environmental Protection Agency's drinking-water regulation of 50 μg/L in most samples and may have contributed to elevated aluminum concentrations measured in ground water beneath the impoundment. Algal activity was less intense in the Annapolis impoundment, where the median pond-water pH was 7.7 and the median aluminum concentration was 30 μg/L; occasional measurements of aluminum concentrations greater than 50 μg/L in pond water corresponded with pH near or greater than 9.0. In ground water beneath the Annapolis pond, aluminum concentrations were below 50 μg/L in the samples collected, with one exception.

The solubility of most trace metals increases with pH decrease below neutrality. Therefore, the decreases in pond pH below neutral possibly mobilized iron, copper, nickel, and zinc periodically from bottom materials; alternatively, metals dissolved in storm water could have been transported to the ground water because kinetics were unfavorable for sorption to bottom materials.

The pH of ground water tended to keep the metals in solution at each site. Ground-water pH beneath the impoundments was reduced to below background pH; from 5.13 to between 4.18 and 4.94 at Annapolis, from 5.38 to between 4.9 and 5.29 at Greenmount, and from 6.71 to between 4.39 and 4.8 at Prince Frederick. Periodic mobilization of iron from the impoundment to the ground water (and the consequent precipitation of iron hydroxides in the aquifer) has been suggested as a cause of reduced pH in beneath-pond ground water at the Annapolis and Greenmount sites. Lithologic composition is the primary control on order-of-magnitude changes in ground-water pH at Prince Frederick.

With the exception of chloride, ground-water contamination was least at the Prince Frederick site, possibly because of low contaminant concentrations in storm water entering the Prince Frederick impoundment, or because contaminant mobility was restricted by the well-buffered and stable chemical environment in the impoundment. Dissolution of the rock aggregate in the Prince Frederick impoundment buffered impounded water to a pH of about 8.4, but dissolution also released high concentrations of magnesium and low concentrations of nickel and possibly chromium that affected ground-water chemistry.

Chloride contamination was ubiquitous in ground water receiving storm-runoff infiltrate. The ground water beneath the impoundments was modified to a chloride-dominated solution at each site throughout the period of study (native ground waters were mixed cation-mixed anion, magnesium-nitrate/chloride, and calcium-bicarbonate types at respective study sites). The only major source of chloride to ground water was storm-water infiltration during periods of road salting (road salting occurred no more than five time a year during the study period).

Chloride concentrations were measured at least biweekly and before, during and after selected storms. The effect of seasonal and storm-specific recharge on concentrations of chloride in ground water beneath the impoundments monitored was a temporary dilution--usually lasting no longer than several days. Chloride concentrations in ground water beneath impoundments increased whenever rainfall was low and evapotranspiration rates were high, resulting in highest concentrations during the summer and early autumn at each site. The magnitude and persistence of the chloride contamination indicated that chloride, although a very soluble constituent, was not being flushed readily from the ground-water systems studied. Chloride concentrations in ground water beneath impoundments increased whenever rainfall was low and evapotranspiration rates were high.

Probable factors contributing to the persistent chloride domination of the major-ion chemistry of ground water at each study site were (1) low ground-water flow rates relative to storm-water infiltration rates; (2) limited dilution potential because sites were within a maximum of 300 feet from the inferred ground-water divide; and (3) capillary forces.

The unsaturated-zone chloride data suggest that capillary processes cause retardation of chloride transport and can allow chloride buildup, especially in the zone of tension saturation. This could serve as a model for explaining inhibition of transport of other contaminants. With the exception of chloride concentrations, however, the periods of data collection and (or) sampling frequency generally were insufficient to determine temporal trends in concentrations for trace metals and other constituents.

Wilson, L. G., M.D. Osborn, K. L. Olson, S. M. Maida and L. T. Katz. "The Ground Water Recharge And Pollution Potential Of Dry Wells In Pima County, Arizona." ***Ground Water Monitoring Review.*** **V. 10. pp. 114-121. 1990.**

Abstract. This paper summarizes a study to estimate the potential for dry- well drainage of urban runoff to recharge and pollute ground water in Tucson, Arizona. We selected three candidate dry wells for study. At each site we collected samples of runoff, dry-well sediment, vadose-zone sediment, perched ground water, and ground water. Water content data from vadose-zone samples suggest that dry-well drainage has created a transmission zone for water movement at each site. Volatile organic compounds, while undetected in runoff samples, were present in dry-well sediment, perched ground water at one site, and ground water at two sites. The concentrations of volatile organics (toluene and ethylbenzene) in the water samples were less than the corresponding EPA human health criteria. Pesticides were detected only in runoff and dry-well sediment. Lead and chromium occurred in runoff samples at concentrations above drinking water standards. Nickel, chromium, and zinc concentrations were elevated in vadose-zone samples at the commercial site. Of the metals, only manganese, detected at the residential site, exceeded Secondary Drinking Water Standards in ground water. It is concluded that the three dry wells examined during this study are currently not a major source of ground water pollution.

Wolff, J., J. Ebeling, A. Muller and H. Wacker. "Waste Water Irrigation Suited To The Environment As Shown By The Example Of the 'Abwasserverband Wolfsburg'." ***Hydrological Process And Water Management In Urban Areas, Duisburg, Federal Republic Of Germany, 1988.*** **(International Hydrological Programme, UNESCO, pp. 599-606). 1988.**

Abstract. Changes in the chemistry of ground water by the influences of waste water land treatment will be discussed by the research at the area of the 'Abwasserverband Wolfsburg', south east Lower Saxony. The results of a four-year research programme shows that, under certain conditions, waste water land treatment can be realized in an ecological justifiable way.

Yurewicz, M. C. and J. C. Rosenau. ***Effects On Ground Water Of Spray Irrigation Using Treated Municipal Sewage Southwest Of Tallahassee, Florida.*** **Geological Survey Water-Resources Investigation Report 86-4109. U.S. Geological Survey, Tallahassee, Florida. 1986.**

Abstract. Increases in the concentrations of chloride and nitrate nitrogen in ground water have resulted from land application of secondary- treated municipal sewage southwest of Tallahassee, Florida. The increases occurred predominantly during periods of above normal application rates. This result is based upon a data-collection program which began in 1972, 6 years after the initial application of treated sewage. The data collection period for this report is 1982 through June 1981.

Although an estimated minimum volume of 4,220 million gallons of treated sewage was spray irrigated from July 1966 through June 1981, distortion of the local ground-water flow pattern did not occur because of the high, natural recharge and high permeability of the limestone aquifer. Direct recharge from the land surface to the Floridan aquifer system occurs by rapid infiltration through the sand overburden and a discontinuous clay layer above the limestone formation. Soluble constituents move laterally and vertically with the ground-water flow pattern. Use of chloride as a tracer of water movement indicates that treated sewage occurs at depths greater than 200 feet below land surface below the spray sites. The direction and rate of ground-water movement is southwesterly toward the Gulf of Mexico, at a rate of approximately 5 feet per day, with significant downward movement also occurring.

The most significant effect on ground-water quality has been high nitrate nitrogen concentrations which were detected between 1972 and 1976 when high volumes of treated sewage were applied for experimental purposes. During this period, nitrate nitrogen concentrations in the upper limestones of the Floridan aquifer system exceeded the maximum contaminant level of 10 milligrams per liter established for potable water supplies. Computations indicate that if the monthly load of nitrogen does not exceed 130 to 180 pounds per acre, the concentration of nitrate nitrogen in the upper part of the aquifer will not exceed 10 milligrams per liter.

Other water-quality characteristics were not significantly affected by the application of treated sewage. Concentrations of trace metals including arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, selenium, and zinc in ground water remained at background levels. Organochlorine insecticides and chlorinated phenoxy acid herbicides were analyzed, but not detected in 18 ground-water samples collected in 1974 and 1978. Concentrations of major inorganic ions in the ground water likely are controlled by equilibrium conditions between the water and the aquifer matrix.

GROUNDWATER CONTAMINATION BIBLIOGRAPHY

Alhajjar, B. J., G. V. Simsiman and G. Chesters. "Fate And Transport Of Alachlor, Metolachlor And Atrazine In Large Columns." *Water Science And Technology: A Journal Of The International Association Of Water Pollution Research*. Vol. 22, No. 6. pp. 87-94. 1990.

American Water Works Association. "Fertilizer Contaminates Nebraska Groundwater." *AWWA Mainstream.* Vol. 34, No. 4. pp. 6. 1990.

Amoros, I., J. L. Alonso and I. Peris. "Study Of Microbial Quality And Toxicity Of Effluents From Two Treatment Plants Used For Irrigation." *Water Science And Technology: A Journal Of The International Association On Water Pollution Research.* Vol. 21, No. 3. pp. 243-246. 1989.

Armstrong, D. E. and R. Llena. *Stormwater Infiltration: Potential For Pollutant Removal.* Project Report To The U.S. Environmental Protection Agency. Wisconsin Department Of Natural Resources, Water Chemistry Program. 1992.

Aronson, D. A. and G. E. Seaburn. *Appraisal Of Operating Efficiency Of Recharge Basins On Long Island, New York, In 1969*. Geological Survey Water-Supply Paper 2001-D. U.S. Government Printing Office, Washington, D.C. 1974.

Asano, T. "Irrigation With Reclaimed Wastewater - Recent Trends." *Irrigation Systems For The 21st Century, Portland, Oregon, 1987.* (American Society Of Civil Engineers, New York, New York, pp. 735-742). 1987.

Bao-rui, Y. "Investigation Into Mechanisms Of Microbial Effects On Iron And Manganese Transformations In Artificially Recharted Groundwater." *Water Science And Technology: A Journal Of The International Association On Water Pollution Research.* Vol. 20, No. 3. pp. 47-53. 1988.

Barraclough, J. T. "Waste Injection Into A Deep Limestone In Northwestern Florida." *Ground Water*. Vol. 3, No. 1. pp. 22-24. 1966.

Boggess, D. H. *Effects Of A Landfill On Ground Water Quality*. Geological Survey Open File Report 75-594. U.S. Geological Survey, Tallahassee, Florida. 1975.

Bouchard, A. B. "Virus Inactivation Studies For A California Wastewater Reclamation Plant." *Water Environment Federation 65th Annual Conference & Exposition, New Orleans, Louisiana, 1992.*

(Water Environment Federation, Alexandria, Virginia). 1992.

Bouwer, E. J., P. L. McCarty, H. Bouwer and R. C. Rice. "Organic Contaminant Behavior During Rapid Infiltration Of Secondary Wastewater At The Phoenix 23rd Avenue Project." *Water Resource*. Vol. 18, No. 4. pp. 463-472. 1984.

Bouwer, H. "Agricultural Contamination: Problems And Solutions." *Water Environment And Technology*. Vol. 1, No. 2. pp. 292-297. 1989.

Bouwer, H. "Effect Of Irrigated Agriculture On Groundwater." *Journal of Irrigation and Drainage Engineering*. Vol. 113, No. 1. pp. 4-15. 1987.

Bouwer, H. and E. Idelovitch. "Quality Requirements For Irrigation With Sewage Water ." *Journal of Irrigation and Drainage Engineering*. Vol. 113, No. 4. pp. 516-535. 1987.

Brown, D. P. *Effects Of Effluent Spray Irrigation On Ground Water At A Test Site Near Tarpon Springs, Florida*. Geological Survey Open-File Report 81-1197. U.S. Geological Survey, Tallahassee, Florida. 1982.

Butler, K. S. "Urban Growth Management And Groundwater Protection: Austin, Texas." *Planning For Groundwater Protection*. Academic Press, New York, New York. pp. 261-287. 1987.

Cavanaugh, J. E., H. S. Weinberg, A. Gold, R. Sangalah, D. Marbury, W. H. Glaze, T. W. Collette, S. D. Richardson and A. D. Thurston Jr. "Ozonation Byproducts: Identification Of Bromohydrins From The Ozonation Of Natural Water With Enhanced Bromide Levels." *Environmental Science & Technology*. Vol. 26, No. 8. pp. 1658-1662. 1992.

Chang, A. C., A. L. Page, P. F. Pratt and J. E. Warneke. "Leaching Of Nitrate From Freely Drained-Irrigated Fields Treated With Municipal Sludges." *Planning Now For Irrigation And Drainage In The 21st Century, Lincoln, Nebraska, 1988*. (American Society Of Civil Engineers, New York, New York, pp. 455-467). 1988.

Chase, W. L. J. "Reclaiming Wastewater In Phoenix, Arizona." *Irrigation Systems For The 21st Century, Portland, Oregon, 1987*. (American Society Of Civil Engineers, New York, New York, pp. 336-343). 1987.

Cisic, S., D. Marske, B. Sheikh, B. Smith and F. Grant. "City Of Los Angeles Effluent - Today's Waste, Tomorrow's Resource." *Water Environment Federation 65th Annual Conference & Exposition, New Orleans, Louisiana, 1992*. (Water Environment Federation, Alexandria, Virginia). 1992.

Close, M. E. "Effects Of Irrigation On Water Quality Of A Shallow Unconfined Aquifer." *Water Resources Bulletin*. Vol. 23, No. 5. pp. 793-802. 1987.

Clothier, B. E. and T. J. Sauer. "Nitrogen Transport During Drip Fertigation With Urea." *Soil Science Society Of America Journal.* Vol. 52, No. 2. pp. 345-349. 1988.

Craun, G. F. "Waterborne Disease - A Status Report Emphasizing Outbreaks In Ground-Water Systems." *Ground Water.* Vol. 17, No. 2. pp. 183-191. 1979.

Crites, R. W. "Micropollutant Removal In Rapid Infiltration." *Artificial Recharge Of Groundwater.* Butterworth Publishers, Boston. pp. 579-608. 1985.

Crook, J., T. Asano and M. Nellor. "Groundwater Recharge With Reclaimed Water In California." *Water Environment & Technology.* Vol. 2, No. 8. pp. 42-49. 1990.

Deason, J. P. "Irrigation-Induced Contamination: How Real A Problem?" *Journal of Irrigation and Drainage Engineering.* Vol. 115, No. 1. pp. 9-20. 1989.

Deason, J. P. "Selenium: It's Not Just In California." *Irrigation Systems For The 21st Century, Portland, Oregon, 1987.* (American Society Of Civil Engineers, New York, New York, pp. 475-482). 1987.

DeBoer, J. G. "Wastewater Reuse: A Resource Or A Nuisance?" *Journal of the American Water Works Association.* Vol. 75, . pp. 348-356. 1983.

Domagalski, J. L. and N. M. Dubrovsky. "Pesticide Residues In Ground Water Of The San Joaquin Valley, California." *Journal Of Hydrology.* Vol. 130, No. 1-4. pp. 299-338. 1992.

Ehrlich, G. G., E. M. Godsy, C. A. Pascale and J. Vecchioli. "Chemical Changes In An Industrial Waste Liquid During Post- Injection Movement In A Limestone Aquifer, Pensacola, Florida." *Ground Water.* Vol. 17, No. 6. pp. 562-573. 1979.

Ehrlich, G. G., H. F. H. Ku, J. Vecchioli and T. A. Ehlke. *Microbiological Effects Of Recharging The Magothy Aquifer, Bay Park, New York, With Tertiary-Treated Sewage.* Geological Survey Professional Paper 751-E. U.S. Government Printing Office, Washington, D.C. 1979.

Elder, J. F., J. D. Hunn and C. W. Calhoun. *Wastewater Application By Spray Irrigation On A Field Southeast Of Tallahassee, Florida: Effects On Ground-Water Quality And Quantity.* Geological Survey Water-Resources Investigations Report 85-4006. U.S. Geological Survey, Tallahassee, Florida. 1985.

Eren, J. "Changes In Wastewater Quality During Long Term Storage." . pp. 1291-1300.

Ferguson, B. K. "Role Of The Long-term Water Balance In Management of Stormwater Infiltration." *Journal Of Environmental Management.* Vol. 30, No. 3. pp. 221-233. 1990.

Ferguson, R. B., D. E. Eisenhauer, T. L. Bockstadter, D. H. Krull and G. Buttermore. "Water And Nitrogen Management In Central Platte Valley Of Nebraska." *Journal Of Irrigation And Drainage*

Engineering. Vol. 116, No. 4. pp. 557-565. 1990.

Gerba, C. P. and S. M. Goyal. "Pathogen Removal From Wastewater During Groundwater Recharge." *Artificial Recharge Of Groundwater*. Butterworth Publishers, Boston. pp. 283-317. 1985.

Gerba, C. P. and C. N. Haas. "Assessment Of Risks Associated With Enteric Viruses In Contaminated Drinking Water." *Chemical And Biological Characterization Of Sludges, Sediments, Dredge Spoils, And Drilling Muds. ASTM STP 976*. American Society For Testing And Materials, Philadelphia, Pennsylvania. pp. 489-494. 1988.

German, E. R. *Quantity And Quality Of Stormwater Runoff Recharged To The Floridan Aquifer System Through Two Drainage Wells In The Orlando, Florida, Area.* Geological Survey Water Supply Paper 2344. U.S. Government Printing Office, Washington, D.C.. 1989.

Goldschmid, J. "Water-Quality Aspects Of Ground-Water Recharge In Israel." *Journal Of The American Water Works Association*. Vol. 66, No. 3. pp. 163-166. 1974.

Goolsby, D. A. *Geochemical Effects And Movement Of Injected Industrial Waste In A Limestone Aquifer*. Memoir No. 18. American Association Of Petroleum Geologists. 1972.

Greene, G. E. *Ozone Disinfection And Treatment Of Urban Storm Drain Dry-Weather Flows: A Pilot Treatment Plant Demonstration Project On The Kenter Canyon Storm Drain System In Santa Monica*. The Santa Monica Bay Restoration Project, Monterey Park, CA. 1992.

Hampson, P. S. *Effects Of Detention On Water Quality Of Two Stormwater Detention Ponds Receiving Highway Surface Runoff In Jacksonville, Florida*. Geological Survey Water-Resources Investigations Report 86-4151. U.S. Geological Survey, Tallahassee, Florida. 1986.

Harper, H. H. *Effects Of Stormwater Management Systems On Groundwater Quality*. DER Project WM190. Florida Department Of Environmental Regulation, Orlando, Florida. 1988.

Hickey, J. J. "Subsurface Injection Of Treated Sewage Into A Saline-Water Aquifer At St. Petersburg, Florida-Aquifer Pressure Buildup." *Ground Water*. Vol. 22, No. 1. pp. 48-55. 1984.

Hickey, J. J. and J. Vecchioli. *Subsurface Injection of Liquid Waste With Emphasis on Injection Practices in Florida*. Geological Survey Water-Supply Paper 2281. United States Government Printing Office, Washington D.C. 1986.

Hickey, J. J. and W. E. Wilson. *Results Of Deep-Well Injection Testing At Mulberry, Florida*. Geological Survey Water-Resources Investigations Report 81-75. U.S. Geological Survey, Tallahassee, Florida. 1982.

Higgins, A. J. "Impacts On Groundwater Due To Land Application Of Sewage Sludge." *Water Resources Bulletin*. Vol. 20, No. 3. pp. 425-434. 1984.

Horsley, S. W. and J. A. Moser. "Monitoring Ground Water For Pesticides At A Golf Course - A Case Study On Cape Cod, Massachusetts." *Ground Water Monitoring Review*. Vol. 10. pp. 101-108. 1990.

Hull, R. W. and M. C. Yurewicz. *Quality Of Storm Runoff To Drainage Wells In Live Oak, Florida, April 4, 1979*. Geological Survey Open-File Report 79-1073. U.S. Government Printing Office, Washington, D.C. 1979.

Ishizaki, K. "Control Of Surface Runoff By Subsurface Infiltration Of Stormwater: A Case Study In Japan." *Artificial Recharge Of Groundwater*. Butterworth Publishers, Boston. pp. 565-575. 1985.

Jansons, J., L. W. Edmonds, B. Speight and M. R. Bucens. "Movement Of Viruses After Artificial Recharge." *Water Research*. Vol. 23, No. 3. pp. 293-299. 1989.

Jansons, J., L. W. Edmonds, B. Speight and M. R. Bucens. "Survival Of Viruses In Groundwater." *Water Research*. Vol. 23, No. 3. pp. 301-306. 1989.

Johnson, R. B. "The Reclaimed Water Delivery System And Reuse Program For Tucson, Arizona." *Irrigation Systems For The 21st Century, Portland, Oregon, 1987*. (American Society Of Civil Engineers, New York, New York, pp. 344-351). 1987.

Karkal, S. S. and D. L. Stringfield. "Wastewater Reclamation And Small Communities: A Case History." *Water Environment Federation 65th Annual Conference & Exposition, New Orleans, Louisiana, 1992*. (Water Environment Federation, Alexandria, Virginia, pp. 419-425). 1992.

Katopodes, N. D. and J. H. Tang. "Self-Adaptive Control Of Surface Irrigation Advance." *Journal Of Irrigation And Drainage Engineering*. Vol. 116, No. 5. pp. 696-713. 1990.

Kaufman, M. I. "Subsurface Wastewater Injection, Florida." *Journal Of Irrigation And Drainage Engineering*. Vol. 99, No. 1. pp. 53-70. 1973.

Knisel, W. G. and R. A. Leonard. "Irrigation Impact On Groundwater: Model Study In Humid Region ." *Journal Of Irrigation And Drainage Engineering*. Vol. 115, No. 5. pp. 823-839. 1989.

Krawchuk, B. P. and B. G. R. Webster. "Movement Of Pesticides To Ground Water In An Irrigated Soil." *Water Pollution Research Journal Of Canada*. Vol. 22, No. 1. pp. 129-146. 1987.

Ku, H. F. H., N. W. Hagelin and H. T. Buxton. "Effects Of Urban Storm-Runoff Control On Ground-Water Recharge In Nassau County, New York." *Ground Water*. Vol. 30, No. 4. pp. 507-513. 1992.

Ku, H. F. H. and D. L. Simmons. *Effect Of Urban Stormwater Runoff On Ground Water Beneath Recharge Basins On Long Island, New York*. Geological Survey Water-Resources Investigations Report 85-4088. U.S. Geological Survey, Syosset, New York. 1986.

Ku, H. F. H., J. Vecchioli and S. E. Ragone. "Changes In Concentration Of Certain Constituents Of Treated Waste Water During Movement Through The Magothy Aquifer, Bay Park, New York." *Journal*

Research U.S. Geology Survey. Vol. 3, No. 1. pp. 89-92. 1975.

Lauer, D. A. "Vertical Distribution In Soil Of Sprinkler-Applied Phosphorus." *Soil Science Society Of America Journal*. Vol. 52, No. 3. pp. 862-868. 1988.

Lauer, D. A. "Vertical Distribution In Soil Of Unincorporated Surface-Applied Phosphorus Under Sprinkler Irrigation." *Soil Science Society Of America Journal*. Vol. 52, No. 6. pp. 1685-1692. 1988.

Lee, E. W. "Drainage Water Treatment And Disposal Options." *Agricultural Salinity Assessment And Management*. American Society Of Civil Engineers. pp. 450-468. 1990.

Lloyd, J. W., D. N. Lerner, M. O. Rivett and M. Ford. "Quantity And Quality Of Groundwater Beneath An Industrial Conurbation - Birmingham, UK." *Hydrological Processes And Water Management In Urban Areas, Duisburg, Federal Republic Of Germany, 1988*. (International Hydrological Programme, UNESCO, pp. 445-453). 1988.

Loh, P. C., R. S. Fujioka and W. M. Hirano. "Thermal Inactivation Of Human Enteric Viruses In Sewage Sludge And Virus Detection By Nitrose Cellulose-Enzyme Immunoassay." *Chemical And Biological Characterization Of Sludges, Sediments, Dredge Spoils, And Drilling Muds. ASTM STP 976*. American Society For Testing And Materials, Philadelphia, Pennsylvania. pp. 273-281. 1988.

Malik, A., M. Stone, F. R. Martinez and R. Paul. "First Wastewater Desalting Plant In Central Coast, California." *Water Environment Federation 65th Annual Conference & Exposition, New Orleans, Louisiana, 1992*. (Water Environment Federation, Alexandria, Virginia, pp. 395-406). 1992.

Mancini, J. L. and A. H. Plummer Jr. "A Method For Developing Wet Weather Water Quality Criteria for Toxics." *Water Environment Federation 65th Annual Conference & Exposition, New Orleans, Louisiana, 1992*. (Water Environment Federation, Alexandria, Virginia, pp. 15-26). 1992.

Markwood, I. M. "Waterborne Disease -- Historical Lesson." *Ground Water*. Vol. 17, No. 2. pp. 197-198. 1979.

Marton J. and Mohler I. "The Influence Of Urbanization On The Quality Of Groundwater." *Hydrological Processes And Water Management In Urban Areas, Duisburg, Federal Republic Of Germany, 1988*. (International Hydrological Programme, UNESCO, pp. 452- 461). 1988.

Marzouk, Y., S. M. Goyal and C. P. Gerba. "Prevalence Of Enteroviruses In Ground Water Of Israel." *Ground Water*. Vol. 17, No. 5. pp. 487-491. 1979.

Merkel, B., J. Grossmann and P. Udluft. "Effect Of Urbanization On A Shallow Quarternary Aquifer." *Hydrological Processes And Water Management In Urban Areas, Duisburg, Federal Republic Of Germany, 1988*. (International Hydrological Programme, UNESCO, pp. 461-469). 1988.

Mossbarger, W. A. Jr. and R. W. Yost. "Effects Of Irrigated Agriculture On Groundwater Quality In Corn Belt And Lake States." *Journal of Irrigation and Drainage Engineering*. Vol. 115, No. 5. pp.

773-789. 1990.

Nellor, M. H., R. B. Baird and J. R. Smyth. "Health Aspects Of Groundwater Recharge." *Artificial Recharge Of Groundwater*. Butterworth Publishers, Boston. pp. 329-355. 1985.

Nightingale, H. I., J. E. Ayars, R. L. McCormick and D. C. Cehrs. "Leaky Acres Recharge Facility: A Ten-Year Evaluation." *Water Resources Bulletin*. Vol. 19, No. 3. pp. 429-437. 1983.

Nightingale, H. I. "Accumulation Of As, Ni, Cu, And Pb In Retention And Recharge Basins Soils From Urban Runoff." *Water Resources Bulletin*. Vol. 23, No. 4. pp. 663-672. 1987.

Nightingale, H. I. "Water Quality Beneath Urban Runoff Management Basins." *Water Resources Bulletin*. V. 23, No. 2. pp. 197-205. 1987.

Nightingale, H. I. and W. C. Bianchi. "Ground-Water Chemical Quality Management By Artificial Recharge ." *Ground Water*. V. 15, No. 1. pp. 15-22. 1977.

Nightingale, H. I. and W. C. Bianchi. "Ground-Water Turbidity Resulting From Artificial Recharge." *Ground Water*. Vol. 15, No. 2. pp. 146-152. 1977.

Norberg-King, T. J., E. J. Durhan, G. T. Ankley and E. Robert. "Application Of Toxicity Identification Evaluation Procedures To The Ambient Waters Of The Colusa Basin Drain, California." *Environmental Toxicology And Chemistry*. Vol. 10. pp. 891-900. 1991.

Pahren, H. R. "EPA's Research Program On Health Effects Of Wastewater Reuse For Potable Purposes." *Artificial Recharge Of Groundwater*. Butterworth Publishers, Boston. pp. 319-328. 1985.

Peterson, D. A. "Selenium In The Kendrick Reclamation Project, Wyoming." *Planning Now For Irrigation And Drainage In The 21st Century, Lincoln, Nebraska, 1988*. (American Society Of Civil Engineers, New York, New York, pp. 678-685). 1988.

Petrovic, A. M. "The Fate Of Nitrogenous Fertilizers Applied To Turfgrass." *Journal Of Environmental Quality*. Vol. 19, No. 1. pp. 1-14. 1990.

Phelps, G. G. *Effects Of Surface Runoff And Treated Wastewater Recharge On Quality Of Water In The Floridan Aquifer System, Gainesville Area, Alachua County, Florida* . Geological Survey Water-Resources Investigations Report 87-4099. U.S. Geological Survey, Tallahassee, Florida. 1987.

Pierce, R. C. and M. P. Wong. "Pesticides In Agricultural Waters: The Role of Water Quality Guidelines." *Canadian Water Resources Journal.* Vol. 13, No. 3. pp. 33-49. 1988.

Pitt, W. A. J. Jr. *Effects Of Septic Tank Effluent On Ground- Water Quality, Dade County, Florida: An Interim Report.* Geological Survey Open File Report 74010. U.S. Geological Survey, Tallahassee, Florida. 1974.

Pitt, W. A. J. Jr., H. C. Mattraw and H. Klein. *Ground-Water Quality In Selected Areas Serviced By Septic Tanks, Dade County, Florida*. Geological Survey Open File Report 75-607. U.S. Geological Survey, Tallahassee, Florida. 1975.

Power, J. F. and J. S. Schepers. "Nitrate Contamination Of Groundwater In North America." *Agriculture, Ecosystems and Environment.* Vol. 26, No. 3-4. pp. 165-187. 1989.

Pruitt, J. B., D. E. Troutman and G. A. Irwin. *Reconnaissance Of Selected Organic Contaminants In Effluent And Ground Water At Fifteen Municipal Wastewater Treatment Plants In Florida.* Geological Survey Water-Resources Investigations Report 85-4167. U.S. Geological Survey, Tallahassee, Florida. 1985.

Ragone, S. E. *Geochemical Effects Of Recharging The Magothy Aquifer, Bay Park, New York, With Tertiary-Treated Sewage*. Geological Survey Professional Paper 751-D. U.S. Government Printing Office, Washington, D.C. 1977.

Ragone, S. E., H. F. H. Ku and J. Vecchioli. "Mobilization Of Iron In Water In The Magothy Aquifer During Long-Term Recharge With Tertiary-Treated Sewage, Bay Park, New York." *Journal Research U.S. Geological Survey*. Vol. 3, No. 1. pp. 93-98. 1975.

Ragone, S. E. and J. Vecchioli. "Chemical Interaction During Deep Well Recharge Bay Park, New York." *Ground Water*. Vol. 13 , No. 1. pp. Reprint. 1975.

Ramsey, R. H. III, J. Borreli and C. B. Fedler. "The Lubbock, Texas, Land Treatment System." *Irrigation Systems For The 21st Century, Portland, Oregon, 1987*. (American Society Of Civil Engineers, New York, New York, pp. 352-361). 1987.

Razack, M., C. Drogue and M. Baitelem. "Impact Of An Urban Area On The Hydrochemistry Of A Shallow Groundwater (Alluvial Reservoir) Town Of Narbonne, France." *Hydrological Processes And Water Management In Urban Areas, Duisburg, Federal Republic Of Germany, 1988*. (International Hydrological Programme, UNESCO). 1988.

Rea, A. H. and J. D. Istok. "Groundwater Vulnerability To Contamination: A Literature Review." *Irrigation Systems For The 21st Century, Portland, Oregon, 1987*. (American Society Of Civil Engineers, New York, New York, pp. 362-367). 1987.

Reichenbaugh, R. C. *Effects On Ground-Water Quality From Irrigating Pasture With Sewage Effluent Near Lakeland, Florida*. Geological Survey Water-Resources Investigations 76-108. U.S. Geological Survey, Tallahassee, Florida. 1977.

Reichenbaugh, R. C., D. P. Brown and C. L. Goetz. *Results Of Testing Landspreading Of Treated Municipal Wastewater At St. Petersburg, Florida*. Geological Survey Water-Resources Investigations Report 78-110. U.S. Geological Survey, Tallahassee, Florida. 1979.

Rein, D. A., G. M. Jamesson and R. A. Monteith. "Toxicity Effects Of Alternative Disinfection Processes." *Water Environment Federation 65th Annual Conference & Exposition, New Orleans, Louisiana, 1992*. (Water Environment Federation, Alexandria, Virginia, pp. 461-470). 1992.

Rice, R. C., D. B. Jaynes and R. S. Bowman. "Preferential Flow Of Solutes And Herbicide Under Irrigated Fields." *Transactions Of The American Society Of Agricultural Engineers*. Vol. 34, No. 2. pp. 914-918. 1991.

Ritter, W. F., F. J. Humenik and R. W. Skaggs. "Irrigated Agriculture And Water Quality In East." *Journal of Irrigation and Drainage Engineering*. Vol. 115, No. 5. pp. 807-821. 1989.

Ritter, W. F., R. W. Scarborough and E. M. Chirnside. "Nitrate Leaching Under Irrigation On Coastal Plain Soil." *Journal of Irrigation and Drainage Engineering*. Vol. 117, No. 4. pp. 490-502. 1991.

Robinson, J. H. and H. S. Snyder. "Golf Course Development Concerns In Coastal Zone Management." *Coastal Zone '91: Proceedings Of The Seventh Symposium On Coastal And Ocean Management, Long Beach, California, 1991*. (American Society Of Civil Engineers, New York, New York, pp. 431-442). 1991.

Rosenshein, J. S. and J. J. Hickey. "Storage Of Treated Sewage Effluent And Storm Water In A Saline Aquifer Pinellas Peninsula, Florida." *Ground Water*. Vol. 15, No. 4. pp. 284-293. 1977.

Sabatini, D. A. and T. A. Austin. "Adsorption, Desorption And Transport Of Pesticides In Groundwater: A Critical Review." *Planning Now For Irrigation And Drainage In The 21st Century, Lincoln, Nebraska, 1988*. (American Society Of Civil Engineers, New York, New York, pp. 571-579). 1988.

Sabol, G. V., H. Bouwer and P. J. Wierenga. "Irrigation Effects In Arizona And New Mexico." *Journal of Irrigation and Drainage Engineering*. Vol. 113, No. 1. pp. 30-57. 1987.

Salo, J. E. ,., D. Harrison and E. M. Archibald. "Removing Contaminants By Groundwater Recharge Basins." *Journal Of The American Water Works Association*. Vol. 78, No. 9. pp. 76-81. 1986.

Schiffer, D. M. *Effects Of Three Highway-Runoff Detention Methods On Water Quality Of the Surficial Aquifer System In Central Florida*. Geological Survey Water-Resources Investigations Report 88-4170. U.S. Geological Survey, Tallahassee, Florida. 1989.

Schmidt, K. D. and I. Sherman. "Effect Of Irrigation On Groundwater Quality In California." *Journal Of Irrigation And Drainage Engineering*. Vol. 113, No. 1. pp. 16-29. 1987.

Schneider, B. J., H. F. H. Ku and E. T. Oaksford. *Hydrologic Effects Of Artificial-Recharge Experiments With Reclaimed Water At East Meadow, Long Island, New York*. Geological Survey Water Resources Investigations Report 85-4323. U.S. Geological Survey, Denver, Colorado. 1987.

Seaburn, G. E. and D. A. Aronson. *Influence Of Recharge Basins On The Hydrology Of Nassau And Suffolk Counties, Long Island, New York*. Geological Survey Water Supply Paper 2031. U.S.

Government Printing Office, Washington, D.C. 1974.

Shirmohammadi, A. and W. G. Knisel. "Irrigated Agriculture And Water Quality In South." *Journal of Irrigation and Drainage Engineering*. Vol. 115, No. 5. pp. 791-806. 1989.

Smith, S. O. and D. H. Myott. "Effects Of Cesspool Discharge On Ground-Water Quality On Long Island, N.Y." *Journal Of The American Water Works Association*. Vol. 67, No. 8. pp. 456-458. 1975.

Spalding, R. F. and L. A. Kitchen. "Nitrate In The Intermediate Vadose Zone Beneath Irrigated Cropland." *Ground Water Monitoring Review*. Vol. 8, No. 2. pp. 89-95. 1988.

Squires, R. C., G. R. Groves and W. R. Johnston. "Economics Of Selenium Removal From Drainage Water." *Journal of Irrigation and Drainage Engineering*. Vol. 115, No. 1. pp. 48-57. 1989.

Squires, R. C. and R. Johnston. "Selenium Removal -- Can We Afford It?" *Irrigation Systems For The 21st Century, Portland, Oregon, 1987*. (American Society Of Civil Engineers, New York, New York, pp. 455-467). 1987.

Steenhuis, T., R. Paulsen, T. Richard, W. Staubitz, M. Andreini and J. Surface. "Pesticide And Nitrate Movement Under Conservation And Conventional Tilled Plots." *Planning Now For Irrigation And Drainage In The 21st Century, Lincoln, Nebraska, 1988*. (American Society Of Civil Engineers, New York, New York, pp. 587-595). 1988.

Strutynski, B., R. E. Finger, S. Le and M. Lundt. "Pilot Scale Testing Of Alternative Technologies For Meeting Effluent Reuse Criteria." *Water Environment Federation 65th Annual Conference & Exposition, New Orleans, Louisiana, 1992*. (Water Environment Federation, Alexandria, Virginia, pp. 69-79). 1992.

Tim, U. S. and S. Mostaghimi. "Model For Predicting Virus Movement Through Soils." *Ground Water*. Vol. 29, No. 2. pp. 251- 259. 1991.

Townley, J. A., S. Swanback and D. Andres. *Recharging A Potable Water Supply Aquifer With Reclaimed Wastewater In Cambria, California*. John Carollo Engineers, Walnut Creek, CA. 1992.

Treweek, G. P. "Pretreatment Processes For Groundwater Recharge." *Artificial Recharge Of Groundwater*. Butterworth Publishers, Boston. pp. 205-248. 1985.

Troutman, D. E., E. M. Godsy, D. F. Goerlitz and G. G. Ehrlich. *Phenolic Contamination In The Sand-And-Gravel Aquifer From A Surface Impoundment Of Wood Treatment Wastewaters, Pensacola, Florida*. Geological Survey Water-Resources Investigations Report 84-4230. U.S. Geological Survey, Tallahassee, Florida. 1984.

U.S. Environmental Protection Agency Office Of Water, O. O. W. E. A. C. *Manual: Guidelines For Water Reuse*. EPA/625/R-92/004. U.S. Environmental Protection Agency, Washington, D.C. 1992.

Varuntanya, C. P. and D. R. Shafer. "Techniques For Fluoride Removal In Industrial Wastewaters." *Water Environment Federation 65th Annual Conference & Exposition, New Orleans, Louisiana, 1992*. (Water Environment Federation, Alexandria, Virginia, pp. 159-170). 1992.

Vaughn, J. M., E. F. Laudry, L. J. Baranosky, Beckwith C.A., M. C. Dahl and Delihas N.C. "Survey Of Human Virus Occurrence In Wastewater-Recharged Groundwater On Long Island." *Applied And Environmental Microbiology*. Vol. 36, No. 1. pp. 47-51. 1978.

Vecchioli, J., G. G. Ehrlich, E. M. Godsy and C. A. Pascale. "Alterations In The Chemistry Of An Industrial Waste Liquid Injected Into Limestone Near Pensacola, Florida ." *Hydrogeology Of Karstic Terrains: Case Histories*. International Association Of Hydrogeologists, UNESCO, Vol. 1. pp. 217-220. 1984.

Verdin, J., G. Lyford and L. Sims. *Application Of Satellite Remote Sensing For Identification Of Irrigated Lands In The Newlands Project*. . 1987.

Waller, B. G., B. Howie and C. R. Causaras. *Effluent Migration From Septic Tank Systems In Two Different Lithologies, Broward County, Florida*. Geological Survey Water-Resources Investigations Report 87-4075. U.S. Geological Survey, Tallahassee, Florida. 1987.

Wanielista, M., J. Charba, J. Dietz, R. S. Lott and B. Russell. *Evaluation Of The Stormwater Treatment Facilities At The Lake Angel Detention Pond Orange County, Florida*. Report No. FL-ER- 49-91. Florida Department Of Transportation Environmental Office, Tallahassee, Florida. 1991.

Wellings, F. M. "Perspective On Risk Of Waterborne Enteric Virus Infections." *Chemical And Biological Characterization Of Sludges, Sediments, Dredge Spoils, And Drilling Muds. ASTM STP 976*. American Society For Testing And Materials, Philadelphia, Pennsylvania. pp. 257-264. 1988.

White, E. M. and J. N. Dornbush. "Soil Changes Caused By Municipal Wastewater Applications In Eastern South Dakota." *Water Resources Bulletin*. Vol. 24, No. 2. pp. 269-273. 1988.

Wilde, F. D. *Geochemistry and Factors Affecting Ground-Water Quality at Three Storm-Water-Management Sites in Maryland: Report of Investigations No. 59*. Department of Natural Resources, Maryland Geological Survey, Baltimore, Maryland. (Prepared in Cooperation with the U.S. Department of the Interior Geological Survey, The Maryland Department of the Environment, and The Governor's Commission on Chesapeake Bay Initiatives). 1994.

Wilson, L. G., Osborn M.D., K. L. Olson, S. M. Maida and L. T. Katz. "The Ground Water Recharge And Pollution Potential Of Dry Wells In Pima County, Arizona." *Ground Water Monitoring Review*. Vol. 10. pp. 114-121. 1990.

Wolff, J., J. Ebeling, A. Muller and H. Wacker. "Waste Water Irrigation Suited To The Environment As Shown By The Example Of the 'Abwasserverband Wolfsburg'." *Hydrological Process And Water Management In Urban Areas, Duisburg, Federal Republic Of Germany, 1988*. (International

Hydrological Programme, UNESCO). 1988.

Yurewicz, M. C. and J. C. Rosenau. *Effects On Ground Water Of Spray Irrigation Using Treated Municipal Sewage Southwest Of Tallahassee, Florida*. Geological Survey Water-Resources Investigation Report 86-4109. U.S. Geological Survey, Tallahassee, Florida. 1986.

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Effect of Urbanization on Aquifer Recharge on the Santa Clarita Valley

Effect of Urbanization on Aquifer Recharge in the Santa Clarita Valley

TO: Tom Worthington/Impact Sciences, Inc.

FROM: John Porcello/CH2M HILL

DATE: February 22, 2004

Introduction

In a groundwater basin, the effect of urbanization on recharge to underlying groundwater is dependent on land uses, water uses, vegetative cover, and geologic conditions. Groundwater recharge from undeveloped lands occurs from precipitation alone, whereas areas that are developed for agricultural or urban land uses receive both precipitation and irrigation of vegetative cover. In an urban area, groundwater recharge occurs directly beneath irrigated lands and in drainages whose bottoms are not paved or cemented. This memorandum discusses the general effects of urbanization on groundwater recharge and the specific effects in the Santa Clarita Valley.

Summary of Findings

In the Santa Clarita Valley, stormwater runoff finds its way to the Santa Clara River and its tributaries, whose channels are predominantly natural and consist of vegetation and coarse-grained sediments (rather than concrete). The stormwater that flows across paved lands in the Santa Clarita Valley is routed to stormwater detention basins and to the river channels, where the porous nature of the sands and gravels forming the streambeds allow for significant infiltration to occur to the underlying groundwater.

Increased urbanization in the Valley has resulted in the irrigation of previously undeveloped lands. The effect of irrigation is to maintain higher soil moisture levels during the summer than would exist if no irrigation were occurring. Consequently, a greater percentage of the fall/winter precipitation recharges groundwater beneath irrigated land parcels than beneath undeveloped land parcels. In addition, urbanization in the Santa Clarita Valley has occurred in part because of the importation of State Water Project (SWP) water, which began in 1980. SWP water use has increased steadily, reaching nearly 44,500 acre-feet (AF) in 2003. Two-thirds of this water is used outdoors, and a portion of this water eventually infiltrates to groundwater. The other one-third is used indoors and is subsequently routed to local water reclamation plants (WRPs) and then to the Santa Clara River (after treatment). A portion of this water flows downstream out of the basin, and a portion infiltrates to groundwater.

Records show that groundwater levels and the amount of groundwater in storage were similar in both the late 1990s and the early 1980s, despite a significant increase in the urbanized area during these two decades. This long-term stability of groundwater levels is attributed in part to the significant volume of natural recharge that occurs in the streambeds, which do not contain paved, urban land areas. On a long-term historical basis, groundwater pumping volumes have not increased due to urbanization, compared with pumping volumes during the 1950s and 1960s when water was used primarily for agriculture. Also, the importation of SWP water is another process that contributes to recharge in the Valley. In summary, urbanization has been accompanied by long-term stability in pumping and groundwater levels, plus the addition of imported SWP water to the Valley, which together have not reduced recharge to groundwater, nor depleted the amount of groundwater that is in storage within the Valley.

Effect of Pavement on Recharge Beneath Specific Land Parcels

The amount of paved cover on the ground affects the degree to which rainfall and outdoor-applied urban water will be able to infiltrate to groundwater. In heavily industrialized areas with high percentages of paved cover, such as exist in portions of the Los Angeles Basin, less rainfall recharge will occur than if the land is in an undeveloped condition. Furthermore, if the bottoms of rivers and other drainages are paved, then the majority of stormwater generated during a rainfall event will be unable to infiltrate to groundwater. In contrast, the amount of recharge to groundwater will be greater in urbanized areas, such as the Santa Clarita Valley, that have natural soils in the bottoms of rivers and local drainages or that have lower percentages of paved cover on the developed areas lying outside the principal drainages. In these areas, the outdoor use of water for irrigation landscape vegetation or agricultural lands can notably increase the amount of groundwater recharge, particularly if the outdoor water is imported from outside the local groundwater basin. This is discussed further below.

Effect of Vegetative Cover and Water Use

From the 1930s through the 1960s, H.F. Blaney and other researchers at the U.S. Department of Agriculture performed numerous studies to measure the amount of infiltration to groundwater that occurs beneath undeveloped lands and irrigated farmlands, and the differences in recharge rates for different types of native vegetation and crops. In California, these studies included a 1933 study by Blaney in Ventura County, a 1963 study by Blaney and others in the Lompoc Uplands, studies by the U.S. Geological Survey and various consultants in the Montecito and Carpenteria groundwater basins, and a groundwater basin study by Santa Barbara County[1] that incorporated the results of these earlier studies.

Together, these studies concluded that deep percolation to groundwater from undeveloped lands occurs only during years of average or above-average precipitation. This occurs because:

1. Southern California's rainfall is highly seasonal in nature, whereupon most rainfall occurs during the relatively cool period November through March, when plant water

[1] See Santa Barbara County Water Agency, December 15, 1977. *Report on Adequacy of the Groundwater Basins of Santa Barbara County.*

requirements are low, and little, if any, rainfall occurs during the remaining (and warmer months) when plant water requirements increase.

2. During the summer, when little or no rainfall occurs, the native vegetation extracts the residual moisture that is present in the soil, which substantially decreases the soil moisture within the root zone of the vegetation. At the end of the dry season, soil moisture levels on undeveloped lands are below the soil's field capacity, which is the amount of moisture that must be present in the soil before free drainage of water can occur below the rooting zone of the native vegetation.

3. When the seasonal rains arrive, the incident rainfall that is not consumed by plants and does not become stormwater runoff must first raise the soil moisture level to the soil's field capacity before any groundwater recharge will occur. The various studies indicate that about 17 inches/year of rainfall is necessary to raise the soil moisture to the field capacity on an undeveloped parcel of land. This is similar to the average annual rainfall in the Santa Clarita Valley and in other lowland coastal and near-coastal valleys in southern California.

On irrigated lands, irrigation occurs during several months of the year, with the exact duration depending on the amount and timing of rainfall and also the crops or type of urban landscaping being irrigated. The principal effect of converting undeveloped land to land that receives agricultural or urban irrigation is to increase the amount of water that is applied to the land during the low-rainfall months. This application of water to the vegetative cover on the surface of the developed land parcel results in the maintenance of higher soil moisture levels during the warm, dry months than would occur without development. This has three effects:

1. Because irrigation will generally be performed in a manner that maintains the health of the vegetative cover, enough water will be applied to maintain the soil moisture at, or close to, the field capacity of the soil. This in turn will allow some deep percolation to occur from the irrigation water itself.

2. When the rainy season begins, because irrigation has maintained soil moisture at or near field capacity, less of the initial rainfall entering the root zone needs to be stored in the soil (to meet soil moisture deficits) beneath an irrigated parcel than in the case of an undeveloped parcel. Therefore, a greater percentage of the initial rainfall and annual rainfall will be able to infiltrate to groundwater. The southern California studies estimated that irrigated land parcels would allow rainfall infiltration to occur in years when annual rainfall is at least 10.5 inches/year. This threshold rainfall value is 6.5 inches less than the threshold rainfall value that the studies estimated to be necessary for generating groundwater recharge beneath undeveloped land parcels.

3. Because the majority of irrigation occurs during the dry (low-rainfall) months, the total annual recharge to groundwater from irrigated developed lands is the sum of: (a) the deep percolation arising from irrigation (during the low-rainfall months); and (b) rainfall (during the months when less irrigation is occurring). Therefore, groundwater recharge beneath developed lands is greater and occurs for a longer period of time each year than in the case of undeveloped lands where no irrigation is occurring.

Historical Observations of Groundwater Conditions in the Santa Clarita Valley

The findings of the studies described above for other groundwater basins in southern California are consistent with observations that have been made in the Santa Clarita Valley, which are based on long-term water level records, water budget analyses, and groundwater modeling. Based on a month-by-month calibration to a 20-year record of historical water level records (throughout the Valley) and stream gaging records (at the Los Angeles - Ventura County line), the model simulates 10 percent of the applied outdoor water as being available for recharge to groundwater in retail and residential areas, with greater percentages infiltrating beneath golf courses and agricultural lands. This is consistent with a 1980 study by DWR of the groundwater resources of the Santee and El Monte hydrologic subareas of San Diego County. In that study, which was performed to evaluate reclaimed water use plans, DWR concluded that approximately 20 percent of the applied outdoor water in municipal areas infiltrates to the water table, with the remaining 80 percent going to evapotranspiration and direct evaporation. DWR also concluded that there would likely be no significant change in these percentages as urbanization continues.[2]

In the Santa Clarita Valley, as in any urbanized area, urbanization increases the paved area and can increase the magnitude and intensity of stormwater runoff from paved land areas. In the Santa Clarita Valley, this stormwater runoff will find its way to the Santa Clara River and its tributaries, whose channels are predominantly natural and consist of vegetation and coarse-grained sediments (rather than concrete). The stormwater that flows across paved lands in the Santa Clarita Valley is routed to stormwater detention basins and to the river channels, where the porous nature of the sands and gravels forming the streambeds allow for significant infiltration to occur to the underlying groundwater. Consequently, for a developed land parcel, the water that runs off of the paved portion of the land parcel will infiltrate to groundwater from a detention basin or a riverbed, rather than infiltrating onsite.

Riverbed infiltration is a significant percentage of total recharge in the Santa Clarita Valley in any given year. Streamflow records and the model calibration process together demonstrate that year-to-year fluctuations in total recharge in the Valley arise not just from year-to-year variations in incident rainfall within the Valley, but also from year-to-year variations in streamflows in the Santa Clara River and its tributaries. Because the areas contributing flow to the rivers are located both within and outside of the Valley, the recharge that occurs from riverbeds is a significant source of groundwater recharge within the Valley.

Evidence that stormwater infiltration to groundwater is not significantly decreased by urbanization comes from long-term water level records at wells completed in the Alluvial aquifer. These records show that groundwater levels and the amount of groundwater in storage were similar in both the late 1990s and the early 1980s, despite a significant increase in the urbanized area during these two decades. This long-term stability is attributed in part to the significant volume of natural recharge that occurs in the streambeds, which do not contain paved, urban land areas. Also, groundwater pumping volumes have not increased

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[2] See State of California, Department of Water Resources, Southern District. August 1984, *San Diego County Cooperative Ground Water Studies: Reclaimed Water Use, Phase II.* Pages 40-41.

due to urbanization, compared with pumping volumes during the 1950s and 1960s when water was used primarily for agriculture. Additionally, beginning in 1980, water was imported into the Santa Clarita Valley from the State Water Project (SWP) for urban use, with SWP water use reaching nearly 30,000 acre-feet per year (AF/yr) by the end of the 1990s, and progressively increasing from about 32,500 AF in 2000 to nearly 44,500 AF in 2003. Because two-thirds of the total urban water demand is used outdoors, a substantial portion of the imported SWP water has been and continues to be applied to urban landscaping, thereby increasing the amount of recharge to groundwater. The remaining urban water is used indoors, and is subsequently routed to local water reclamation plants (WRPs) and then to the Santa Clara River (after treatment). A portion of this water flows downstream out of the basin, and a portion infiltrates to groundwater.

In summary, urbanization has been accompanied by long-term stability in pumping and groundwater levels, plus the addition of imported SWP water to the Valley, which together have not reduced recharge to groundwater, nor depleted the amount of groundwater that is in storage within the Valley.

Project Summary, Potential Groundwater Contamination From Intentional and Nonintentional Stormwater Infiltration

United States
Environmental Protection
Agency

Research and Development

Risk Reduction
Engineering Laboratory
Cincinnati, OH 45268

EPA/600/SR-94/051 May 1994

EPA

Project Summary

Potential Groundwater Contamination from Intentional and Nonintentional Stormwater Infiltration

Robert Pitt, Shirley Clark, and Keith Parmer

The research summarized here was conducted during the first year of a 3-yr cooperative agreement to identify and control stormwater toxicants, especially those adversely affecting groundwater. The purpose of this research effort was to review the groundwater contamination literature as it relates to stormwater. Potential problem pollutants were identified, based on their mobility through the unsaturated soil zone above groundwater, their abundance in stormwater, and their treatability before discharge. This information was used with earlier EPA research results to identify the possible sources of these potential problem pollutants. Recommendations were also made for stormwater infiltration guidelines in different areas and monitoring that should be conducted to evaluate a specific stormwater for its potential to contaminate groundwater.

This Project Summary was developed by EPA's Risk Reduction Engineering Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Before urbanization, groundwater was recharged by precipitation infiltrating through pervious surfaces, including grasslands and woods. This infiltrating water was relatively uncontaminated. Urbanization, however, reduced the permeable soil surface area through which recharge by infiltration could occur. This resulted in much less groundwater recharge and greatly increased surface runoff. In addition, the waters available for recharge generally carried increased quantities of pollutants. With urbanization, waters having elevated contaminant concentrations also recharge groundwater, including effluent from domestic septic tanks, wastewater from percolation basins and industrial waste injection wells, infiltrating stormwater, and infiltrating water from agricultural irrigation. This report addresses potential groundwater problems associated with stormwater toxicants and describes how conventional stormwater control practices can reduce these problems.

Sources of Pollutants

High bacteria populations have been found in sheetflow samples from sidewalks, roads, and some bare ground (collected from locations where dogs would most likely be "walked"). Tables 1 and 2 summarize toxicant concentrations and likely sources or locations having some of the highest concentrations found during an earlier phase of this EPA-funded research. The detection frequencies for the heavy metals are all close to 100% for all source areas, and the detection frequencies for the organics listed on these tables ranged from about 10% to 25%. Vehicle service areas had the greatest abundance of observed organics.

Table 1. *Concentrations of Heavy Metals in Observed Areas (µg/L)*

Toxicant	*Highest Median*		*Highest Observed*	
Cadmium	*Vehicle service area runoff*	*8*	*Street runoff*	*220*
Chromium	*Landscaped area runoff*	*100*	*Roof runoff*	*510*
Copper	*Urban receiving water*	*160*	*Street runoff*	*1250*
Lead	*CSO*	*75*	*Storage area runoff*	*330*
Nickel	*Parking area runoff*	*40*	*Landscaped area runoff*	*130*
Zinc	*Roof runoff*	*100*	*Roof runoff*	*1580*

Table 2. *Maximum Concentrations of Toxic Organics from Observed Sources*

Toxicant	*Maximum, µg/L*	*Detection Frequency, %*	*Significant Sources*
Benzo (a) anthracene	*60*	*12*	*Gasoline, wood preservative*
Benzo (b) fluoranthene	*226*	*17*	*Gasoline, motor oils*
Benzo (k) fluoranthene	*221*	*17*	*Gasoline, bitumen, oils*
Benzo (a) pyrene	*300*	*17*	*Asphalt, gasoline, oils*
Fluoranthene	*128*	*23*	*Oils, gasoline, wood preservative*
Naphthalene	*296*	*13*	*Coal tar, gasoline, insecticides*
Phenanthrene	*69*	*10*	*Oils, gasoline, coal tar*
Pyrene	*102*	*19*	*Oils, gasoline, bitumen, coal tar, wood preservative*
Chlordane	*2.2*	*13*	*Insecticide*
Butyl benzyl phthalate	*128*	*12*	*Plasticizer*
Bis (2-chloroethyl) ether	*204*	*14*	*Fumigant, solvents, insecticides, paints, lacquers, varnishes*
Bis (2-chloroisopropyl) ether	*217*	*14*	*Pesticide manufacturing*
1,3-Dichlorobenzene	*120*	*23*	*Pesticide manufacturing*

Stormwater Constituents Having High Potential to Contaminate Groundwater

Nutrients

Nitrates are one of the most frequently encountered contaminants in groundwater. Phosphorus contamination of groundwater has not been as widespread, or as severe, as that of nitrogen compounds. Whenever nitrogen-containing compounds come into contact with soil, a potential exists for nitrate leaching into groundwater, especially in rapid-infiltration wastewater basins, stormwater infiltration devices, and agricultural areas. Nitrate has leached from fertilizers and affected groundwaters under various turf grasses in urban areas, including golf courses, parks, and home lawns. Significant leaching of nitrates occurs during the cool, wet seasons. Cool temperatures reduce denitrification and ammonia volatilization and limit microbial nitrogen immobilization and plant uptake. The use of slow-release fertilizers (including composted organic mulches, urea formaldehyde (UF), methylene urea, isobutylidene diurea (IBDU), and sulfur-coated urea) is recommended in areas having potential groundwater nitrate problems.

Residual concentrations of nitrate in soil vary greatly and depend on the soil texture, mineralization, rainfall and irrigation patterns, organic matter content, crop yield, nitrogen fertilizer/sludge application rate, denitrification, and soil compaction. Nitrate is highly soluble (>1 kg/L) and will stay in solution in the percolation water. If it leaves the root zone without being taken-up by plants, it will readily reach the groundwater.

Pesticides

Urban pesticide contamination of groundwater can result from municipal and homeowner use for pest control and the subsequent collection of the pesticide in stormwater runoff. Pesticides that have been found in urban groundwaters include: 2,4-D, 2,4,5-T, atrazine, chlordane, diazinon, ethion, malathion, methyl trithion, silvex, and simazine. Heavy repetitive use of mobile pesticides (those that are not likely to be retained by various processes in the soil before they reach the groundwater, such as 2,4-D, acenaphthylene, alachlor, atrazine, cyanazine, dacthal, diazinon, dicamba, and malathion) on irrigated and sandy soils will likely contaminate groundwater. Fungicides and nematocides must be mobile to reach the target pest, and hence, they generally have the highest groundwater contamination potential. Pesticide leaching depends on patterns of use, soil texture, total organic carbon content of the soil, pesticide persistence, and depth to the water table.

The greatest pesticide mobility occurs in areas with coarse-grained or sandy soils without a hardpan layer, and with soils that have low clay and organic matter content and high permeability. Structural voids, generally found in the surface layer of finer-textured soils rich in clay, can transmit pesticides rapidly when the voids are filled with water and the adsorbing surfaces of the soil matrix are bypassed. In general, pesticides with low water solubilities, high octanol-water partitioning coefficients, and high carbon partitioning coefficients are less mobile. The slower moving pesticides that may better sorb to soils have been recommended for use in areas of groundwater contamination concern. These include the fungicides iprodione and triadimefon, the insecticides isofenphos and chlorpyrifos, and the herbicide glyphosate.

Pesticides decompose in soil and water, but the total decomposition time can range from days to years. Literature half-lives for pesticides generally apply to surface soils and do not account for the reduced microbial activity found deep in the vadose zone. Pesticides with a 30-day half life can show considerable leaching. An order-of-magnitude difference in half-life results in a five- to ten-fold difference in percolation loss. Organophosphate pesticides are less persistent than organochlorine pesticides, but they also are not strongly adsorbed by the sediment and are likely to leach into the vadose zone and the groundwater.

Other Organics

The most commonly occurring organic compounds found in urban groundwaters include phthalate esters (especially bis(2-ethylhexyl)phthalate) and phenolic compounds. Other, more rarely found, organics include the volatiles: benzene, chloroform, methylene chloride, trichloroethylene, tetrachloroethylene, toluene, and xylene. Polycyclic aromatic hydrocarbons (PAHs) (especially benzo(a)anthracene, chrysene, anthracene, and benzo(b)fluoroanthenene) have also been found in groundwaters near industrial sites.

Groundwater contamination from organics, like that from other pollutants, occurs more readily in areas with sandy soils and where the water table is near the land surface. Organics can be removed from the soil and recharge water by volatilization, sorption, and degradation. Volatilization can significantly reduce the concentrations of the most volatile compounds in groundwater, but the rate of gas transfer from the soil to the air is usually limited by the presence of soil water. Hydrophobic sorption onto soil organic matter limits the mobility of less soluble base/neutral and acid extractable compounds through organic soils and the vadose zone. Sorption is not always a permanent removal mechanism, however. Organic resolubilization can occur during wet periods following dry periods. Many organics can be degraded by microorganisms, at least partially, but others cannot. Temperature, pH, moisture content, ion exchange capacity of the soil, and air availability may limit the microbial degradation potential for even the most degradable organic compound.

Microorganisms

Viruses have been detected in groundwater where stormwater recharge basins were located short distances above the aquifer. Enteric viruses are more resistant to environmental factors than are enteric bacteria, and they exhibit longer survival times in natural waters. They can occur in potable and marine waters in the absence of fecal coliforms. Enteroviruses are also more resistant to commonly used disinfectants than are indicator bacteria (such as fecal coliforms), and they can occur in groundwater in the absence of indicator bacteria.

The factors that affect the survival of enteric bacteria and viruses in the soil include pH, antagonism from soil microflora, moisture content, temperature, sunlight, and organic matter. The two most important attributes of viruses that permit their long-term survival in the environment are their structure and very small size. These characteristics permit virus occlusion and protection within colloid-size particles. Viral adsorption is promoted by increasing cation concentration, decreasing pH, and decreasing soluble organics. Since the movement of viruses through soil to groundwater occurs in the liquid phase and involves water movement and associated suspended virus particles, the distribution of viruses between the adsorbed and liquid phases determines the viral mass available for movement. Once the virus reaches the groundwater, it can travel laterally through the aquifer until it is either adsorbed or inactivated.

The major bacterial removal mechanisms in soil are straining at the soil surface and at intergrain contacts, sedimentation, sorption by soil particles, and inactivation. Because their size is larger than viruses, most bacteria are retained near the soil surface because of this straining effect. In general, enteric bacteria survive in soil between 2 and 3 mo, although survival times up to 5 yr have been documented.

Metals

From a groundwater pollution standpoint, the metals in stormwater presenting the most environmental concern are aluminum, arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, and zinc. The majority of these metals (with the common exception of zinc) are, however, mostly associated with the particulate fractions and can be mostly removed by either sedimentation or filtration processes.

In general, studies of recharge basins receiving large metal loads found that most of the heavy metals are removed either in the basin sediment or in the vadose zone. Dissolved metal ions are removed from stormwater during infiltration mostly by adsorption onto the near-surface particles in the vadose zone, and the particulate metals are filtered out at the soil surface. Studies at recharge basins found that lead, zinc, cadmium, and copper accumulated at the soil surface with little downward movement over many years. At a commercial site, however, nickel, chromium, and zinc concentrations have exceeded regulatory limits in the soils below a recharge area. Allowing percolation ponds to go dry between storms can be counterproductive to the removal of lead from the water during recharge. Apparently, the adsorption bonds between the sediments and the metals can be weakened during the drying period.

Similarities in water quality between runoff water and groundwater have shown that there is significant downward movement of copper and iron in sandy and loamy soils. Arsenic, nickel, and lead, however, did not significantly move downward through the soil to the groundwater. The exception to this was some downward movement of lead with the percolation water in sandy soils beneath stormwater recharge basins. Zinc, which is more soluble than iron, has been found in higher concentrations in groundwater than iron. The order of attenuation in the vadose zone from infiltrating stormwater is: zinc (most mobile) > lead > cadmium > manganese > copper > iron > chromium > nickel > aluminum (least mobile).

Salts

Salt applications for winter traffic safety is a common practice in many northern areas, and the sodium and chloride, which are collected in the snowmelt, travel down through the vadose zone to the groundwater with little attenuation. Soil is not very effective at removing salts. Salts that are still in the percolation water after it travels through the vadose zone will contaminate the groundwater. Infiltrating stormwater has increased sodium and chloride concentrations above background concentrations. Fertilizer and pesticide salts also accumulate in urban areas and can leach through the soil to the groundwater.

Studies of depth of pollutant penetration in soil have shown that sulfate and potassium concentrations decrease with depth, whereas sodium, calcium, bicarbonate, and chloride concentrations increase with depth. Once contamination with salts begins, the movement of salts into the groundwater can be rapid. The salt concentration may not lessen until the source of the salts is removed.

Treatment of Stormwater

Table 3 summarizes the filterable fraction of toxicants found in runoff sheet flows from many urban areas found during an earlier phase of this EPA-funded research. Pollutants that are mostly in filterable forms have a greater potential of affecting groundwater and are more difficult to control with the use of conventional stormwater control practices which mostly rely on sedimentation and filtration principles. Luckily, most of the toxic organics and metals are associated with the nonfilterable (suspended solids) fraction of the wastewaters during wet weather. Possible exceptions include zinc, fluoranthene, pyrene, and 1,3-dichlorobenzene, which may be mostly found in the filtered sample portions. Pollutants in dry-weather storm drainage flows, however, tend to be much more associated with filtered sample fractions and would not be as readily controlled with the use of sedimentation.

Sedimentation is the most common fate and control mechanism for particulate-related pollutants. This would be common for most stormwater pollutants, as noted above. Particulate removal can occur in many conventional stormwater control processes, including catchbasins, screens, drainage systems, and detention ponds. Sorption of pollutants onto solids and metal precipitation increases the sedimentation potential of these pollutants and also encourages more efficient bonding of the pollutants in soils to prevent their leaching

Table 3. *Reported Filterable Fractions of Stormwater Toxicants from Source Areas*

Constituent	Filterable Fraction (%)
Cadmium	20 to 50
Chromium	<10
Copper	<20
Iron	Small amount
Lead	<20
Nickel	Small amount
Zinc	>50
Benzo (a) anthracene	None found in filtered fraction
Fluoranthene	65
Naphthalene	25
Phenanthrene	None found in filtered fraction
Pyrene	95
Chlordane	None found in filtered fraction
Butyl benzyl phthalate	Irregular
Bis (2-chloroethyl) ether	Irregular
Bis (2-chlrorisopropyl) ether	None found in filtered fraction
1,3-Dichlorobenzene	75

to groundwaters. Detention ponds are probably the most common management practice for the control of stormwater runoff. If properly designed, constructed, and maintained, wet detention ponds can be very effective in controlling a wide range of pollutants. The monitored performance of wet detention ponds indicates more than 90% removal for suspended solids, 70% for BOD_5 and COD, about 60% to 70% for nutrients, and about 60% to 95% for heavy metals. Catchbasins are very small sedimentation devices. Adequate cleaning can help reduce the total solids and lead urban runoff yields by between 10% and 25%, and COD, total Kjeldahl nitrogen, total phosphorus, and zinc by between 5% and 10%. Other important fate mechanisms available in wet detention ponds, but which are probably not important in small enclosed sump devices such as catchbasins, include volatilization and photolysis. Biodegradation, biotransformation, and bioaccumulation (into plants and animals) may also occur in larger and open ponds.

Upland infiltration devices (such as infiltration trenches, porous pavements, percolation ponds, and grass roadside drainage swales) are located at urban source areas. Infiltration (percolation) ponds are usually located at stormwater outfalls or at large paved areas. These basins, along with perforated storm sewers, can infiltrate flows and pollutants from all upland sources combined. Infiltration devices can safely deliver large fractions of the surface flows to groundwater, if carefully designed and located. Local conditions that can make stormwater infiltration inappropriate include steep slopes, slowly percolating soils, shallow groundwater, and nearby groundwater uses. Grass filter strips may be quite effective in removing particulate pollutants from overland flows. The filtering effects of grasses, along with increased infiltration/recharge, reduce the particulate sediment load from urban landscaped areas. Grass swales are another type of infiltration device and can be used in place of curb and gutter drainages in most land uses, except possibly strip commercial and high density residential areas. Grass swales allow the recharge of significant amounts of surface flows. Swales can also reduce pollutant concentrations because of filtration. Soluble and particulate heavy metal (copper, lead, zinc, and cadmium) concentrations can be reduced by at least 50%, COD, nitrate nitrogen, and ammonia nitrogen concentrations can be reduced by about 25%, but only inconsistent concentration reductions can be expected for organic nitrogen, phosphorus, and bacteria.

Sorption of pollutants to soils is probably the most significant fate mechanism of toxicants in biofiltration devices. Many of the devices also use sedimentation and filtration to remove the particulate forms of the pollutants from the water. Incorporation of the pollutants onto soil with subsequent biodegradation and minimal leaching to the groundwater is desired. Volatilization, photolysis, biotransformation, and bioconcentration may also be significant in grass filter strips and grass swales. Underground seepage drains and porous pavements offer little biological activity to reduce toxicants.

Results and Conclusions

This entire research project will provide guidance on critical source area treatment, especially for the protection of groundwater quality. Much of the information will also be useful for analyzing stormwater problems and needed controls for surface water discharges.

Table 4 is a summary of the pollutants found in stormwater that may cause groundwater contamination problems for various reasons. This table does not consider the risk associated with using groundwater contaminated with these pollutants. Causes of concern include high mobility (low sorption potential) in the vadose zone, high abundance (high concentrations and high detection frequencies) in stormwater, and high soluble fractions (small fraction associated with particulates that would have little removal potential using conventional stormwater sedimentation controls) in the stormwater. The contamination potential is the lowest rating of the influencing factors. As an example, when no pretreatment is used before percolation through surface soils, the mobility and abundance criteria are most important. When a compound is mobile but in low abundance (such as for volatile organic compounds, VOCs), then the groundwater contamination potential would be low. When the compound is mobile, however, and also in high abundance (such as for sodium chloride, in certain conditions), then the groundwater contamination potential would be high. When sedimentation pretreatment is to be used before infiltration, then some of the pollutants will likely be removed before infiltration. In this case, all three influencing factors (pollutant mobility, pollutant abundance in stormwater, and fraction of the pollutant associated with the filtered sample fraction) would be considered. As an example, chlordane would have a low contamination potential with sedimentation pretreatment, whereas it would have a moderate contamination potential when no pretreatment is used. In addition, when subsurface infiltration/injection is used instead of surface percolation, the compounds would most likely be more mobile, making the abundance criteria the most important, with some regard given to the filterable fraction information for operational considerations.

This table is only appropriate for initial estimates of contamination potential because of the simplifying assumptions made, such as the worst case mobility conditions assumed (for sandy soils having low organic content). When the soil is clayey and has a high organic content, then most of the organic compounds would be less mobile than that shown on this table. The abundance and filterable fraction information is generally applicable for warm weather stormwater runoff in residential and commercial areas. The pollutant concentrations and detection frequencies, however, would be greater for critical source areas (especially vehicle service areas) and critical land uses (especially manufacturing industrial areas).

The stormwater pollutants of most concern (those that may have the greatest adverse impacts on groundwaters) include:

- Nutrients: nitrate has a low to moderate potential for contaminating groundwater when both surface percolation and subsurface infiltration/injection are used because of its relatively low concentrations in most stormwaters. When the stormwater nitrate concentration is high, then the groundwater contamination potential would likely also be high.
- Pesticides: lindane and chlordane have moderate potentials for contaminating groundwater when surface percolation (with no pretreatment) or when subsurface injection (with minimal pretreatment) are used. The groundwater contamination potentials for both of these compounds would very likely be substantially reduced with adequate sedimentation pretreatment.
- Other organics: 1,3-dichlorobenzene may have a high potential for contaminating groundwater when subsurface infiltration/injection (with minimal pretreatment) is used. It would, however, probably have a lower groundwater contamination potential for most surface percolation practices because of its relatively strong sorption to vadose zone soils. Both pyrene and fluoranthene would also very likely have high groundwater contamination potentials for subsurface infiltration/injection practices, but lower contamination potentials for surface percolation practices because of their more limited mobility through the unsaturated zone (vadose zone). Others (including benzo(a)anthracene, bis (2-ethylhexyl) phthalate, pentachlorophenol, and phenanthrene) may also have moderate groundwater contamination potentials when surface percolation with no pretreatment, or subsurface injection/infiltration, is used. These compounds would have low groundwater contamination potentials when surface infiltration is used with sedimentation pretreatment. VOCs may also have high groundwater contamination potentials if present in the stormwater (which is possible for some industrial and commercial facilities and vehicle service establishments).
- Pathogens: enteroviruses very likely have high potentials for contaminating groundwater when any percolation or subsurface infiltration/injection practice is used, depending on their presence in stormwater (especially if contaminated with sanitary sewage). Other pathogens, including *Shigella*, *Pseudomonas aeruginosa*, and various protozoa, would also have high groundwater contamination potentials when subsurface infiltration/injection practices are used without disinfection. When disinfection (especially by chlorine or ozone) is used, then disinfection by-products (such as trihalomethanes or ozonated bromides) would have high groundwater contamination potentials.
- Heavy Metals: nickel and zinc possibly have high potentials for contaminating groundwater when subsurface infiltration/injection is used. Chromium and lead would have moderate groundwater contamination potentials for subsurface infiltration/injection practices. All metals would possibly have low groundwater contamination potentials when surface infiltration is used with sedimentation pretreatment.
- Salts: chloride would very likely have a high potential for contaminating groundwater in northern areas where road salts are used for traffic safety, irrespective of the pretreatment, infiltration, or percolation practices used.

Pesticides have been mostly found in urban runoff from residential areas, especially in dry weather flows associated with landscaping irrigation runoff. The other organics, especially the volatiles, are mostly found in industrial areas. The phthalates are found in all areas. The PAHs are also found in runoff from all areas, but they are in higher concentrations and occur more frequently in industrial areas. Pathogens are most likely associated with sanitary sewage contamination of storm drainage systems, but several bacterial pathogens are commonly found in surface runoff in residential areas. Zinc is mostly found in roof runoff and other areas where galvanized metal comes into contact with rainwater. Salts are at their greatest concentrations in snowmelt and early spring runoff in northern areas.

The control of these compounds requires various approaches, including source area controls, end-of-pipe controls, and pollution prevention. All dry weather flows should be diverted from infiltration devices because of their potentially high concentrations of soluble heavy metals, pesticides, and pathogens. Similarly, all runoff from manufacturing industrial areas should also be diverted from infiltration devices because of their relatively high concentrations of soluble toxicants. Combined sewer overflows should also be diverted because of sewage contamination. In areas of snow and ice control, winter snowmelt and runoff and early spring runoff should also be diverted from infiltration devices.

All other runoff should include pretreatment using sedimentation processes before infiltration, to both minimize groundwater contamination and to prolong the life of the infiltration device (if needed). This pretreatment can take the form of grass filters, sediment sumps, wet detention ponds, etc., depending on the runoff volume to be treated, treatment flow rate, and other site specific factors. Pollution prevention can also play an important role in minimizing groundwater contamination problems, including reducing the use of galvanized metals, pesticides, and fertilizers in critical areas. The use of specialized treatment devices, such as those being developed and tested during this research, can also play an important role in treating runoff from critical source areas before these more contaminated flows commingle with cleaner runoff from other areas. Sophisticated treatment schemes, especially the use of chemical processes or disinfection, may not be warranted, except in special cases, especially when the potential of forming harmful treatment byproducts (such as THMs and soluble aluminum) is considered.

The use of surface percolation devices (such as grass swales and percolation ponds) that have a substantial depth of underlying soils above the groundwater is preferable to the use of subsurface infiltration devices (such as dry wells, trenches or seepage drains, and especially injection wells), unless the runoff water is known to be relatively free of pollutants. Surface devices are able to take greater advantage of natural soil pollutant removal processes. Unless all percolation devices are carefully designed and maintained, however, they may not function properly and may lead to premature hydraulic failure or contamination of the groundwater.

Recommendations

With a reasonable degree of site-specific design considerations to compensate for soil characteristics, infiltration may be

Table 4. *Potential of Stormwater Pollutants to Contaminate Groundwater*

Compounds		Mobility (sandy/low organic soils)	Abundance in Stormwater	Fraction Filterable	Contamination Potential: Surface Infilt. and No Pretreatment	Surface Infilt. with Sedimentation	Sub-surface Inj. with Minimal Pretreatment
Nutrients	nitrates	mobile	low/moderate	high	low/moderate	low/moderate	low/moderate
Pesticides	2,4-D	mobile	low	likely low	low	low	low
	γ-BHC (lindane)	intermediate	moderate	likely low	moderate	low	moderate
	malathion	mobile	low	likely low	low	low	low
	atrazine	mobile	low	likely low	low	low	low
	chlordane	intermediate	moderate	very low	moderate	low	moderate
	diazinon	mobile	low	likely low	low	low	low
Other organics	VOCs	mobile	low	very high	low	low	low
	1,3-dichloro-benzene	low	high	high	low	low	high
	anthracene	intermediate	low	moderate	low	low	low
	benzo(a) anthracene	intermediate	moderate	very low	moderate	low	moderate
	bis (2-ethylhexyl) phthalate	intermediate	moderate	likely low	moderate	low	moderate
	butyl benzyl phthalate	low	low/moderate	moderate	low	low	low/moderate
	fluoranthene	intermediate	high	high	moderate	moderate	high
	fluorene	intermediate	low	likely low	low	low	low
	naphthalene	low/inter.	low	moderate	low	low	low
	pentachlorophenol	intermediate	moderate	likely low	moderate	low	moderate
	phenanthrene	intermediate	moderate	very low	moderate	low	moderate
	pyrene	intermediate	high	high	moderate	moderate	high
Pathogens	enteroviruses	mobile	likely present	high	high	high	high
	Shigella	low/inter.	likely present	moderate	low/moderate	low/moderate	high
	Pseudomonas aeruginosa	low/inter.	very high	moderate	low/moderate	low/moderate	high
	protozoa	low/inter.	likely present	moderate	low/moderate	low/moderate	high
Heavy metals	nickel	low	high	low	low	low	high
	cadmium	low	low	moderate	low	low	low
	chromium	inter./very low	moderate	very low	low/moderate	low	moderate
	lead	very low	moderate	very low	low	low	moderate
	zinc	low/very low	high	high	low	low	high
Salts	chloride	mobile	seasonally high	high	high	high	high

very effective in controlling both urban runoff quality and quantity problems. This strategy encourages infiltration of urban runoff to replace the natural infiltration capacity lost through urbanization and to use the natural filtering and sorption capacity of soils to remove pollutants; however, the potential for some types of urban runoff to contaminate groundwater through infiltration requires some restrictions. Infiltration of urban runoff having potentially high concentrations of pollutants that may pollute groundwater requires adequate pretreatment or the diversion of these waters away from infiltration devices. The following general guidelines for the infiltration of stormwater and other storm drainage effluent are recommended in the absence of comprehensive site-specific evaluations:

- Dry weather storm drainage effluent should be diverted from infiltration devices because of their probable high concentrations of soluble heavy metals, pesticides, and pathogenic microorganisms.
- Combined sewage overflows should be diverted from infiltration devices because of their poor water quality, especially their high pathogenic microorganism concentrations and high clogging potential.
- Snowmelt runoff should be diverted from infiltration devices because of its potential for having high concentrations of soluble salts.
- Runoff from manufacturing industrial areas should be diverted from infiltration devices because of its potential for having high concentrations of soluble toxicants.
- Construction site runoff must be diverted from stormwater infiltration devices (especially subsurface devices) because of its high suspended solids concentrations, which would quickly clog infiltration devices.
- Runoff from other critical source areas, such as vehicle service facilities and large parking areas, should at least receive adequate pretreatment to eliminate their groundwater contamination potential before infiltration.
- Runoff from residential areas (the largest component of urban runoff in most cities) is generally the least polluted urban runoff flow and should be considered for infiltration. Very little treat-

ment of residential area stormwater runoff should be needed before infiltration, especially if surface infiltration is through the use of grass swales. When subsurface infiltration (seepage drains, infiltration trenches, dry wells, etc.) is used, then some pretreatment may be needed, such as by using grass filter strips, or other surface filtration devices.

Recommended Stormwater Quality Monitoring to Evaluate Potential Groundwater Contamination

Most past stormwater quality monitoring efforts have not adequately evaluated stormwater's potential for contaminating groundwater. The following list shows the stormwater contaminants that are recommended for monitoring when stormwater contamination potential needs to be considered, or when infiltration devices are to be used. Other analyses are appropriate for additional monitoring objectives (such as evaluating surface water problems). In addition, all phases of urban runoff should be sampled, including stormwater runoff, dry-weather flows, and snowmelts.

- Urban runoff contaminates with the potential to adversely affect groundwater:
  - Nutrients (especially nitrates)
  - Salts (especially chloride)
  - VOCs (if expected in the runoff, such as runoff from manufacturing industrial or vehicle service areas, could screen for VOCs with purgable organic carbon analyses)
  - Pathogens (especially enteroviruses, if possible, along with other pathogens such as *Pseudomonas aeruginosa*, *Shigella*, and pathogenic protozoa)
  - Bromide and total organic carbon (to estimate disinfection by-product generation potential, if disinfection by either chlorination or ozone is being considered)
  - Pesticides, in both filterable and total sample components (especially lindane and chlordane)
  - Other organics, in both filterable and total sample components (especially 1,3 dichlorobenzene, pyrene, fluoranthene, benzo(a)anthracene, bis (2-ethylhexyl) phthalate, pentachlorophenol, and phenanthrene)
  - Heavy metals, in both filterable and total sample components (especially chromium, lead, nickel, and zinc)
- Urban runoff compounds with the potential to adversely affect infiltration and injection operations:
  - Sodium, calcium, and magnesium (to calculate the sodium adsorption ratio to predict clogging of clay soils)
  - Suspended solids (to determine the need for sedimentation pretreatment to prevent clogging)

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***Richard Field** is the EPA Project Officer (see below).*
The complete report, entitled "Potential Groundwater Contamination from Intentional and Nonintentional Stormwater Infiltration," (Order No. PB94-165354AS; Cost: $27.00, subject to change) will be available only from:
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5285 Port Royal Road
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The EPA Project Officer can be contacted at:
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FRESNO NATIONWIDE URBAN RUNOFF PROGRAM PROJECT

FRESNO METROPOLITAN FLOOD CONTROL DISTRICT

FINAL REPORT

MAY 1984

BC BROWN AND CALDWELL

BROWN AND CALDWELL
CONSULTING ENGINEERS

May 11, 1984

Mr. Doug Harrison, General Manager
Fresno Metropolitan Flood Control District
Rowell Bulding, Suite 300
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Fresno, California 93721

017-1206-50/4

Subject: Final Report for Fresno Nationwide Urban Runoff Program Project

Dear Mr. Harrison:

We are pleased to submit the final report for the Fresno Nationwide Urban Runoff Program (NURP) project. This report provides a comprehensive documentation of the work conducted on this project over the past three years. For convenience, Chapter 1 is a summary of the key findings of each of the report chapters. A set of specific management practices to improve the current operation of the retention/recharge system is presented in Chapter 9. These recommendations incorporate the suggestions made by the project team and the technical and citizen committees at our review meetings on April 24, 1984.

We have thoroughly enjoyed participating in the Fresno NURP project. Its success can in large part be attributed to the team approach that has been followed since the outset of the project. We thank you and the other District staff, including Bob Van Wyk and Jerry Lakeman for your guidance and support. The excellent work performed by Rick Oltmann of the U.S. Geological Survey and Harry Nightingale of the U.S. Department of Agriculture form the technical foundation for the final report. The other key individuals who have contributed to the project are identified in the listing following this letter.

Very truly yours,

BROWN AND CALDWELL

Lyle N. Hoag
Vice President

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Enclosure

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CHAPTER 1

SUMMARY

In a report of this magnitude, a summary is essential to provide an overview of the study and its findings. The following sections briefly describe the important points of each chapter of the report.

INTRODUCTION

This study is part of the Nationwide Urban Runoff Program (NURP) initiated by the U.S. Environmental Protection Agency (EPA) in 1978. The Fresno project is one of 28 projects being conducted at locations across the country. The primary objectives of NURP are to determine to what extent urban runoff is contributing to water quality problems and to evaluate various management practices for controlling urban runoff.

The Fresno project was selected as one of the NURP projects for three main reasons. First, the receiving water for urban runoff in the Fresno-Clovis area is the groundwater. Only one other NURP project (Long Island, New York) is addressing impacts on groundwater. Secondly, the Fresno groundwater supply is a sole source aquifer, and the potential for degradation is a matter of significant importance to the local community. Third, the Fresno project can demonstrate the effectiveness of a specific best management practice, i.e., the total retention and recharge of urban storm runoff.

OBJECTIVES AND APPROACH

The Fresno Metropolitan Flood Control District (District) has developed a system of retention/recharge basins to handle runoff during storm periods. The system has a dual purpose: it services urban drainage needs and at the same time recharges the groundwater aquifer. The District currently has a total of 86 recharge basins of which 74 are completed or are in various stages of excavation. These basins have a total area of over 1,000 acres.

The participation of the District in NURP was initiated at the request of the District because of the recognition that urban storm runoff recharged to the groundwater represented a potential source of pollution. Thus, the major objective of the

Fresno NURP project is to determine the environmental impacts of the current practice of retention and recharge of urban storm runoff. The two areas of specific concern are potential impacts on the quality of drinking water which is obtained from the groundwater supply, and recreation, which is permitted during the summer months in the turfed recharge basins.

This project has been conducted over a three-year period. The project was fully authorized in early 1981, and the bulk of the field work was completed in the fall of 1983. The District has utilized three subcontractors. The U.S. Geological Survey (USGS) has conducted the runoff monitoring program. The Water Management Research Unit of the U.S. Department of Agriculture (USDA) conducted the soils and groundwater monitoring program. Brown and Caldwell has been responsible for preparation of the interim and final reports and conducted portions of the laboratory work.

RUNOFF MONITORING PROGRAM

The USGS collected extensive data on the quantity and quality of storm runoff and rainfall and on the quality of dry deposition and street particulate material. Samples were collected from a total of 27 storms over the two-year monitoring program. Runoff samples were collected from four land use types: single-family residential, multiple-family residential, commercial, and industrial. Samples were analyzed for a wide array of constituents, including nutrients, solids, major ions, metals, and pesticides.

The runoff results indicated that urban runoff contains significant levels of many contaminants, including most heavy metals and some organic compounds. Constituents which have runoff concentrations significantly higher than the regional groundwater include lead, zinc, copper, mercury, iron, and manganese. In contrast, runoff is better in quality than the regional groundwater from the standpoint of minerals and nutrients. Rainfall samples contained 14 organic compounds, including 11 pesticides.

Comparison of the runoff data for the four land use types showed that the industrial area had the worst runoff quality. Concentrations in the industrial runoff fluctuated greatly during storms, and numerous unexplained concentration spikes were monitored. Runoff concentrations over the course of a storm event at the non-industrial sites followed the traditional "first flush" concept. The highest concentrations for most constituents occurred during the initial storm runoff and then decreased throughout the remainder of the storm. Contaminant concentrations were also generally highest for the first two or three storms of the year and fairly constant thereafter.

SOILS AND GROUNDWATER MONITORING PROGRAM

The USDA field program consisted of sampling of four major components: soils, soil water, groundwater, and plant tissue. Five of the District's recharge basins were monitored: three turfed basins and two unturfed basins that receive imported surface water for recharge during the summer. Several sets of soil samples were collected between the summer of 1981 and the fall of 1983. Water samples were collected first on a bimonthly then on a monthly basis between January 1982 and July 1983. Water samples were collected from the unsaturated zone and at top of the water table underlying each test basin using vacuum soil water extractors.

Soil results showed that the soils in the recharge basins provide a high degree of removal of storm runoff contaminants, thereby protecting groundwater quality. Although there is some evidence of downward movement of some contaminants in the soil, no contamination of the soil water or groundwater has occurred in any of the five basins studied.

Lead and chlordane were the most commonly found contaminants in the surface soils. Lead is a component of gasoline, brake linings, and rubber tires. Chlordane was first introduced as an agricultural pesticide, but currently its use is restricted to subterranean termite control. The surface distribution of lead was determined through a spatial survey of two recharge basins. The highest concentrations of lead occurred at low spots in the basin and close to the basins outfalls.

The recharge of imported irrigation water appears to have a beneficial impact on groundwater quality, although some leaching of basin soils is occurring. There appears to be a correlation between the degree of removal of metals and the proportion of silt plus clay and organic matter in the surface soils.

SYSTEM ANALYSIS

The data collected in the two main elements of the program (USGS runoff monitoring and USDA soils and groundwater monitoring) were integrated, so that pollutants could be traced through the entire system from rainfall to regional groundwater. The system components included rainfall, dry deposition, street particulate material, runoff, basin soils, soil water, and groundwater. Results for lead, specific conductance, calcium, and nitrate were analyzed to demonstrate changes that occur in the runoff/recharge system for different types of constituents.

For example, lead concentrations were fairly low in rainfall and quite high in runoff, indicating lead comes primarily from ground sources. Lead concentrations in the soil water and groundwater underlying the recharge basins were very comparable to background levels found in the regional groundwater. This shows that the soil layer is an excellent mechanism for removing the lead from the percolating runoff water.

A loading analysis was performed to determine if the pollutant loads can be correlated with the amounts of the pollutants present in the basin soils. Although several variables could not be quantified in the loading analysis, the comparison of runoff loads with soils loads provided some general insights. In most cases, the runoff loads corresponded reasonably well to the soil loads. Although in a few cases the data imply that there may be some loss of lead and other constituents from the basin soils to the groundwater, no increase in constituent levels were observed in the groundwater measurements.

IMPACTS OF RUNOFF ON WATER SUPPLY AND RECREATION

The two areas of primary concern in our evaluation of recharge impacts are water supply and recreation. The groundwater to which storm runoff is being recharged is the drinking water supply for the Fresno area. In addition, 13 of the District's recharge basins are turfed and are used for various forms of recreation during the late spring and summer months. The key findings related to these two primary areas of concern are listed below.

1. Water Supply Impacts--Currently, there are no apparent adverse impacts on the groundwater resulting from recharge of urban storm runoff. Of the metals and organic compounds tested, concentrations in the soil water and groundwater underlying the five test basins are well within the drinking water standards established by the Safe Drinking Water Act. Two of the basins tested have been in operation for over 20 years. It is unlikely that continued recharge to basins similar to those tested in this program will cause adverse impacts on the groundwater in the near future. Continued monitoring of the groundwater underlying the recharge basins would detect changes in groundwater quality well in advance of a problem occurring.

   However, one situation where storm recharge could pose a potential threat to the groundwater was not evaluated in this program: a basin serving an area that has a significant amount of industrial development.

We are recommending that additional monitoring be conducted to cover this particular situation.

2. Recreation Impacts--Lead levels, and to a lesser extent chlordane levels, in the surface soils of localized areas in some of the recharge basins exceed the California Department of Health Services (DHS) soil criteria. The primary public health concern for lead is ingestion of soil. The opportunity for soil ingestion in the District's recreational basins is limited, since the recreational basins are entirely turfed with the exception of the baseball diamonds in three basins. These violations of the soil criteria are of concern, but appear to be manageable through management practices. The impact of inhalation of dust particles containing lead was preliminarily assessed and this does not appear to be a problem based on comparison with the lead criterion for worker exposure.

   Although there are no identified health problems associated with current basin operation, the potential for future impacts does exist. Thus, the District should continue to manage and operate the basins in a manner that minimizes the risk to both groundwater quality and recreation.

BEST MANAGEMENT PRACTICES

The current operation of the District's retention/recharge system is the best management practice for stormwater management that has been the focus of this study. The results show that the current system is basically a sound methodology for meeting its two goals: stormwater management and recharge of the groundwater supply. The fact that the system has operated successfully with proven water quality and recreation benefits for over 20 years is a credit to the original design concept.

Since our analysis indicated that there is some potential for future impacts, certain modifications to the District's current procedures are warranted to insure a future which continues to be free of adverse impacts. Basin management practices that have been considered include: providing additional low-flow basins, removing basin soils, modifying pumpout methods, turfing unturfed areas, and long-term monitoring. Two source control measures have also been evaluated: street sweeping and upstream controls at industrial areas.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions from the Fresno NURP project and specific recommendations to improve the retention/recharge system operation are delineated in Chapter 9. Most of the key conclusions have been cited in the previous sections of this summary. Specific recommended management practices are summarized in Table 1-1.

Table 1-1. Recommended Management Practices

1.	Maintain the basic practice of retention and recharge of urban storm runoff subject to certain modifications.
2.[a]	Provide low-flow basins for all recreational basins and evaluate low-flow basins for basins serving industrial areas. Periodically remove solids from the bottom of low-flow basins and from basins serving principally industrial areas.
3.[a]	Remove the portion of the turf and upper soil layer from the recreational basins as necessary.
4.[a]	Monitor soil from unturfed areas in recreational basins and remove as necessary.
5.	Consider having industrial developments contain or pretreat runoff from portions of their site that may contain toxic material.
6.	Have the District work together with other local agencies to be certain that water quality aspects are adequately considered in the review process for future industrial developments.
7.	Develop a management plan to determine the best means of disposing of hazardous soil removed from the basins.
8.	Continue the practice of recharging high quality imported surface water.
9.	Implement a long-term monitoring program of basin soils and groundwater.

[a]The need for soil removal should be based on further soils monitoring and contaminant buildup curves relative to public contact and drinking water standards.

The recommended practices listed in Table 1-1 involve physical improvements to some basins, additional operational measures, and changes in District policy. In the case of some of the recommendations, a detailed course of action cannot be implemented without further research or engineering. Such additional engineering and research needs include: a detailed determination of soil conditions in the recreational basins, a determination of specific runoff quality from existing industrial sites, and a determination of the quality and downstream impacts of runoff water pumped from recharge basins into the irrigation canals. It is also recommended that an evaluation of the engineering design standards for all future storm drainage retention basins be performed. Ongoing monitoring work is recommended in order to develop a continuing record of soil and groundwater conditions, to evaluate some situations not covered by this project, and to assess the effectiveness of recommended control measures.

CHAPTER 2

INTRODUCTION

urban runoff study being conducted in Fresno County of the Nationwide Urban Runoff Program (NURP). This describes the study area, purpose and scope of NURP, the of Fresno as one of the projects, initial planning for o NURP project, and the organization of this report.

STUDY AREA

study deals with recharge of stormwater runoff in the ovis metropolitan area of Fresno County, California. o-Clovis area is located about 160 miles southeast of cisco and lies within the highly agricultural San alley (Figure 2-1). The study area contains over 166 les and includes a population of about 350,000 people.

the study area, the climate is generally mild and Summers are hot and dry, while winter is marked by temperatures and relatively light precipitation. st daytime highs occur in July and pass 100 degrees all quickly to night lows of 65 degrees F. Major ement follows the major axis of the valley from t to southeast and humidity is low. The winter res are mild between infrequent cold periods. The days usually occur in December and January with the ximum over 50 degrees F. and the normal minimums at s F.

tudy area is subject to winter storms that move on m Pacific low pressure systems, dropping rain in the d generous amounts of snow at higher elevations in the vada. The Coast Range insulates the valley from the ects of the Pacific Ocean. The rainfall in the valley from north to south. The average annual rainfall in area is about ten inches, falling primarily between d April.

opography & Soils

eological composition of the area is characteristic of oaquin Valley, being comprised of recent aluvium fans sediment deposition from streams flowing from the vada mountains. The vast majority of the geologic nt consists of materials of granitic origin. Both old granitic alluvium, as well as granitic parent rock . The young alluvium generally consists of deep of silts and sands, while the older deposits are of consolidated and cemented substratums.

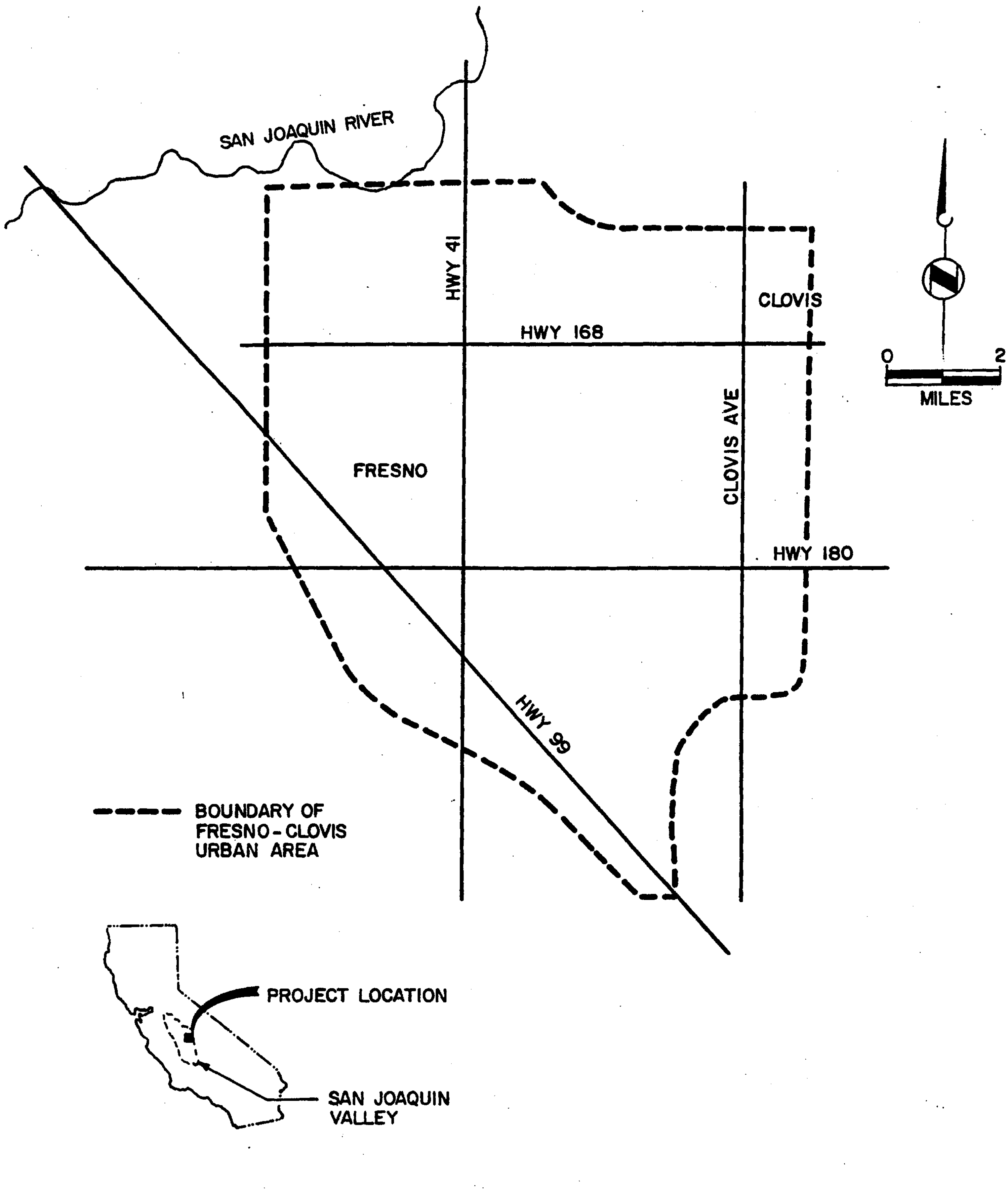


Figure 2-1 Location Map

The topography of the study area is similar to the balance of the San Joaquin Valley, essentially flat with no distinguishable land forms. Only slight changes in elevations occur across the entire study area. Older alluvial terraces east of Fresno develop an undulating relief of rounded hills; while the granitic and metamorphic rocks of the Sierra Nevada foothills develop moderate to steep slopes.

The soils of Fresno County are noted for being among the richest and most productive in the world. Soil types which occur in the vicinity of the study area are generally level, well drained and have a surface layer of loam or sandy loam.

Hydrology and Water Supply

The study area is traversed by several low-elevation streams which drain a portion of the western slope of the Sierra Nevada mountains. The drainage basins of these streams lie between the San Joaquin River on the north and the Kings River on the south. Streamflow in these low-elevation streams is at a very low level during the summer months and increases in the late fall in response to precipitation.

Although surface water (from the Kings and San Joaquin Rivers) is used to meet some of the agricultural water needs of the region, potable water for the metropolitan area is obtained exclusively from groundwater underlying the area. There are hundreds of wells operated by various water purveyors in the area. The aquifer covering the study area is part of the much larger Tulare Lake Basin. Groundwater generally flows from the northeast to the southwest with a large cone of depression in the central area. The water table has gradually dropped over time due to the high degree of groundwater pumping. In 1978, the depth to groundwater ranged from about 40 feet in the southern portion of the urban area to more than 110 feet in the northern portion of the urban area.

The recharge occurring in the storm runoff retention basins serves an important role in mitigating the groundwater overdraft. The basins are used to replenish the groundwater supply through the retention and recharge of the storm runoff itself and through the recharge of high quality imported surface waters delivered to the basins through connections to the irrigation canal system. The use of the basins has become a major water supply management practice which will be expanded as facilities become available as the community continues to grow.

NATIONWIDE URBAN RUNOFF PROGRAM

The water quality effects of nonpoint sources in general, and urban runoff in particular, were recognized by PL 92-500, the Water Pollution Control Act Amendments of 1972. An assessment of urban runoff was included as a study element in 93 of the Section 208 Areawide Waste Management Plans being conducted across the nation. In 1978, the U.S. Environmental Protection Agency (EPA) reviewed the results of these 208 urban runoff evaluations and determined that additional, consistent data were needed to obtain an adequate understanding of the pollution effects of urban runoff. In response, EPA initiated NURP to build upon pertinent prior work, to provide additional practical information and to create a basis for future policy and program development and implementation. The five-year program is intended to answer three broad questions:

1. To what extent is urban runoff a contributor to water quality problems across the nation?

2. What is the effectiveness of controls, short of treatment, in reducing water quality problems where they exist?

3. Are best management practices for control of urban runoff cost-effective in comparison to alternative options?

NURP consists of 28 projects at locations distributed throughout the country (Table 2-1). It represents a federal commitment of nearly $20 million, together with local resources amounting to an additional $7.5 million. The NURP projects are being managed by either state, county, city, or regional governments. The Water Planning Division of EPA in Washington, D.C. has coordination responsibility for the individual projects and provides technical assistance. EPA is utilizing the data from the projects to prepare a national assessment of urban runoff. EPA completed a final draft of their final report in September 1983.

Table 2-1. Nationwide Urban Runoff Program Project Locations

1.	Durham, New Hampshire	15.	Ann Arbor, Michigan
2.	Lake Quinsigamond, Massachusetts	16.	Champaign-Urbana, Illinois
3.	Mystic River, Massachusetts	17.	Chicago, Illinois
4.	Long Island, New York	18.	Milawukee, Wisconsin
5.	Lake George, New York	19.	Austin, Texas
6.	Irondequoit Bay, New York	20.	Little Rock, Arkansas
7.	Metro Washington, D.C.	21.	Kansas City, Kansas
8.	Baltimore, Maryland	22.	Denver, Colorado
9.	Myrtle Beach, South Carolina	23.	Salt Lake City, Utah
10.	Winston-Salem, North Carolina	24.	Rapid City, South Dakota
11.	Tampa, Florida	25.	Castro Valley, California
12.	Knoxville, Tennessee	26.	Fresno, California
13.	Lansing, Michigan	27.	Bellevue, Washington
14.	Oakland County, Michigan	28.	Eugene, Oregon

PROJECT SELECTION

NURP projects were selected from among the original 93 areawide agencies that had identified urban runoff as one of their significant problems. The selection criteria used to screen the agencies included: existence of a water quality problem, type of receiving water, hydrologic characteristics, urban characteristics, and beneficial use of the receiving water. An effort was made to select projects which collectively represented a wide range of characteristics. EPA utilized a matrix analysis to be sure that all of the major types of urban runoff situations were covered by at least one project.

The Fresno-Clovis metropolitan area was selected as one of the NURP projects for several reasons:

1. The receiving water for urban runoff in the Fresno-Clovis area is the groundwater. Only one other NURP project (Long Island, New York) is addressing impacts on groundwater.

2. The groundwater reservoir underlying the Fresno-Clovis area has been designated by EPA as a sole source aquifer. The potential for degradation of such a reservoir is a matter of significant importance to the local community.

3. The Fresno project can demonstrate the effectiveness of a specific best management practice, i.e., the total retention and recharge of urban storm runoff. This practice has potential application in a number of other locations. For example, many communities rely on groundwater as the principal source of their drinking water supply. Data from the Fresno project will be directly applicable to those communities who are considering or practicing retention and recharge of urban runoff.

INITIAL PLANNING

Because of the sole reliance on groundwater as a water supply for the Fresno-Clovis area, water quality protection has been an important matter for local authorities. Groundwater-related issues have been the subject of a number of studies.

The 208 Water Management Plan for the Fresno-Clovis area evaluated water quantity and water quality issues. The plan identified some existing groundwater quality problems in specific areas, including high nitrate, hardness, salinity, and chloride levels. A number of potential pollution sources were also identified: industrial wastes, septic tanks, agricultural nonpoint sources, and storm runoff. Storm runoff was included as a potential pollution source because by design, virtually all storm runoff in the metropolitan area is recharged to the groundwater aquifer. There are no significant watercourses passing through the area to which storm runoff can be discharged. Thus, the Fresno Metropolitan Flood Control District (District) has developed a system of retention/recharge basins to handle runoff during storm periods. Presently, there are over 1,000 acres of basins. Trace elements and organic chemicals were considered to be the largest sources of pollution in storm runoff. Although domestic supply wells in the urban area had generally shown no noticeable impact resulting from recharge of urban storm runoff, the 208 plan indicated that there was a need for more comprehensive monitoring in the vicinity of the recharge basins. More specifically, the Interim Best Management Plan of June 1979 recommended that the District develop a monitoring program to determine the impact of stormwater recharge on groundwater.

Detailed planning for a monitoring program was initiated in mid-1979. Discussions were held with EPA officials about including such a study for Fresno in NURP. With assistance from various water quality experts, the District prepared a work plan entitled "Determination of Potential Adverse Environmental Impacts Associated with the Retention and Recharge of Urban Storm Runoff". The work plan was originally submitted to EPA and the State Water Resources Control Board (State Board) in October 1979 and was revised in November 1979. EPA conditionally approved the work plan in December 1979, subject to certain modifications to the proposed program. A 208 grant of $796,000 was authorized for the three-year study.

Data gathering was scheduled to begin in the fall of 1980. However, due to the late entry of the State of California into the project, the time required to prepare and execute contracts, make funding arrangements, and refine work plans to the satisfaction of all participants was much greater than anticipated. The transfer of the 208 program authority from EPA to the State Board further complicated contract arrangements. The Technical Advisory Resource Group met in March and October 1980 to review the work plan and to discuss monitoring program details such as sampling sites and procedures. The master contract among the State Board, County of Fresno, and the District, and the individual contracts between the District, the U.S. Department of Agriculture (USDA) and the U.S. Geological Survey (USGS), were not executed until the spring of 1981, although these contracts were all technically effective October 31, 1980.

Because of the time needed to finalize contract arrangements and the subsequent time needed to obtain and calibrate equipment, the monitoring program was delayed about one year from the original work plan. USDA began their monitoring work in July 1981 and USGS initiated monitoring in October 1981. The delays in initiating the monitoring program created corresponding delays throughout the entire project, although efforts were continually made to complete the project within the "contract limits". The schedule of the various elements included in the monitoring program is contained in Chapter 3.

REPORT ORGANIZATION

The Fresno NURP project has had extensive reporting requirements. A series of 12 quarterly reports were prepared over the course of the project. The quarterly reports summarized work progress to date, provided preliminary conclusions, identified problems, and compiled data. Two annual reports were prepared. The First Annual Report (October 1982) served primarily as a vehicle for defining changes in the study design for the second year of monitoring and for reporting early runoff quality data. The Second Annual Report (September 1983) summarized most of the data collected in the monitoring program and made an initial assessment of the impacts of recharging urban runoff.

Both USGS and USDA have prepared individual project reports covering their portion of the study. USDA and USGS issued their draft reports in September 1983 and November 1983, respectively. These reports, together with supporting appendices, contain the complete data tabulations and statistical analysis for the project.

This final report for the Fresno NURP project is intended to be a comprehensive report in that it contains the key features of the previous reports. However, because of the large amount of data collected in this program, data are generally presented in summary form in this report. For example, maximum, minimum, and median values are often reported for a particular data set rather than tabulating individual data points. The complete data tabulation is contained in the USGS and USDA final reports, appendices, and quarterly reports. In addition, most of the USGS data can be accessed from WATSTORE, their data management system.

This final report contains a total of nine chapters. Chapter 1 is a summary of the key points of each of the following chapters. Chapter 2 provides background information on the project, and Chapter 3 describes the project objectives and approach. The results of the USGS runoff monitoring program and the USDA soils and groundwater monitoring program are contained in Chapters 4 and 5, respectively. Chapter 6 is a system overview of the key results from the USGS and USDA programs. Chapter 7 is an assessment of the impacts of recharging urban storm runoff. Chapter 8 analyzes various management practices that can be implemented to minimize adverse environmental impacts. Specific conclusions and recommendations are identified in Chapter 9.

CHAPTER 3

OBJECTIVES AND APPROACH

The work plan for the Fresno Nationwide Urban Runoff Program (NURP) project (October 1979) set forth the objectives and general approach for the study. These objectives and the specific tasks required to meet these objectives have subsequently been refined and described in more detail by the Fresno Metropolitan Flood Control District (District) staff and their subcontractors. This chapter presents the objectives, organization, scope of work, and schedule for the Fresno NURP project. A brief description of the District's retention/recharge system is initially presented so the objectives of the project can be beter understood.

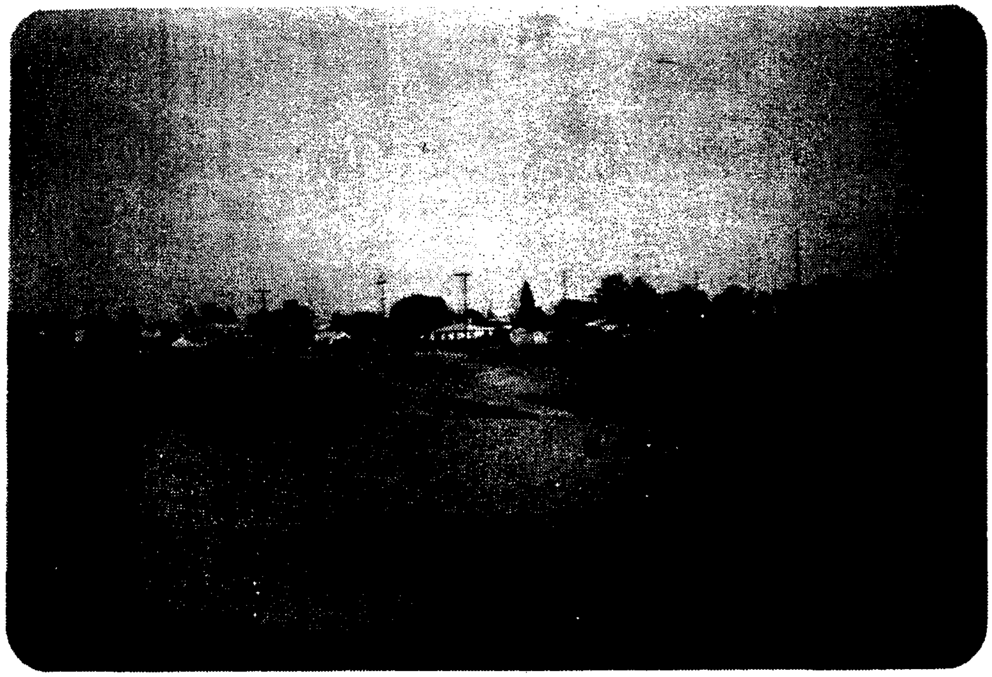
RETENTION/RECHARGE SYSTEM

Stormwater management in the Fresno metropolitan area is complicated by the fact that there are no significant watercourses passing through the area to which storm runoff can be discharged. Therefore, the District has developed a system of retention/recharge basins to handle runoff during storm periods. The system has a dual-purpose: it serves urban drainage needs and at the same time recharges the groundwater aquifer, which is the sole water supply for the region.

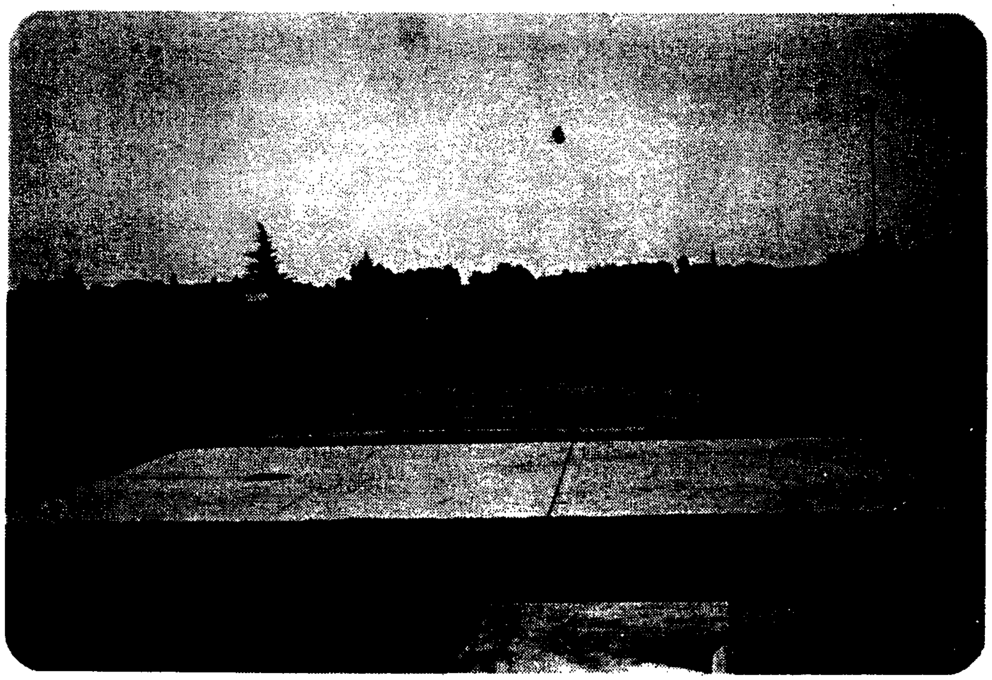
The District currently has a total of 86 recharge basins of which 74 are completed or are in various stages of excavation (Figure 3-1). The basins have a total area of over 1,000 acres. Fourteen of the basins are turfed or partially turfed, with 13 of these used for recreation during the dry weather season. Three of the turfed basins have improved baseball diamonds (Figure 3-1), while the other turfed basins are used for soccer and passive recreation. In order to maximize the recharge of the groundwater aquifer, a number of the basins receive irrigation water for recharge during the summer. Irrigation water is diverted into these basins from the canal system that passes through the Fresno area.

OBJECTIVES

The Fresno NURP project was developed because of the District's recognition that urban storm runoff recharged to the groundwater represented a potential source of pollution. Thus,



UNTURFED BASIN USED FOR RECHARGE OF STORM RUNOFF AND IMPORTED SURFACE WATER BASIN EE



MULTIPLE USE BASIN WITH BASEBALL DIAMOND BASIN B/E

Figure 3-1 Photographs of Recharge Basins the major objective of the project is to determine the environmental impacts of the current practice of retention and recharge of urban storm runoff. The subobjectives of the project are described below and their interrelationships are graphically shown on Figure 3-2.

The first subobjective is to characterize the chemical composition of runoff, soils, and groundwater. Before any conclusions can be drawn about the potential impacts of recharge, the water quality of the urban runoff that occurs during storm events must be clearly defined. The physical and chemical properties of the runoff have been evaluated, with particular emphasis on toxic pollutants, such as metals and pesticides. The runoff percolates down through the soils and eventually reaches the water table which is generally located about 100 feet below the ground surface. Some compounds are altered or partially removed as a result of various physical, chemical, and biochemical processes occurring in the soil. Thus, it is necessary to determine the chemistry of the soils, as well as the quality of the water located in the unsaturated zone above the water table. Finally, measurements need to be made of the groundwater itself.

The second subobjective is to determine whether there is currently or there is a future potential for adverse impacts associated with the recharge of urban runoff. The primary issue of concern is protection of the area's groundwater supply. A secondary concern is the potential for impacts on recreational use that occurs in some of the recharge basins during non-winter periods; for example, does a potential hazard exist when dust is stirred up on the basin baseball diamonds and is inhaled or when basin soil is ingested by a child?

The third subobjective is to identify and evaluate management practices that can be used to alleviate adverse impacts, if any are found to exist. Management practices will fall into two categories:

1. Changes in the way the recharge basins are designed and operated to minimize impacts.

2. Source controls to change the quality of runoff before it reaches the basins.

ORGANIZATION

Several organizations have been involved in the Fresno NURP project (Figure 3-3). The project is part of a nationwide program initiated by the U.S. Environmental Protection Agency (EPA). EPA has provided a 208 grant, which is one of the

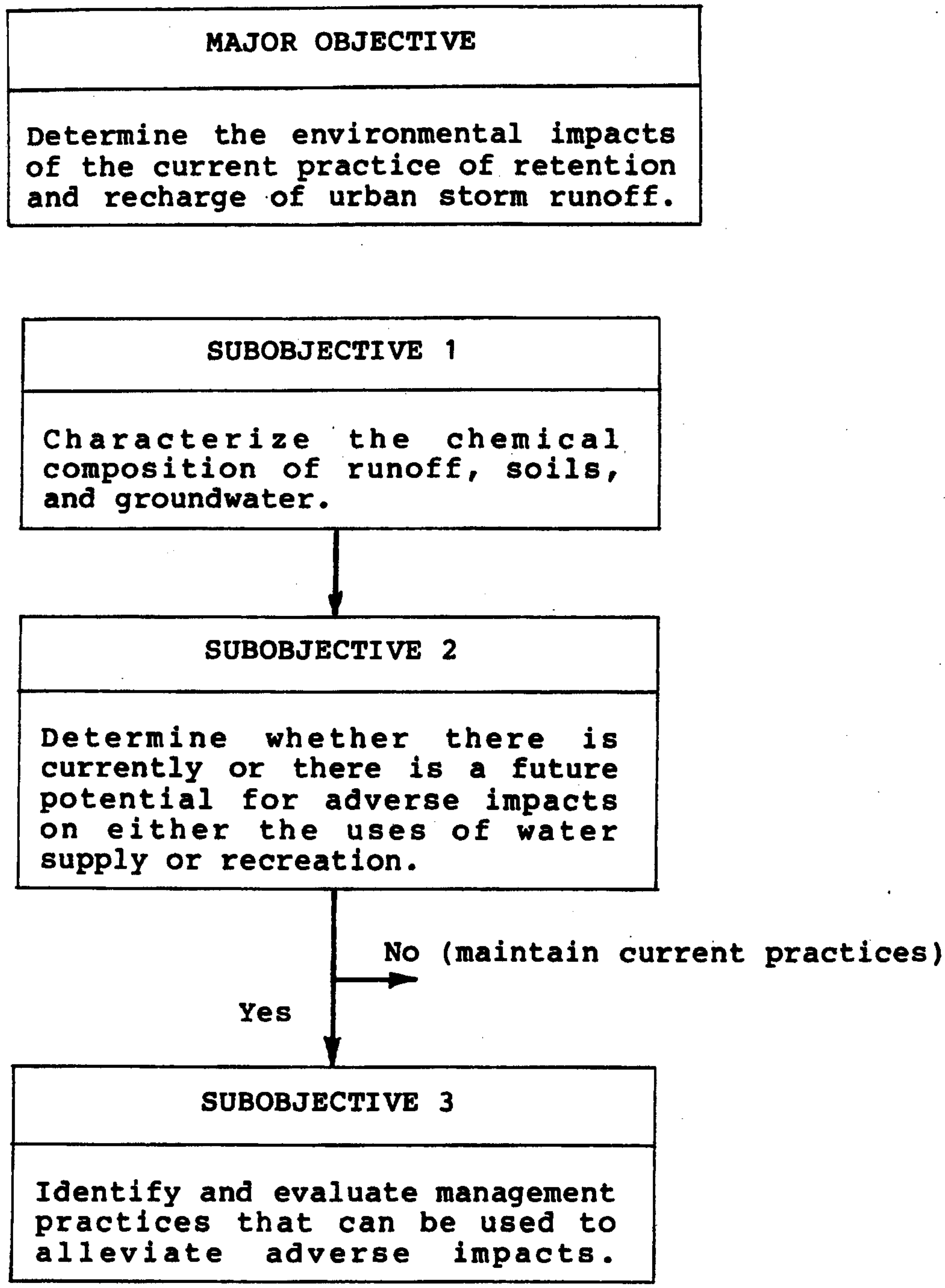


Figure 3-2. Objectives of Fresno Nationwide Urban Runoff Program Project

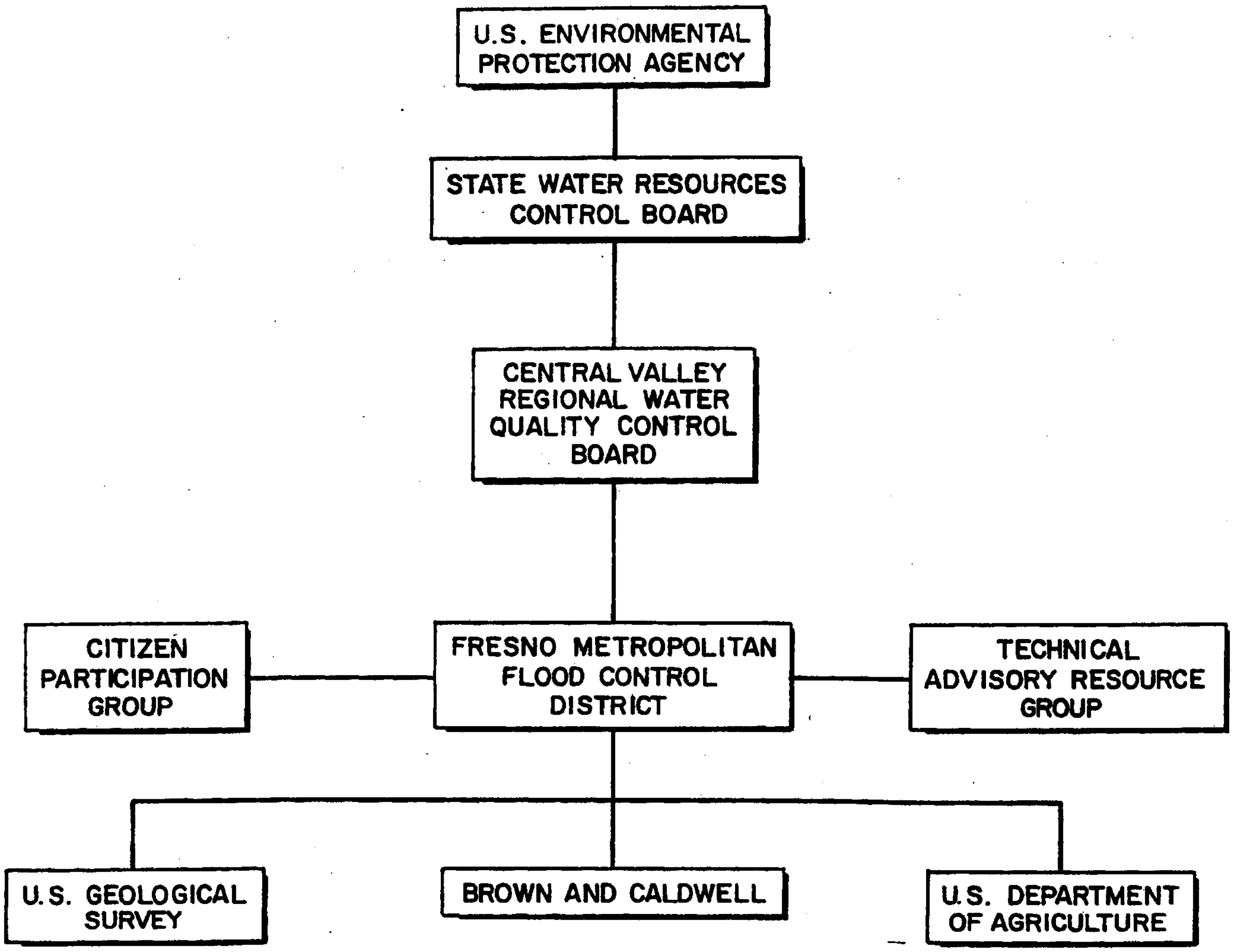


Figure 3-3 Organization Chart for Fresno NURP Project

primary sources of funding for the study. The District provided the remainder of the direct funding, and in-kind services were provided by several other agencies. EPA has delegated contract administration responsibilities for the project to the California State Water Resources Control Board. These duties are actually carried out through the Central Valley Regional Water Quality Control Board in Fresno. The project has been directed by the District. The District utilized three primary subcontractors: U.S. Geological Survey (USGS), U.S. Department of Agriculture (USDA), and Brown and Caldwell Consulting Engineers. USGS conducted the runoff monitoring program. The Water Management Research Unit of the USDA conducted the soils and groundwater monitoring program. Brown and Caldwell assisted the District in coordinating the program, was responsible for preparation of the interim and final reports, and conducted portions of the laboratory work.

Two advisory groups have been organized for the project. The Citizen Participation Group consists of about 20 individuals from the community who have an interest in groundwater quality and management practices that could be instituted. The Citizen Participation Group has met several times over the course of the study to review work progress and to assist in the finalization of study recommendations. The Technical Advisory Resource Group consists of technical representatives from various local and state governmental agencies. The Technical Group was formed in early 1980 after the project work plan had been approved. The Technical Group reviewed the work plan, project design, testing locations and criteria, and data station design at the outset of the project and has reviewed study reports and provided technical guidance throughout the study.

SCOPE OF WORK AND SCHEDULE

The Fresno NURP project has been conducted over a three-year period. The project was fully authorized in early 1981, and the bulk of the field work was completed in the fall of 1983. Major elements of the project and their individual schedules are shown on Figure 3-4 and are briefly described below.

U.S. Geological Survey Work

The main objective of the USGS work was to characterize the quality of urban storm runoff from various land uses. USGS conducted all of the aboveground sampling, which consisted of samples of storm runoff, rainfall, dry deposition (dust fall), and material from street surfaces. Samples were collected from drainage areas that represent four different types of land use: industrial, commercial, multiple-family residential, and single-family residential.

Data were collected during two wet weather seasons (1981-82 and 1982-83). The results of the USGS work are summarized in Chapter 4 of this report. A complete discussion of the USGS results is included in the USGS project report. A draft of the USGS report was issued in November 1983, and the report is in the process of being finalized.

U.S. Department of Agriculture Work

The two main objectives of the USDA work were: (1) determine the physical, chemical, hydraulic, and biological properties of the soils that could influence the rate of percolation (recharge) and the deposition of runoff pollutants on or within the soils and (2) determine the quality of water in the soil and in the groundwater underlying each test basin. As shown on Figure 3-4, the USDA data collection work consisted of four main sampling components: soils, soil water, groundwater, and plant tissue. Five recharge basins were sampled.

Soils samples were collected in 1981, 1982, and 1983. Water sampling covered a 19-month period from January 1982 through July 1983. The results of the USDA work are summarized in Chapter 5 of this report. A complete discussion of the USDA results is included in the final USDA project report completed in September 1983.

Brown and Caldwell Work

Brown and Caldwell has been responsible for preparing interim reports and the overall final report for the project. Interim reports have been prepared quarterly and incorporate the quarterly technical reports submitted by USGS and USDA. The quarterly reports were also intended to summarize work progress to date, provide preliminary conclusions, and identify problems. Twelve quarterly reports were prepared; the first five were prepared by the District staff. Brown and Caldwell prepared the First and Second Annual Reports which were completed in October 1982 and September 1983, respectively. Brown and Caldwell also conducted the laboratory testing for metals and organics on soils and ground water samples.

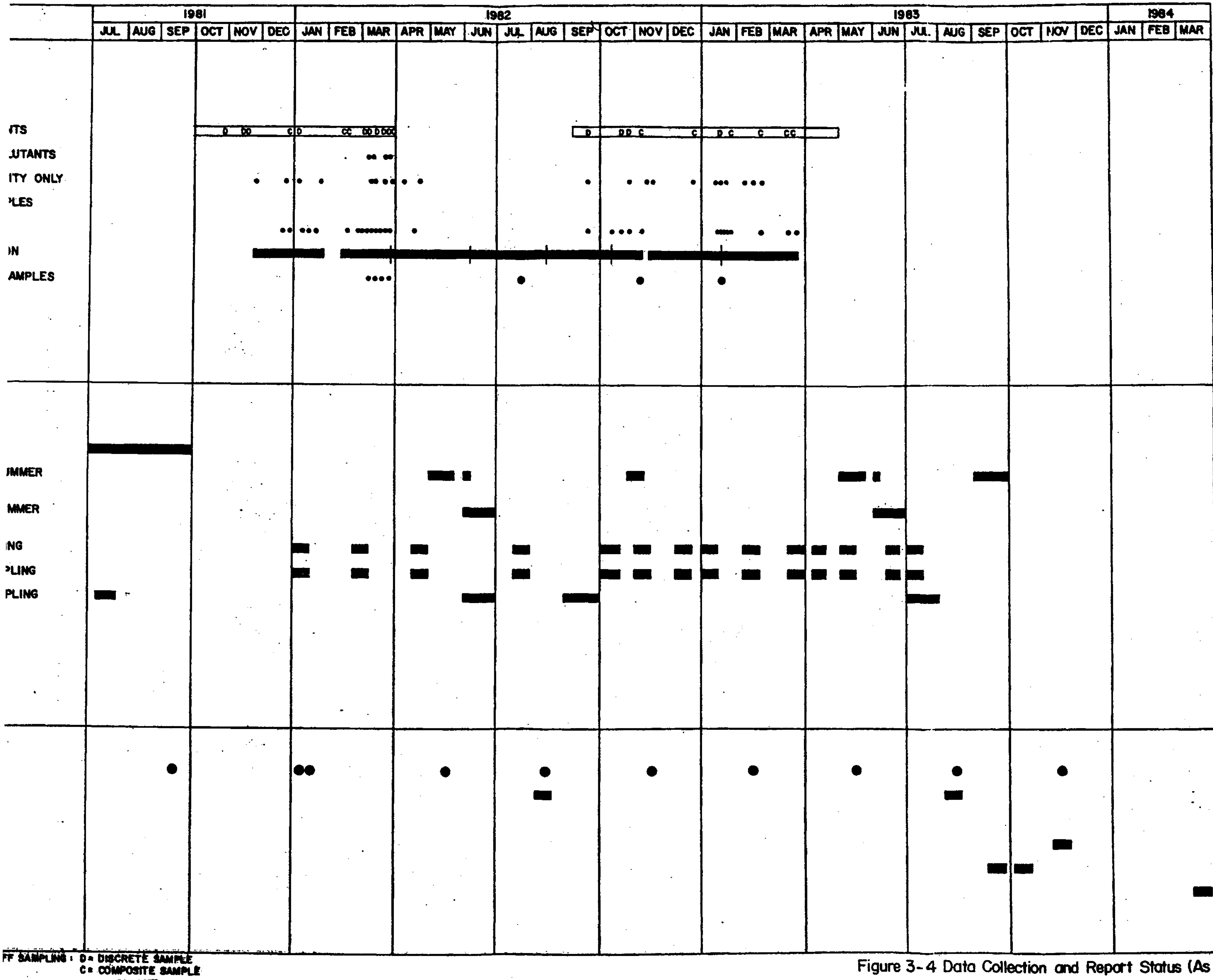


Figure 3-4 Data Collection and Report Status (As of March 1984)

CHAPTER 4

RUNOFF MONITORING PROGRAM

During the Fresno Nationwide Urban Runoff Program (NURP) project, a major effort was made to gather data on the quality and quantity of storm runoff, rainfall, and dry deposition. An extensive sampling program was conducted by the U.S. Geological Survey (USGS). The program, the data gathered by the USGS, and an analysis of the data are described in this chapter.

DESCRIPTION OF MONITORING PROGRAM

Extensive data were collected on the quantity and quality of storm runoff and rainfall and the quality of dry deposition and street particulate material. The USGS also collected a limited amount of data on the quality of dry weather runoff. Several runoff samples collected by USGS in 1982 were analyzed for the priority pollutants by the U.S. Environmental Protection Agency (EPA). The U.S. Department of Agriculture (USDA) collected data on the quality of summer recharge water, in addition to the soils, soil water, and groundwater data described in Chapter 5. Figure 4-1 shows the location of the USGS and USDA sampling sites. A wide range of water quality constituents were measured by USGS. Data were collected on the concentrations of conventional constituents such as nutrients, solids, and major ions; metals; and organic pesticides. A complete list of the constituents measured by USGS is presented in Appendix B. Samples were collected at one location from four land use types (single-family residential, multiple-family residential, commercial, and industrial) to characterize the pollutant concentrations and loads from these typical land uses in the Fresno area. The characteristics of the drainage areas sampled by USGS are presented in Table 4-1. The runoff coefficients for each drainage area are also shown in Table 4-1. The runoff coefficients were calculated for each storm by dividing the amount of runoff at the sampling points by the amount of precipitation that fell on the drainage area. The arithmetic average coefficients were determined by calculating the average of all storms. The average coefficients were also calculated by weighting each storm's runoff coefficient by the amount of runoff that occurred. Using this method, a storm with a large volume of runoff received more weight than a low-volume storm. These coefficients are used later in this chapter. It should be noted that the runoff coefficients for the industrial area are quite low since the street system and drainage system for this particular area are not complete.

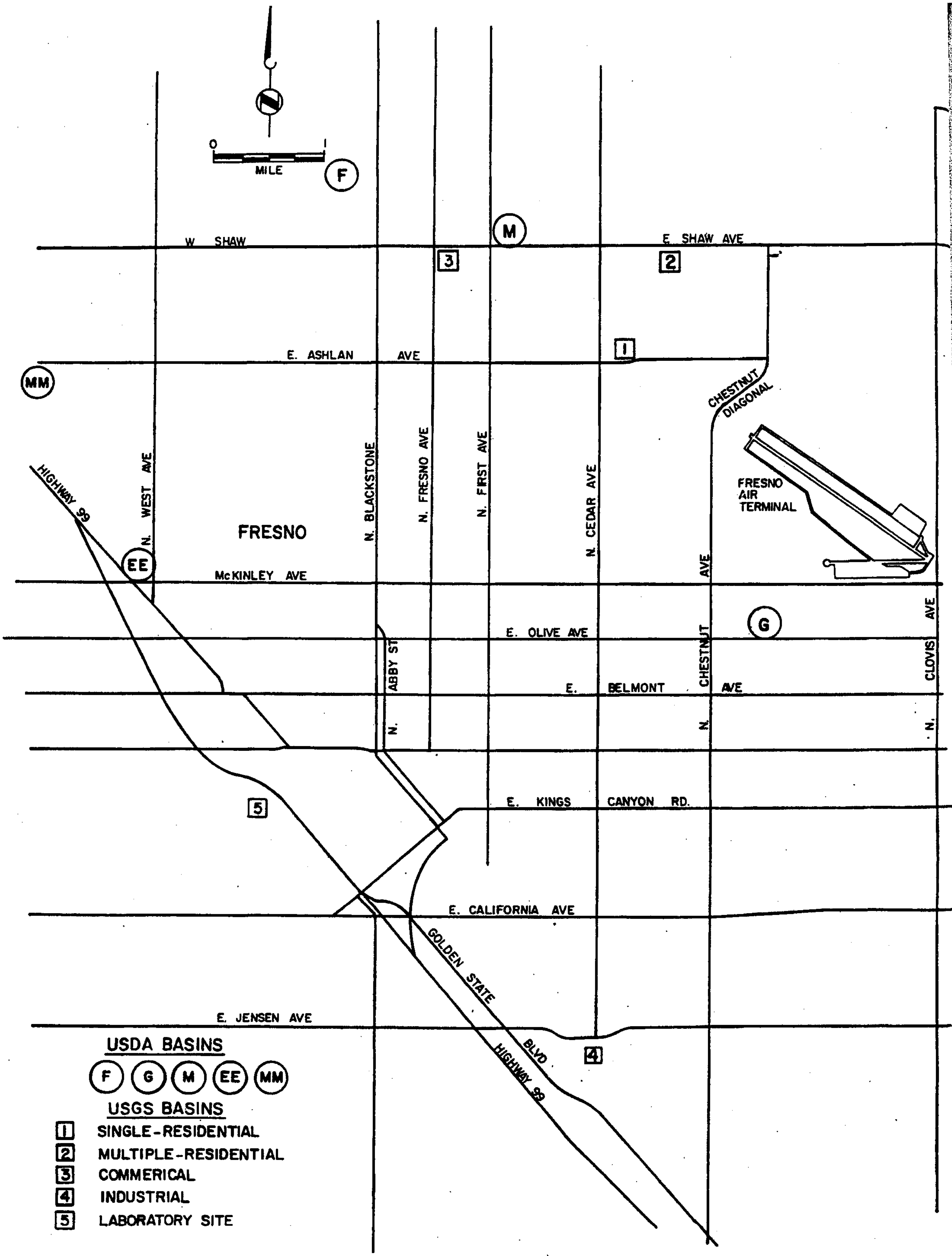


Figure 4-1 Location of Sampling Sites

Table 4-1. Key Characteristics of USGS Drainage Areas

Characteristic	Land use			
	Single-family residential	Multiple-family residential	Commercial	Industrial
Drainage area, square miles	0.15	0.07	0.09	0.43
Land use, percent of drainage area				
Low-density residential	9.0	0	0	0
Medium-density residential	87.3	0	0	0
High-density residential	0	87.0	0	0
Commercial	0	0	100	0
Industrial	0	0	0	65.8
Idle or vacant	3.7	13.0	0	34.2
Population density, persons/square mile	7,700	16,400	0	0
Runoff coefficient				
Arithmetic average				
1981-82	0.19	0.29	0.93	0.18
1982-83	0.21	0.51	—	0.16
Both years	0.21	0.39	0.93	0.18
Flow-weighted average				
1981-82	0.22	0.38	1.05	0.24
1982-83	0.25	0.69	—	0.23

Detailed descriptions of the sampling programs are contained in reports prepared by USGS and USDA. The programs are summarized in this section.

Rainfall

The rainfall monitoring program was initiated in December 1981 and continued through March 1983. Eight samples were analyzed from each of the single-family residential and industrial sites in the 1981-82 rain season. During the 1982-83 rain season, eight samples were analyzed from three sites: the single-family residential and industrial sites and an additional site at the project laboratory. The laboratory site was established for additional data to determine if the single-family residential site rainfall quality was affected by its proximity to the flight path from the Fresno Airport, and if the industrial site quality was influenced by the adjacent environment. If these concerns were valid, data from the laboratory site might provide data more representative of the rainfall quality for the majority of the Fresno urban area. The samples were analyzed for nutrients, major ions, pesticides, and heavy metals. The rainfall and dry deposition samples were collected with a wet/dry sampler which allows collection of rain samples and dry fallout samples in separate buckets. A lid that is activated by a precipitation sensor moves to cover the "dry" collection bucket during storms. The "wet" bucket is covered between storms. Chemical analyses were conducted separately on the two kinds of samples.

Storm Runoff

The storm runoff sampling program was started in October 1981 and continued through March 1983. Samples were collected from the four land use types and analyzed for numerous physical, inorganic, organic, and biological constituents. During the first year of the sampling program, 16 storms were sampled. Flow-weighted composite samples were collected during 5 of the 16 storms. During the other 11 storms, discrete grab samples were collected and analyzed. The number of samples collected varied from storm to storm, but generally about 5 samples were collected. Flow, pH, and specific conductance were measured during an additional 18 storms. During the second year of the program, 11 storms were sampled. Composite samples were collected during 6 of the 11 storms and discrete samples were collected during the other 5 storms. Flow, pH, and specific conductance were measured during an additional 21 storms.

Dry Deposition

Dry deposition samples were collected at the single-family residential and industrial sites and routinely analyzed for nutrients, major ions, and lead. During the second year of the sampling program, the samples were also analyzed for other metals and one sample was analyzed for pesticides. A total of 19 samples were analyzed between November 1981 and March 1983.

Street Particulate Material

The street particulate data program was conducted between March 1982 and January 1983. Six samples were collected from the commercial site and five samples were collected from the other three sites. All of the streets in each of the four drainage areas were divided into 200-foot sections. Each section was assigned to a category as follows:

A--Residential Street
B--Intersection
C--Major Street

The entire street area in each drainage zone was broken into these three categories to determine the number of sections in each drainage zone. A total of 20 to 25 sections were sampled in each land use drainage area. The number of sections sampled in each of the three categories was based on the relative proportion of the number of sections in a particular category to the total number of sections in the drainage area. A commercial vacuum cleaner was used to collect a sample by vacuuming a 6-inch strip across the street from one curb to the other curb. The samples from the 20 to 25 sites in each drainage area were composited to produce one sample for analysis. The samples were analyzed for major ions, nutrients, metals, and organics.

Dry Weather Runoff

During August and September 1982, stage records of dry weather runoff were periodically collected at the two residential sites to estimate the "nuisance" runoff volume (i.e., runoff from lawn irrigation, car washing, and other activities during the summer months). Grab samples were collected from the residential sites on September 3, 1982, and analyzed for physical constituents, nutrients, major ions, metals, and pesticides.

Imported Recharge Water

Canal water from Fresno Irrigation District is used as recharge water in Basins MM and EE during the summer months. The USDA collected a limited amount of data on the quality of this recharge water during the summer of 1982. Samples were collected 24 times between June 22 and September 27, 1982, and analyzed for specific conductance, turbidity, and suspended solids. An additional sample was collected on July 15, 1982, and analyzed for specific conductance, pH, major ions, and nitrate. One sample was analyzed for metals and organics.

EPA Metals and Organics

EPA conducted two studies as part of the NURP project, using runoff samples collected by USGS during some of the storms.

1. Special Metals Project--EPA contract laboratories analyzed two grab samples from each of the four land use sites during a storm on January 4, 1982. The samples were analyzed for 29 metals. Total, total recoverable, and dissolved fractions were measured.

2. Priority Pollutant Sampling Program--EPA contract laboratories analyzed samples from each of the four land use sites collected by USGS during four storms during March 1982. The samples were analyzed for all of the 129 priority pollutants except asbestos.

RESULTS

A summary of the results of the runoff monitoring program is presented in this section. A detailed discussion of the data is contained in the USGS project report. Table 4-2 presents a summary of the metals and organics data. The table indicates if each constituent was detected in precipitation, dry deposition, street particulate material, and storm runoff. The conventional constituents (nutrients, major ions, physical parameters) are not shown in the table because they were detected in each component of the study. The conventional constituents are identified later in this chapter. The metals were generally detected in all four components of the study. Lindane, chlordane, DDE, diazinon, and malathion were detected in all four components. Most of the organics listed in Table 4-2 were detected in runoff. Many were detected in rainfall and street particulates. Most of the organics were not detected in dry deposition. The data collected for each of the study components are presented in this section. The USGS collected an extensive amount of data on a great number of constituents. All of the data are not presented in this section. Data are presented on the constituents that are most important in terms of the potential for contamination of the water supply and the potential for health hazards associated with recreational activities within the basins.

Storm Characteristics

There was a total of 123 storms in the Fresno area during the rain seasons (September to April) of 1981-82 and 1982-83. Seventy-eight storms produced 0.10 inch or more of rain. According to the 104-year rainfall record collected by the National Weather Service, the average annual rainfall at the Fresno Air Terminal is 10.24 inches with 9.84 inches falling between September and April. During the study period, the rainfall was 110 percent of normal (10.79 inches) for the 1981-82 rain season and 240 percent of normal (23.56 inches) in the 1982-83 rain season. Information on the storm sampling program is presented in Table 4-3.

Multiple-linear regression was used to develop relationships between rainfall and the amount of runoff. The total amount

Table 4-2. Metals and Organics Detected in Fresno NURP Project

Constituent	Component[a] Rainfall	Component[a] Dry deposition	Component[a] Street particulates	Runoff
Priority pollutant metals				
Antimony	-	-	-	X
Arsenic	O	X	X	X
Beryllium	X	-	-	-
Cadmium	-	-	X	X
Chromium	X	X	X	X
Copper	X	X	X	X
Cyanide	-	-	-	X
Lead	X	X	X	X
Mercury	X	X	O	X
Nickel	X	X	X	X
Zinc	X	X	X	X
Other metals				
Aluminum	X	X	X	X
Barium	X	-	-	X
Boron	-	-	-	X
Cobalt	-	-	-	X
Iron	X	X	X	X
Lithium	X	-	-	X
Manganese	X	X	X	X
Molybdenum	-	-	-	X
Strontium	X	-	-	X
Titanium	-	-	-	X
Vanadium	-	-	-	X

Constituent	Component[a] Rainfall	Component[a] Dry deposition	Component[a] Street Particulates	Runoff
Priority pollutant organics[b]				
Aldrin	O	O	O	X
Anthracene	-	-	-	X
Benzo(a) pyrene	-	-	-	X
Benzo(b) fluoranthene	-	-	-	X
α-BHC	-	-	-	X
γ-BHC (lindane)	X	X	X	X
Butyl benzyl phthalate	-	-	-	X
Chlordane	X	X	X	X
Chrysene	-	-	-	X
DDD	O	O	X	O
DDE	X	X	X	X
DDT	O	O	X	X
Dieldrin	X	O	X	X
Di-n-octyl phthalate	-	-	-	X
Endosulfan	X	O	X	X
Endrin	O	O	O	X
Fluoranthene	-	-	-	X
Heptachlor	O	O	X	X
Heptachlor epoxide	O	O	X	X
4-nitrophenol	-	-	-	X
Total PCB	X	O	X	X
Pentachlorophenol	-	-	-	X
Phenol	X	-	-	X
Pyrene	-	-	-	X
Other organics[c]				
Diazinon	X	X	X	X
Dibromochloropropane	-	-	-	X
Ethion	X	O	O	O
Malathion	X	X	X	X
Methoxychlor	X	X	O	X
Methyl parathion	X	O	O	X
Parathion	X	O	X	X
Silvex	O	O	-	X
Trithion	O	O	X	X
2,4-D	X	O	O	X

[a]Table symbols : X indicates detected; O indicates not detected; - indicates not measured.
[b]The runoff samples were analyzed for the complete list of priority pollutants. Those pollutants not listed in the table were not detected in any of the samples.
[c]The samples were analyzed for the following additional organics but concentrations were always less than the analytical detection limit: perthane, methomyl, propham, polychlorinated napthalenes, 2,4,5-T, sevin, mirex, methyl trithion, and 2,4-DP.

Table 4-3. Storm Summary

Storm characteristic	Rain season[a] 1981-82	1982-83	Total
Amount of rain, inches			
Produced by storms >0.1 inch	10.3	19.95	30.25
Produced by storms <0.1 inch	0.49	3.61	4.10
Total	10.79	23.56	34.35
Number of storms			
Storms >0.1 inch	34	44	78
Storms <0.1 inch	22	23	45
Total	56	67	123
Number of storms sampled			
Storms >0.1 inch			
All constituents			
Runoff	15	8	23
Rain	13	16	29
Specific conductance and pH			
Runoff	12	18	30
Rain	5	8	13
Storms [illegible]ch			
All [illegible]ents			
[illegible]	1	3	4
[illegible]	0	1	1
Spe[illegible]ctance and pH			
[illegible]	6	3	9
[illegible]	0	0	0
Total [illegible]			
Runo[illegible]	34	32	66
Rain[illegible]	18	25	43

[a]Does [illegible]rms which occurred between May and August of the[illegible]

of rainfall in each storm, the number of dry hours since the last storm, and the maximum 20-minute rainfall intensity were regressed against the amount of runoff in each land use drainage area. The total amount of rainfall for each storm was the only significant variable at the 0.05 level for the commercial site. All three variables were significant for the multiple-family residential site. The total amount of rainfall and the number of dry hours since the last storm were significant for the single-family residential and industrial sites. The total amount of rainfall was probably the only significant variable at the commercial site because the drainage area is 98.9 percent impervious. There are no large areas of exposed soil where runoff can vary with the degree of soil saturation and infiltration rate. If the number of hours since the last storm is a significant variable, it indicates that there are exposed soil areas in the drainage area that must reach saturation before runoff occurs. If the maximum 20-minute rainfall intensity is a significant variable, it indicates that the drainage area soils have a high infiltration rate, and the rainfall rate must exceed the infiltration rate before runoff occurs from these pervious soil areas.

The rainfall-runoff coefficients were determined for each storm by dividing the runoff volume by the rainfall volume falling on the drainage area. The average rainfall-runoff coefficients for each drainage area during the study period are listed in Table 4-1.

Rainfall

Rainfall quality samples were collected during 18 storms in the 1981-82 season and 25 storms in the 1982-83 season. During 30 of these storms, the samples were analyzed for all of the constituents. During the remaining 13 storms, only specific conductance and pH were measured.

Conventional Constituents. Table 4-4 presents the ranges and mean concentrations of conventional constituents at the three sampling sites (single-family residential, industrial, and laboratory). Conventional refers to those constituents which are not metals or organics and consist of physical properties, cations, and anions. The data show that the rainfall quality was generally similar at the three stations. The concentrations of most constituents were lowest at the single-family residential and laboratory sites and highest at the industrial site. Statistical testing conducted by USGS showed that there were statistically significant differences at the 0.05 level in the concentrations of dissolved ammonia and pH between the single-family residential and industrial sites. The differences could be due to the discharge of industrial plant emissions into the atmosphere near the sampling site. The statistical testing showed that there were no differences at the 0.05 significance level in constituent concentrations at the single-family residential site between the two rain seasons. At the industrial site, only dissolved phosphorus and dissolved organic carbon were significantly different in the two rain seasons.

Table 4-4. Ranges and Mean Concentrations of Conventional Constituents in Rainfall

Constituent	Units	Concentration								
		Single-family residential			Industrial			Laboratory		
		N[a]	Range	Mean	N[a]	Range	Mean	N[a]	Range	Mean
Specific conductance	umhos/cm	32	2.4-57	13.8	36	3.0-52	13.9	16	4.0-30	11.8
pH	standard units	33	4.7-7.7	5.9	37	5.0-7.7	6.4	16	4.7-7.4	6.0
Alkalinity	mg/l as $CaCO_3$	16	3.0-9.0	7.2	15	4.0-10.0	7.5	3	5.0-7.0	6.3
COD	mg/l	15	7.0-30	14.5	14	<10-27	16	5	<10-23	16.4
Dissolved nitrogen	mg/l as N	10	0.4-10	2.0	10	5.0-7.7	6.4	6	0.7-2.6	1.3
Dissolved organic nitrogen	mg/l as N	10	0.1-0.99	0.43	9	0.08-2.7	0.70	4	0.1-0.74	0.49
Dissolved ammonia	mg/l as N	13	0.1-0.74	0.37	12	0.19-1.3	0.70	7	0.2-0.76	0.46
Dissolved nitrite	mg/l as N	13	<0.02-0.04	0.02	12	<0.02-0.04	0.02	7	<0.02-0.05	0.02
Dissolved nitrate + nitrite	mg/l as N	16	<0.01-0.60	0.22	15	<0.09-0.96	0.25	8	<0.1-0.56	0.23
Dissolved phosphorus	mg/l as P	16	<0.01-0.14	0.03	15	0.01-0.26	0.08	7	<0.01-0.04	0.02
Dissolved orthophorphorus	mg/l as P	13	<0.01-0.04	0.01	12	<0.01-0.06	0.02	8	<0.01-0.07	0.02
Dissolved organic carbon	mg/l	13	2.1-6.2	3.6	14	0.3-6.2	3.8	7	1.8-16	6.9
Dissolved calcium	mg/l	16	0.1-1.3	0.48	15	0.1-1.5	0.60	3	0.2-0.92	0.47
Dissolved magnesium	mg/l	16	<0.01-0.18	0.08	15	<0.01-0.24	0.09	3	<0.01-0.08	0.06
Dissolved sodium	mg/l	16	<0.2-1.1	0.47	15	0.2-1.2	0.50	3	0.2-0.7	0.43
Dissolved potassium	mg/l	16	<0.10-0.30	0.14	15	0.10-0.60	0.24	3	0.20-0.30	0.23
Dissolved chloride	mg/l	16	0.10-1.2	0.46	15	0.20-1.0	0.53	3	0.30-1.2	0.60
Dissolved sulfate	mg/l	14	<0.50-5.0	3.4	12	0.60-5.0	3.3	3	1.1-1.4	1.2
Dissolved silica	mg/l	8	<0.01-0.60	0.25	7	0.01-0.60	0.29	0		

[a]N = number of samples.

Metals. The ranges and median concentrations of metals at the three sites are presented in Table 4-5. For some metals, the median concentrations were similar at the three sites. Only aluminum, copper, zinc, lead, and iron concentrations varied appreciably among the three sites. The lowest concentrations were generally found at the laboratory site and the highest concentrations were found at the industrial site. Statistical testing conducted by USGS showed that there were no statistically significant differences in the concentrations between the three sites.

Table 4-5. Ranges and Median Concentrations of Metals in Rainfall

Constituent	Total recoverable metal concentrations, ug/l								
	Single-family residential			Industrial			Laboratory		
	N[a]	Range	Median	N[a]	Range	Median	N[a]	Range	Median
Priority pollutant metals									
Arsenic[b]	7	<1.0	<1.0	7	<1.0	<1.0	5	<1.0-1.0	<1.0
Chromium	3	<1.0	<1.0	4	<1.0-1.0	<1.0	3	<1.0	<1.0
Copper	3	<1.0-6	4.0	4	1.0-12	6.0	3	<2.0-8.0	2.0
Cyanide[b]	1		0.01	1		0.01	1		<0.01
Lead	16	<1.0-61	8.0	15	<1.0-51	7.0	6	2.0-44	5.0
Mercury	7	<0.1-0.1	0.1	7	<0.1-0.2	<0.1	5	<0.1-0.1	<0.1
Nickel	9	<1.0-12	5.0	9	<1.0-11	5.0	6	2.0-9.0	5.0
Zinc	3	30-60	60	4	30-90	55	3	20-30	20
Other metals									
Aluminum	3	30-80	50	4	60-580	100	3	60-90	80
Iron	9	10-1,400	90	9	10-2,800	130	6	40-1,300	80
Manganese	9	<10-60	10	9	<10-80	10	6	<10-40	10

[a]N = number of samples.
[b]Total arsenic and total cyanide.

Organics. The rainfall samples were analyzed for 32 organic constituents including many of the pesticides commonly used in the agricultural areas surrounding Fresno. Only 14 of these constituents were found at concentrations exceeding the analytical detection limit in at least one sample. The ranges and median concentrations of these 14 organic constituents are presented in Table 4-6. The organics detected in rainfall were generally found at all three sites. Statistical testing conducted by USGS showed that there were no statistically significant differences in the constituent concentrations at the three sampling sites except for total phenol. The median concentrations of most constituents were less than the detection limit (0.01 to 0.1 ug/l) at each of the three sites. The organophosphorus compounds, parathion, malathion, and diazinon, were the most prevalent pesticides detected in rainfall. Chlordane, lindane, methoxychlor, endosulfan, and 2,4-D were also found in rainfall. Their presence in rainfall is probably due to their use in the agricultural area around Fresno. Parathion and diazinon are insecticides used in the San Joaquin Valley primarily as dormant sprays on fruit trees. They are commonly applied with a truck-mounted sprayer that tends to suspend large quantities of spray in the air. Lindane is commonly applied by aerial spraying from an airplane. The USGS project report further discusses the occurrence of pesticides in rainfall and runoff.

Table 4-6. Ranges and Median Concentrations of Organics in Rainfall

Constituent[b]	Concentration,[a] ug/l					
	Single-family residential		Industrial		Laboratory	
	Range	Median	Range	Median	Range	Median
Priority pollutant organics						
Chlordane	<0.10-0.40	<0.10	<0.10-0.40	<0.10	<0.10	<0.10
DDE	<0.01-0.01	<0.01	<0.01-0.02	<0.01	<0.01-0.02	<0.01
Dieldrin	<0.01-0.01	<0.01	<0.01-0.01	<0.01	<0.01-0.01	<0.01
Endosulfan	<0.01-0.04	<0.01	<0.01-0.08	<0.01	<0.01-0.07	<0.01
Lindane	<0.01-0.02	0.01	<0.01-0.04	0.01	<0.01-0.01	0.01
Total PCB	<0.10	<0.10	<0.10-0.10	<0.10	<0.10	<0.10
Phenol	1.0-25	8.0	2.0-15	4.0	2.0-14	6.0
Other organics						
Diazinon	0.01-0.42	0.08	0.01-0.93	0.14	0.01-0.26	0.11
Ethion	<0.01	<0.01	<0.01	<0.01	<0.01-0.01	<0.01
Malathion	<0.01-0.11	0.03	<0.01-0.11	0.02	0.01-0.10	0.03
Methoxychlor	<0.01-0.05	<0.01	<0.01-0.12	<0.01	<0.01-0.04	<0.01
Methyl parathion	<0.01-0.07	<0.01	<0.01	<0.01	<0.01	<0.01
Parathion	<0.01-0.86	0.20	<0.01-1.0	0.16	<0.01-0.66	0.16
2,4-D	<0.01-0.04	<0.01	<0.01-0.08	<0.01	<0.01-0.04	<0.01

[a]The median concentrations are based on 20 samples collected at the single-family residential and industrial sites and 10 samples collected at the laboratory site.

[b]The samples were analyzed for the following organics but concentrations were always less than the analytical detection limit: methomyl, propham, polychlorinated napthalenes, aldrin, DDT, DDD, endrin, toxaphene, heptachlor, heptachlor epoxide, 2,4,5-T, sevin, mirex, perthane, silvex, trithion, methyl trithion, and 2,4-D.

Storm Runoff

Storm runoff quality and quantity were measured at the single-family residential, multiple-family residential, commercial, and industrial sites. Storm runoff quality samples were collected during 34 storms in the 1981-82 rain season and 32 storms in the 1982-83 rain season. During 27 of these storms, the samples were analyzed for all of the constituents listed in Appendix B. During the remaining 39 storms, only specific conductance and pH were measured. The tabulations in this section include all the discrete sample data, but do not include the results from the several composite samples.

Conventional Constituents. Table 4-7 presents the ranges and mean concentrations of conventional constituents at the four sampling sites. Statistical testing showed that the concentrations of most of the conventional constituents were significantly higher at the industrial site than at the other three sites. The concentrations at the other three sites were generally similar. The lowest concentrations were generally found at the single-family residential site. The runoff concentrations of conventional constituents were higher than the concentrations in rainfall. Most concentrations were an order of magnitude higher in runoff than in rainfall.

Table 4-7. Ranges and Mean Concentrations of Conventional Constituents in Runoff

Constituent	Units	Concentration											
		Single-family residential			Multiple-family residential			Commercial			Industrial		
		N[a]	Range	Mean	N[a]	Range	Mean	N[a]	Range	Mean	N[a]	Range	Mean
Turbidity	NTU	49	1.7-900	57	72	2.0-320	49	71	1.6-300	31	83	1.0-800	160
Specific conductance	umhos/cm	121	15-222	56	230	17-606	66	256	8.0-808	90	285	96-9,960	404
pH	Standard units	97	6.5-8.3	7.2	169	6.4-8.8	7.1	203	6.1-8.9	6.9	221	4.9-7.5	6.7
Hardness	mg/l as $CaCO_3$	62	4.0-70	20	85	6.0-230	30	95	3.0-330	49	101	17-410	65
Alkalinity	mg/l as $CaCO_3$	65	7.0-73	19	89	5.0-150	25	96	1.0-257	36	101	5.0-221	84
Oil and grease	mg/l	11	1.0-8.0	3.0	17	0-5.0	1.5	18	0-26	4.2	15	0-80	11
Suspended solids	mg/l	64	9.0-1,540	246	86	8.0-4,300	634	94	2.0-3,720	264	100	51-2,770	684
Dissolved solids	mg/l	64	9.0-224	63	81	14-775	104	87	1.0-1,010	143	93	77-5,870	423
BOD-ultimate	mg/l	22	2.3-81	21	45	5.2-150	23	44	3.4-64	13	42	39-830	189
BOD-5-day	mg/l	22	2.1-53	15	45	3.1-110	15	44	2.7-30	8.4	42	30-330	149
COD	mg/l	34	27-290	106	58	31-1,400	157	50	12-460	95	56	150-2,580	620
Dissolved nitrogen	mg/l as N	64	0.63-21	4.8	86	0.8-33	5.5	83	0.7-66	8.1	79	4.0-54	20
Dissolved organic nitrogen	mg/l as N	62	0.19-12	2.6	84	0.10-25	3.0	85	0.01-27	3.6	86	0.01-38	12
Dissolved ammonia	mg/l as N	65	0.12-6.4	1.4	83	<0.01-7.3	1.4	87	0.22-17	2.2	86	0.90-20	6.6
Dissolved nitrite	mg/l as N	31	0.02-0.13	0.05	53	0.01-0.41	0.05	45	0.02-0.56	0.05	53	0.01-0.55	0.21
Dissolved nitrate	mg/l as N	25	0.18-2.1	0.75	45	0.10-6.6	0.89	39	0.14-4.5	0.78	42	0.01-3.3	1.2
Total phosphorus	mg/l as P	65	0.10-2.4	0.63	89	0.01-5.0	0.87	87	0.03-9.1	0.63	90	0.90-20	6.6
Dissolved phosphorus	mg/l as P	65	0.09-1.6	0.37	'87	0.01-4.7	0.58	87	0.02-8.0	0.45	89	0.40-11	4.9
Dissolved orthophorphorus	mg/l as P	64	0.09-1.6	0.31	88	0.01-2.1	0.38	87	<0.02-4.8	0.28	66	0.60-9.0	3.7
Dissolved organic carbon	mg/l	36	4.4-550	75	58	4.6-460	64	47	4.4-260	54	56	20-2,300	190
Suspended organic carbon	mg/l	33	0.8-17	3.2	54	1.3-15	3.7	46	0.90-10	2.5	54	5.8-41	25
Dissolved calcium	mg/l	65	1.3-18	5.8	87	2.0-65	8.3	96	0.80-100	13.6	101	4.0-120	15
Dissolved magnesium	mg/l	65	0.01-6.2	1.3	87	0.20-16	2.1	96	0.10-22	3.5	101	1.6-26	6.4
Dissolved sodium	mg/l	65	0.70-18	3.9	87	1.0-49	6.8	96	0.60-37	6.8	102	5.7-1,800	74
Dissolved potassium	mg/l	65	0.80-9.8	3.3	87	0.8-19	3.4	96	0.30-15	2.9	99	5.2-62	24
Dissolved chloride	mg/l	64	0.60-14	3.4	88	0.60-65	5.1	95	0.20-31	5.5	102	4.8-3,000	112
Dissolved sulfate	mg/l as SO_4	61	4.2-27	8.3	88	3.6-76	12.2	95	3.1-190	21	102	<5.0-110	25
Dissolved silica	mg/l as SiO_2	44	0.34-27	3.0	68	1.5-25	4.7	64	0.50-44	3.2	74	1.6-30	5.4

[a]N = number of samples.

Metals. The ranges and median concentrations of metals in runoff at the four sites are presented in Table 4-8. Cyanide was the only constituent which was consistently below the analytical detection limit. All of the other metals were present at concentrations that exceeded the detection limit in at least one sample. For most metals, the median concentrations were similar at the two residential and commercial sites and considerably higher at the industrial site. The concentrations of iron, aluminum, and manganese at the multiple-family residential site were statistically significantly higher than at the single-family residential site. The higher concentrations may be due to soil erosion from undeveloped land in the multiple-family residential drainage area and not to differences in urban runoff. The arsenic and zinc concentrations were higher at the industrial site than the other sites. The lead concentrations were highest at the residential sites. The runoff concentrations of metals were generally 2 to 70 times higher than the concentrations in rainfall.

Table 4-9 presents the median concentrations of total recoverable and dissolved metals at each of the four sampling sites. The particulate fraction of most metals was much larger than the dissolved fraction. Less than 25 percent of the aluminum, chromium, iron, and lead was in the dissolved form at all four sites. Arsenic was the only metal which was predominantly in the dissolved form at all sites.

Organics. The runoff samples were analyzed for 34 organic constituents. Only 19 of these constituents were found at concentrations exceeding the analytical detection limit in at least one sample. The ranges and median concentrations of these 19 organic constituents are presented in Table 4-10. The organics detected in runoff were generally found at all four sites. The median concentrations of most constituents were less than the detection limit (0.01 to 0.1 ug/l) at each of the four sites. The median concentrations of lindane, phenol, diazinon, malathion, parathion, and 2,4-D exceeded the detection limits at all four sites. All of these constituents were also found in the precipitation samples. Chlordane and DDE were also found at some of the sampling sites. Chlordane occurred more frequently in runoff than in rainfall. The highest concentrations of chlordane and DDE were found at the single-family residential site and the industrial site, while the lowest concentrations were found at the commercial site. This is probably due to the use of pesticides in landscaping and gardens in residential areas and the manufacturing, storage, transport, or handling of pesticides in industrial areas. There is minimal landscaping in the commercial area, so it is not surprising to find low levels of pesticides in commercial runoff.

Table 4-8. Ranges and Median Concentrations of Metals in Runoff

Metals	Total recoverable metal concentration, ug/l											
	Single-family residential			Multiple-family residential			Commercial			Industrial		
	N[a]	Range	Median	N[a]	Range	Median	N[a]	Range	Median	N[a]	Range	Median
Priority pollutant metals												
Arsenic[b]	64	<1.0-8.0	1.0	87	<1.0-16	2.0	95	<1.0-17	2.0	16	1.0-67	14
Cadmium	31	<1.0-4.0	1.0	53	<1.0-6.0	1.0	49	<1.0-12	1.0	70	<1.0-4.0	1.0
Chromium	48	<1.0-40	8.5	70	1.0-62	15	68	1.0-37	11	86	<1.0-51	14
Copper	47	4.0-180	14	70	7.0-270	22	68	6.0-380	18	86	30-400	66
Cyanide[b]	5	<0.01	<0.01	5	<0.01	<0.01	6	<0.01	<0.01	3	<0.01	<0.01
Lead	63	15-2,100	170	91	25-940	170	95	9.0-1,200	100	107	16-360	74
Mercury	64	<0.10-8.6	0.10	88	<0.10-1.6	0.20	95	<0.10-0.50	0.10	107	<0.10-2.5	0.10
Nickel	62	1.0-85	11	91	2.0-310	19	94	1.0-120	10	107	4.0-98	24
Zinc	47	30-1,300	90	70	60-1,800	170	68	50-3,400	150	86	280-3,100	535
Other metals												
Aluminum	17	530-20,000	3,400	17	1,600-37,000	6,300	19	120-45,000	3,400	16	3,000-18,000	7,000
Iron	64	160-29,000	1,700	91	450-72,000	5,600	95	140-57,000	1,600	107	480-62,000	9,000
Manganese	32	20-480	110	38	40-1,600	200	46	30-1,700	280	37	170-1,600	360

[a]N = number of samples.
[b]Total arsenic and total cyanide.

Table 4-9. Total Recoverable and Dissolved Metals Concentrations in Runoff

Metals	Median concentration, ug/l							
	Single-family residential		Multiple-family residential		Commercial		Industrial	
	Total recoverable	Dissolved	Total recoverable	Dissolved	Total recoverable	Dissolved	Total recoverable	Dissolv
Aluminum	3,400	50	6,300	195	3,400	75	7,000	150
Arsenic[a]	1.0[a]	1.0	2.0[a]	1.0	2.0[a]	1.0	14[a]	9.0
Cadmium	1.0	2.0	1.0	<1.0	1.0	<1.0	1.0	<1.0
Chromium	8.5	<1.0	15	<1.0	11	<1.0	14	<1.0
Copper	14	5.0	22	5.0	18	4.0	66	15
Cyanide[a]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron	1,700	91	5,600	150	1,600	89	9,000	370
Lead	170	25	170	12	100	12	74	9.0
Manganese	110	23	200	56	280	105	360	130
Mercury	0.1	<0.1	0.2	<0.1	0.1	<0.1	0.1	0.1
Nickel	11	4.0	19	5.0	10	4.0	24	8.0
Zinc	90	43	170	50	150	80	535	190

[a]Total arsenic and total cyanide.

Table 4-10. Ranges and Median Concentrations of Organics in Runoff

Constituent[a]	Concentration, ug/l											
	Single-family residential			Multiple-family residential			Commercial			Industrial		
	N[b]	Range	Median	N[b]	Range	Median	N[b]	Range	Median	N[b]	Range	Median
Priority pollutant organics												
Aldrin	16	<0.1	<0.01	27	<0.01-0.02	<0.01	24	<0.01	<0.01	19	<0.01	<0.01
Chlordane	16	0.10-0.30	0.10	26	<0.10-1.2	0.10	23	<0.10-0.30	0.10	19	<0.10-0.30	<0.10
DDE	16	<0.01-0.01	<0.01	27	<0.01-0.06	<0.01	24	<0.01-0.01	0.01	19	<0.01-0.03	0.01
DDT	16	<0.01-0.01	<0.01	27	<0.01-0.01	<0.01	24	<0.01	<0.01	19	<0.01	<0.01
Dieldrin	16	<0.01-0.01	<0.01	27	<0.01-0.02	<0.01	24	<0.01-0.01	<0.01	19	<0.01-0.02	<0.01
Endosulfan	16	<0.01-0.01	<0.01	27	<0.01	<0.01	24	<0.01	<0.01	19	<0.01-0.02	<0.01
Endrin	16	<0.01-0.01	<0.01	27	<0.01	<0.01	24	<0.01	<0.01	19	<0.01	<0.01
Lindane	16	0.01-0.06	0.03	27	<0.01-0.03	0.01	24	0.01-0.03	0.01	19	0.01-0.27	0.03
PCB	16	<0.10	<0.10	27	<0.10	<0.01	24	<0.10	<0.01	19	<0.10	<0.10
Phenol	5	13-35	18	9	6.0-41	16	9	6.0-52	17	5	8.0-500	20
Other organics												
Diazinon	16	0.11-1.1	0.27	27	0.06-8.1	0.22	24	0.13-18	0.39	18	0.14-3.3	0.53
Dibromochloropropane	4	<0.003-0.003	<0.003	7	<0.003-0.004	<0.003	8	<0.003-0.01	<0.003	7	<0.003-0.005	<0.003
Malathion	16	0.19-13	0.99	27	0.08-14	0.49	24	0.08-1.4	0.23	18	0.20-3.0	0.44
Methoxychlor	16	<0.01-0.19	<0.01	27	<0.01-0.02	<0.01	24	<0.01	<0.01	19	<0.01-0.03	<0.01
Methyl parathion	16	<0.01-0.03	<0.01	27	<0.01	<0.01	24	<0.01-0.03	<0.01	18	<0.01	<0.01
Parathion	16	<0.01-0.92	0.13	27	<0.01-2.5	0.06	24	<0.01-0.90	0.09	18	<0.01-0.38	<0.01
Silvex	16	<0.01-0.03	<0.01	26	<0.01	<0.01	23	<0.01	<0.01	19	<0.01-0.07	<0.01
2,4-D	16	<0.01-1.7	0.07	26	<0.01-3.7	0.08	23	<0.01-0.63	0.01	19	<0.01-3.2	0.03
Trithion	16	<0.01	<0.01	27	<0.01	<0.01	24	<0.01	<0.01	19	<0.01-0.10	<0.01

[a]The samples were analyzed for the following organics but concentrations were always less than the analytical detection limit: polychlorinated napthalenes, DDD, heptachlor, heptachlor epoxide, mirex, perthane, toxaphene, ethion, methyl trithion, methomyl, propham, sevin, 2,4-DP, 2,4,5-T.

[b]N = number of samples.

Dry Deposition

Dry deposition samples were collected at the single-family residential and industrial sites between storms for ten periods during the study period. The samples were analyzed for all of the constituents listed in Table B-1 in Appendix B. It is difficult to collect dry deposition data that are representative of a large area. The amount of material collected in a dry deposition collector bucket is influenced by the location of the bucket with respect to the ground, wind conditions, and the activity in the surrounding area. The two deposition collectors for this study were mounted in similar positions approximately 3 meters above the ground on the roof of the study's instrumentation shelters. They were located about 10 to 20 meters from light traffic-density streets.

Conventional Constituents. Table 4-11 presents the ranges and mean concentrations of conventional constituents at the single-family residential and industrial sites. The dry deposition quality was generally similar at the two sites. The nitrogen concentrations were higher at the residential site and the phosphorus concentrations were higher at the industrial site.

Table 4-11. Ranges and Mean Concentrations of Conventional Constituents in Dry Deposition

Constituent	Concentration, mg/kg					
	Single-family residential			Industrial		
	N[a]	Range	Mean	N[a]	Range	Mean
Total solids	9	20-527	135	10	41-856	211
Total organic nitrogen	7	10,300-70,000	24,357	9	12,400-129,000	52,133
Total ammonia	9	<114-82,800	13,729	10	1,050-46,800	11,989
Dissolved nitrite + nitrate	9	1,890-295,000	41,263	10	1,200-42,200	9,328
Total phosphorus	9	588-6,900	2,479	10	1,290-10,600	5,156
Total orthophosphorus	9	304-5,860	1,504	10	553-25,800	4,489
Dissolved organic carbon	7	30,400-266,000	118,357	10	10,100-390,000	117,700
Dissolved calcium	9	3,770-121,000	24,440	10	2,760-31,100	12,419
Dissolved magnesium	9	638-13,800	5,005	10	780-21,000	5,949
Dissolved sodium	9	<4,260-55,200	16,011	10	1,380-21,000	9,068
Dissolved potassium	9	1,890-24,100	8,034	10	2,760-74,200	18,466
Dissolved chloride	9	498-58,600	14,965	10	2,300-25,800	9,364
Dissolved sulfate	9	4,260-250,000	79,232	10	<922-178,000	63,777
Dissolved silica	4	3,430-24,100	12,605	5	1,050-7,320	3,000

[a]N = number of samples.

Metals. The ranges and median concentrations of metals at the two sites are presented in Table 4-12. Based on the limited data collected, the median concentrations of most metals were similar at the two sites. The lead and mercury concentrations were higher at the single-family residential site, and the chromium concentration was higher at the industrial site. The USGS estimated the deposition rates and found that the rates for most constituents were fairly constant throughout the year.

Table 4-12. Ranges and Median Concentrations of Metals in Dry Deposition

	Total recoverable metal concentration, mg/kg					
	Single-family residential			Industrial		
Constituent	N[a]	Range	Median	N[a]	Range	Median
Priority pollutant metals						
Arsenic[b]	5	4.5-50	19	5	4.6-24	14
Chromium	5	57-250	85	5	28-289	143
Copper	5	91-1,950	481	5	115-689	443
Lead	9	304-8,280	1,640	10	140-1,610	592
Mercury	5	0.91-10	3.9	5	0.74-4.4	1.8
Nickel	5	21-350	94	5	28-329	100
Zinc	5	543-4,000	2,340	5	369-2,440	1,760
Other metals						
Aluminum	5	9,950-40,500	12,300	5	8,290-33,300	10,400
Iron	5	15,200-50,000	17,500	5	11,100-42,400	15,600
Manganese	5	362-1,500	385	5	276-1,330	444

[a]N = number of samples.
[b]Total arsenic.

Organics. One dry deposition sample from each site was analyzed for 31 organic constituents but only 6 were found at concentrations exceeding the analytical detection limit. These data are presented in Table 4-13. The organics concentrations of chlordane, DDE, lindane, diazinon, malathion, and methoxychlor were higher at the single-family residential site than at the industrial site. All of the pesticides detected in dry deposition were also detected in precipitation and runoff.

Table 4-13. Concentrations of Organics in Dry Deposition

Constituent[b]	Concentration,[a] ug/kg	
	Single-family residential	Industrial
Priority pollutant organics		
Chlordane	610	270
DDE	30	13
Lindane	30	13
Other organics		
Diazinon	180	120
Malathion	850	200
Methoxychlor	30	<0.01

[a]Based on one sample.

[b]The samples were analyzed for the following organics, but concentrations were less than the analytical detection limit: aldrin, DDD, DDT, dieldrin, endosulfan, endrin, ethion, PCB, polychlorinated napthalenes, heptachlor, heptachlor epoxide, methyl parathion, methyl trithion, mirex, parathion, perthane, silvex, toxaphene, trithion, 2,4-D, 2,4-DP, 2,4,5-T, methomyl, propham, and sevin.

Street Particulate Material

Street particulate samples were collected from each of the four land use types from March 1982 through January 1983. Six samples were collected in the commercial drainage area and five samples were collected in each of the other drainage areas. The initial objectives of the sampling program were to determine a particulate buildup curve for each land use, to determine which constituents were present, and to determine the concentrations of those constituents on the street surfaces. Due to problems with data collection, it was not possible to determine buildup curves.

Conventional Constituents. Table 4-14 presents the ranges and mean concentrations of conventional constituents at the four sampling sites. The concentrations of most constituents were highest at the commercial site and lowest at the multiple-family residential site. The high concentrations at the commercial site may be due to construction activities in the drainage basin. The street particulate concentrations of conventional constituents were consistently one to two orders of magnitude lower than the concentrations in dry deposition; however, the quantity of street particulate material greatly exceeded the amount of dry deposition material.

Table 4-14. Ranges and Mean Concentrations of Conventional Constituents in Street Particulates

Constituent	Concentration, mg/kg											
	Single-family residential			Multiple-family residential			Commercial			Industrial		
	N[a]	Range	Mean	N[a]	Range	Mean	N[a]	Range	Mean	N[a]	Range	Mean
COD	5	44,000-66,000	52,400	5	25,000-49,000	36,200	6	91,000-150,000	123,500	5	30,000-65,000	40,800
Volatile solids	5	38,100-98,000	62,540	5	19,600-53,200	27,720	6	41,200-98,300	73,168	5	19,900-31,100	26,300
Total nitrogen	4	507-1,210	878	4	255-580	429	6	643-1,910	1,202	3	347-574	453
Total ammonia	5	19-64	35	5	22-38	30	6	24-100	49	5	5.8-80	38
Total nitrite	3	<2.0->2.0	2.0	3	<2.0->2.0	2.0	4	<2.0->2.0	2.0	3	<2.0	<2.0
Total nitrite + nitrate	5	<2.0-12	5.8	5	<2.0-15	7.3	6	6.6-42	16	5	<2.0-7.4	4.4
Total phosphorus	5	220-1,200	450	5	160-300	206	6	180-450	327	5	120-250	202
Total inorganic carbon	5	<100-700	240	5	<100-200	120	6	<100-800	380	5	<100-200	140
Total carbon	5	13,000-25,000	2,080	5	11,000-14,000	12,000	6	29,000-55,000	45,000	5	9,800-17,000	12,500
Calcium	3	30-110	67	3	30-40	33	4	70-120	90	3	30-40	37
Magnesium	3	20	20	3	10-20	17	4	30-50	43	3	20-40	33
Sodium	3	<10	<10	3	<10	<10	4	<10	<10	3	<10	<10
Potassium	3	690-800	763	3	460-640	533	4	500-1,400	950	3	310-420	347

[a]N = number of samples.

Metals. The ranges and median concentrations of metals at the four sites are presented in Table 4-15. Cadmium was the only metal which was consistently at the detection limit. For most metals, the concentrations were similar at the two residential sites and the industrial site and considerably higher at the commercial site. This difference may be due to the fact that the commercial site is the only one of the four sites that receives regular street sweeping. The residual material after sweeping is the finer particles, which have more surface area per weight allowing them to adsorb more contaminants. Concentrations at the multiple-family residential site were generally lower than the other sites. The concentrations of metals in street particulates were generally an order of magnitude lower than the concentrations in dry deposition; however, the quantity of street particulate material greatly exceeded the amount of dry deposition material.

Organics. The street particulate samples were analyzed for 25 organic constituents. As shown in Table 4-16, the concentrations of 14 of these constituents were generally below the analytical detection limits. The highest concentrations of many of the remaining organics were found at the commercial site, and the lowest concentrations were found at the industrial site. The concentrations of organics were generally quite low in runoff from the commercial site. The higher concentrations in the street particulate material at the commercial site may be related to the routine street sweeping that this drainage area receives. The routine street sweeping tends to pick up the larger sediment particles and leave the smaller particles. The smaller particles tend to have more organics per unit weight (ug/kg) than the larger particles. Since the other drainage areas are not routinely swept, the samples collected in this study were a mixture of large and small particles, so the organics content was lower on a unit weight basis. Only 6 organic constituents exceeded the detection limit in dry deposition samples, whereas 11 constituents were found in street particulates at concentrations greater than the detection limits. With the exception of methoxychlor, the concentrations in dry deposition were considerably larger than the concentrations in street particulates; however, the quantity of street particulate material greatly exceeded the amount of dry deposition material. All pesticides detected in street particulates were also detected in rainfall and runoff.

Dry Weather Runoff

On September 3, 1982, USGS collected grab samples of dry weather runoff from the single-family and multiple-family residential sites. The dry weather concentrations of several conventional, metal, and organic constituents are compared to the mean wet weather runoff concentrations in Table 4-17.

Table 4-15. Ranges and Median Concentrations of Metals in Street Particulates

Constituent	Total recoverable metal concentration, ug/g											
	Single-family residential			Multiple-family residential			Commercial			Industrial		
	N[a]	Range	Median	N[a]	Range	Median	N[a]	Range	Median	N[a]	Range	Median
Priority pollutant metals												
Arsenic[b]	5	2.0–3.0	2.0	5	1.0–2.0	2.0	6	1.0–7.0	4.0	5	2.0–4.0	3.0
Cadmium	3	<1.0–<10	<1.0	3	<1.0–<10	<1.0	4	1.0–<10	2.0	3	<1.0–<10	1.0
Chromium	3	4.0	4.0	3	3.0–4.0	3.0	4	20	20	3	10–30	10
Copper	5	<10–18	12	5	5.0–17	10	6	12–50	34	5	27–54	40
Lead	5	500–790	562	5	200–430	400	6	280–1,000	770	5	100–300	150
Mercury	5	0.01–0.05	0.03	5	0.02–0.04	0.03	6	0.05–0.13	0.07	5	0.01–0.03	0.02
Nickel	5	<10–<100	10	5	8.0–<100	<10	6	10–<100	26	5	20–<100	20
Zinc	5	59–300	85	5	40–150	49	6	130–1,300	240	5	49–120	70
Other metals												
Aluminum	2	1,100–1,400	1,250	2	720–1,700	1,210	2	1,200–1,900	1,550	2	780–830	805
Iron	5	2,100–3,600	3,200	5	1,200–3,000	2,400	6	2,500–7,000	5,000	5	2,000–3,700	2,300
Manganese	2	43–65	54	2	31–60	46	2	61–110	86	2	34–46	40

[a]N = number of samples.
[b]Total arsenic.

Table 4-16. Ranges and Median Concentrations of Organics in Street Particulates

Constituent	Concentration, ug/kg											
	Single-family residential			Multiple-family residential			Commercial			Industrial		
	N[a]	Range	Median	N[a]	Range	Median	N[a]	Range	Median	N[a]	Range	Median
Priority pollutant organics												
Aldrin	5	<0.50-<1.0	<1.0	5	<0.50-<1.0	<0.5	3	<0.50-<4.0	<1.0	5	<0.50-<4.0	<1.0
Chlordane	5	170-470	290	5	57-160	110	3	280-3,400	420	5	69-260	110
DDD	5	<0.50-<4.0	<1.0	5	<0.20-<1.0	<0.50	3	<1.0-7.9	<4.0	5	<0.50-<4.0	<0.50
DDE	5	3.3-11	6.0	5	3.1-10	4.5	3	<0.50-<4.0	<1.0	5	8.1-15	12
DDT	5	11-31	15	5	<0.50-15	4.4	3	<1.0-19	3.3	5	7.4-33	21
Dieldrin	5	0.70-5.2	3.7	5	0.30-2.8	1.2	3	1.2-89	6.8	5	0.20-2.3	1.2
Endosulfan	5	<0.50-<4.0	<1.0	5	<0.20-6.7	<0.50	3	<0.50-<4.0	<1.0	5	<0.50-<4.0	<0.50
Endrin	5	<0.50-<1.0	<1.0	5	<0.10-<1.0	<0.50	3	<0.50-<4.0	<1.0	5	<0.50-<1.0	<0.50
Heptachlor epoxide	5	<0.50-1.2	<1.0	5	<0.10-2.2	<0.50	3	2.4-35	9.9	5	<0.50-2.8	<0.50
Heptachlor	5	1.0-2.2	1.4	5	<0.80-1.9	1.2	3	0.70-3.0	2.2	5	0.20-<4.0	<0.50
Lindane	5	1.5-26	2.8	5	0.60-3.3	1.5	3	1.7-4.8	4.1	5	2.0-4.6	2.1
PCB	5	10-51	13	5	30-49	38	3	220-860	820	5	23-37	33
Toxaphene	5	<50-<400	<100	5	<20-<100	<50	3	<50-<400	<100	5	<50-<400	<50
Other organics												
Diazinon	5	3.0-18	6.0	5	1.8-25	3.9	3	16-80	26	5	<0.10-20	<1.0
Ethion	5	<0.10-<1.0	<1.0	5	<0.10-<1.0	<0.10	3	<0.10-<1.0	<1.0	5	<0.10-<1.0	<1.0
Malathion	5	<1.0-10	2.9	5	<0.10-8.7	2.1	3	4.4-17	15	5	<0.10-2.1	<1.0
Methoxychlor	5	<0.50-<8.0	<1.0	5	<0.50-<8.0	<2.5	3	<0.50-<8.0	<1.0	5	<0.50-<8.0	<2.5
Methyl parathion	5	<0.10-<1.0	<1.0	5	<0.10-<1.0	<0.10	3	<0.10-<1.0	<1.0	5	<0.10-<1.0	<1.0
Methyl trithion	5	<0.10-<1.0	<1.0	5	<0.10-<1.0	<0.10	3	<0.10-<1.0	<1.0	5	<0.10-<1.0	<1.0
Mirex	5	<0.50-<1.0	<1.0	5	<0.50-<1.0	<0.50	3	<0.50-<4.0	<1.0	5	<0.50-<4.0	<1.0
Parathion	5	<0.10-29	<1.0	5	<0.10-36	1.0	3	<0.10-38	<1.0	5	<0.10-16	<1.0
Polychlorinated napthalenes	2	<10	<10	2	<5.0	<5.0	0	-	-	2	<10	<10
Perthane	5	<5.0-<40	<10	5	<2.0-<10	<5.0	3	<5.0-<40	<10	5	<5.0-<40	<5.0
Trithion	5	<0.10-<1.0	<1.0	5	<0.10-<1.0	<0.10	3	<0.10-<1.0	<1.0	5	<0.10-<1.0	<1.0
2,4-D	2	<0.50	<0.50	2	<0.50	<0.50	2	<0.50	<0.50	2	<0.50	<0.50

[a]N = number of samples.

Table 4-17. Comparison of Wet and Dry Weather Runoff Concentrations of Conventional Constituents, Metals, and Organics

Constituent	Units	Mean concentration: Single-family residential		Mean concentration: Multiple-family residential	
		Wet	Dry	Wet	Dry
Specific conductance	umhos/cm	56	266	66	291
Dissolved nitrate	mg/l as N	0.75	0.93	0.89	1.5
Total phosphorus	mg/l as P	0.63	1.0	0.81	0.45
Dissolved calcium	mg/l	5.8	21	8.3	22
Dissolved chloride	mg/l	3.4	18	5.1	10
Arsenic	ug/l	2.1	4.0	2.7	6.0
Cadmium	ug/l	1.5	<1.0	1.5	1.0
Chromium	ug/l	9.3	2.0	16	4.0
Copper	ug/l	32	13	39	11
Lead	ug/l	353	93	225	6.0
Mercury	ug/l	0.60	0.10	0.33	0.10
Nickel	ug/l	14	12	40	12
Zinc	ug/l	211	70	290	20
Iron	ug/l	4,594	2,000	10,877	540
Chlordane	ug/l	0.16	0.10	0.25	<0.10
Lindane	ug/l	0.03	0.03	0.01	0.01
Diazinon	ug/l	0.36	1.1	0.70	2.1
Malathion	ug/l	2.2	5.7	1.3	2.1
Parathion	ug/l	0.21	<0.01	0.20	<0.01
2,4-D	ug/l	0.26	0.04	0.36	0.20

The dry weather concentrations of all of the conventional constituents except total phosphorus were greater than the wet weather concentrations. With the exception of arsenic, the wet weather concentrations of metals were greater than the dry weather concentrations. This may be due to the fact that metals adsorb to sediment particles, and wet weather storms are able to suspend sediment particles that are not moved by dry weather runoff. The concentrations of chlordane, parathion, and 2,4-D were greater in the wet weather samples and the concentrations of diazinon and malathion were greater in the dry weather samples. Diazinon and malathion are pesticides which are commonly used by homeowners.

Imported Recharge Water

The conventional constituent data collected by USDA on the quality of imported canal water used for recharge in Basins MM and EE are presented in Table 4-18. The data from samples collected from the canals show that the imported water is of excellent quality. All of the major anions and cations were found at low concentrations. Table 4-19 presents the concentrations of metals in the one sample that was collected. All of the metals concentrations are considerably lower than the concentrations in runoff. One sample was analyzed for 28 organic constituents. The concentrations were all less than the analytical detection limits, which ranged from 0.01 to 0.10 ug/l.

EPA Metals and Organics

The EPA conducted a supplemental analysis on several samples collected by USGS. Two grab samples were collected from each land use type on January 4, 1982, and analyzed for metals. Four samples were collected in March 1982 and analyzed for all of the priority pollutant metals and organics. Most of the organics were found at levels near or below the analytical detection limits. Table 4-20 presents the median concentrations of metals that were sampled by EPA but not sampled by USGS. The EPA analytical detection limits were much higher than the USGS limits, so most of the metals concentrations are reported as less than the detection limit. The concentrations of barium, boron, strontium, and titanium exceeded the detection limits. The highest concentrations of these four metals were found at the industrial site. The concentrations at the other three sites were similar. The concentrations of most of the priority pollutant organics were less than the detection limits of 1 to 25 ug/l.

ANALYSIS

The concentrations of various constituents measured in the runoff monitoring program were presented in the previous section of this chapter. Variations in the concentrations of key constituents during storm events and over the rain season are described in this section. The annual runoff and rainfall loads and unit runoff load factors for each land use type are also presented.

Water Quality Variations with Time

An analysis of the data collected in the Fresno NURP project showed that the runoff concentrations of many constituents varied during the storm events and seasonally.

Table 4-18. Concentrations of Conventional Constituents in Imported Recharge Water

Constituent	Units	Concentration[a] Basin MM	Basin EE
Specific conductance	umhos/cm	35.6	31.9
pH	Standard units	6.6	7.7
Turbidity	NTU	2.8	3.0
Suspended solids	mg/l	5.2	3.3
Calcium	mg/l	1.6	1.9
Magnesium	mg/l	0.20	0.20
Sodium	mg/l	1.0	1.1
Potassium	mg/l	0.13	0.13
Carbonate	mg/l	0	0
Bicarbonate	mg/l	25	24
Sulfate	mg/l	3.7	4.0
Chloride	mg/l	2.3	2.2
Nitrate	mg/l as N	0	0

[a]Mean concentrations of 24 samples are shown for specific conductance, turbidity, and suspended solids. All other concentrations are based on one sample collected on July 15, 1982.

Table 4-19. Concentrations of Metals in Imported Recharge Water

Constituent	Concentration, ug/l
Arsenic	<1
Cadmium	<1
Chromium	4
Copper	2
Iron	160
Lead	1.0
Mercury	0.1
Nickel	3.0
Zinc	10

Table 4-20. Median Concentrations of Metals Analyzed by EPA

Constituent	Total recoverable metal—median concentration, ug/l			
	Single-family residential	Multiple-family residential	Commercial	Industrial
Priority pollutant metals				
Antimony	<5	<5	<5	8
Beryllium	<1	<1	<1	<1
Selenium	<25	<25	<25	<25
Silver	<0.5	<0.5	<0.5	<0.5
Thallium	<10	<10	<10	<10
Other metals				
Barium	15	35	20	160
Boron	20	25	15	150
Cobalt	<10	<10	<10	10
Lithium	<10	<10	<10	15
Molybdenum	<10	<10	10	<10
Strontium	15	25	15	175
Tin	<50	<50	<50	<50
Titanium	70	230	65	790
Vanadium	<10	10	<10	35
Yttrium	<10	<10	<10	<10

Storm Event Variations. The USGS collected discrete grab samples during a number of storms monitored during the two years of the project. The number of samples analyzed varied from 2 to 17 depending on the length of the storm, and averaged about 5. The concentrations of most constituents were higher in the initial runoff samples than in samples collected later in the storms at the residential and commercial sites. Pollutants that have collected in the drainage area since the previous storm are washed off by the initial storm runoff. Therefore, the initial runoff results in high constituent concentrations because of the low runoff volumes that transport the collected constituents.

Constituent concentrations vary differently during a runoff event depending upon the type of constituent. Figures 4-2 and 4-3 show the concentrations of several key constituents at the multiple-family residential and commercial sites during several storms. Nutrient concentrations are generally highest at the beginning of storm runoff and then steadily decrease throughout the storm, independent of flow variations. Chemical oxygen demand (COD), biochemical oxygen demand (BOD), and specific conductance show the same pattern as nutrients. Metal concentrations are also generally higher at the beginning of runoff, but vary thereafter depending on velocity. This is probably due to the adsorption of metals to sediment particles. Larger sediment particles are moved by higher velocities; therefore, higher metal concentrations are generally found on the rising limb of a hydrograph.

There was no definite pattern in constituent concentrations at the industrial site during a storm. Figure 4-4 shows typical constituent concentrations throughout a storm at this site. The highest dissolved phosphorus and COD concentrations unexpectedly occur in the middle of the hydrograph and are not associated with a peak flow. Numerous specific conductance spikes were recorded at the industrial site during the study period, the largest of which occurred October 25, 1982, when the specific conductance rose from 666 umhos/cm to 9,960 umhos/cm in 8 minutes, and then receded to 1,025 umhos/cm 24 minutes later. These types of random concentration spikes were very common at this site.

Rain Season Variations. To determine if there were any seasonal variations in constituent concentrations, the USGS related the event mean concentration (EMC) of various constituents at each land use sampling site to the time in days since the first storm of the rain season. These relationships for various constituents are shown on Figure 4-5. The highest EMCs occur during the first two or three storms of the year and then become almost constant for the remainder of the rain season at the residential and commercial sites. This indicates

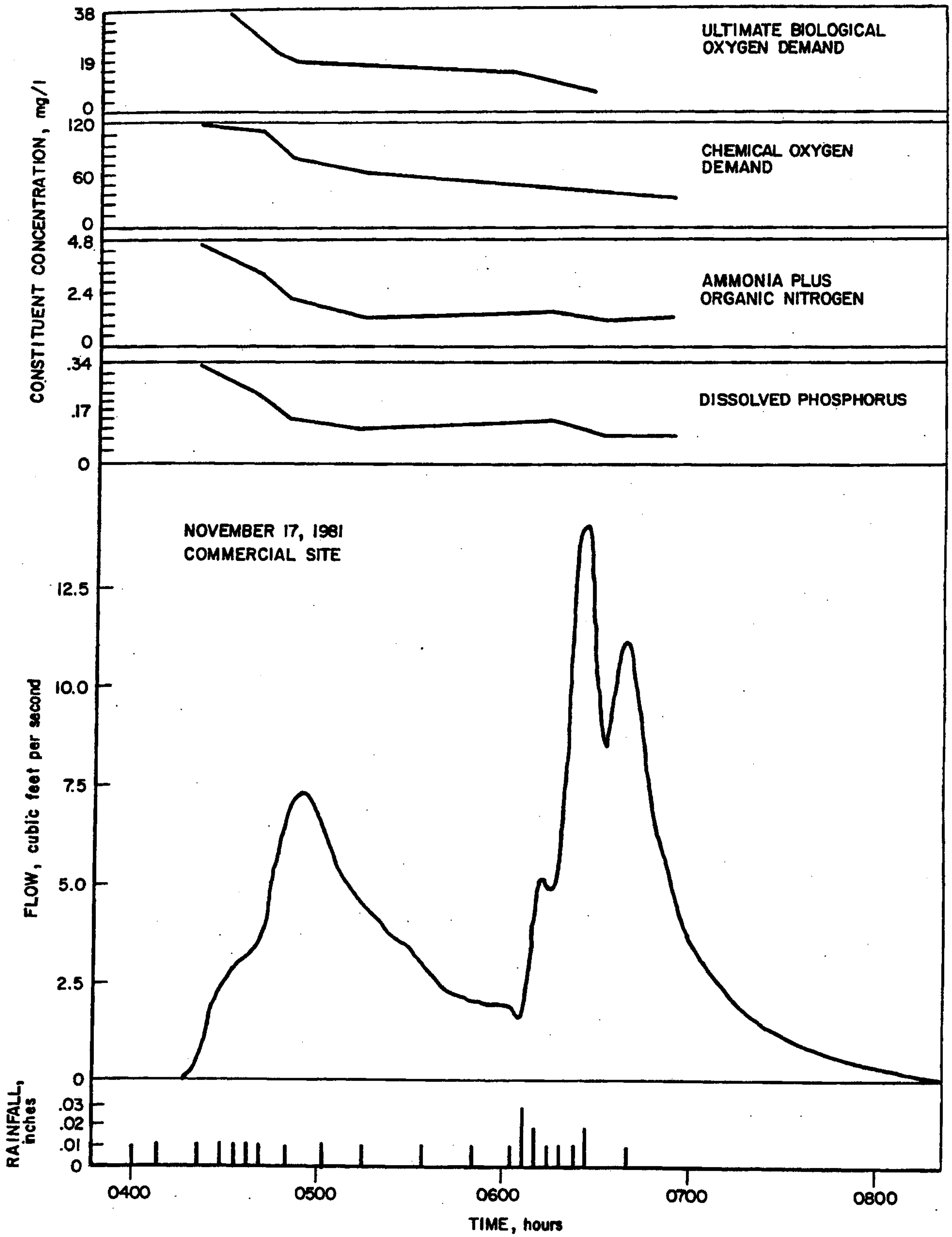


Figure 4-2 Water Quality Variations in Conventional Constituents During a Storm

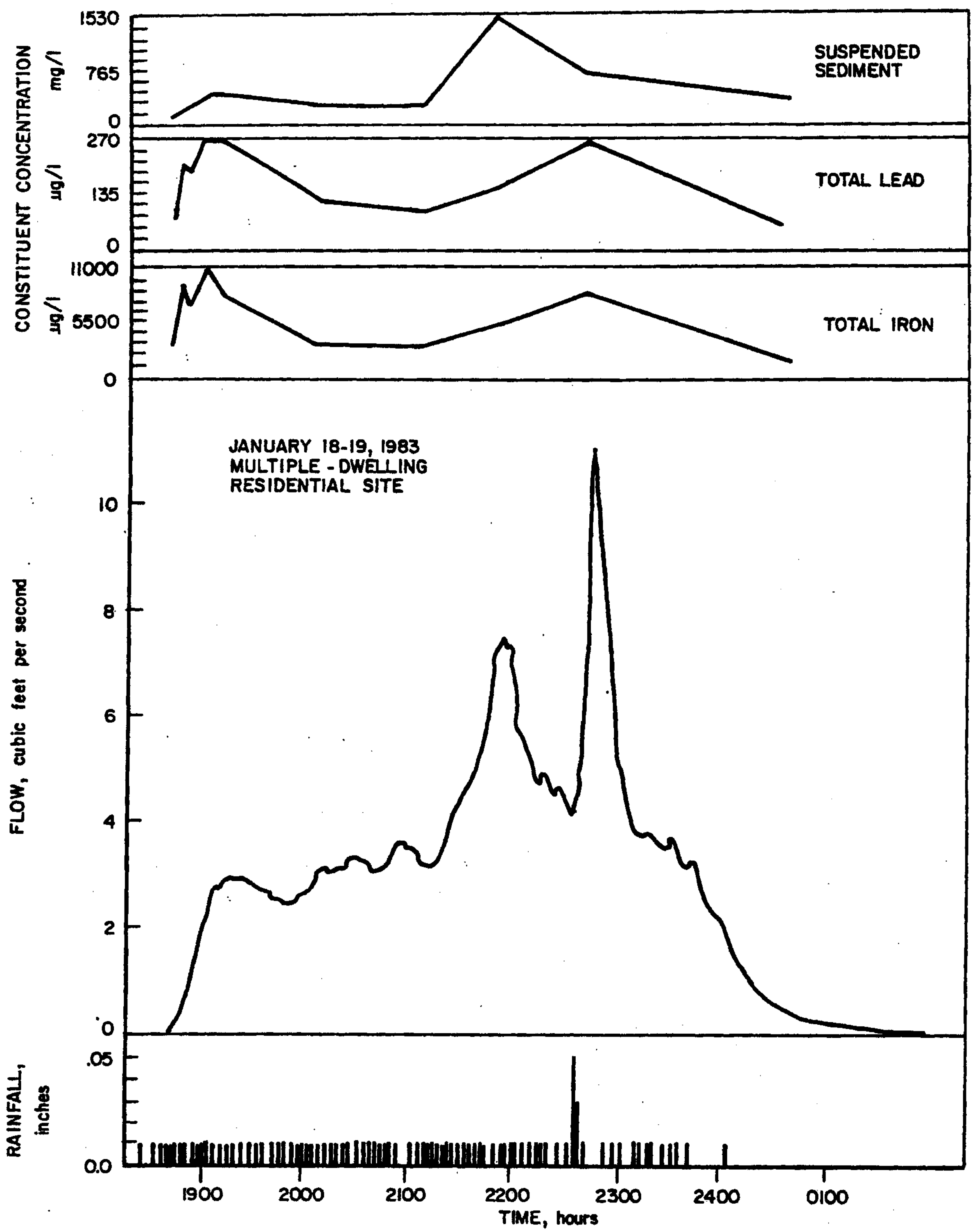


Figure 4-3 Water Quality Variations in Suspended Sediment and Metals During a Storm

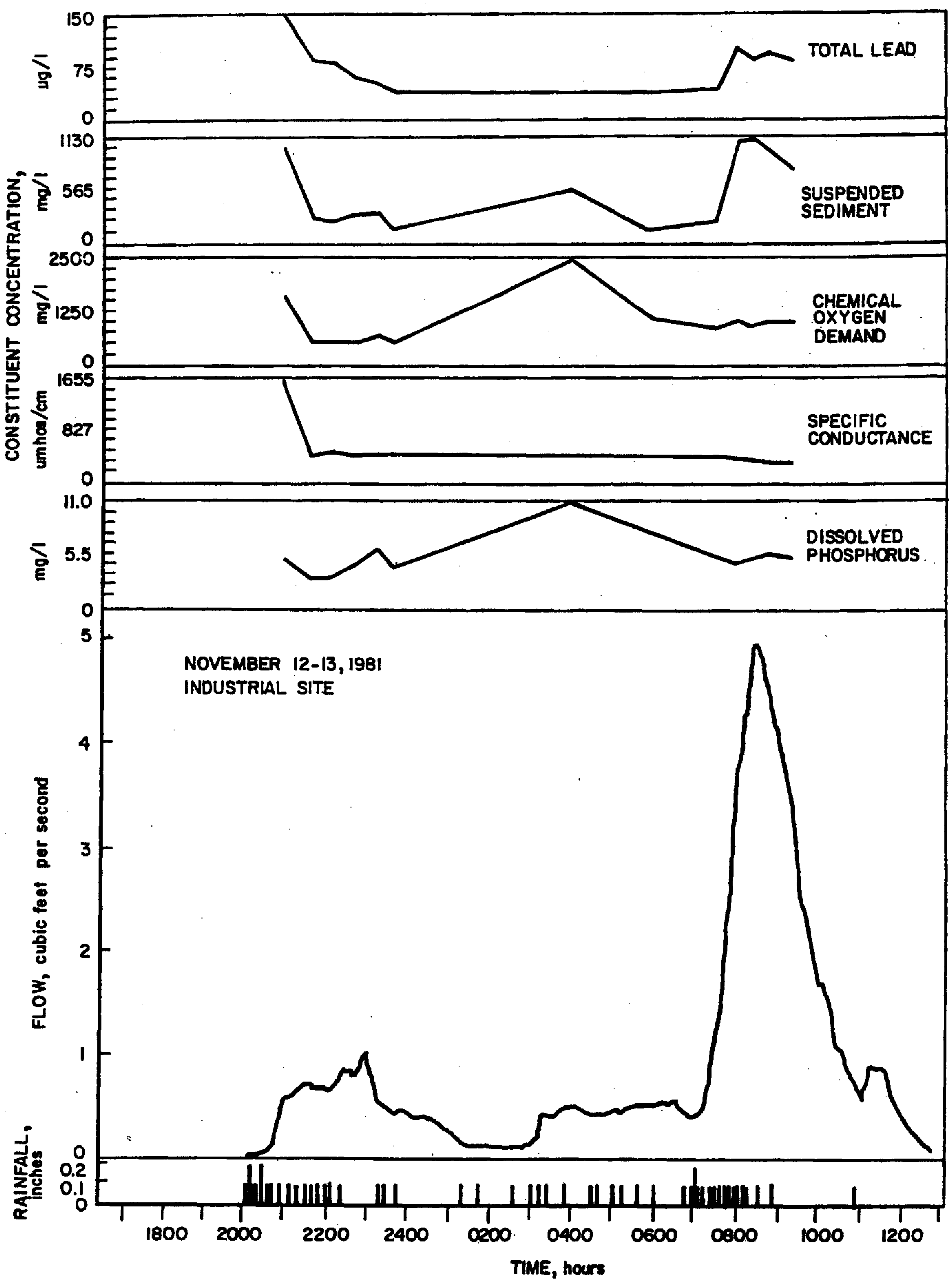
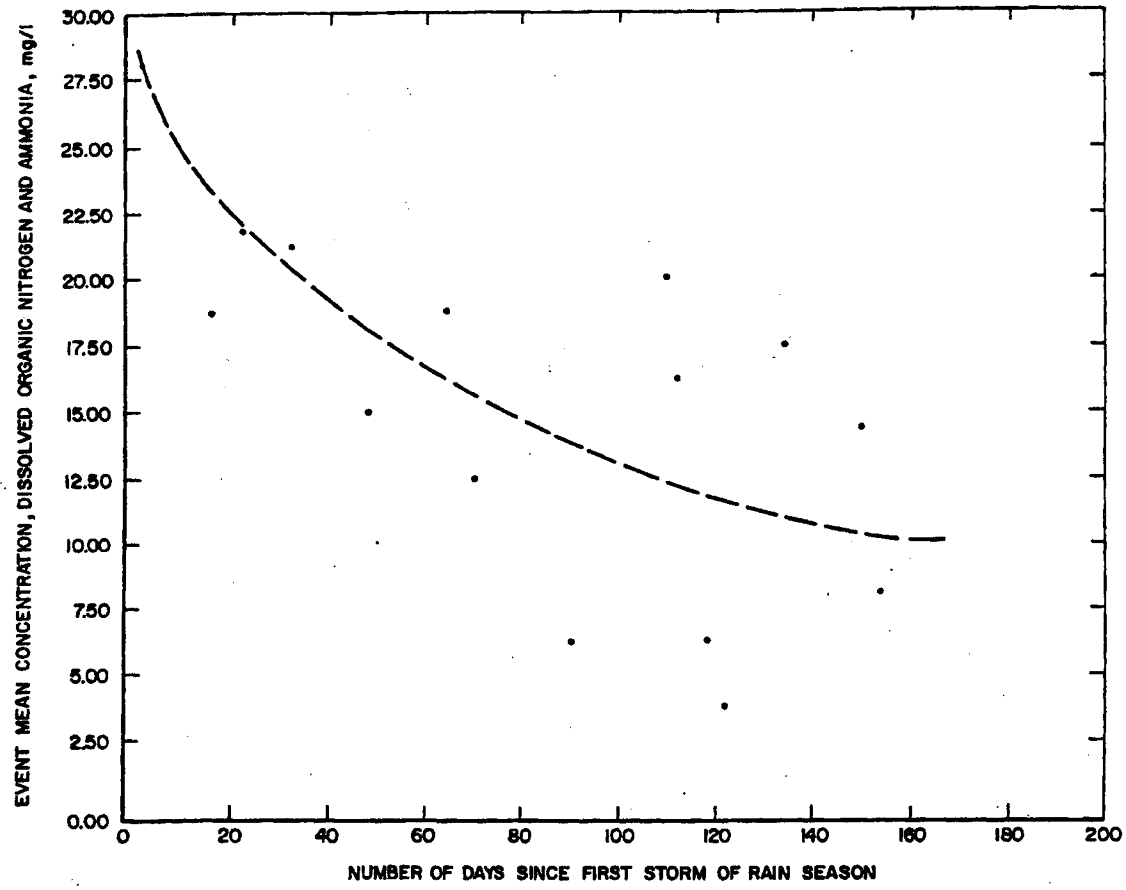


Figure 4-4 Water Quality Variations at the Industrial Site During a Storm



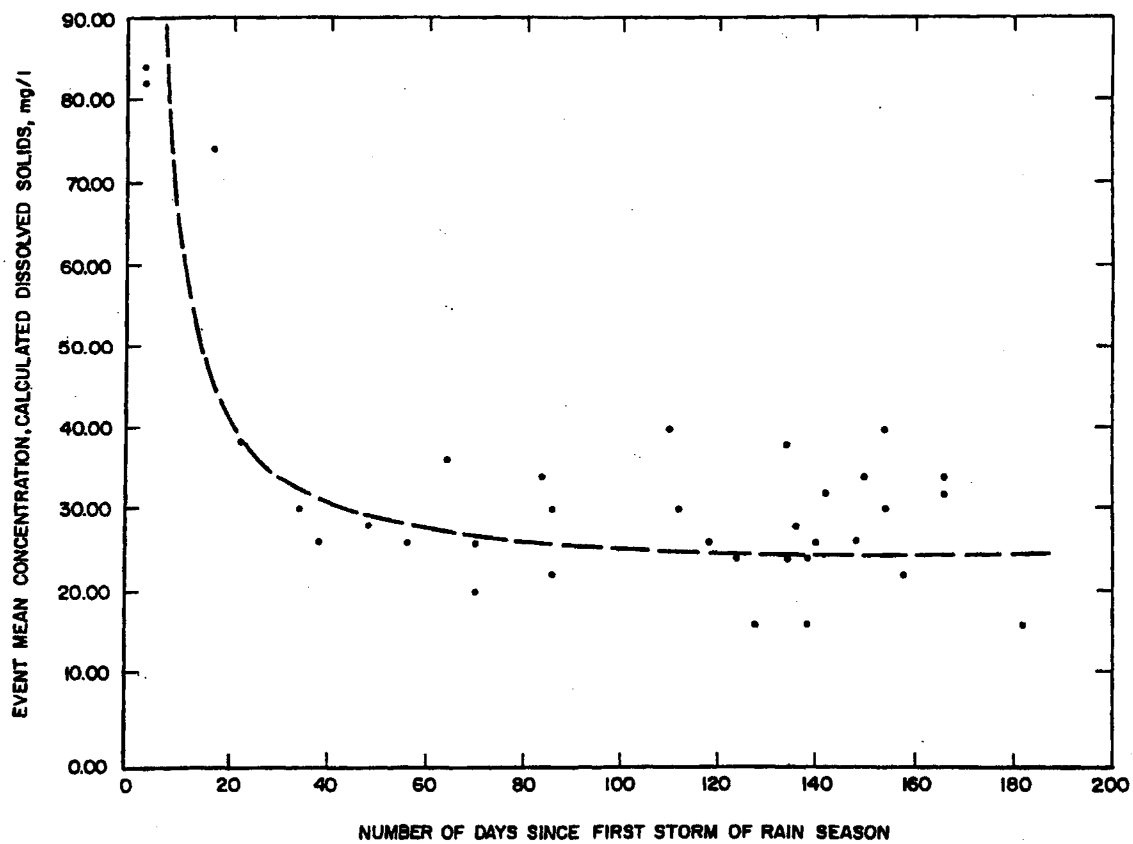
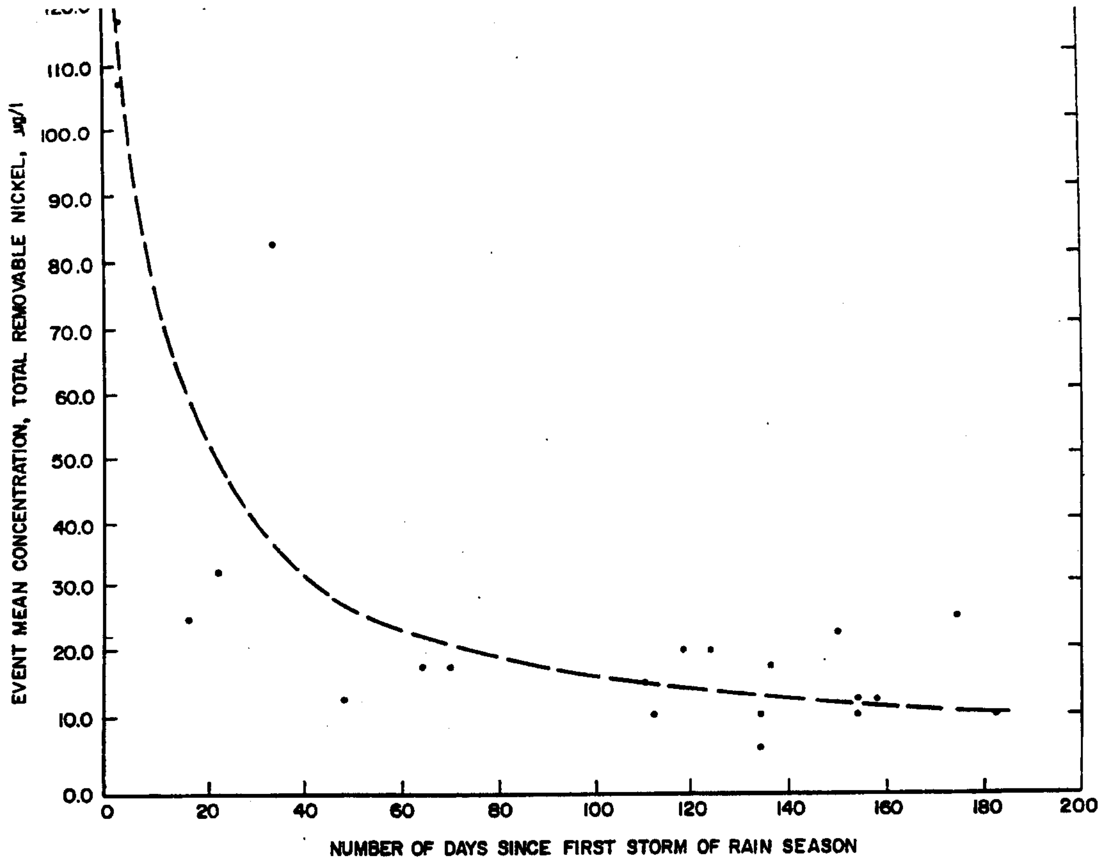


Figure 4-5 Relationships Between Event Mean Concentrations and Number of Days Since the First Storm of the Season



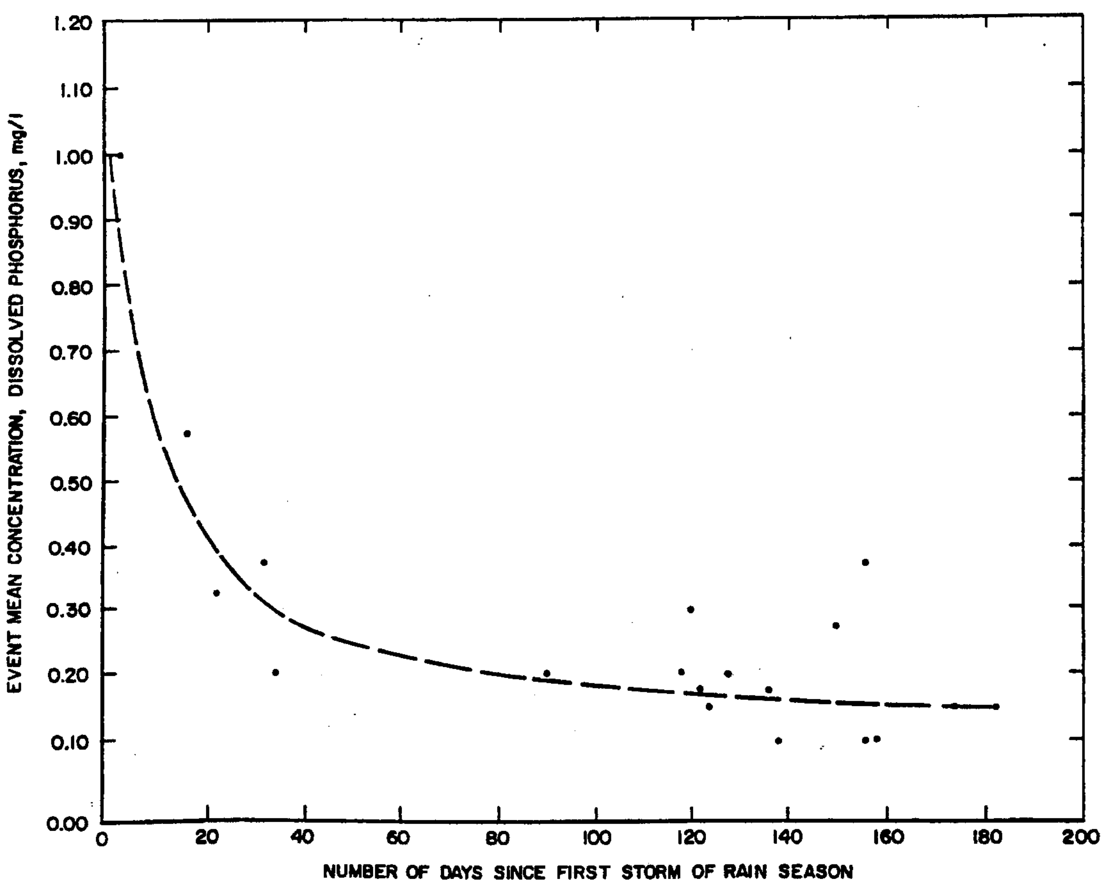


Figure 4-5 Relationships Between Event Mean Concentrations and Number of Days Since the First Storm of the Season (continued)

that at least two or three storms are necessary to wash off the pollutants that have accumulated in the drainage area throughout the dry months (usually May through September). Some constituent EMCs for the industrial catchment tend to decline uniformly throughout the entire rain season while other constituents showed no pattern at all. The constituent EMCs which did not show any pattern with the time since the first storm of the rain season at any of the land use types include dissolved and suspended organic carbon, total recoverable chromium, arsenic, and mercury. The remaining metal EMCs also did not show any pattern for the commercial and industrial catchments.

After this early rain season wash off, the EMC is influenced by the number of dry hours since the last storm and the storm runoff volume. Immediately after a storm, the drainage area begins accumulating atmospheric dry deposition along with vehicular deposition and other sources of constituents. Therefore, the longer the time since the last storm, the more material available to be washed off.

Upon wash off, the volume of runoff influences the constituent EMCs. If a small storm occurs and only washes off a part of the accumulated pollutants, the EMC will be higher than if a large storm occurs washing off all the available pollutants because of a greater degree of dilution. This is particularly true in the case of a highly impervious drainage area such as the commercial site where the pollutants are rapidly washed off, and as the storm progresses, the constituent concentrations approach the concentrations of the rain.

Annual Loads

Based on data collected by USGS, it was possible to determine the annual loads of several key constituents in rainfall and runoff. Key constituents are those constituents which were detected in soil or groundwater or are of concern in drinking water. The loads are based on a large amount of data collected during two wet seasons, 1981-82 and 1982-83. The rainfall during the 1981-82 season was 10.79 inches, which is 110 percent of normal. This rain season was not entirely normal since 40 percent of the rain fell in one month. The rainfall during the 1982-83 season was 23.56 inches, which is 240 percent of normal. The annual loads calculated for the 1981-82 season are, therefore, more representative of normal annual loads. The loads from dry deposition are based on less data and are not as accurate due to problems in gathering dry deposition data. It was not possible to calculate loads from street particulates. The methods used to calculate the loads are presented in this section. The loads are presented later in this chapter in the quasi mass balance section.

Rainfall. The annual loads of several key constituents in precipitation were calculated by determining the average EMC for each year at each site and then multiplying the EMC by the amount of rainfall in each year and by the drainage area of the single-family and industrial catchments. Since a single precipitation sample was collected over the duration of a storm, the concentration measured in this "composite" sample is considered the EMC for that storm. The average annual EMC is the mean of the individual storm EMCs. The loads of several constituents were calculated on a "flow-weighted" basis. The individual storm EMCs were weighted by the amount of precipitation that occurred. The flow-weighted loads were similar to the other loads.

Storm Runoff. The average EMC for each year was calculated to determine the annual loads from storm runoff. An EMC was calculated for each storm. For many storms, several discrete samples were collected and analyzed. For these storms, runoff loads were calculated and the EMC was determined by dividing the total storm load by the total storm runoff volume. During other storms, flow-weighted discrete samples were composited and analyzed as one sample. The EMC was equal to the concentration of that sample.

The annual runoff loads were calculated by determining the arithmetic average EMC for each year and multiplying it by the amount of precipitation, the drainage area of each land use catchment, and the flow-weighted runoff coefficients of each land use. The loads of several key constituents were calculated on a "flow-weighted" basis. The annual average EMC was calculated by weighting the individual storm EMCs by the amount of runoff that occurred in the storm. The arithmetic mean and flow-weighted loads are compared later in this chapter.

Dry Deposition. As discussed in the USGS report, it is extremely difficult to collect accurate dry deposition data. Extrapolating a limited amount of data collected at one site to the entire drainage area is questionable; however, it does allow a comparison of the dry deposition loads to the loads from other sources. The nutrient and metal loads are based on nine samples and the organic loads are based on one sample.

Street Particulate Material. It was not possible to calculate annual loads of constituents collected on street surfaces due to problems in collecting the data. According to USGS, the 20 to 25 curb-to-curb samples that were collected for each drainage area represent only about 0.1 percent of the street surface area in the drainage area. The multiple-dwelling residential and industrial drainage areas often had sand and silt deposits in the gutters due to erosion from adjacent slopes. When this material was accidentally collected along with the sample, it heavily influenced the results. Due to these types of problems, street particulate loads were not calculated.

Quasi-Mass Balance. To determine the relative contributions of rain and dry deposition to runoff, a mass balance of several key constituents was calculated. Table 4-21 presents the annual loads of several key constituents from runoff, precipitation, and dry deposition at the single-family residential and industrial sites. The average loads using both years of data are shown for the conventional constituents. Since less data were collected on the metals and organics, it was only possible to show the loads from 1982-83. The actual pollutant loads from precipitation were multiplied by the flow-weighted runoff coefficients for the single-family residential site and the industrial site, since these coefficients represent the proportion of rainfall that runs off the drainage area at the runoff sampling sites. The remaining rainfall and the associated pollutant load never reach the runoff sampling site. The following runoff coefficients were used:

Conventional constituents (1981-82 and 1982-83)	
Single-family residential	0.24
Industrial	0.23
Metals and organics (1982-83)	
Single-family residential	0.25
Industrial	0.23

There is no rigorous method for estimating the amount of dry deposition that ends up in runoff. The amount of dry deposition that is picked up by runoff and carried to a recharge basin is dependent on rain intensity and the scouring velocity of the runoff water, as well as the type of ground surface. For purposes of this balance, the runoff coefficients used to estimate the portion of rainfall that runs off the drainage area were also used for estimating the portion of dry deposition that ends up in runoff.

The pollutant loads from rainfall and dry deposition should be less than the pollutant loads in runoff. This is because there are other sources of these pollutants in the drainage area which could not be quantified. For example, cars contribute metals, particularly lead, to the drainage areas. Homeowners contribute pesticides to the drainage area when they spray lawns and gardens. Animal wastes and fertilizer contribute nutrients to the drainage areas. As shown in Table 4-21, the runoff loads of many constituents at

Table 4-21. Mass Balance of Contaminant Sources to Urban Runoff

	Loads, lbs/year per drainage area[a]							
	Single-family residential				Industrial			
Constituent	Rainfall[b]	Dry deposition[b]	Atmospheric total	Runoff	Rainfall[b]	Dry deposition[b]	Atmospheric total	Runoff
Dissolved nitrate + nitrite	19	160	180	86	63	170	230	600
Total phosphorus	1	9	10	78	23	87	110	1,700
Dissolved calcium	43	85	130	400	140	200	340	4,500
Dissolved chloride	43	53	96	160	130	150	280	44,000
Arsenic[c]	0.14	0.10	0.24	0.19	0.36	0.20	0.56	3.6
Chromium[c]	0.14	0.50	0.64	0.70	0.36	2.7	3.1	4.0
Copper[c]	0.48	3.0	3.5	1.1	2.9	6.9	9.8	17
Lead	1.1	9.1	10.2	21	3.9	10.4	14.3	21
Mercury[c]	0.014	0.018	0.032	0.13	0.045	0.037	0.082	0.20
Iron[c]	44	95	139	518	240	341	581	3,389
Manganese[c]	2.3	2.5	4.8	13	9.6	10.1	19.7	119
Chlordane[c]	0.014	0.002	0.016	0.019	0.039	0.004	0.043	0.037
DDT[c]	0.001	0	0.001	0.001	0.004	0	0.044	0.004
Diazinon[c]	0.011	0.0007	0.012	0.037	0.043	0.003	0.046	0.23

[a]The characteristics of the single-family residential and industrial drainage areas are presented in Table 4-1.

[b]The annual rainfall and dry deposition loads were multiplied by the flow-weighted runoff coefficients for the single-family residential site and the industrial site to correct for the amount of pollutants that never reach the runoff sampling sites.

[c]Loads for these constituents are based on 1982-83 data only. Loads for all other constituents are the average load for 1981-82 and 1982-83.

the single-family residential site and most constituents at the industrial site were considerably higher than the sum of rainfall and dry deposition loads, indicating a significant contribution from other sources. Over 50 percent of the load of total phosphorus, calcium, mercury, iron, manganese, and diazinon at the single-family residential and industrial sites is from other sources. In addition, over 50 percent of the nitrate-nitrite, chloride, and arsenic loads at the industrial site are from other sources. The majority of the atmospheric load of most constituents came from dry deposition. The majority of the arsenic, chlordane, DDT, and diazinon loads came from rainfall; however, only one dry deposition sample was analyzed for organics so it is difficult to compare these data.

Although the mass balance is not precise, it does give a good indication of the relative sources of several key constituents. The mass balance is fairly good considering the problems involved in collecting dry deposition data and the fact that street particulate loads could not be included in it.

Unit Runoff Load Factors. Unit runoff loads in pounds per acre per year (lbs/acre/year) were calculated for the key constituents at each land use site. Although unit loads were not calculated for rainfall and dry deposition, it is possible to calculate these loads from the data presented in Table 4-21. The unit loads presented in Table 4-22 are based on the 1981-82 runoff loads, since 1981-82 was closer to a normal rainfall year in Fresno than was 1982-83. Some of the unit loads presented in Table 4-22 differ from those presented in the USGS report because they were calculated differently. The unit loads in the USGS report were based on loads from both years of the project and excluded some of the fall storms.

In general, the highest unit load factors were found at the commercial site and the lowest were found at the single-family residential site. The runoff load factors for suspended solids ranged from 51 lbs/acre/year at the single-family residential site to 280 lbs/acre/year at the industrial site. The high suspended solids factors at the multiple-family residential and industrial sites are probably due to erosion from vacant land in these two drainage areas. The unit loads of major ions and nutrients were all lowest at the single-family residential site and highest at the commercial and industrial sites. The unit loads of major ions and nutrients were generally less than 10 lbs/acre/year at all sites. The unit loads of metals were generally less than 0.1 lb/acre/year at all sites. The lowest metal unit loads were generally found at the single-family residential site and the highest unit loads were found at the commercial site. The unit loads of organics were generally less than 0.001 lb/acre/year at all sites.

Table 4-22. Annual Loads of Key Constituents in Runoff

Constituent	Load, lbs/year											
	Single-family residential			Multiple-family residential			Commercial			Industrial		
	1981-82	1982-83	Mean	1981-82	1982-83	Mean	1981-82	1982-83	Mean	1981-82	1982-83	Mean
Suspended solids	4,900	23,000	14,000	9,500	94,000	52,000	7,700	160,000	84,000	77,000	211,000	144,000
Dissolved solids	3,500	7,400	5,500	3,500	23,000	13,000	5,800	85,000	45,000	41,000	249,000	145,000
Dissolved nitrate + nitrite	42	130	86	35	270	150	120	1,200	660	190	1,000	600
Total phosphorus	46	110	78	23	190	110	59	300	180	1,100	2,200	1,700
Dissolved calcium	230	560	400	310	1,600	960	670	8,000	4,300	1,900	7,000	4,500
Dissolved chloride	93	230	160	200	920	560	440	2,800	1,600	5,700	83,000	44,000
Arsenic	0.10	0.19	0.15	0.12	0.30	0.21	0.42	1.6	1.0	3.5	3.6	3.6
Chromium	0.48	0.70	0.59	0.71	1.7	1.2	1.5	4.1	2.8	3.7	4.0	3.9
Copper	1.2	1.1	1.2	1.2	1.8	1.5	2.0	5.2	3.6	12	17	15
Lead	8.8	33	21	8.9	30	19	16	89	53	13	29	21
Mercury	0.005	0.13	0.068	0.017	0.039	0.028	0.026	0.049	0.038	0.041	0.20	0.12
Iron	80	518	299	361	1,668	1,015	167	2,726	1,447	1,835	3,389	2,612
Manganese	-	13	-	-	39	-	-	87	-	-	119	-
Chlordane	0.008	0.019	0.014	0.006	0.048	0.027	0.017	0.040	0.029	0.016	0.037	0.027
DDT	0.0005	0.001	0.0008	0.0004	0.002	0.001	0.001	0.003	0.002	0.001	0.004	0.003
Diazinon	0.025	0.037	0.031	0.062	0.058	0.06	0.11	0.66	0.39	0.15	0.23	0.19

A sensitivity analysis was conducted to determine if unit loads calculated from an arithmetic average EMC differed from loads calculated from a flow-weighted EMC. The 1981-82 data were used since the amount of precipitation during that year was more normal than during 1982-83. The loads of lead, copper, iron, and arsenic were calculated with both methods. The flow-weighted loads were calculated from a flow-weighted EMC. The EMC was determined by weighting the individual storm EMCs by the amount of runoff that occurred during the storm. The EMCs and unit loads calculated with both methods are shown in Table 4-23. Most of the flow-weighted unit loads at the single-family residential and commercial sites are 10 to 20 percent lower than the arithmetic unit loads. The exceptions are arsenic and lead at the single-family residential site. The lower flow-weighted loads are due to the occurrence of one large storm that had low concentrations of metals.

When the loads are calculated on a flow-weighted basis, this method significantly reduces the unit load factors. The flow-weighted unit loads at the multiple-family residential and industrial sites were 10 to 20 percent higher than the arithmetic unit loads. There were two large storms that had high metals concentrations at these sites. When the loads are calculated on a flow-weighted basis, these storms increase the unit load factors.

Table 4-23. Comparison of Arithmetic and Flow-Weighted EMCs and Loads

Land use/constituent	Arithmetic basis		Flow-weighted basis	
	EMC, ug/l	Unit load, lbs/acre/yr	EMC, ug/l	Unit load, lbs/acre/yr
Single-family residential				
Lead	170	0.092	100	0.054
Copper	22	0.013	16	0.009
Iron	1,538	0.83	1,225	0.66
Arsenic	2.0	0.0010	2.1	0.0011
Multiple-family residential				
Lead	212	0.20	245	0.23
Copper	29	0.027	32	0.030
Iron	8,616	8.0	10,072	9.4
Arsenic	2.8	0.0027	3.1	0.0030
Commercial				
Lead	103	0.28	90	0.24
Copper	13	0.034	12	0.031
Iron	1,091	2.9	951	2.5
Arsenic	2.7	0.0072	2.1	0.0056
Industrial				
Lead	86	0.047	99	0.054
Copper	72	0.044	77	0.047
Iron	11,396	6.7	14,173	8.3
Arsenic	21	0.013	23	0.014

CHAPTER 5

SOILS AND GROUNDWATER MONITORING PROGRAM

To evaluate the effect of recharging urban storm runoff, the soils and groundwater underlying several recharge basins were monitored. This portion of the Fresno Nationwide Urban Runoff Program (NURP) project was conducted by the U.S. Department of Agriculture (USDA), Agricultural Research Service's Water Management Research Unit in Fresno, California. Data gathered by USDA are presented and analyzed in this chapter. A more detailed presentation and statistical analysis of the data are contained in the project report prepared by USDA.

DESCRIPTION OF MONITORING PROGRAM

The field program consisted of sampling of four major components: soils, soil water, groundwater, and plant tissue. The investigation was conducted at five of the District's recharge basins. Test basin locations are shown on Figure 4-1. The principal characteristics of these basins are listed in Table 5-1. Samples were analyzed for a wide range of constituents, including physical properties, minerals, metals, and organics. A complete list of the constituents measured in this portion of the program is presented in Appendix B Detailed descriptions of the sampling programs are contained in the USDA project report. The programs are briefly described in this section.

Table 5-1. Key Characteristics of USDA Test Basins

Characteristic	Basin name				
	F	G	M	EE	MM
Size, acres	6.0	8.5	9.0	10.0	8.5
Depth, feet	9.0	6.0 to 8.0	10.0	29.0	21.0
Drainage area, acres	475	403	620	2,314	895
Storage capacity, cubic feet	1,768,500	1,546,400	4,310,300	8,716,400	5,131,900
Vegetation	Fully turfed	Fully turfed	Fully turfed	Unturfed	Unturfed
Availability of canal water for artificial recharge	Yes	No	No	Yes	Yes
Completion year	1965	1962	1969	1977	1978

Soils

Initial soils samples were collected at all five sites during the summer of 1981. Samples were then collected in the spring of 1982 and 1983 after each wet weather season. In addition, the basins that receive summer irrigation water for recharge were sampled at the end of the irrigation season in both 1982 and 1983. The technique for collecting soils samples varied with depth. The surface soil layer was sampled at several depths to a maximum of 0.3 meter (m) with a hand core sampler. The soil layer from the surface to 3 m was sampled every 0.3 m with a bucket auger. The soil layer from 3.0 m to the top of the water table was core sampled (0.8m long core) every 1.5 m with a hollow-stem flight auger. Soil samples were also collected at "uncontaminated" control sites near each test basin to determine background conditions. About 1,550 soil samples were collected for analysis.

Soil Water and Groundwater

Obtaining a suitable (0.5 to 1.5 liter) sample of percolating runoff water in the unsaturated zone is difficult under the best of subsurface stratification conditions. Vacuum ceramic-Teflon soil water extractors were used in this project. Extractors were placed on top of a soil layer known to have a lower hydraulic conductivity than the soil just above that layer. This was done with the hope that soil water would be more available in these locations than elsewhere in the unsaturated zone. Soil water was collected at two or three depths in each basin. The very top zone of the water table or deep perched water table was sampled in each basin since, if runoff pollutants are moving downward, they should most easily be detected at the top of the water table. The volume of water extracted from the soil in the unsaturated zone was variable and depended on soil physical properties and availability of water resulting from the recharge taking place. Water samples were collected on a bimonthly basis between January and September 1982, and on a monthly basis between October 1982 and July 1983. A total of 334 water samples were collected for chemical analysis.

Plant Tissue

Plant tissue samples were collected to evaluate the uptake of certain metals by vegetation covering the surface of some of the basins. Two locations were sampled within each of the three turfed basins. One location was in a deeper portion of the basin where pollutants tend to accumulate. The second was above the high-water line in an area that should not be directly affected by runoff water. Four sets of plant tissue samples were collected during the two-year study producing a total of 61 samples.

RESULTS

A summary of the results of the soils and groundwater monitoring program is presented in this section. All of the data are not presented, since this report focuses on the constituents that are most important in terms of the potential contamination of the water supply and the potential for health hazards associated with recreational activities within the basins. A more complete presentation and discussion of the data are contained in the USDA project report.

Soils

Soils data results are divided into three groups: physical properties, metals, and organics.

Physical Properties. The soil texture (sand, silt, and clay content) and cation exchange capacity help define the stratigraphy of each basin in relation to its recharge potential. Soil texture and cation exchange capacity profiles are presented on Figure 5-1. The upper half of each figure is for the 0-to-30-centimeter (cm) soil samples and the bottom half is the 0-to-3 m bucket auger samples, plus the flight auger cores below 3 m. There are significant variations among recharge capabilities of the five basins:

1. Basin F--The first 3 m of the profile is sandy followed by a silt loam layer from about 3 to 10.5 m, then a loamy sand layer to 15 m, followed by a second silt loam layer to 19.5 m, then into sandy loam and first zone of water saturation. Basin F has a profile that is fairly good for recharge in spite of the two silt loam layers.

2. Basin G--The major clay layer extends from 7.5 to 13 m and silty layer from 13 to 18 m. The soil profile for Basin G has a poorer recharge potential compared to Basin F because of the higher clay content.

3. Basin M--There is a sandy loam layer extending from about 4 to 9 m, but below this the soils are loamy sands. The soil profile for Basin M has greater recharge potential than Basins F and G.

4. Basin EE--There is a very tight clay layer extending from 1 to 3 m below the basin floor, which has the highest cation exchange capacity of any of the five main basins sampled. Below the clay layer there are some sands, but at 4.5 m there is a second clayey layer. Below about 6 m, the silt content increased. The first zone of saturation encountered was at 10 m below the

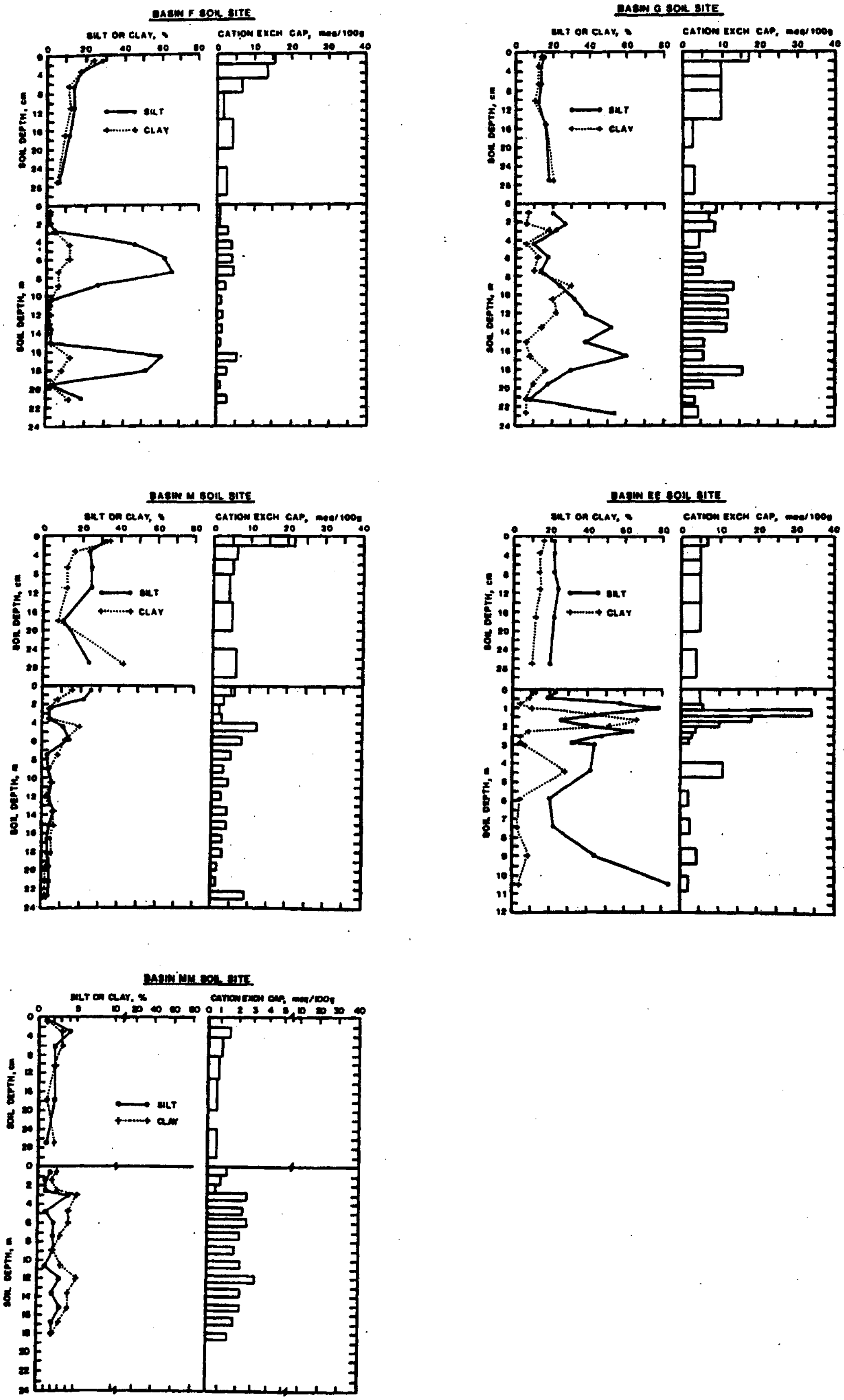


Figure 5-1 Silt, Clay, and Cation Exchange Capacity Profiles in Basin Soils

asin floor and is believed to be a perched water able. Basin EE has the poorest recharge potential of ny of the five basins.

asin MM--The entire soil profile is loamy sand to sands d consequently has the highest recharge potential of l the five basins.

. The metals of primary interest in this study were opper, and lead. Arsenic was also included in this oncentrations of these elements detected in the soil each test basin are listed in Table 5-2. The mean ion of each metal for each soil horizon are presented sed on three samplings: summer 1981, spring 1982, and 3. Concentrations decrease rapidly with depth. For the maximum lead concentration of 1,600 milligrams/ (mg/kg) was measured in the surface layer (0.00 to Basin M. However, within 0.14 m or about 6 inches, concentrations had decreased to 15 mg/kg or less. some differences among the metal concentrations ns. Concentrations tend to be highest in Basin M and Basin MM. Differences may be caused by several ncluding the type and amount of runoff received, soil s, and whether the basin receives summer recharge ome of these factors will be analyzed later in this d in Chapter 6.

esence of mercury in basin soils was investigated with samples from Basins G and EE, after mercury was in several runoff samples. Mercury was detected e upper 0.14 m of soil. The maximum concentrations ured at the surface (0.00 to 0.02 m) and were 0.07 0.10 mg/kg in Basins G and EE, respectively.

cs. Soils samples were regularly tested for numerous organic compounds, including chlorinated pesticides, sphorus pesticides, chlorophenoxy herbicides, and compounds. Specific constituents for which analyses ducted are listed in Appendix B. Several samples analyzed for semivolatile organics and purgeable y gas chromatography/mass spectrometry in accordance onmental Protection Agency (EPA) Methods 625 and 624. onstituents covered by these methods are also listed x B. Organics results are briefly described below.

lorinated pesticides--Only four of the chlorinated sticides were detected in at least one soil sample. e most prevalent compound was chlordane, which was

Table 5-2. Mean Concentrations of Arsenic, Nickel, Copper, and Lead in Basin Soils

Depth, m	Basin F Mean concentration, mg/kg				Basin G Mean concentration, mg/kg				Basin M Mean concentration, mg/kg			
	Arsenic	Nickel	Copper	Lead	Arsenic	Nickel	Copper	Lead	Arsenic	Nickel	Copper	Lead
0.00 to 0.02	20.0	32.0	37.0	713.0	7.4	37.0	25.0	487.0	31.0	53.0	55.0	1,333.0
0.02 to 0.05	16.0	26.0	27.0	370.0	9.9	37.0	19.0	467.0	5.8	20.0	16.0	283.0
0.05 to 0.08	10.0	16.0	9.2	73.0	8.8	37.0	15.0	184.0	6.7	14.0	11.0	37.0
0.08 to 0.14	7.8	15.0	7.3	27.0	7.2	33.0	16.0	39.0	6.1	13.0	8.7	22.0
0.14 to 0.20	4.4	15.0	5.2	17.0	4.3	29.0	15.0	26.0	4.3	13.0	7.4	7.2
0.24 to 0.30	2.3	9.1	3.8	13.0	6.3	30.0	9.5	7.5	6.9	16.0	8.1	10.0
0.30 to 0.60	2.3	7.3	5.3	3.6	7.2	71.0	11.0	9.1	10.0	19.0	8.3	9.1
0.90 to 1.20	1.5	8.0	4.5	2.8	9.2	37.0	14.0	5.2	6.4	16.0	9.5	4.6
1.50 to 1.80	1.4	6.0	4.8	2.4	3.0	22.0	12.0	4.0	6.7	17.0	7.6	4.6
2.10 to 2.40	1.7	6.8	5.3	2.8	3.5	18.0	7.8	4.3	4.9	13.0	7.6	3.7
2.70 to 3.00	1.7	5.7	2.1	2.8	10.0	87.0	21.0	5.3	2.2	9.1	6.5	2.4

Depth, m	Basin EE Mean concentration, mg/kg				Basin MM Mean concentration, mg/kg			
	Arsenic	Nickel	Copper	Lead	Arsenic	Nickel	Copper	Lead
0.00 to 0.02	4.8	22.0	25.0	297.0	4.5	11.0	9.5	93.0
0.02 to 0.05	6.4	16.0	20.0	250.0	3.5	8.6	5.8	34.0
0.05 to 0.08	4.7	13.0	15.0	160.0	1.8	5.4	2.0	12.0
0.08 to 0.14	3.6	11.0	7.7	87.0	2.4	6.6	1.9	4.5
0.14 to 0.20	4.1	9.8	5.8	11.0	2.3	6.2	1.4	2.5
0.24 to 0.30	2.2	10.0	6.7	3.4	2.3	4.2	1.8	1.7
0.30 to 0.60	11.0	11.0	5.6	4.8	2.1	6.0	2.1	4.3
0.90 to 1.20	7.6	11.0	8.6	5.4	1.9	4.9	1.5	1.9
1.50 to 1.80	11.0	14.0	17.0	7.2	1.2	4.3	1.8	2.1
2.10 to 2.40	4.7	10.0	6.2	3.0	2.9	6.6	2.7	2.0
2.70 to 3.00	3.1	10.0	5.5	2.2	2.9	7.3	3.0	1.9

consistently detected in all five basins. Table 5-3 indicates the concentration of chlordane found in the soil profile in 1981, 1982, and 1983. Chlordane was present in the highest concentrations in the surface soil of the older, turfed basins (F, G, and M). Maximum concentration detected was 2.7 mg/kg in Basins G and M in 1982. Concentrations rapidly decreased with depth and concentrations were generally less than detection limits within 24 cm (10 inches).

In addition, three other chlorinated organics were occasionally detected: lindane, DDT, and DDE. Table 5-4 lists the concentrations of these three compounds for samples when they were detected. Lindane was detected only in Basin F at concentrations between 0.01 and 0.02 mg/kg in a total of five samples, which were near the surface. DDT was detected at the surface in four of the five basins in a total of seven samples. DDE was detected in three of five basins in a total of ten samples. The maximum penetration of any of these three chlorinated organics was 0.20 m (8 inches).

2. Organophosphorus pesticides--The organophosphorus pesticides searched for in selected soil depth intervals from the surface to the first zone of saturation were: diazinon, ethion, malathion, methylparathion, and parathion. None of these pesticides were detected in any of the soil samples. Detection limit for these constituents was 0.003 mg/kg (or three parts per billion).

3. 2,4-D--Soil samples collected in 1982 were analyzed for the herbicide 2,4-D. The herbicide was not detected in any of the samples. Detection limit was 0.02 mg/kg.

4. Phenolic compounds--Total phenol was detected in the surface soils in several samples. Total phenol was detected in all five basins. The maximum concentration encountered was 0.17 mg/kg in Basin MM. Phenol concentrations decreased with depth and below 1.5 m concentrations were less than the detection limit of 0.005 mg/kg, except for Basin MM. Phenol was detected in sandy Basin MM down to 3 m. Specific phenols searched for were: pentachlorophenol, 2,4-dimethylphenol, 4-nitrophenol. These compounds were not detected in any of the soil samples.

5. Semivolatile and purgeable priority pollutants--Several samples were analyzed for the semivolatile and purgeable priority pollutants in accordance with EPA methods 625 and 624. These tests covered over 110 individual organic compounds. A complete listing of these

Table 5-3. Chlordane Concentrations in Basin Soil Samples

Sampling year	Soil depth, m	Concentration, mg/kg				
		Basin F	Basin G	Basin M	Basin EE	Basin MM
1981	0.00-0.02	1.30	0.22	2.00	0.76	<0.03
	0.02-0.05	0.80	0.16	0.66	1.10	<0.03
	0.05-0.08	0.04	<0.03	0.05	0.74	<0.03
	0.08-0.14	<0.03	<0.03	<0.03	1.20	<0.03
	0.14-0.20	<0.03	0.51	<0.03	<0.03	<0.03
	0.24-0.30	<0.03	<0.03	<0.03	<0.03	<0.03
	0.30-0.60	<0.03	<0.03	<0.03	<0.03	0.04
	0.60-0.90	<0.03	<0.03	<0.03	<0.03	<0.03
	0.90-SZ[a]	<0.03	<0.03	<0.03	<0.03	<0.03
1982	0.00-0.02	1.10	2.70	2.70	0.07	0.63
	0.02-0.05	1.10	2.40	0.27	0.67	0.08
	0.05-0.08	0.11	0.47	0.03	0.63	<0.03
	0.08-0.14	0.07	0.08	<0.03	0.28	<0.03
	0.14-0.20	<0.03	0.04	<0.03	<0.03	<0.03
	0.24-0.30	<0.03	<0.03	<0.03	<0.03	<0.03
	0.30-SZ[a]	<0.03	<0.03	<0.03	<0.03	<0.03
1983	0.00-0.02	1.40	1.50	<0.13	<0.13	<0.13
	0.02-0.05	0.94	1.80	<0.13	<0.13	<0.13
	0.05-0.08	0.14	0.90	<0.13	<0.13	<0.13
	0.08-0.14	0.067	<0.13	<0.13	<0.13	<0.13
	0.14-0.20	0.061	<0.13	<0.13	<0.13	<0.13
	0.24-0.30	<0.03	<0.13	<0.13	<0.13	<0.13
	0.30-SZ[a]	<0.03	<0.13	<0.13	<0.13	<0.13

[a]First "Saturated Zone"

Table 5-4. Lindane, DDT, and DDE Concentrations in Basin Soil Samples

Constituent	Date	Concentration, mg/kg	Basin	Depth, m
Lindane (Gamma BHC)	6-24-81	0.02	F	0.00-0.02
	6-22-81	0.01	F	0.00-0.02
	6-22-81	0.01	F	0.02-0.05
	6-22-81	0.02	F	0.05-0.08
	6-22-81	0.01	F	0.08-0.14
DDT	6-8-82	0.47	G	0.00-0.02
	6-8-82	0.48	G	0.02-0.05
	6-8-82	0.10	G	0.05-0.08
	6-16-82	0.46	M	0.00-0.02
	6-16-82	0.05	M	0.02-0.05
	5-26-82	0.06	EE	0.00-0.02
	5-5-82	0.06	MM	0.00-0.02
DDE	6-10-81	0.04	G	0.00-0.30
	6-8-81	0.03	G	0.02-0.05
	6-8-81	0.03	G	0.14-0.20
	6-8-82	0.05	G	0.00-0.02
	6-8-82	0.06	G	0.02-0.05
	6-8-82	0.02	G	0.05-0.08
	6-17-81	0.02	M	0.00-0.02
	6-16-82	0.04	M	0.00-0.02
	7-31-81	0.01	EE	0.02-0.05
	7-31-81	0.01	EE	0.05-0.08

Note: Concentrations of these three constituents were less than detection limits in all other soil samples.

compounds and their detection limits are included in Appendix B. None of the semivolatile organics were detected in any of the samples. Two of the purgeable organics were detected in one sample (5 to 8 cm depth) in Basin F--toluene at 0.007 mg/kg and methyl cyclohexane at 0.0005 mg/kg. None of the other purgeable organics were detected in any of the samples.

6. Polychlorinated biphenyl (PCB)--PCB was not included in the regular analytical program. However, in the process of running other organics tests, PCB was detected. Thus, several other samples were tested for PCB. Aroclor 1260 was detected in four of eleven samples. Aroclors 1016 through 1262 were not detected. Detection limit for PCB was 0.10 mg/kg. Aroclor 1260 results are listed in Table 5-5.

Table 5-5. Concentrations of Polychlorinated Biphenyl (Aroclor 1260) in soils

	Concentration, mg/kg		
Depth, cm	Basin F	Basin M	Basin MM
0-2	0.18	0.43	ND[a]
2-5	0.22	ND[a]	ND[a]
5-8	0.13	ND[a]	ND[a]
8-14	ND[a]	—	ND[a]

[a]ND = Not detected.

Groundwater

Groundwater data results are divided into three groups: cations and anions, metals, and organics.

Cations and Anions. Soil water and groundwater samples were analyzed for electrical conductivity, cations, and anions to define general mineral quality. These results are summarized in Table 5-6 for samples collected in 1982 and 1983. Soil water samples include all samples collected in the unsaturated zone. There were two or three different sampling depths locations in the unsaturated zone. The groundwater samples were collected at the top of the zone of saturation.

Table 5-6. Concentration of Selected Cations and Anions in Soil Water and Groundwater

		Basin P			Basin G			Basin M			Basin EE			Basin MM		
Constituent[a]	Location	N[b]	Range	Mean	N	Range	Mean	N	Range	Mean	N	Range	Mean	N	Range	Mean
Electrical conductivity	SW[c]	28	54-260	115	2	119-541	330	9	112-294	170	25	46-209	120	13	37-80	52.5
	GW[d]	18	85-377	153	16	595-843	744	12	82-180	109	14	122-246	175	8	37-89	61
Calcium	SW	24	3.7-26.7	9.4	2	8-38	23	8	11-37	18.4	23	3.8-22	11	12	3.0-7.1	4.6
	GW	18	5.9-27	11.1	16	42-64	55	12	5.1-13	8.3	14	8.7-23	15	8	2.8-8	4.5
Magnesium	SW	24	1.0-6.6	3.1	2	3-141	72	8	3.9-7.2	5.5	23	0.45-11	4.2	12	0.76-1.7	1.2
	GW	18	2.5-12	4.7	16	23-45	36	12	2.6-6.3	3.9	14	5.1-12	8.1	8	0.85-3.1	1.9
Sodium	SW	24	2.3-16.6	7.5	2	14.5-70	42	8	5.3-13	8.5	23	2.2-9.2	5.4	12	1.8-4.9	2.6
	GW	18	6.3-17	9.4	16	45-80	55	12	4.9-11	7.2	14	4.7-11	7.4	8	2.4-5.6	3.3
Potassium	SW	24	1.4-4.7	2.4	2	1.2-2.1	1.7	8	2-3.2	2.5	23	1.7-3.8	2.6	12	0.35-1.5	1.1
	GW	18	1.8-4.1	2.4	16	7.4-13	11	12	1.8-3.6	2.4	14	1.7-2.6	2.3	8	1.1-2.4	1.7
Bicarbonate	SW	13	34-131	57	2	34.2-54	44.1	6	84-171	105	20	4-149	67.2	11	16-39	26
	GW	17	37-64	52	13	293-414	356	11	35-104	58	13	64-128	94	7	18-41	29
Sulfate	SW	16	1.6-14.6	5.2	2	5.6-7.2	6.4	6	3.2-14	5.9	20	1-19	4.9	12	0.9-3.3	2.4
	GW	17	2.7-13.8	5.3	14	4-51	36	11	1.3-6.9	4.1	13	1.1-7.1	3.6	7	1.8-4.4	3.1
Chloride	SW	18	1.42-18	6.6	2	1.6-17	9.3	6	0.9-6.1	4.1	20	0.64-10	3.6	12	0.38-5.7	3.6
	GW	17	3.4-53.9	13	16	18-36	28	11	0.89-4.7	2.7	13	1.3-7.3	4.1	7	0.62-4.3	2.7
Nitrate as N	SW	20	0.05-5.9	1.1	2	0.25-0.75	0.50	6	0.12-1.8	1.0	21	0.11-1.8	0.80	11	0.08-0.98	0.26
	GW	17	0.69-13.2	2.8	15	0.83-11	5.6	11	0.11-2.2	0.45	14	0.10-2.6	1.1	7	0.07-1.3	0.44
Phosphate as P	SW	12	0.101-0.20	0.15	2	0.078-0.11	0.094	6	0.173-0.258	0.19	20	0.04-0.202	1.12	9	0.04-0.36	0.15
	GW	13	0.068-0.56	0.174	10	0.026-0.271	0.075	8	0.082-0.40	0.165	11	0.039-0.30	0.126	6	0.02-0.248	0.177

[a]Concentrations are in mg/l, except electrical conductivity which is in umho/cm.
[b]N = Number of samples.
[c]SW = Soil water.
[d]GW = Groundwater.

In comparing the results for the five basins, it is clear that Basin G samples have higher concentrations of most constituents than the other four basins. The area where Basin G is located was previously unsewered and septic tanks and leach pits were used for sewage disposal. This area has been known to have high nitrate concentrations. Table 5-6 indicates that the mean concentration of nitrate in the groundwater samples was 5.6 milligrams per liter (mg/l). Water samples collected beneath Basin MM, the basin with the sandy profile and best permeability, consistently had the lowest mineral concentrations.

Metals. Water samples were regularly analyzed for arsenic and the heavy metals nickel, copper, iron, and lead. Several water samples were tested for the other priority pollutant metals. Detection limits varied because of varying sample size (see Appendix B for detection limits). Results for arsenic, nickel, copper, iron, and lead are summarized in Table 5-7 and described below.

Table 5-7. Range and Median Concentration of Metals in Soil Water and Groundwater

Constituent[a]	Location	Basin F			Basin G			Basin M			Basin EE			Basin MM		
		N[b]	Range	Median	N	Range	Median	N	Range	Median	N	Range	Median	N	Range	Median
Arsenic	SW[c]	22	<1-4	<1	0	—	—	3	<1-5	<1	22	<1-4	<1	10	<1-5	<1
	GW[d]	14	<1-6	<1	15	<1-9	<1	10	<1-8	<1	12	<1-10	<1	6	<1-2	<1
Nickel	SW	22	<1	<1	0	—	—	3	<1	<1	22	<1-11	<1	10	<1-2	<1
	GW	14	<1-1	<1	15	<1	<1	10	<1-1	<1	12	<1	<1	6	<1-1	<1
Copper	SW	16	<1-81	6.4	0	—	—	1	—	42	17	0.1-30	7.9	8	0.5-60	18
	GW	12	<1-16	3.0	12	1.3-75	20	8	0.2-23	2.8	8	0.2-11	2.0	5	2.1-21	3
Iron	SW	16	<1-15	4.0	0	—	—	1	—	<6	17	<1-60	6.5	8	<1-11	3.5
	GW	12	<1-19	3.5	12	<1-21	4	8	<1-9	4.5	8	<1-15	7.0	5	<1-7	1
Lead	SW	16	<1-6	<1	0	—	—	1	—	<2	17	<1-3	<1	8	<1-4	2
	GW	12	<1-1	<1	12	<1-2	<1	8	<1-6	<1	8	<1-2	<1	5	<1	<1

[a] = Concentrations are in ug/l.
[b]N = Number of samples.
[c]SW = Soil water.
[d]GW = Groundwater.

1. Arsenic--Median concentrations of arsenic in both soil water and groundwater were less than detection limits in all basins. The maximum concentration measured was 10 micrograms per liter (ug/l).

2. Nickel--Median concentrations of nickel in both soil water and groundwater were less than detection limits in all basins. Whenever nickel was detected, it was only measured at a concentration of 1 or 2 ug/l.

3. Copper--Copper was detected in most all samples. The highest median concentration in the groundwater was 20 ug/l in Basin G. Median concentrations in the groundwater in the other four basins were 3 ug/l or less.

4. Iron--Iron was also detected in most samples. Highest concentrations were found in Basin EE, while the lowest concentrations were found in Basin MM.

5. Lead--Median concentrations of lead in both soil water and groundwater were less than detection limits in all basins except Basin MM. The median concentration of lead in the soil water in Basin MM was 2 ug/l, only slightly above the detection limit. The lead concentration never exceeded 6 ug/l.

Several water samples were tested for the nine priority pollutant metals not included in the regular testing program. Results are contained in Table 5-8. Antimony, beryllium, cadmium, selenium, silver, and thallium were not detected. Chromium was detected in most samples at a concentration of 0.5 ug/l or less. Mercury was detected in five of eight samples, with the highest concentration being 1.0 ug/l in the groundwater at Basin G. The source of the mercury is unknown, although it was also detected in the runoff samples from all four land use types. Zinc, common to nearly all alluvium, was detected in at least one sample from each basin. The maximum zinc concentration was 90 ug/l in a soil water sample in Basin MM.

Table 5-8. Concentration of Priority Pollutant Metals in Soil Water and Groundwater

	Concentration, ug/l							
	Basin F				Basin G	Basin M	Basin MM	
Constituent	SW1a	SW2	SW3	GWb	GW	GW	SW2	GW
Antimony	<1	<1	<1	<1	<1	<1	<1	<1
Beryllium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	<1	<1	<1	<1	<1	<1	<1	<1
Chromium	<0.1	0.5	0.3	0.5	0.3	0.3	0.4	0.1
Mercury	<0.2	0.2	0.2	0.2	1.0	<0.2	<0.2	0.4
Selenium	<1	<1	<1	<1	<1	<1	<1	<1
Silver	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Thallium	<1	<1	<1	<1	<1	<1	<1	<1
Zinc	<10	<10	10	<10	20	20	90	20

[a]SW = Soil water. Samples were collected at one or more locations in the unsaturated zone.

[b]GW = Groundwater. Samples were collected at the top of the water table.

<u>Organics</u>. Water samples were regularly analyzed for chlorinated pesticides, organophosphorus pesticides, chlorophenoxy herbicides, and phenolic compounds. Specific constituents for which analyses were conducted are listed in Appendix B. Two water samples from Basins F and G were also tested for semivolatile organics using EPA Method 625. It was not possible to analyze for the purgeable priority pollutants, since water samples are collected by vacuum. Detection limits for the organics are listed in Appendix B and vary with the size of the available water sample. Results of the testing for organics are described below.

1. Chlorinated pesticides--None of the ten chlorinated pesticides were detected. Detection limits ranged from 0.02 to 1.4 ug/l.

2. Organophosphorus pesticides--Diazinon was the only organophosphorus pesticide detected. It was detected in three soil water samples (once in Basin F and twice in Basin EE) at a concentration of 0.3 ug/l or less. None of the other organophosphorus pesticides were detected. Detection limits ranged from 0.02 to 1.0 ug/l.

3. 2,4,-D--The chlorophenoxy herbicide 2,4-D was not detected in any water sample. The detection limit ranged from 0.25 to 2.2 ug/l.

4. Phenolic compounds--In all samples, total phenols and the specific phenols (pentachlorophenol; 2,4-dinitrophenol; and 4 nitrophenol) were less than the detection limit of 25 ug/l.

5. Semivolatile organics--None of the 59 semivolatile organics covered by EPA Method 625 were detected. Detection limits for most of the constituents were between 10 and 25 ug/l.

<u>Plant Tissue</u>

It was believed that the presence of metals in the surface 30 cm of soil might be reflected in the uptake of these metals by grasses present in the turfed basins. Thus, sets of leaf samples of bermudagrass, dallisgrass, and crabgrass were collected from each of the three turfed basins in 1981, 1982, and 1983. These samples were analyzed for arsenic, nickel, copper, and lead. Mean concentration of these constituents are presented in Table 5-9 for samples collected from the three test basins and nearby control sites.

Although the amount of plant tissue data collected was limited, some general trends are apparent. The data indicated that for bermudagrass and dallisgrass, the range of increase in nickel content was from 0 to 125 percent of that observed in leaves from the control sites. Copper increased from 20 to 90 percent in the turfed basins. Lead showed the greatest increases, which ranged from 110 to 1,300 percent, excluding crabgrass because of only one sample. These results indicate that these plants do take up nickel, copper, and lead that are present in the turfed basins. Statistical tests performed by USDA indicated that the correlation between lead content of grass leaves and lead content of soil is positive but low. Poor correlation is likely due to the fact that the root-density distribution with depth is not the same as for the soil lead distribution with depth, especially for bermudagrass which is deep-rooted. Crabgrass, which is shallow-rooted, could take up more lead, but it grows best near sprinkler heads where excess leaching would be expected.

Table 5-9. Mean Concentration of Metals in Plant Tissue

Sample location	Constituent	Concentration, mg/kg								
		Bermudagrass			Crabgrass			Dallasgrass		
		N	CSS[a]	BSS[b]	N	CSS	BSS	N	CSS	BSS
Basin F	Arsenic	5	<0.1	<0.1	1	<0.1	<0.03	4	<0.2	<0.1
	Nickel	5	2.6	3.5	1	2.9	5.9	4	3.6	8.1
	Copper	5	9.3	11.0	1	13.0	31.0	4	8.8	17.0
	Lead	5	0.31	5.5	1	0.69	14.0	4	1.4	3.0
Basin G	Arsenic	5	<0.2	<0.02	2	<0.3	<0.3	3	<0.2	<0.2
	Nickel	5	4.2	5.4	2	2.5	4.4	3	7.0	6.6
	Copper	5	8.9	13.0	2	7.1	12.0	3	15.0	15.0
	Lead	5	2.1	15.0	2	0.43	1.4	3	1.5	8.0
Basin M	Arsenic	5	<0.1	<0.1	1	<0.1	<0.1	4	<0.1	<0.1
	Nickel	5	2.8	4.6	1	2.1	8.7	4	4.7	6.2
	Copper	5	9.0	13.0	1	15.0	14.0	4	12.0	18.0
	Lead	5	1.3	18.0	1	0.97	6.2	4	1.5	15.0

[a]CSS = Control sampling site.
[b]BSS = Basin sampling site.

ANALYSIS

In this section, the results presented in the previous section are analyzed to determine the effect of various factors on the recharge of stormwater runoff and summer recharge water. The analysis is divided into two main parts: soil profiles and water quality data. In addition, a final section is included that summarizes the mechanisms affecting movement of contaminants in soils.

Soil Profile Comparisons

The following aspects of the soil profile data have been evaluated.

1. Basin samples versus control samples.

2. Effects of storm recharge.

3. Effects of recharge with imported irrigation canal water.

4. Turfed versus unturfed basins and variation with soil type.

5. Spatial distribution of contaminant concentrations.

Basin Samples Versus Control Samples. Comparison of results from basin soil samples and control soil samples is one indicator of the effect of recharge on the soil profile. USDA analyzed the chemical data to determine if the differences between test sites and control sites can be statistically established. By dividing the data into upper soil profile (0 to 3 m) and deeper soil profile (greater than 3 m), it was also possible to evaluate leaching effects. A summary of the USDA statistical analyses is contained in Table 5-10. In this case differences are assumed to be statistically significant if the confidence coefficient is 90 percent or greater.

These statistical results show that runoff water has leached the basin soils to some degree in all five basins. In all basins except Basin G, the electrical conductivity and most of the soluble cations are lower at the test site than in the control. In the deeper soils in Basin F some of the cations are higher in the test basin than in the controls, indicating movement from the surface soils to the deeper soils. The most intensive leaching has occurred in Basin MM, which has a very sandy profile and the greatest permeability.

The concentrations of metals in the basin test site soils have been compared with concentrations in the control test sites. To facilitate the comparison, a background concentration for each metal has been calculated. All of the data collected at the control sites at depths greater then 3 m were used to determine the background concentration, which is assumed to be free of urban runoff pollutants. The median background concentrations of arsenic ranged from 1.7 to 5.9 mg/kg with an overall median of 2.7 mg/kg. Nickel ranged from 5.9 to 25 mg/kg with an overall median of 12.0 mg/kg. Copper ranged from 4.3 to 15 mg/kg with an overall median of 10.0 mg/kg. Lead ranged from 2.0 to 4.9 mg/kg with an overall median of 3.4 mg/kg. A comparison of lead concentration in the test sites with the median background level of 3.4 mg/kg is provided in Table 5-11. Both the maximum and median levels of lead are shown and are expressed as a percentage of the background concentration. In all five basins the median concentrations of lead are greater

Table 5-10. Differences Between Control Soil Sites (CSS) and Basin Soil Sites (BSS) for Selected Chemical Properties

Constituent	Basin F		Basin G		Basin M		Basin EE		Basin MM	
	0-3 m	>3 m	0-3 m	>3 m	0-3 m	>3m	0-3 m	>3 m	0-3 m	>3m
Soluble sodium	-	+		+	-	-	-	-	-	-
Soluble potassium				-		-	-			-
Soluble calcium		+			-	-	-		-	-
Soluble magnesium	-			-	-	-	-		-	-
Exchangeable sodium percentage	+		+							+
Exchangeable potassium percentage	+	+			-	+			+	+
Exchangeable calcium percentage		+	-	+		-			+	+
Exchangeable magenesium percentage	-	-	+			+			-	-
Nitrate nitrogen			+	-		-		-	-	-
Phosphate	-				+		-		-	
Electrical conductivity	-	+			-	-	-	-	-	-
pH				+		-			+	
Soluble chloride		+			-	-		-	-	-
Cation exchange capacity	-	-							-	-

Key: m = meters.
+ indicates BSS mean is greater than CSS mean at 90 percent confidence level.
- indicates CSS mean is greater than BSS mean at 90 percent confidence level.
Blank = No statistically significant difference at 90 percent confidence level.

Table 5-11. Soil Lead Concentration with Depth Expressed as a Percentage of Soil Background Concentration

Soil depth, meters	Concentration as percent of background level[a]									
	Basin F		Basin G		Basin M		Basin EE		Basin MM	
	Maximum level	Median level	Maximum level	Median level	Maximum level	Median level	Maximum level	Median level	Maximum level	Median level
0.00-0.02	24,118	19,706	19,188	16,764	47,059	41,176	10,294	9,118	4,118	3,824
0.02-0.05	14,412	10,588	18,529	17,941	12,059	9,412	10,882	7,941	1,059	971
0.05-0.08	2,529	2,382	8,824	6,471	1,706	1,029	5,882	5,000	706	244
0.08-0.14	1,088	912	2,118	1,147	1,235	471	3,235	2,559	253	88
0.14-0.20	599	500	1,147	853	294	232	500	353	94	88
0.24-0.30	824	179	268	238	441	294	112	100	53	38
0.30-0.60	135	126	382	232	382	229	165	141	232	91
0.90-1.20	112	79	215	150	197	106	206	147	65	44
1.50-1.80	88	62	179	115	197	115	353	147	97	26
2.10-2.40	94	91	215	100	138	126	150	59	68	59
2.70-3.00	106	82	262	126	91	71	88	59	59	50

[a]Background concentration of lead is 3.4 mg/kg soil.

than the background level to a depth of about 3 m. Below 3 m, the median concentrations decrease to background levels. The highest lead concentrations were found in Basin M and the lowest were found in Basin MM. Levels of arsenic, nickel, and copper in the surface soils of the test sites (Table 5-2) are also considerably higher than background levels.

Short-Term Effects of Storm Recharge. The short-term effects of storm recharge on basin soils can be demonstrated by looking at concentration profiles before and after the wet weather period. Figure 5-2 shows lead profiles for Basins EE and MM for 1981-82 and 1982-83. Data are plotted from the fall sampling prior to the wet weather period and in the spring after the wet weather period. Both basins had been scraped prior to the fall sample to improve percolation. In Basin EE the spring profile is distinctly higher down to about 0.1 m in 1981-82 and 0.17 m in 1982-83. In Basin MM the increase due to storm recharge is confined to the near surface; below 0.05 m (2 inches) the spring and fall profiles are comparable. In Chapter 6, as part of the loading synthesis, the increases in lead in the soil will be quantitatively compared to runoff loads for that time period.

Another way of estimating the potential effect of recharging storm runoff on the groundwater supply is to compare runoff quality with the regional groundwater quality. Recent groundwater data from 46 municipal supply wells operated by the City of Fresno have been compiled to characterize the regional groundwater quality. These wells are distributed throughout the metropolitan area and provide a reasonable representative of the groundwater quality of the Fresno area. Table 5-12 compares runoff quality at the single-family residential site with the regional groundwater quality.

Table 5-12. Comparison of Runoff and Regional Groundwater Quality

Constituent	Units	Runoff quality at single-family residential site		Regional groundwater quality of 46 wells	
		Mean	Range	Mean	Range
Specific conductance	umhos/cm	56	15-222	308	95-681
pH	Standard units	7.2	6.5-8.3	7.6	7.3-8.1
Alkalinity	mg/l as $CaCO_3$	19	7.0-73	129	40-320
Nitrate	mg/l as N	0.75	0.18-2.1	3.8	1.0-8.4
Calcium	mg/l	5.8	1.3-18	25	6-55
Magnesium	mg/l	1.3	0.01-6.2	14.5	3.5-38
Sodium	mg/l	3.9	0.70-18	21	10-42
Chloride	mg/l	3.4	0.60-14	11.3	2.6-50
Sulfate	mg/l	8.3	4.2-27	8	<1-25
Arsenic	ug/l	1.5	<1.0-8.0	2	<1-4
Cadmium	ug/l	2.0	<1.0-4.0	1	<1-4
Chromium	ug/l	1.4	<1.0-40	3	<1-6
Copper	ug/l	6.1	4.0-180	<50	<50
Lead	ug/l	42	15-2,100	5	<1-8
Mercury	ug/l	0.10	<0.10-8.6	<0.1	<0.1
Zinc	ug/l	70	30-1,300	20	<10-50
Iron	ug/l	188	160-29,000	<20	<20-170
Manganese	ug/l	50	20-480	5	<5-15

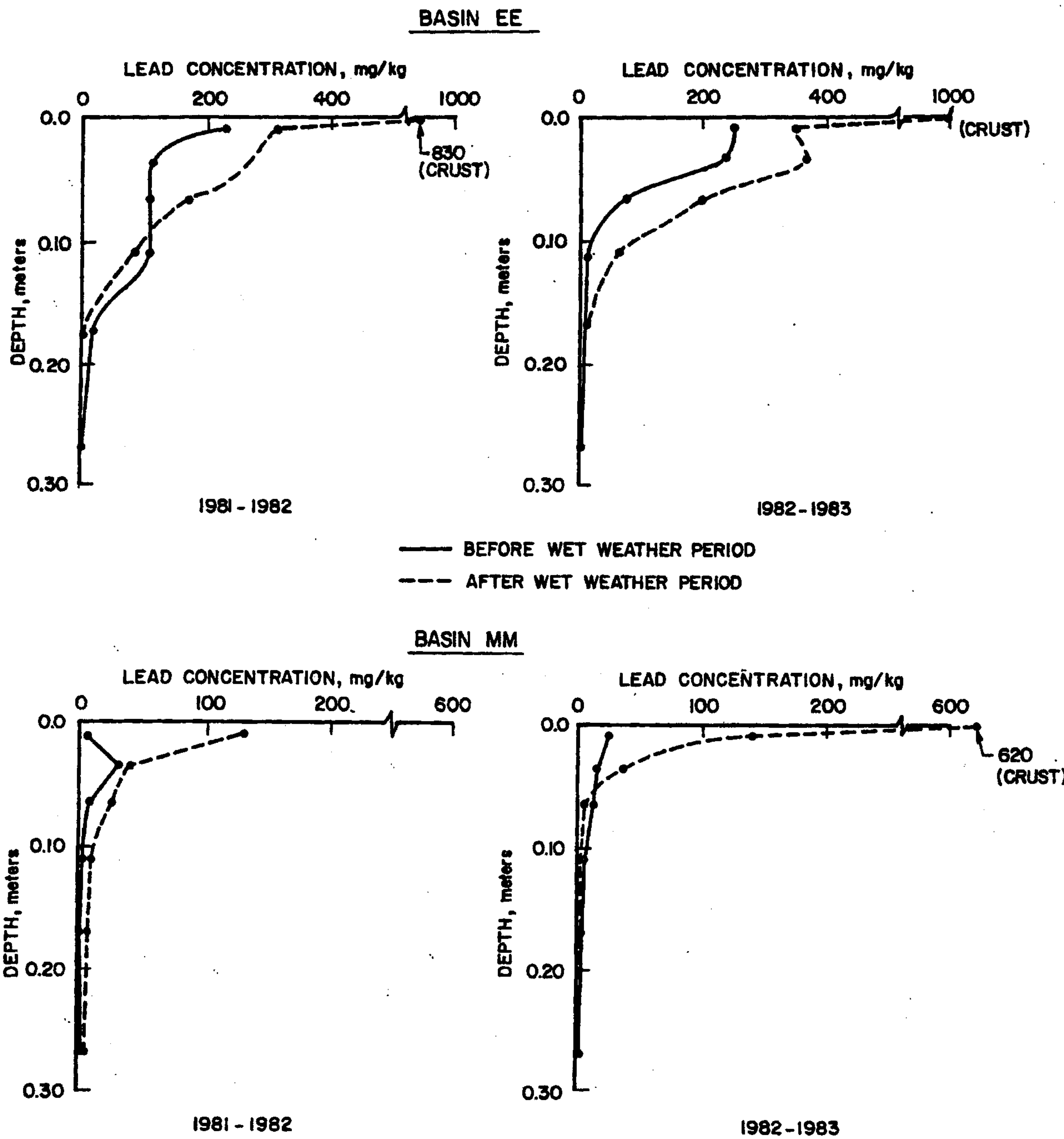


Figure 5-2 Lead Profiles Before and After the Wet Weather Period

The specific conductance of the regional groundwater is several times greater than the level measured in runoff. The concentrations of most of the individual cations and anions are also much higher than concentrations in the runoff. Thus, from the standpoint of mineral quality, storm runoff can improve the regional groundwater quality. In contrast, most of the metal concentrations are significantly higher in the runoff, particularly lead, zinc, iron, and manganese.

Effects of Imported Water. One of the objectives of the Fresno NURP project was to determine the effect of recharging imported irrigation water during the summer. Two of the test basins (EE and MM) receive summer recharge water. The other three basins (F, G, and M) do not. Three areas have been analyzed in trying to determine the effects of summer recharge:

1. Evaluate the quality of imported recharge water.

2. Compare the soil properties of basins with and without imported water recharge.

3. Analyze the results of soils samples collected before and after the imported water recharge period.

The quality of the imported recharge water was presented in Chapter 4. These data indicate that the irrigation water is of high quality. None of organic priority pollutants were detected and metal concentrations were very low. The electrical conductivity of the irrigation water averages from 30 to 35 umhos/cm, compared to an electrical conductivity of over 300 umhos/cm in the regional groundwater. Major cations and anions in the imported recharge water are also much lower than the levels found in the regional groundwater. Thus, the imported recharge water itself has a very favorable effect on the receiving groundwater, by diluting the existing mineral levels.

The remaining concern about imported water recharge is whether the movement of the large volumes of water could be leaching any stormwater-produced compounds from the soils that could adversely affect the groundwater. USDA statistically analyzed the differences in soil chemical properties between the basins with and without imported water recharge. For most of the cations and anions, concentrations tended to be slightly less in the basins receiving imported water recharge, possibly indicating some leaching due to the additional recharge during the summer. However, the magnitude of the differences is generally quite small. Thus, as far as the common cations and anions are considered, imported water recharge is not having a significant adverse impact on the receiving groundwater.

Part of the testing program included collecting soil samples in the spring prior the the imported water recharge period and in the fall after imported water recharge. Prior to collecting the spring samples, 1 to 2 inches of soil was scraped from the basin surface to improve percolation. Lead profiles for Basin EE and Basin MM are presented in Table 5-13 for 1982 and 1983.

Table 5-13. Comparison of Lead Concentrations Before and After Imported Water Recharge

Year	Depth, meters	Lead Concentration, mg/kg			
		Basin EE		Basin MM	
		Before	After	Before	After
1982	0.0–0.3	46.0	55.0[a]	6.2	7.2[a]
	0.3–0.6	2.7	8.8	3.2	7.7
	0.9–1.2	4.1[b]	13.0	1.5[b]	2.1
	1.5–1.8	4.6[b]	3.4	0.9[b]	2.2
	2.1–2.4	2.0[b]	6.3	1.6[b]	1.8
	2.7–3.0	1.5[b]	3.4	1.7[b]	2.4
1983	0.00–0.05	160.0	103.0[a]	16.0	15.0[a]
	0.05–0.08	—	6.5	—	6.6
	0.08–0.14	—	5.3	—	5.6
	0.14–0.20	—	3.1	—	3.2
	0.3–0.6	7.3	—	3.4	—

[a]Computed from individual samples collected over the 0.0 to 0.3-meter depth.

[b]Based on data collected before the basin was scraped.

During 1982, the lead concentration in the upper 0.3 m showed no appreciable increase in either basin. However, in the 0.3 to 0.6 m depth in Basin MM and in both the 0.3 to 0.6 m and 0.9 to 1.2 m depths in Basin EE, lead concentrations were higher after imported water recharge. This indicates that there may be some leaching of lead due to the imported water recharge. Below 1.5 m, lead levels before and after imported water recharge are comparable and are in the range of the background lead concentration found in the control sites which is about 3 mg/kg. During 1983, no soil samples were collected below 0.2 m after imported water recharge, so it is not possible to determine if a similar leaching effect was occurring. Additional data should be collected to confirm whether leaching is occurring.

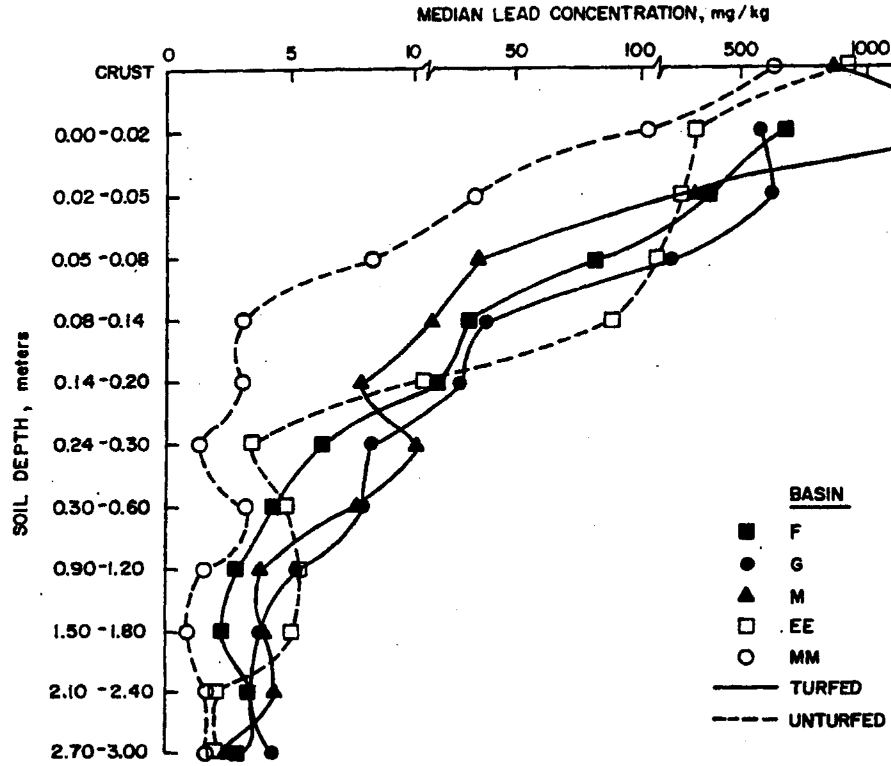
Turfed Versus Unturfed Basins. Another objective of the project was to determine if there are differences between turfed and untrufed recharge basins. This comparison is complicated by two factors: (1) the two unturfed basins (EE and MM) are the ones that receive summer recharge, while the three unturfed basins (F, G, and M) do not receive summer recharge and (2) the turfed basins are considerably older than the unturfed basins and thus have received a greater accumulation of runoff loads. These two variables make it difficult to focus on just differences due to presence of turfing, but some general comparisons can still be made.

Figure 5-3 shows the median profiles of lead and nickel for all five basins. The turfed basin data are connected with a solid line, while the unturfed basin data are connected with a dashed line.

The surface levels (0.02 m to 0.05 m) of lead are higher in the three older, turfed basins. Of the two unturfed basins, Basin MM with the sandy profile has considerably lower lead concentrations. Since the two unturfed basins are similar in age, this raises the question of whether less of the lead input to Basin MM is being removed in the surface soil layer, as compared to Basin EE. This issue is further evaluated in Chapter 6, when runoff loads are considered. The effect of disking of the surface soils in Basin EE is apparent in the profile; the Basin EE profile is relatively constant between the surface and 0.08 m due to the mixing of the surface soils. In the past, the District has periodically disked surface soils to improve recharge.

The nickel profiles shown on Figure 5-3 also indicate that Basin MM has the lowest concentrations. The nickel profile for the other unturfed basin (Basin EE) is very similar to the profiles for two of the turfed basins (Basins F and G). Disking did not have the effect on the nickel profile as it had on the lead profile.

Two important factors that may be influencing the removal of contaminants in the soil are soil texture and the extent of organic matter. Soils with a higher proportion of silt and clay than sand generally have higher cation exchange capacities and can better attenuate migrating contaminants. Organic matter also adds to the cation exchange capacity of the soil. Table 5-14 shows the levels of silt plus clay and organic matter in the surface soils of the five basins. Basin MM has the lowest levels of silt plus clay and organic matter by a substantial margin. The second unturfed basin (Basin EE) also exhibits a much lower amount of organic matter than the turfed basins. The higher levels of silt plus clay and organic matter in the turfed basins are likely to be contributing to the higher removal of lead and nickel that appears to be occurring on Figure 5-3.



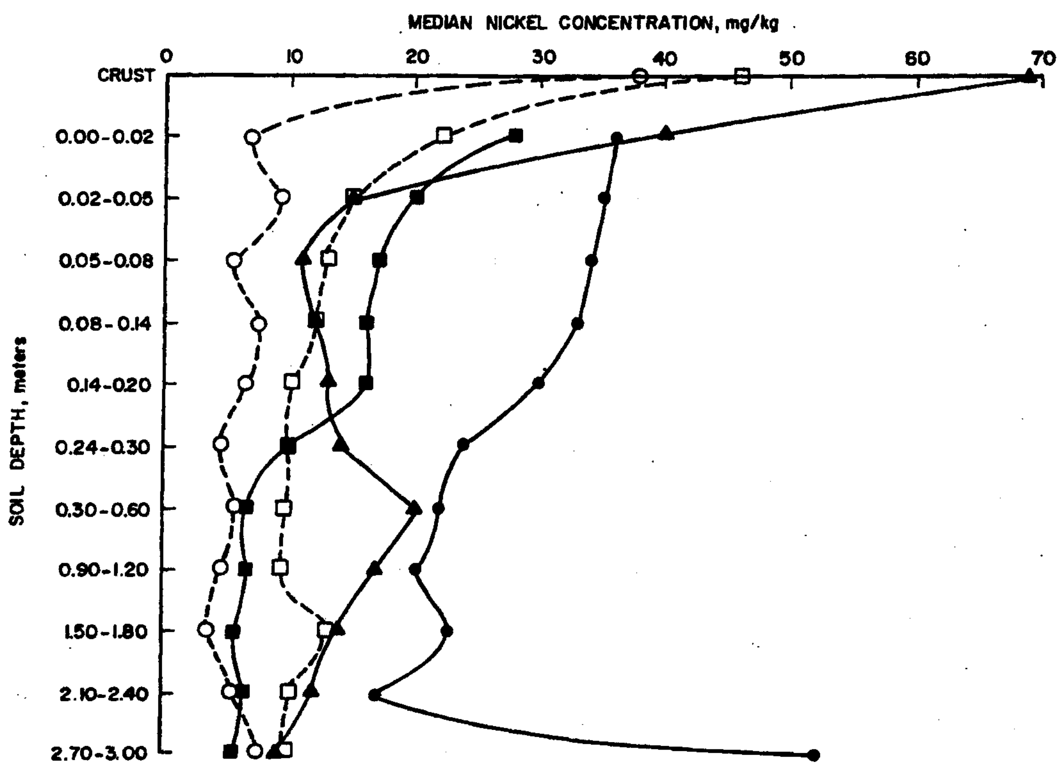


Figure 5-3 Median Lead and Nickel Concentrations in Basin Soils

Table 5-14. Concentrations of Silt Plus Clay and Organic Matter in Surface Soils

Basin	Silt plus clay,[a] g/100 g		Organic matter,[a] g/100 g	
	0.0-0.3 meters	0.3-0.6 meters	0.0-0.3 meters	0.3-0.6 meters
F	22	5	1.06	0.03
G	31	29	1.14	0.11
M	46	44	1.44	0.16
EE	35	28	0.49	0.01
MM	5	4	0.05	0.03

[a]Data are from 1981 basin soil site profiles.

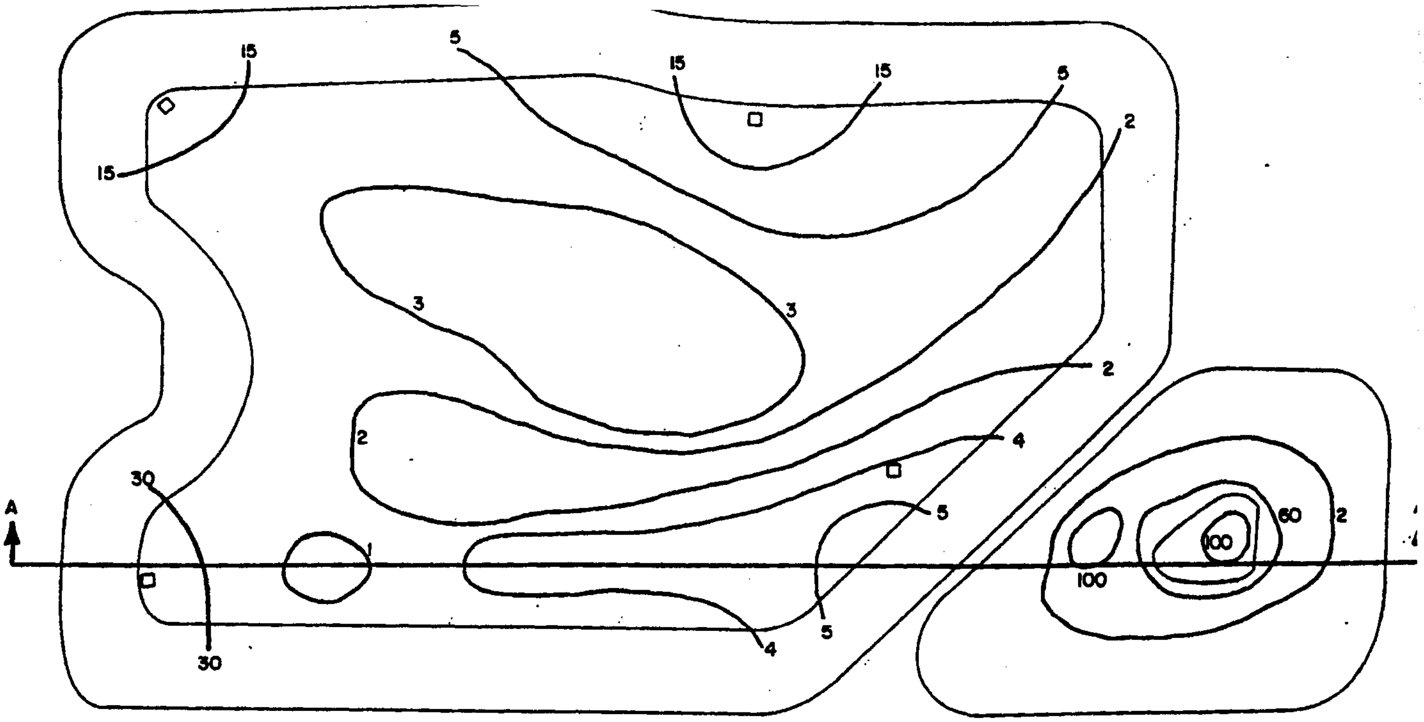
Spatial Distribution of Lead. This section presents the results of a special survey conducted to determine the variation in contaminant concentrations over the surface of the recharge basins. All of the other soils data presented in this report were collected at a single location in each basin. The spatial data are useful for three purposes:

1. Help assess the representativeness of the regular sampling location.

2. Identify differences between the deeper low-flow portion of the basin and the shallower recreational area of the basin.

3. Show spatial distribution needed in analyzing management practices (Chapter 8).

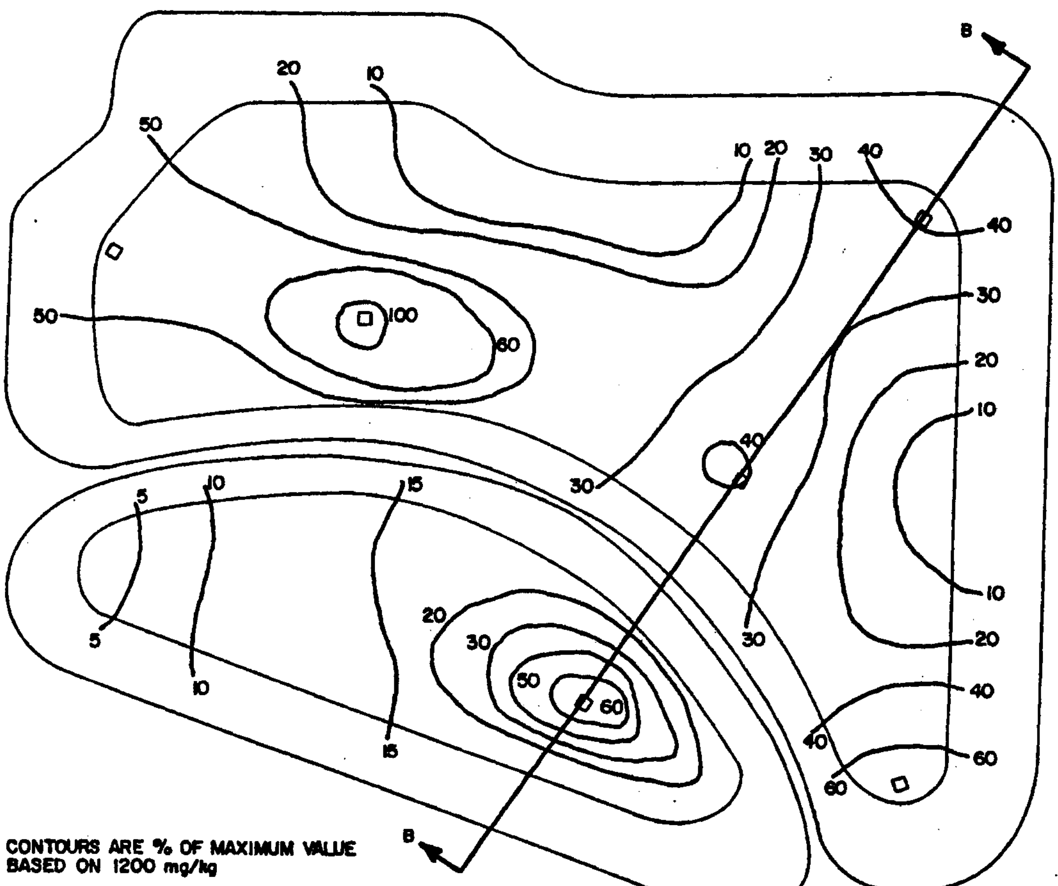
Two basins were used in the spatial survey: Basin B/E and Basin F. Cores of the upper 8 cm of soil were collected on January 3, 1984 for analysis. The samples were taken along basic directions of flow of water within the basins to assess the degree of lead buildup as a function of distance from outfalls. The results are presented on Figure 5-4. The data are plotted as contours which are based on the percentage of the maximum concentration measured. Basin B/E had a maximum



NOTE: CONTOURS ARE % OF MAXIMUM VALUE BASED ON 3300 mg/kg

□ OUTFALLS

BASIN B/E



NOTE: CONTOURS ARE % OF MAXIMUM VALUE BASED ON 1200 mg/kg

BASIN F

□ OUTFALLS

Figure 5-4 Spatial Distribution of Lead in Basin Soils concentration of 3,300 mg/kg, which occurred in the lower basin. Basin F had a maximum concentration of 1,200 mg/kg which occurred in the upper basin. Elevation profiles for the two basins are shown on Figure 5-5.

The analysis of these results tends to show the following: (1) High levels of lead are deposited near the outfalls. At outfalls for Basin B/E, lead levels were between 15 and 30 percent of the maximum, while the levels in interior areas only ranged from 1 to 5 percent. Basin F outfall areas had levels ranging between 40 and 60 percent, while levels in the remainder of the basin were only 10 to 30 percent. (2) Basin topography and distance from outfalls mutually affect distribution. By plotting the surface elevation along the sampling lines, it is evident that soil concentrations are highest at low spots and gradually fall off at locations farther from the source. (3) The elevation relationship between the shallower recreation area of the basin and the recharge area affects lead buildup in the recreation area. The difference in elevation between B/E basins is roughly 20 feet. The lead levels are about one magnitude higher in the recharge area. At Basin F the difference is only about 2 feet and the lead levels are about the same in the two basins.

From these results, it is apparent that there are three major factors affecting the spatial distribution of lead:

1. Number and location of basin outfalls.
2. Basin topography.
3. Elevation difference between deeper and shallower areas of the basins.

The spatial lead data will be further used in Chapter 6 in developing the loading synthesis; in Chapter 7 in assessing impacts on recreation; and in Chapter 8 in analyzing management practices.

Water Quality Variations

The results from soil water and groundwater samples have been analyzed from two primary viewpoints:

1. Variations with depth.
2. Variations with time.

Variations with Depth. Water samples were collected at two or three sampling depths in the unsaturated zone and at the top of the saturated zone in each basin. The results for the samples were tabulated previously in this chapter (Tables 5-6, 5-7, and 5-8). To determine if there are any trends with depth,

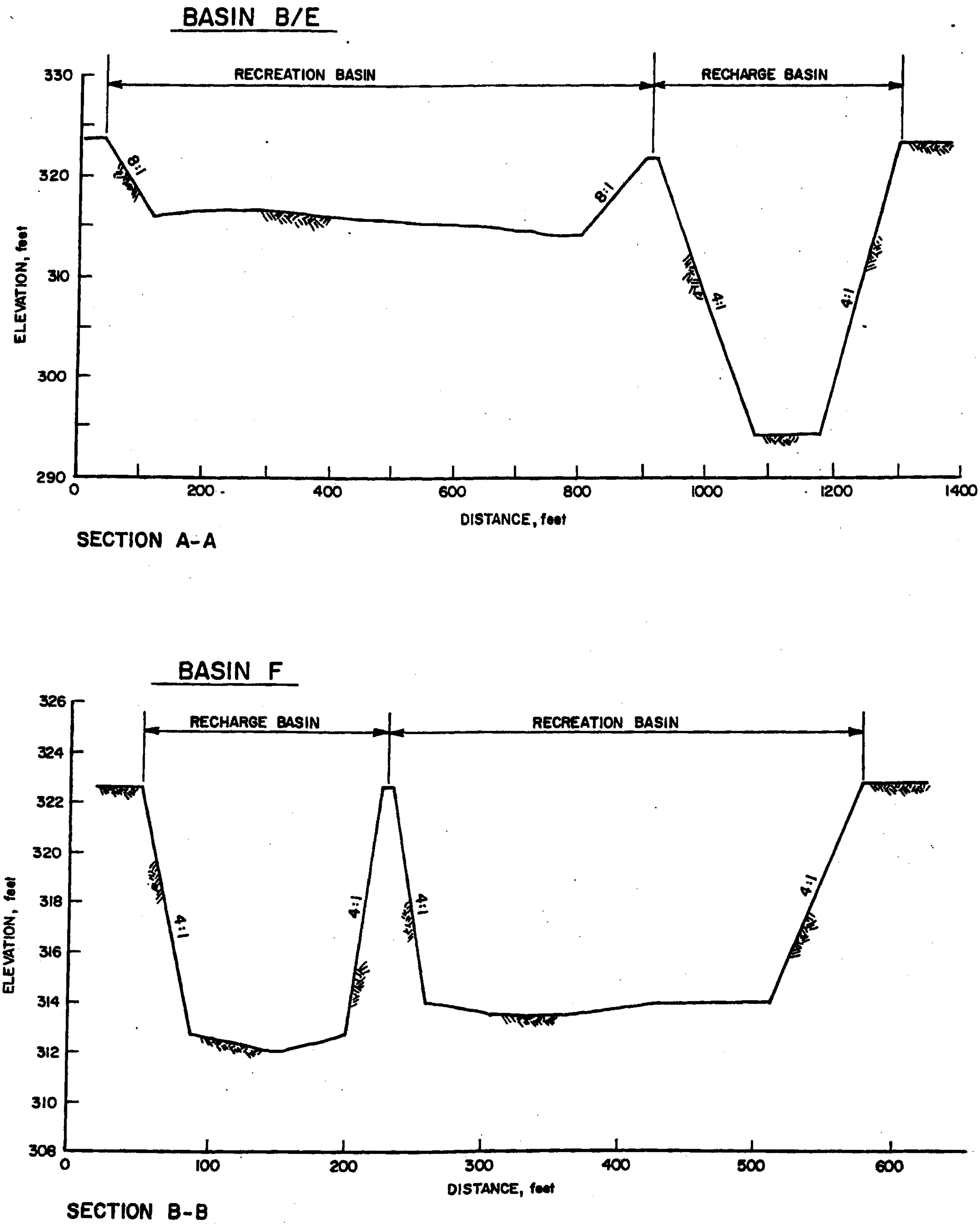


Figure 5-5 Basin Elevation Profiles

the data for nitrate and lead have been plotted (Figure 5-6). The concentrations of nitrate and lead in the runoff and the regional groundwater are shown, as well as the soil water and groundwater concentrations.

Nitrate levels in the soil water and groundwater are comparable to the levels detected in runoff in Basins F, M, and EE, indicating minimal removal of nitrate as recharge water percolates through the soil. This is not surprising since nitrate is negatively charged and thus is quite mobile in soil. It is unclear as to why nitrate levels in the soil water and groundwater in Basin MM are considerably lower than the concentration of nitrate in the runoff. This basin receives canal water during the summer months. The canal water recharge may be improving the quality of the soil water and groundwater in this basin. The mean concentration of nitrate in the regional groundwater is about 4 mg/l, which is significantly higher than the concentration of nitrate in runoff.

Changes in lead concentration with depth are also shown on Figure 5-6. In contrast to nitrate, there is a dramatic reduction in the lead concentration found in runoff. Concentrations in the soil water and groundwater range between less than 1 ug/l and 8 ug/l compared to median level of 150 ug/l in the runoff. It is also important to note that the levels of lead in the soil water and groundwater are generally lower than the concentration of lead in the regional groundwater. It is difficult to discern any consistent trends in the variation of lead in the unsaturated zone, since the concentrations are so low. However, it does appear that in Basin MM and Basin F, lead concentrations are decreasing with depth.

Variations with Time. Water samples were collected on a bimonthly basis between January and September 1982 and on a monthly basis between October 1982 and July 1983. Figure 5-7 shows the time variation of lead and iron in the soil water and groundwater. Data are shown for one basin that received summer recharge (Basin EE) and one basin that did not receive summer recharge (Basin F).

Iron concentrations were quite variable in both the soil water and groundwater. In Basin F, the highest concentrations were measured during December and January, which is the heaviest storm recharge period. Concentrations generally dropped off in the spring, although there is a rise in the groundwater iron concentration in June and July 1984 for Basin F. In Basin EE, the iron concentration was consistently higher in the soil water than in the groundwater.

Lead concentrations were relatively constant in both Basin F and Basin EE. The only time that concentrations were greater than the detection limit was in late spring and early summer, after the winter recharge period.

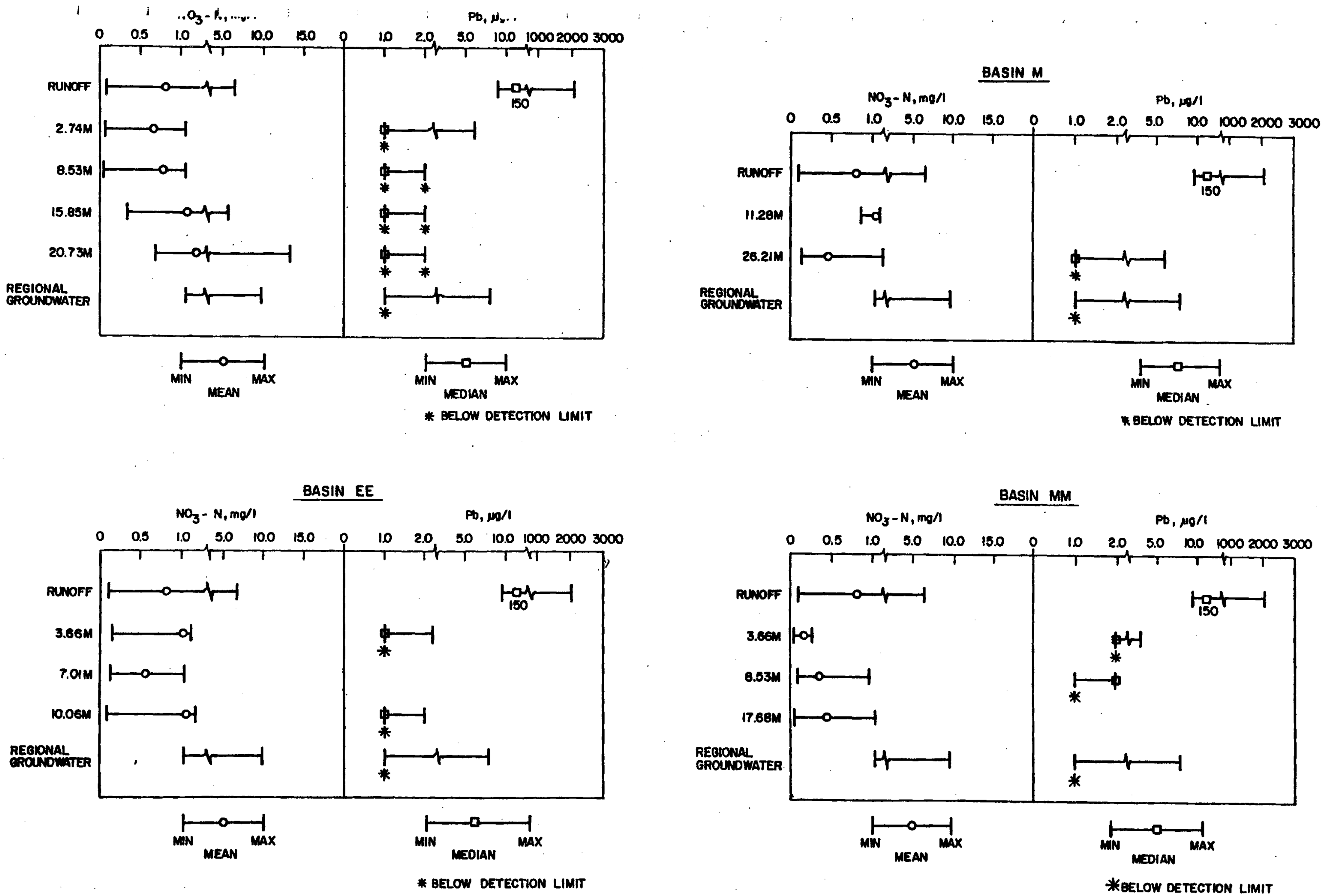


Figure 5-6 Variances in Water Quality with De

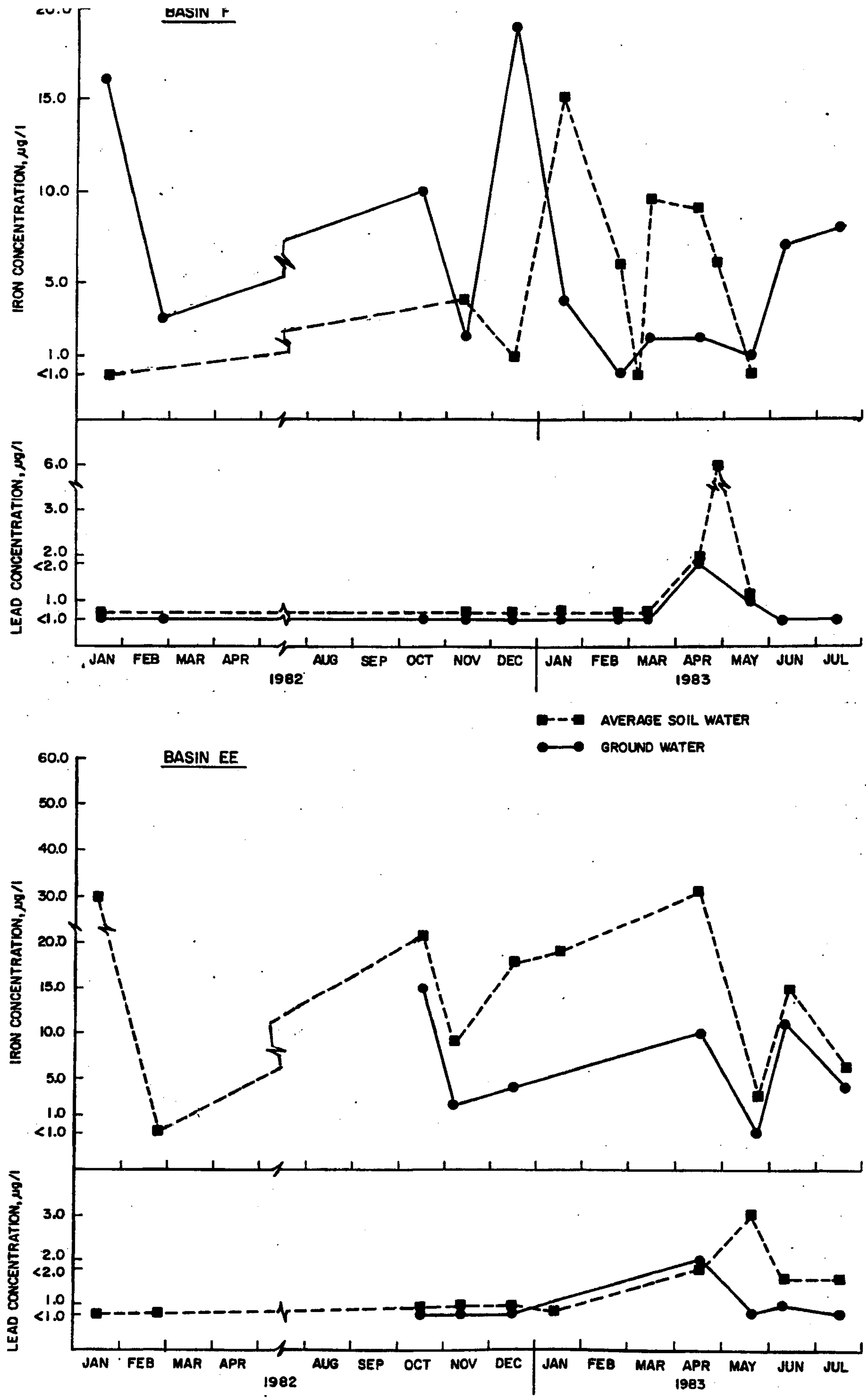


Figure 5-7 Iron and Lead Concentrations in Soil Water and Groundwater

Contaminant Migration in Soils

The data and analyses presented in this chapter have dealt specifically with the soils and groundwater monitoring program conducted in Fresno. The following discussion provides a general explanation of the mechanisms affecting movement of contaminants in soils. This discussion is intended to help further explain the significance of the Fresno data previously presented and to provide some background for the discussions of impacts and management practices in Chapters 7 and 8. The discussion focuses primarily on metals.

The migration of contaminants through the soil has been studied by numerous people over the years. The soil has been referred to as the living filter because of its ability to retain, modify, or decompose a wide variety of organic and inorganic contaminants. Relatively little investigative work has been done directly on groundwater recharge of urban runoff, but extensive work has been done on renovation of municipal sludges and effluents. This research in most cases is applicable to the question of contaminant migration in the soils underlying urban runoff retention basins.

Land Disposal of Wastewater Effluents. Land treatment and disposal of wastewater effluents has been successfully practiced for many years. Unfortunately, limited metals data are available in many cases, since metals in treated municipal effluents are often present in very low concentrations which are less than the detection limits of normal metal analyses. Table 5-15 presents selected metal data from the Central Treatment Plant in Sacramento, California. Although this effluent is not used for irrigation of crops, it is of a suitable quality. Table 5-15 also presents comparable data on Sacramento River water. The metals level in the Central Plant effluent, Sacramento River water, and runoff samples collected as a part of the NURP study are at comparable levels for arsenic and copper. Lead is significantly higher in the Fresno runoff, while nickel is somewhat higher in the effluent. The Sacramento River is used directly for irrigation throughout the Central Valley and provides natural recharge for groundwater aquifers.

Metals occur in runoff and wastewaters in the soluble and insoluble form. Insoluble material is in the form of precipitates or is attached to colloidal material in the wastewater. In aquatic systems, the soluble form of the metal often has the greatest toxic effect on aquatic organisms. The insoluble form is relatively less toxic, presumably due to reduced availability, unless it is converted to the soluble form. However, when the runoff percolates in the soil, the difference between the soluble and insoluble forms become much less significant. Once the runoff becomes a part of the soil solution, the soluble and insoluble metals participate in a wide variety of physical, chemical, and biochemical reactions. These reactions are discussed in more detail in the following sections.

Table 5-15. Comparison of Runoff to Municipal Effluent and River Water

Source	Constituent			
	Arsenic	Copper	Lead	Nickel
Fresno urban runoff average of residential and commercial land use	2	18	150	13
Secondary treated municipal effluent,[a] Sacramento, California	19	22	8	90
Sacramento River[a]	<10	5	<2	35

[a]"Toxicant Monitoring Program," Sacramento Regional Wastewater Management Plan, Sacramento Area Consultants, March 1980.

Factors Affecting Contaminant Migration. Urban runoff temporarily stored or disposed of in the runoff retention basins contains a wide variety of organic and inorganic contaminants. Some of the contaminants are at levels that could be harmful if it were possible for them to directly enter the groundwater. As discussed previously most of the contaminants are removed from the water by the near surface soils resulting in a relatively clean leachate that will ultimately reach the groundwater. The metals that have been regularly monitored in the soil are arsenic, copper, lead, and nickel. This section discusses the various organic and inorganic processes responsible for removing these contaminants from the runoff.

Numerous physical, chemical, and biochemical processes influence the mobility of these elements in the soil. These proccesses in turn are based on certain characteristics of the soil. The following key soil characteristics and their effect on contaminant migration are described in this section.

1. Soil texture
2. Cation exchange capacity
3. pH
4. Oxygen
5. Organic matter

Physical factors include soil texture and particle size and soil pore space distribution. Soil texture, which is the relative quantity of sand, silt, and clay, combined with the amount of pore space, has a major influence on the rate of water movement through the soil. Reducing the rate of water movement allows other time-dependent processes to remove these elements from the runoff. In some instances the soil actually filters out larger particulate contaminants such as asbestos or large precipitates of ionic elements, such as iron and manganese.

Cation exchange capacity (CEC) has been identified as having a major influence on soil contaminant migration. CEC refers to the negative charge that exists on most soil particles which then attract and temporarily retain positively charged ions in the soil solution. Most of the metals of concern in this study, including copper, lead, and nickel are positively charged. Arsenic is the only element studied which is found most often in a negatively charged form. Soils with high CEC tend to be more effective at removing positively charged contaminants from leachates. The ion exchange reactions that occur between positively charged ions and negatively charged soil particles play an important part in delaying migration, but usually do not inhibit the ion from eventually being leached downward. In a soil with a high CEC, numerous processes will attenuate the migration of ions. As a contaminant moves through the soil, it will participate in other physical, chemical, and biochemical processes that will more permanently inhibit its migration. The significance of these processes in a soil tends to increase in proportion to the CEC and surface area of a soil. Thus, soils with high CEC such as silty and clayey soils provide greater opportunities for attenuation of migrating contaminants.

Hydrogen ion activity (pH) has been shown to have a significant effect on ion migration. In a well buffered calcareous soil (containing calcium carbonate), most heavy metals and arsenic will form relatively insoluble precipitates which are resistent to leaching. In acid soils or in poorly buffered soils which may become acidified due to leaching, these precipitates will not form, or previously precipitated ions may be dissolved thus making contaminants available for leaching. The effect of pH changes is most pronounced in sandy soils which have little or no calcareous materials and are thus easily acidified by leaching or addition of acidifying materials such as some nitrogenous fertilizers or organic wastes that upon decomposition release organic acids. The effects of calcareous soil materials on the mobility of various contaminants varies from one heavy metal to another. In general though, a soil with a pH of 7 or greater is more effective in controlling metal migration than the same soil with a low pH. The Central Valley Regional Water Quality Control Board requires that soils used for disposal of reclaimed wastewater and sludges be maintained at a pH of 6.5 or greater. Many soils will naturally maintain this level; if not, limestone materials can be added to maintain the pH at 6.5 or above.

The pH levels for soils in the retention basins are generally at pH 7 or above, except for some of the profiles for Basins F, EE, and MM. None of the basin soil samples contained free lime. The soils are non-calcareous. Basin EE shows the most dramatic reduction in soil pH between the 1981 and fall 1982 sampling data. The pH values dropped from near neutral to less than pH 5. The pH in the sandy surface soil of Basin MM with its low buffering capacity also dropped during the same period. Both of these basins received irrigation canal water for recharge during the summer of 1982. The pH in Basin F was only less than 7 in the near surface soil. The lowered pH in these basins could be the result of chemical additions possible from fertilizer. The pH of the runoff from the residential and commercial areas is above pH 7. This water would not tend to lower the soil pH. The pH in the runoff from the industrial areas is sometimes less than pH 7. If this low pH water were consistently drained into one basin, it could over a period of years, lower the pH of the surface soils. Periodic monitoring will determine if this is occurring.

The amount of oxygen in a soil affects the migration of metals. The microorganisms in the soil have a major impact on the mobility of metals. The organisms exist in a complex food chain whereby organic matter is converted into other organic compounds with the releasing of mineral elements into the soil. The amount of oxygen in the soil influences the type of organisms that will thrive and the biochemical reactions that will occur.

Aerobic or oxidizing conditions favor attenuation of contaminants, while anaerobic or reducing conditions favor accelerated migration of contaminants. Water logging of soils, as would occur temporarily under the retention basins, would tend to favor contaminant migration if the oxygen content decreases. However, if the basins are drained in between storms, the frequent wetting and drying that occurs would favor attenuation. It also temporarily favors an increase in the permeability of the surface soil layer.

Organic matter in the soil has a generally decelerating influence on trace contaminant mobility. Soil organic matter, like silt and clay particles, increases the cation exchange capacity of the soil and favors the mechanisms which retain metals. Through biochemical processes involving soil organic matter and soil microorganisms, organic colloids are formed which will retain many metals and result in the formation of insoluble precipitates. The presence of organic chelators (humic and fuluic acids) can promote the formation of chelated metals. Chelated metals are bound into organic complexes, which are mobile in certain soil conditions such as alkaline or very permeable soils. This is not expected to be a problem in neutral soils such as those found in the Fresno basins which were tested.

As discussed above, there are a wide range of processes that affect contaminant mobility. The relative mobility of 13 metals is listed in Table 5-16. This table presents the relative mobilities under aerobic or nonwaterlogged conditions. Under anaerobic conditions, the mobility of most of these ions would be increased. Those tending to form the most insoluble precipitates such as cadmium would still be the least mobile under anaerobic conditions.

Organic Pesticides. The soils data showed little or no migration of the organochlorine or organophosphorus pesticides below the top 24 cm of soil. Many of the mechanisms that retain metals in the soil also retain or cause the retention of pesticides. In addition, many of the pesticides are oxidized or decomposed by soil bacteria.

Chlordane was detected up to the 24 cm depth and lindane, DDT, and DDE were detected, down to a depth of 5 cm. These three pesticides are relatively immobile in the soil and will probably not migrate any deeper. Soil adsorption is probably the most important process affecting the migration of all pesticides and, in particular the organochlorine pesticides. Adsorption occurs as a result of contact of the pesticide with clay or organic substances in the soil. The relative lack of mobility suggests that the organochlorine pesticides may be so tightly adsorbed that they do not participate in exchange reactions. This is unlike the metallic ions which may be adsorbed onto the clay but still be available for exchange reactions, especially if there is a change in solution equilibrium as a pH change.

The organophoshorus pesticides were not detected in any of the soils. This is probably due to their relative short life in the soil. Organophosphorous pesticides are typically decomposed in the soil in less than 12 weeks.

Table 5-16. Relative Mobility of Selected Elements in Soil

Mobility class	Element	Comments
Relatively mobile	Cyanide	Not strongly retained by the soil.
	Selenium	Not strongly retained by the soil, at normal pH levels.
Moderately mobile	Iron Zinc Nickel Lead Copper	Absorbed more strongly by the soil in the order of $Cu^{++}>Pb^{++}>Ni^{++}>Zn^{++}>Fe^{++}$. Stability for complexes of any given type should be increasing in the order of Fe>Zn>Ni>Pb>Cu.
	Beryllium	(Chemistry in soils probably similar to aluminum.)
Slowly mobile	Arsenic	Mobility similar to phosphorus.
	Cadmium	Forms insoluble precipitates in oxidizing conditions.
	Chromium	Forms insoluble precipitates in oxidizing conditions.
	Mercury	Retained in the surface layer of most aerated soils.
	Asbestos (< 2um)	Particles less than 2um, are retained in surface layer of soils like clay.
Immobile	Asbestos (> 2um)	Particles >2um, or greater than clay size are retained on the surface of soils.

CHAPTER 6

SYSTEM ANALYSIS

The Fresno Nationwide Urban Runoff Program (NURP) project consisted of two main data collection programs. Extensive data were collected by the U.S. Geological Survey (USGS) on the concentrations and loads of pollutants in urban runoff. These data are discussed in Chapter 4. Chapter 5 contains a discussion of the soils and groundwater data collected by the U.S. Department of Agriculture (USDA). In this chapter, the data are integrated and pollutants are traced through the entire system from rainfall to regional groundwater.

SYSTEM COMPONENTS

There are seven major system components that were studied in the Fresno NURP project: rainfall, dry deposition, street particulate material, runoff, basin soils, soil water, and groundwater. Table 6-1 shows which metals and organics were detected in each component. As shown in the table, not every constituent was analyzed in every component. Copper, lead, nickel, and iron were detected in all components of the system. Arsenic was detected in every component except rainfall and mercury was detected in every component except street particulates. Although not analyzed in every component, chromium, zinc, aluminum, and manganese were detected in every component in which they were analyzed. Many organics were not analyzed in all system components. A number of organics were detected in runoff, but not in soils, soil water, or groundwater. Lindane, chlordane, DDE, and DDT were found in soils, but not in soil water or groundwater.

The system components are shown on Figure 6-1. Pollutants in dry deposition accumulate on the ground surface until a rainstorm occurs. Pollutants in rainfall, the accumulated dry deposition pollutants, and pollutants from other sources that have accumulated on street surfaces are transported to the storm drainage system. These pollutants are then measured in the storm runoff. The storm runoff is transported via the drainage system to the recharge basins. The recharge water percolates through the basin soils, eventually reaching the shallow and then the deep groundwater.

The ranges and mean values of lead, specific conductance, calcium, and nitrate in each of the system components are shown in Table 6-2 to demonstrate changes that occur in the

Table 6-1. Metals and Organics Detected in Fresno NURP Project

Constituent	Component: Rainfall	Dry deposition	Street particulates	Runoff	Basin soils	Soil water	Groundwater
Priority pollutant metals							
Antimony	-	-	-	X	-	O	O
Arsenic	O	X	X	X	X	X	X
Beryllium	X	-	-	-	-	O	O
Cadmium	-	-	X	X	-	O	O
Chromium	X	X	X	X	-	X	X
Copper	X	X	X	X	X	X	X
Cyanide	-	-	-	X	-	-	-
Lead	X	X	X	X	X	X	X
Mercury	X	X	O	X	X	X	X
Nickel	X	X	X	X	X	X	X
Zinc	X	X	X	X	-	X	X
Other metals							
Aluminum	X	X	X	X	-	-	-
Barium	X	-	-	X	-	-	-
Boron	-	-	-	X	-	-	-
Cobalt	-	-	-	X	-	-	-
Iron	X	X	X	X	X	X	X
Lithium	X	-	-	X	-	-	-
Manganese	X	X	X	X	-	-	-
Molybdenum	-	-	-	X	-	-	-
Strontium	X	-	-	X	-	-	-
Titanium	-	-	-	X	-	-	-
Vanadium	-	-	-	X	-	-	-
Priority pollutant organics							
Aldrin	O	O	O	X	O	O	O
Anthracene	-	-	-	X	O	O	O
Benzo(a) pyrene	-	-	-	X	O	O	O
Benzo(b) fluoranthene	-	-	-	X	O	O	O
α-BHC	-	-	-	X	-	-	-
γ-BHC (lindane)	X	X	X	X	X	O	O
Butyl benzyl phthalate	-	-	-	X	O	O	O
Chlordane	X	X	X	X	X	O	O
Chrysene	-	-	-	X	O	O	O
DDD	O	O	X	O	O	O	O
DDE	X	X	X	X	X	O	O
DDT	X	O	X	X	-	-	-
Dieldrin	X	O	X	X	-	-	-
Di-n-octyl phthalate	-	-	-	X	O	O	O
Endosulfan	X	O	X	X	O	O	O
Endrin	O	O	O	X	-	-	-
Fluoranthene	-	-	-	X	O	O	O
Heptachlor	O	O	X	X	-	-	-
Heptachlor epoxide	O	O	X	X	-	-	-
4-nitrophenol	-	-	-	X	O	O	O
Total PCB	X	O	X	X	X	-	-
Pentachlorophenol	-	-	-	X	O	O	O
Phenol	X	-	-	X	X	O	X
Pyrene	-	-	-	X	O	O	O
Other organics							
Diazinon	X	X	X	X	O	X	O
Dibromochloropropane	-	-	-	X	-	-	-
2,4-D	X	O	O	X	O	O	O
Ethion	X	O	O	O	O	-	-
Malathion	X	X	X	X	O	O	O
Methoxychlor	X	X	O	X	O	O	O
Methyl parathion	X	O	X	X	O	O	O
Parathion	X	O	X	X	O	O	O
Silvex	O	O	-	X	-	-	-
Trithion	O	O	X	X	-	-	-

[a]Table symbols: X indicates detected; O indicates not detected; - indicates not measured.

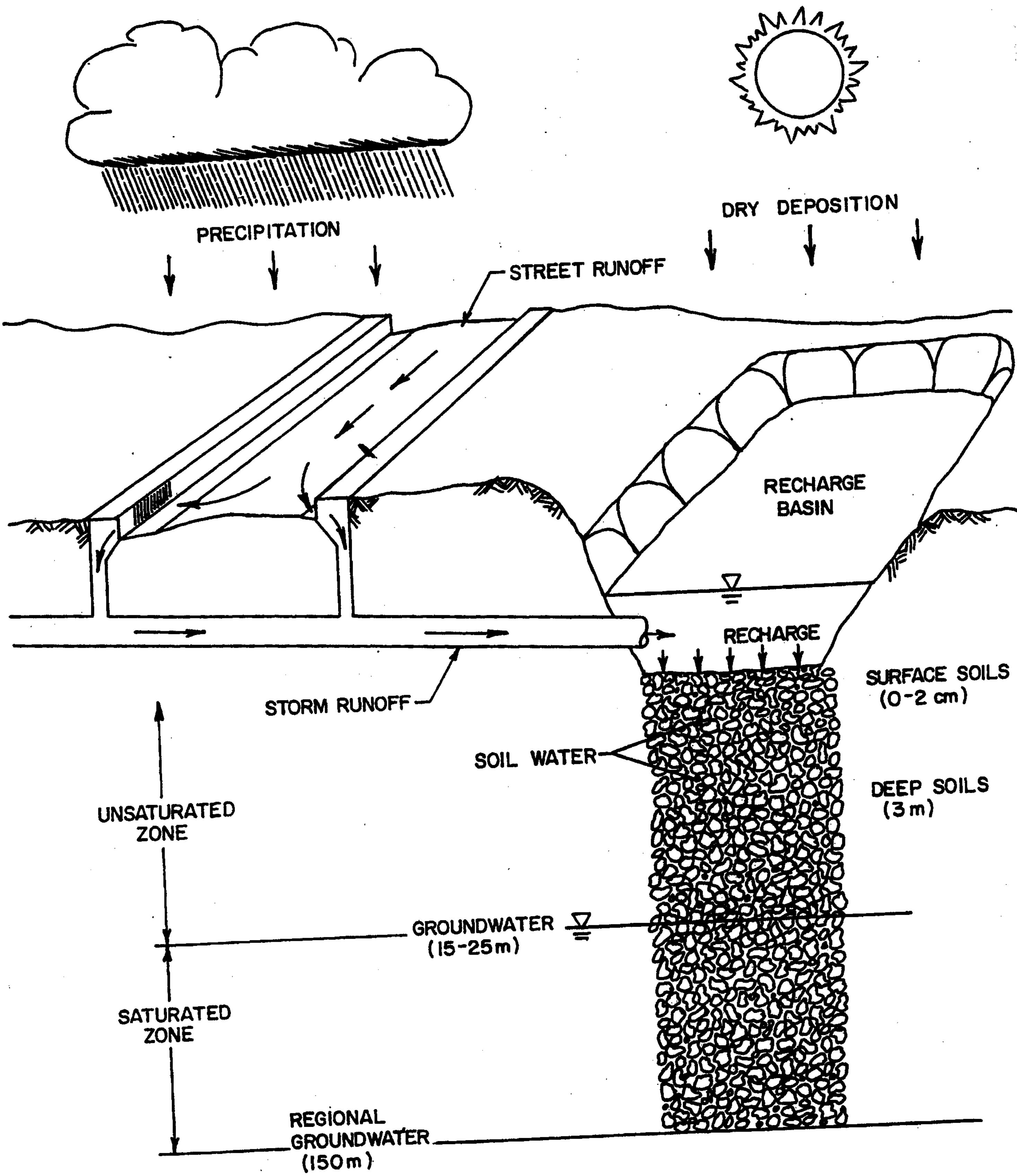


Figure 6-1 Schematic of System Components

Table 6-2. System Concentrations

Constituent	Rainfall	Dry deposition	Street particulates	Runoff	Surface soil	Soil water	Deep soil	Groundwater	Regional groundwat
Lead									
Wet phase, ug/l	<1-61 (11.2)[a]			9-2,100 (204)		<1-6 (1.5)		<1-6 (1.3)	<1-8 (5)
Dry phase, mg/kg		140-8,280 (1,464)	100-1,000 (500)		8.7-1,600 (585)		<2-8.9 (2.9)		
Specific conductance									
Wet phase, umhos/cm[b]	3-57 (14)			8-9,960 (199)		37-541 (118)		37-843 (278)	131-443 (308)
Dry phase, umhos/cm		No data	No data		1,519-4,031 (2,239)		78-204 (114)		
Calcium									
Wet phase, mg/l	0.1-1.5 (0.5)			0.8-120 (11)		3.0-38 (11)		2.8-64 (21)	6-55 (25)
Dry phase, mg/kg		2,760-121,000 (18,113)	30-120 (59)		54-299 (183)		1.2-3.5 (2.0)		
Nitrate									
Wet phase, mg/l	0-0.96 (0.23)			0-6.6 (0.9)		0.05-5.9 (0.8)		0.07-13.2 (2.4)	1.0-8.3 (3.8)
Dry phase, mg/kg		1,200-295,000 (24,455)	<2-42 (8.7)		1.9-101 (52)		0.18-1.1 (0.68)		

[a]Numbers in parentheses are mean values.
[b]umhos/cm = Micromhos per centimeter.

runoff/recharge system for different types of constituents. The data from each land use type and each recharge basin have been grouped together to show the overall ranges and mean values. Concentrations for the regional groundwater quality are also contained in Table 6-2, based on the data presented previously in Table 5-12.

The lead concentrations were fairly low in rainfall [mean = 11.2 micrograms per liter (ug/l)] and quite high in runoff (mean = 204 ug/l), indicating that lead comes primarily from ground sources. The concentrations decreased to about 1.5 ug/l in soil and groundwater. The mean lead concentration in the regional groundwater is higher than the mean levels in the soil water and groundwater underlying the recharge basins. In the dry phase, the highest lead concentrations were found in dry deposition [mean = 1,464 milligrams per kilogram (mg/kg)]. The mean concentrations of 585 mg/kg in surface soil and 2.9 mg/kg in deep soil indicate that the lead generally is attenuated in the surface soil layer and does not migrate to the deep layers of soil. The lead in the runoff is reduced to background levels by the time the runoff water reaches the water table.

The specific conductance and concentrations of calcium and nitrate in both the wet and dry phases show similar patterns. In the wet phase, the concentrations are low in rainfall, somewhat higher in runoff and soil water, even higher in the groundwater, and highest in the regional groundwater. For example, the mean concentrations of calcium were 0.5 mg/l in rainfall, 11 mg/l in runoff and soil water, 21 mg/l in groundwater, and 25 mg/l in the regional groundwater. In the dry phase, the concentrations were highest in dry deposition, lower in street sweepings, slightly higher in surface soil, and lowest in deep soil. The mean calcium concentrations were 18,113 mg/kg in dry deposition, 59 mg/kg in street sweepings, 183 mg/kg in surface soil, and 2 mg/kg in deep soil. The high concentrations of these constituents in dry deposition combined with the concentrations in rainfall and street particulates result in the high runoff concentrations.

The soil water concentrations of calcium and nitrate were essentially equal to the runoff concentrations, indicating that the soil layer has minimal effect on these particular constituents. However, it is also important to note that the concentrations of calcium and nitrate in the runoff are lower than in the regional groundwater. Thus, as discussed in Chapter 5, the runoff water being recharged is tending to improve the quality of the regional groundwater for calcium and nitrate, as well as most of the other cations and anions.

LOADING ANALYSIS

The effects of urban runoff on the recharge basin soils can be further assessed by performing a loading analysis. The purpose of the loading analysis is to determine if the pollutant loads from runoff and other sources can be correlated with the amounts of these pollutants present in the basin soils. The USDA soil profile data can be used to compute the amount of various pollutants in the basin soils. The runoff monitoring program was conducted on a different set of basins, so actual runoff loads for the USDA basins are not available. However, runoff loads to the USDA basins can be "synthesized" using the unit load factors for different land use types from the USGS data. The loading analysis was developed for both a short-term period (i.e., the two years of this study program) and a long-term period.

Short-Term Analysis

Basins EE and MM were chosen for the short-term loading analysis because data on pollutant concentrations in the soil were collected before and after the wet weather season in 1981-82 and 1982-83. Thus, it is possible to calculate a mass balance for each year. Samples were not collected in the fall for the other three test basins. The results of the short-term loading analysis are described below.

Runoff Load. The loads of lead, copper, iron, and arsenic in runoff from the drainage areas of Basins EE and MM were synthesized using the USGS runoff data. USGS collected runoff quality data from single-family residential, multiple-family residential, commercial, and industrial land uses. Unit runoff load factors in pounds per acre per year were calculated for each land use type in the 1981-82 and 1982-83 rain seasons. The unit runoff load factors were based on flow-weighted runoff coefficients and flow-weighted event mean concentrations (EMCs). The unit runoff load factors were multiplied by the number of acres of land in each land use type in the drainage areas of Basins EE and MM to calculate the annual runoff load for each of the two years.

A small amount of runoff water is pumped out of Basins EE and MM each year to prevent flooding. It was estimated that 5 percent of the water was pumped out of Basin EE and 1 percent of the water was pumped out of Basin MM. Typically, the pumps are turned on as soon as the basins begin to fill with runoff water, so it was assumed that there was minimal sedimentation of particulates in the runoff water prior to pumping. Based on this assumption, the runoff loads to Basins EE and MM were reduced by 5 percent and 1 percent, respectively, to account for the pollutant loads that are pumped out of the basins and never reach the basin soils.

Rainfall and Dry Deposition Loads. There is rainfall and dry deposition directly on the basins. The loads of lead, copper, iron, and arsenic in this direct rainfall and dry deposition were calculated. USGS measured the concentrations of these constituents in rainfall and dry deposition at the single-family residential and industrial sites. Based on these concentration data, unit load factors in pounds per acre per year were calculated for both sites. The mean unit load factors for rainfall and for dry deposition were multiplied by the surface areas of Basins EE and MM to determine the pollutant loads from direct rainfall and dry deposition. The runoff and rainfall-dry deposition loads are shown in Table 6-3. The loads of each constituent in rainfall and dry deposition are negligible in comparison to the runoff loads.

Table 6-3. Runoff, Rainfall, and Dry Deposition Loads to Basins EE and MM

	Annual loads, pounds					
	Basin EE			Basin MM		
Constituent	Runoff	Rainfall and dry deposition	Total	Runoff	Rainfall and dry deposition	Total
Lead						
81-82	183	1	184	75	1	76
82-83	648	2	650	251	1	252
Copper						
81-82	30	1	31	10	1	11
82-83	46	1	47	17	1	18
Iron						
81-82	4,503	47	4,550	1,945	29	1,974
82-83	20,238	37	20,275	9,182	22	9,204
Arsenic						
81-82	5	0	5	1	0	1
82-83	8	0	8	3	0	3

Soil Loads. USDA measured the concentrations of lead, copper, iron, and arsenic at 2-to-6-centimeter (cm) depth intervals in the soil column. The soil content or load of each of these constituents in the upper 14 cm of the soil column was calculated at the following times:

Fall 1981--soil load at beginning of study.

Spring 1982--soil load after 1981-82 rain season.

Fall 1982--soil load before 1982-83 rain season.

Spring 1983--soil load after 1982-83 rain season.

If there was no loss of pollutants from the basin soils, the spring 1982 soil loads in Basins EE and MM would equal the fall 1981 soil loads, plus the loads from runoff, rainfall, and dry deposition occurring during the 1981-82 wet weather season. Similarly, the spring 1983 soil loads would equal the fall 1982 soil loads, plus the loads from runoff, rainfall, and dry deposition occurring during the 1982-83 wet weather season. The loads are compared in Table 6-4. In most cases, the calculated loads are within 30 percent of the measured soil loads. The exceptions are lead in Basin MM in both years, copper in Basin EE in 1981-82 and in Basin MM in both years, and arsenic in Basin EE in 1982-83. In four of these cases, the actual load measured in the basin was less than the calculated load. This would imply that all of the load contributed by runoff does not remain in the basin soils. In Basin MM the actual loads of lead and copper were greater than the calculated loads in 1981-82. This implies that the runoff load was overestimated or the soil load was underestimated. There are no consistent differences between the results in Basins EE and MM. For example, in some cases, Basin MM soil loads accounted for less of the runoff load than Basin EE (1982-83 lead and copper). The opposite was true for the 1981-82 lead and copper data and the 1982-83 arsenic data, with Basin MM soil loads accounting for more of the runoff load than Basin EE.

<u>Factors Affecting Short-Term Loading Analysis</u>. There are a number of factors which affect the results of the loading analysis that were not included in the calculations. It was not possible to quantify them and include them in the analysis, but they can be qualitatively considered and are briefly described below.

1. Estimates of amount of runoff water pumped out of the basins--There are no measurements of the amount of water pumped out of the two basins. The figures of 5 percent and 1 percent are simply estimates. If more volume was pumped out than these estimates, the runoff load would be overestimated. In addition, it was assumed that all of the pollutants in the pumped runoff water were pumped out of the basins and that there was no settling of particulate pollutants in the basins. This assumption would tend to underestimate the load to the basins.

Table 6-4. Comparison of Actual and Calculated Soil Loads

Time	Constituent load, pounds							
	Lead		Copper		Iron		Arsenic	
	Basin EE	Basin MM	Basin EE	Basin MM	Basin EE	Basin MM	Basin EE	Basin MM
1981-82								
Fall soil load	1,409	78	218	24	141,000	46,100	72	18
Runoff load[a]	184	76	31	11	4,500	2,000	5	1
Calculated spring soil load	1,593	154	249	35	145,500	48,100	77	19
Actual spring soil load	1,925	253	111	56	111,000	35,700	63	16
Actual load as percent of calculated load	121	164	45	160	76	74	82	84
1982-83								
Fall soil load	1,434	106	152	41	159,000	50,100	185	39
Runoff load[a]	650	252	47	18	20,200	9,200	8	3
Calculated spring soil load	2,084	358	199	59	179,200	39,500	193	42
Actual spring soil load	2,586	245	177	39	No data	No data	41	39
Actual load as percent of calculated load	124	68	89	66	—	—	21	93

[a]Runoff load is actually the load from runoff, rainfall, and dry deposition.

2. Representativeness of USDA sampling sites--USDA sampled at one site in Basins EE and MM. Spatial sampling was not conducted in these two basins to determine if the sampling sites were generally representative of the basins. Spatial data collected in Basin F showed that highest concentrations were found near the inlets and in low spots on the basin floor. Based on this information, the sampling sites in Basins EE and MM appear to be fairly representative of average conditions.

3. Basin floor surface area--The surface area used to calculate the amount of each pollutant in the basin soil was based on an estimate of the average water depth in the basins during the rain seasons. District staff estimate that the average water depth was as follows: Basin EE, 10-feet in 1981-82 and 15 feet in 1982-83; and Basin MM, 8-feet in 1981-82 and 12-feet in 1982-83. The basin floors are not entirely flat, so there are low areas that fill with water more often. The depth of water in the basins varies with the duration and intensity of each rainstorm.

Long-Term Analysis

A long-term mass balance of lead, copper, iron, and arsenic in Basin F was calculated. Basin F was chosen because data were available on the development of the watershed during the 19 years since the basin was constructed and USDA conducted an intensive survey of lead concentrations throughout the basin. From the intensive survey, the representativeness of the study sampling site could be determined.

Runoff Load. The loads of lead, copper, iron, and arsenic in runoff from the drainage area of Basin F were calculated for the period from 1965, when the basin was constructed, to 1983. The acres of land in each land use type in 1965, 1970, 1975, and 1981 were determined. These figures were multiplied by the flow-weighted unit runoff load factors to produce annual loads. The unit runoff load factors from 1982-83 were used for 1969 and 1978 because the rainfall amounts in these two years were significantly above normal, as was the rainfall in 1983. The unit load factors from 1981-82 were used for all of the other years between 1969 and 1983. The annual loads from 1969 to 1983 were summed to produce the accumulated runoff load. The accumulated loads are presented in Table 6-5.

Table 6-5. Accumulated Runoff Loads to Basin F

Constituent	Accumulated runoff load, pounds			
	Before pumping	After pumping	Recharge basin	Recreation basin
Lead	720	576	167	409
Iron	15,081	12,065	3,499	8,566
Copper	85	68	20	48
Arsenic	13.1	10.5	3.0	7.5

Approximately 20 percent of the runoff water is pumped out of Basin F each year to prevent flooding. Since the pump is turned on as soon as the basin begins to fill with water, it was assumed that there was no settling out of particulates, so 20 percent of the pollutant load is pumped out of the basin. The accumulated loads of each pollutant were reduced by 20 percent to account for the pollutant loads that are pumped out of the basin and never reach the basin soils. These adjusted loads are also shown in Table 6-5.

Basin F consists of two basins; a small (1.16-acre) recharge basin and a larger (2.82-acre) recreation basin. The runoff water enters the recharge basin and then overflows to the recreation basin. Since there are no data on the amount of water stored in each basin during a typical year, it was assumed that the amount of water and pollutant loads were directly proportional to the surface areas of the two basins. Based on this assumption, 29 percent of the accumulated load was distributed in the recharge basin and 71 percent was distributed in the recreation basin. These loads are shown in Table 6-5.

Rainfall and Dry Deposition Loads. The loads of lead, copper, iron, and arsenic in the rainfall and dry deposition falling directly on the surface of Basin F are included in the background soil load which is discussed in the following section. These loads were less than 5 percent of the runoff load.

Soil Loads. The loads of lead, copper, iron, and arsenic in the soil of Basin F were calculated by using the average concentration of each constituent in each layer of soil measured by USDA during the study. The soil background concentrations of lead, copper, iron, and arsenic were subtracted from the soil concentrations before the soil load was calculated. The background concentrations were based on data collected at the control site in 1981. These soil loads are presented in Table 6-6.

Table 6-6. Soil Loads in Basin F

Constituent	Soil load based on long-term sampling site, pounds		Soil load based on average data, pounds	
	Recharge basin	Recreation basin	Recharge basin	Recreation basin
Lead	329	799	194	751
Iron	120,992	294,136	71,385	276,488
Copper	1.9	4.5	1.1	4.2
Arsenic	4.7	11.4	2.8	10.7

In January 1984, USDA conducted an intensive sampling program in Basin F to determine the spatial variability in the basin. These data are useful in determining if the long-term sampling site is representative of average conditions in the basin. In the recharge basin, the average lead concentration in the upper 8 cm of soil was 204 mg/kg. The average concentration in the upper 8 cm of soil at the long-term sampling site during the study period was 344 mg/kg. Thus, the average concentration in the recharge basin during the intensive survey was 59 percent of the average at the long-term sampling site. The average concentration in the recreation basin during the intensive survey was 322 mg/kg, which is 94 percent of the average long-term sampling site. Since intensive data were not collected on the concentrations of copper, iron, and arsenic, it was assumed that the long-term sampling data overestimated the average concentrations by the same percentages. The soil loads, based on data collected at the long-term sampling site, were multiplied by 59 percent for the recharge basin and 94 percent for the recreation basin to obtain estimates of the average soil loads. These loads are also presented in Table 6-6.

If there were no loss of pollutants from the basin soils, the soil load of each constituent should approximately equal the load from runoff since the basin was constructed. Table 6-7 presents the soil loads as a percent of the accumulated runoff load. The soil loads presented are based on the adjustment to reflect average conditions. The lead and arsenic soil loads based on the average data are fairly close to the accumulated runoff loads. The recharge basin loads are slightly lower than the loads from runoff and the recreation basin loads are higher. This indicates that proportioning the runoff load between the two basins based on surface areas, may have underestimated the load to the recharge basin and overestimated the load to the recreation basin. If the two basins are combined, the soil loads of lead and arsenic are 164 and 129 percent of the runoff load, respectively. The soil loads of iron were much greater than the runoff loads and the soil loads of copper were much lower than the runoff loads.

Table 6-7. Comparison of Soil Loads to Runoff Loads

Constituent	Soil load as percent of runoff load based on average data	
	Recharge basin	Recreation basin
Lead	116	184
Iron	2,040	3,228
Copper	6	9
Arsenic	93	143

Factors Affecting Long-Term Loading Analysis. As in the case of the short-term analysis, there are several factors that influence the long-term loading analysis that cannot be quantified. However, these factors can be qualitatively considered and are described below.

1. Estimate of amount of runoff water pumped out of the basin--As described in the short-term analysis, this assumption could either underestimate or overestimate the runoff load.

2. Estimate of surface area of basin routinely covered with water--As described in the short-term analysis, there is no clear basis for judging the effect of this assumption on the loading analysis.

3. Applicability of study period data to previous years--The data collected during 1981-82 and 1982-83 were used to estimate loads from 1965 through 1983. Differences in land use over the 19-year period were accounted for in the synthesis, as discussed previously. Differences in rainfall amounts were only partially incorporated into the synthesis. The annual rainfall for each year

since 1965 was obtained. The unit load factors, in pounds per acre per year, from 1981-82 were used for years in which the rainfall was less than 17 inches. The unit load runoff factors from 1982-83 were used for years in which the rainfall exceeded 17 inches. The unit load factors may vary with changes in rainfall, but it was not possible to predict the relationship between rainfall amount and runoff factors with only two years of data.

4. Changes in cultural practices--Since the analysis of Basin F extends over a 19-year period, it is likely that there have been cultural changes during this time that may influence unit runoff loads. The best example is the effect of the reduction in leaded gasoline use. The use of leaded gasoline has changed dramatically since the basin was completed in 1965. Figure 6-2 shows the amount of leaded gasoline consumed in Fresno County since 1960 and projections for future consumption. The consumption of leaded gasoline increased steadily from 1960 to 1973. It has decreased steadily since then, due mainly to the introduction of unleaded gasoline cars in 1975. Chevron Oil Company has projected that it will continue to decrease in the future. The runoff lead load was based on data collected from 1981 to 1983, a period when leaded gasoline usage was lower than in any of the years since 1965 when Basin F was completed. Historic runoff loads of lead were likely much higher than the current loads used in our analysis. Thus, the cumulative lead runoff load is significantly underestimated.

   Changes in street sweeping practices could also influence the magnitude of runoff loads. For example, there was a significant reduction in street sweeping after the passage of Proposition 13 in 1978.

<u>Summary of Loading Analysis</u>

Both the short-term and long-term loading analyses are influenced by several important variables that could not be quantified. Thus, the comparison of runoff loads with soil loads does not represent a complete mass balance. However, some general insights can still be obtained from the evaluation.

In the short-term loading analysis, the loads present in the basin soils were comparable to the runoff loads in the majority of cases. However, there were four cases in which the actual load measured in the basin was substantially less than the incoming runoff load. Three of the four cases occurred in

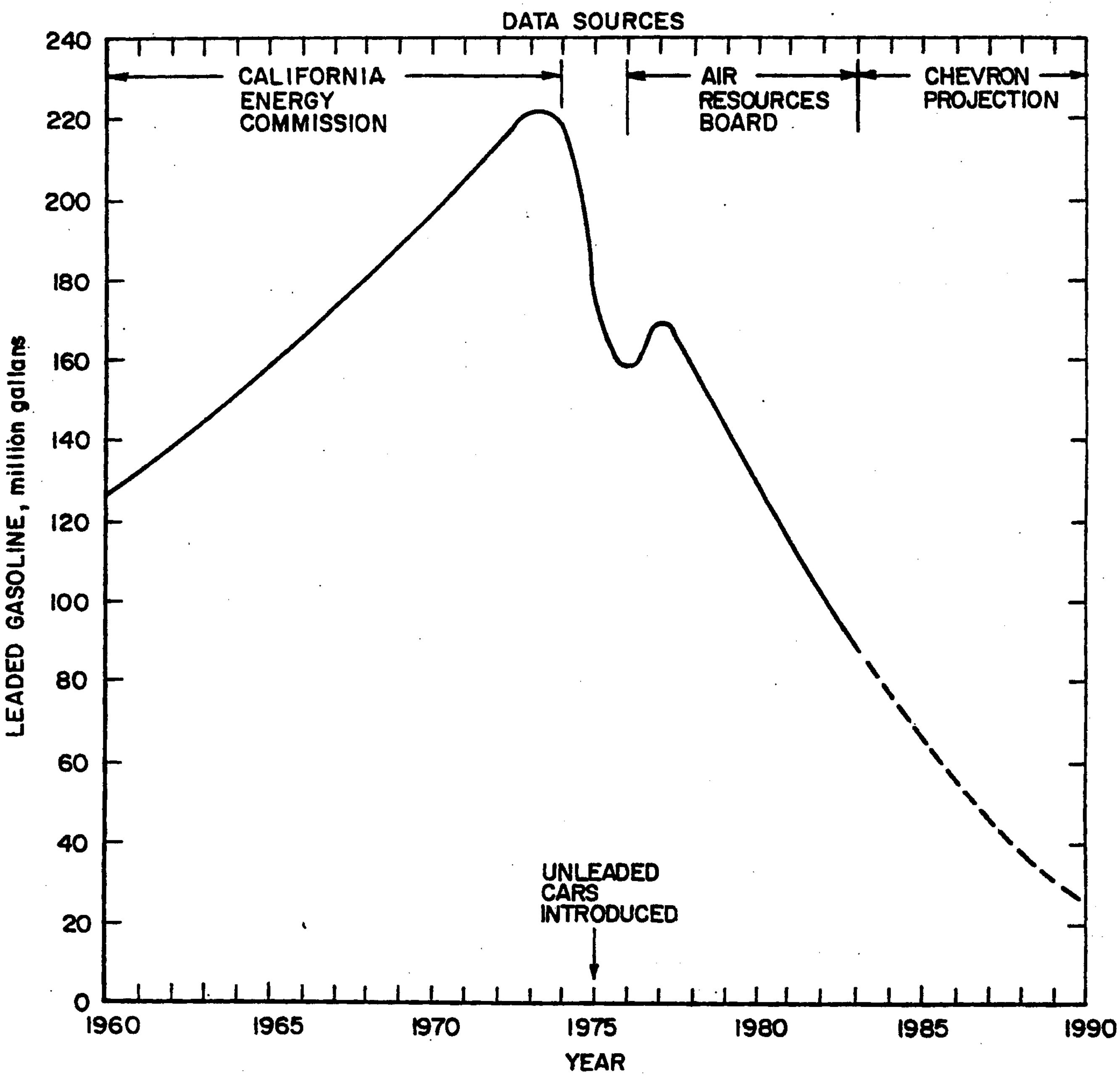


Figure 6-2 Leaded Gasoline Consumption in Frenso County, 1960-1990

1982-83, which was an extremely wet year. These results imply that some of the lead, copper, and arsenic in the runoff may have moved through the soil to the groundwater. However, there was no evidence of an increased level of these contaminants in the groundwater underlying the basins.

It is more difficult to judge exactly what is happening in Basin F, because a 19-year period is covered. Many variables exist which may contribute to the wide discrepancies in the iron and copper results. The accumulated soil load of lead was comparable to the runoff load based on current unit factors. However, due to the more prevalent use of leaded gasoline in the past, historic runoff loads were probably much higher than current levels. If the cumulative runoff load is being substantially underestimated, this would indicate that there may be considerable loss of lead from the basin soils. Loss could be due to both movement through the soil layer to the groundwater and uptake of lead by the vegetation covering this turfed basin.

CHAPTER 7

IMPACTS OF RUNOFF ON WATER SUPPLY AND RECREATION

The effects of the retention of urban storm runoff in recharge basins on groundwater and soils in the Fresno area are discussed in this chapter. The runoff data from the four land use types, rainfall data, and the soil water and groundwater data are compared to the Safe Drinking Water Act (SDWA) criteria and drinking water criteria developed by the California Department of Health Services (DHS) and the Environmental Protection Agency (EPA). The concentrations of several metals and organics in the soil samples are compared to soil criteria for hazardous materials developed by DHS. These comparisons are one method of determining if recharge of urban runoff is adversely affecting groundwater quality underlying the basins and surface soils in the basins used for recreational purposes.

DRINKING WATER IMPACTS

The effects of the retention of urban storm runoff in recharge basins on the quality of the drinking water supply are discussed in this section. The runoff, rainfall, soil water, and groundwater data are compared to drinking water criteria.

Drinking Water Criteria

There are a number of state and federal criteria for metals and organics. The data collected during this program have been compared to the drinking water quality criteria or maximum contaminant levels pursuant to the SDWA. These SDWA criteria are generally similar to the criteria used by the State of California in evaluating water supplies. The data are also compared to DHS Action Levels and EPA Suggested No Adverse Response Levels (SNARLs). These Action Levels and SNARLs are not legally enforceable criteria, but are simply DHS and EPA recommendations on safe levels for drinking water supplies.

Runoff Data. Comparing the quality of urban runoff to the drinking water criteria is not a direct indicator of water supply impacts. The concentrations of most contaminants found in storm runoff will be reduced as the runoff water percolates through the soil layer. Most municipal and industrial water supplies are extracted from depths of up to 400 feet below ground surface. Thus, comparing runoff quality to drinking water criteria represents a "worst case" and is intended primarily to determine what constituents in urban runoff are of potential concern to the groundwater supply.

Table 7-1 presents the SDWA criteria, DHS Action Levels, and EPA SNARLs for parameters that were measured by the U.S. Geological Survey (USGS) or EPA. The maximum and median concentrations of the metals and organics at the industrial site are compared to the criteria in this table. The data from the single-family residential, multiple-family residential, and commercial sites were combined and the maximum and median concentrations were determined. Since the EPA priority pollutant program consisted of only four organics samples and six metals samples at each site, the more comprehensive USGS data are compared to the criteria. In the few cases where parameters were not measured by USGS, the EPA data are presented.

The metals can be divided into several groups:

1. Maximum and median concentrations lower than SDWA criteria: cadmium, copper, zinc, and silver at the industrial site; arsenic, copper, zinc, and silver at the other sites. Since the detection limit for selenium in testing done by the EPA contract laboratories (25 ug/l) exceeds the criterion (10 ug/l), it is not possible to determine if selenium meets the criterion.

2. Median concentration lower than SDWA criterion, but maximum concentration exceeds criterion: arsenic, chromium, and mercury at the industrial site; cadmium, chromium, and mercury at the other sites.

3. Maximum and median concentrations exceed the SDWA criteria: lead, iron, and manganese at the industrial and other sites.

Most of the metals exceed the SDWA criteria by a small amount; however, iron, manganese, and lead significantly exceed the criteria. The criteria for iron and manganese are based on taste and odor concerns, while the criterion for lead is based on health effects. The EPA is currently in the process of reviewing the SDWA criteria. They are considering revising the cadmium and lead criteria downward. The maximum concentration of cadmium at the residential and commercial sites exceeds the current criterion. The maximum and median lead concentrations at all sites exceed the current criterion. When the cadmium and lead criteria are revised, they should be compared to lead and cadmium groundwater concentrations to reassess the potential impact of these metals on the drinking water supply.

Table 7-1. Comparison of Runoff Quality with Drinking Water Criteria and Action Levels

Constituent	Data source	Criterion ug/l	Industrial site concentration, ug/l			Other sites concentration, ug/l		
			N[a]	Maximum	Median	N[a]	Maximum	Median
SDWA constituents[b]								
Arsenic	USGS	50	107	67	14	246	17	2
Cadmium	USGS	10	70	4	1	133	12	1
Chromium	USGS	50	86	51	14	186	62	10
Copper	USGS	1,000	86	400	66	185	380	18
Lead	USGS	50	107	360	74	249	2,100	140
Mercury	USGS	2	107	2.5	0.1	247	8.6	0.1
Zinc	USGS	5,000	86	3,100	535	185	3,400	150
Iron	USGS	300	107	62,000	9,000	250	72,000	2,900
Manganese	USGS	50	37	1,600	360	116	1,700	190
Selenium	EPA	10	6	<25	<25	18	<25	<25
Silver	EPA	50	6	<10	<0.5	18	<10	<0.5
Lindane	USGS	4	19	0.27	0.03	67	0.06	0.01
Endrin	USGS	0.2	19	0.01	<0.01	67	0.01	<0.01
Methoxychlor	USGS	100	19	0.04	<0.01	67	0.19	<0.01
Silvex	USGS	10	19	0.07	<0.01	65	0.03	<0.01
Toxaphene	USGS	5	19	1.0	<0.01	67	1.0	<1.0
2,4-D	USGS	100	19	3.2	0.03	65	3.7	0.04
DHS action level constitutents[c]								
DBCP	USGS	1.0	7	0.005	<0.003	19	0.01	<0.003
Carbon tetrachloride	EPA	5.0	4	<10	<10	12	<10	<10
Tetrachloroethylene	EPA	4-40	4	<10	<10	12	<10	<10
Trichloroethylene	EPA	5-50	4	<10	<10	12	<10	<10
EPA SNARL constituents[d]								
Carbon tetrachloride	EPA	200/—[e]	4	<10	<10	12	<10	<10
Tetrachloroethylene	EPA	2,300/20[e]	4	<10	<10	12	<10	<10
Trichloroethylene	EPA	2,000/75[e]	4	<10	<10	12	<10	<10
1,1-Dichloroethylene	EPA	1,000/70[e]	4	<10	<10	12	<10	<10
Trans-1,2-dichloroethylene	EPA	2,700/—[e]	4	<10	<10	12	<10	<10
Chlordane	USGS	63/8[e]	19	0.3	<0.1	65	1.2	0.1
1,1,1-Trichloroethane	EPA	—/3,300[e]	4	<10	<10	12	<10	<10
Dichloromethane	EPA	13,000/150[e]	2	<10	<10	5	<10	<10

[a]N is the number of samples analyzed.
[b]SDWA = Safe Drinking Water Act.
[c]DHS = California Department of Health Services.
[d]SNARL = Suggested No Adverse Response Level.
[e]The first number represents a one-day average concentration and the second number represents a long-term average concentration.

All measurements of lindane, endrin, methoxychlor, silvex, toxaphene, and 2,4-D were substantially less than the SDWA criteria. Similarly, all measurements of DBCP were substantially less than the DHS Action Level. It is not possible to determine if the DHS Action Levels for carbon tetrachloride, tetrachloroethylene, and trichloroethylene are met because the action levels are lower than the detection limits for these constitutents in testing done by the EPA contract laboratories. For example, the detection limit for tetrachloroethylene is 10 ug/l, which is higher than the low end of the criterion range. None of the EPA SNARLs are exceeded at any of the sites.

Rainfall Data. Table 7-2 compares rainfall data with SDWA criteria. The maximum and median concentrations of the metals and organics which were tested are presented for the three precipitation sites. As in the case of runoff, these comparisons are not a direct indicator of water supply impacts. However, these comparisons are useful in identifying constituents of potential concern.

None of the median metal concentrations exceeded SDWA criteria. However, the maximum concentrations of lead and manganese exceeded the SDWA criteria at the single-family residential and industrial sites, and the maximum concentrations of iron exceeded the SDWA criterion at all three sites. The concentrations of lindane, methoxychlor, and 2,4-D were less than the SDWA criteria.

Soil Water and Groundwater Data. Table 7-3 presents the SDWA criteria for eight metals and the maximum and median concentrations of these constituents in the soil water and groundwater at the five recharge test basins. Approximately 10 to 20 samples were analyzed for arsenic, copper, iron, and lead. One to three samples were analyzed for the other metals. The median and maximum concentrations of these metals in both the soil water and the groundwater at the five sites are substantially less than the criteria. The maximum concentration of arsenic was 10 ug/l compared to the criterion of 50 ug/l. The maximum concentration of copper was 81 ug/l compared to the criterion of 1,000 ug/l. The maximum concentration of iron was 60 ug/l compared to a criterion of 300 ug/l. The maximum concentration of lead was 6 ug/l compared to a criterion of 50 ug/l. Based on the limited data collected, the maximum concentrations of the other metals were significantly lower than the criteria, with the exception of mercury, which was measured at a concentration half the criterion. Additional mercury monitoring should be conducted. Even if the SDWA criteria for cadmium and lead are revised downward, the concentrations in soil water and groundwater will likely still be lower than the criteria.

Table 7-2. Comparison of Precipitation Quality with Drinking Water Criteria

Constituent	SDWA criterion,[a] ug/l	Concentration, ug/l					
		Single-family residential		Industrial		Laboratory	
		Maximum	Median	Maximum	Median	Maximum	Median
Arsenic	50	<1	<1	<1	<1	1	<1
Cadmium	10	1	<1	1	<1	—	—
Chromium	50	<1	<1	<1	<1	<1	<1
Copper	1,000	6	4	12	6	8	2
Lead	50	61	8	51	7	44	5
Mercury	2	0.1	0.1	0.2	<0.1	0.1	<0.1
Zinc	5,000	60	60	90	55	30	20
Iron	300	1,400	90	2,800	130	1,300	80
Manganese	50	60	10	80	10	40	10
Lindane	4	0.02	0.01	0.04	0.01	0.01	0.01
Methoxychlor	100	0.05	<0.01	0.12	<0.01	0.04	<0.01
2,4-D	100	0.04	<0.01	0.08	<0.01	0.04	<0.01

[a]SDWA = Safe Drinking Water Act.

Table 7-3. Comparison of Soil Water and Groundwater Quality with Drinking Water Criteria

Constituent	SDWA criterion, ug/l	Sampling medium	Concentration, ug/l									
			Basin F		Basin G		Basin M		Basin EE		Basin MM	
			Maximum	Median	Maximum	Median	Maximum	Median	Maximum	Median	Maximum	Median
Arsenic	50	Soil water	4.0	<1	—	—	5.0	<1	4.0	<1	5.0	<1
		Groundwater	6.0	<1	9.0	<1	8.0	<1	10	<1	2.0	<1
Copper	1,000	Soil water	81	6.4	—	—	42	42	30	7.9	60	18
		Groundwater	16	3.0	75	20	23	2.8	11	2.0	21	3.0
Iron	300	Soil water	15	4.0	—	—	<6.0	<6.0	60	6.5	11	3.5
		Groundwater	19	3.5	21	4.0	9.0	4.5	15	7.0	7.0	1.0
Lead	50	Soil water	6.0	<1	—	—	<2	<2	3.0	<1	4.0	2.0
		Groundwater	1.0	<1	2.0	<1	6.0	<1	2	<1	<1	<1
Cadmium	10	Soil water	<1	<1	—	—	—	—	—	—	<1	<1
		Groundwater	<1	<1	<1	<1	<1	<1	—	—	<1	<1
Chromium	50	Soil water	0.5	0.3	—	—	—	—	—	—	0.4	0.4
		Groundwater	0.5	0.5	0.3	0.3	0.3	0.3	—	—	0.1	0.1
Mercury	2	Soil water	0.2	0.2	—	—	—	—	—	—	<0.2	<0.2
		Groundwater	0.2	0.2	1.0	1.0	<0.2	<0.2	—	—	0.4	0.4
Zinc	5,000	Soil water	10	<10	—	—	—	—	—	—	90	90
		Groundwater	<10	<10	20	20	20	20	—	—	20	20

As discussed in Chapter 5, soil water and groundwater samples were analyzed extensively for numerous pesticides. Diazinon was the only pesticide that was detected. Three samples of approximately a total of 80 had concentrations that were 0.3 ug/l or less. At this time, a drinking water criterion for diazinon has not been established. A few water samples were also analyzed for semi-volatile organics using EPA method 625. None of semi-volatile organics were at concentrations greater than the detection limits which ranged between 10 and 25 ug/l.

Impacts on Drinking Water

The main objective of the Fresno NURP project has been to determine the present impact of recharge of urban runoff on the quality of the groundwater supply. Future impacts have also been addressed, but at the outset of the project it was recognized that projecting future impacts would be difficult due to the complex factors influencing contaminant migration. Existing and future impacts are decribed in this section.

Present Impacts. Currently, there are no adverse impacts on the groundwater resulting from recharge of urban storm runoff to the five basins tested. Concentrations of all metals and organic compounds in the soil water and groundwater underlying the five test basins are within the SDWA criteria. It is expected that similar conditions would be found in the groundwater underlying most of the other recharge basins in the District. However, basins serving areas with considerable industrial development may pose a greater threat to the groundwater. While runoff quality was tested by this project at such a site, the basin soils, soil water, and groundwater were not tested and should be the object of future monitoring.

The analysis of data presented in Chapter 5 indicated the possibility that some contaminants may be migrating through the soil layer, particularly in Basin MM with its sandy profile. However, there is no evidence of any accumulation of these compounds in the underlying groundwater. From the standpoint of mineral quality (common cations and anions), recharge of urban storm runoff and summer irrigation water is improving the regional groundwater quality, since the mineral quality of the water being recharged is better than the regional groundwater quality.

Future Impacts. The two main factors that will influence the future effects of recharging storm runoff are (1) changes in the volume and quality of urban runoff and (2) changes in contaminant reduction mechanisms now occurring in the soil layer. Each of these key factors is discussed below.

The recharge basins will continue to receive a load of each constituent each year when the storm runoff enters the basins during the rain season. If soil is not removed from the basins, the accumulated load will increase each year. For example, about 18 percent of the Basin F watershed is currently undeveloped so there is some potential for increased annual loads to this basin. Other watersheds served by District recharge basins are also undergoing development and new areas are being provided with drainage and recharge facilities.

There may also be changes in the quality of runoff water due to changes occurring at the contaminant source. Lead is the best example and is an important issue, since lead is one of the contaminants of most potential concern. Based on the data presented on Figure 6-2, it is clear that the runoff loading rate of lead will continue to decrease in the future as the number of cars which use leaded gasoline decreases. Changes in pesticide use practices may also alter runoff quality. For example, there are now restrictions on the use of some pesticides such as chlordane, which will decrease the amount of these pesticides reaching the recharge basins. Currently, chlordane is used exclusively for subterranean termite control by licensed pest control operators. According to the California Department of Food and Agriculture records, chlordane use in Fresno County is less than 10 percent of that used during the 1970s.

The various mechanisms affecting contaminant migration in soils were reviewed in Chapter 5. Numerous physical, chemical, and biochemical processes influence the contaminant mobility. These processes are affected by certain soil properties, including soil texture, cation exchange capacity, pH, oxygen, and organic matter. These properties are unlikely to change unless modifications are made either to the basins or to current operating practices. However, the key question is whether the removal capabilities of the soil layer will become depleted over time, if current basin operations are maintained. The fact that some of the District's basins (e.g., Basins F and G) have been operated for about 20 years provides some perspective on this question. A reduction in contaminant removal capability, if it occurs at all, will happen gradually. Levels of lead and the other metals in the basins tested are currently several times less than SDWA criteria. None of the organics for which criteria exist have even been detected. Thus, there is a significant margin of safety at present. It is unlikely that recharge will cause adverse impacts on the groundwater supply in the near future for the type of recharge basins evaluated in this study. Continued monitoring of the groundwater underlying the recharge basins would detect changes in groundwater quality well in advance of a problem occurring. However, the potential impacts on groundwater underlying basins serving industrial areas may be somewhat greater.

Because of the importance of protecting the sole source aquifer in the Fresno area, present operational practices of the retention/recharge system should be carefully reviewed to be certain that the risk of adversely affecting the groundwater supply continues to be minimized. Operational and management practices are reviewed in Chapter 8.

RECREATIONAL IMPACTS

Presently 13 of the District's 74 completed basins are available for recreation. Three of these basins have improved baseball diamonds, while the other nine are used for soccer and passive recreation. During these activities, contact with basin soils can occur. Thus, the potential for adverse impacts on recreation has been evaluated. Criteria for various contaminants in soils have been considered in assessing impacts on recreational use.

Soil Criteria

Criteria have been developed by the DHS, Hazardous Waste Management Branch, to determine whether or not waste materials containing metal and organic contaminants are hazardous. They are documented in "A Summary of the Draft California Regulatory Wastes", October 1982. We have discussed with DHS the applicability of these criteria to stormwater recharge basins. DHS staff members indicated that since accumulation of contaminants in recharge basins is not being caused by any specific source and is really a nonpoint source situation, it does not fall under their toxics enforcement program. However, if the material in the recharge basins were to be removed and disposed of, the hazardous waste regulations would then be applicable. DHS staff also stated that if there are levels of contaminants in the basin soils that exceed DHS criteria, DHS would be concerned about potential health impacts and would encourage reasonable management practices to alleviate the potential problem. Based on this guidance received from DHS, we believe it is appropriate to use DHS criteria as a basis for assessing the conditions in the recharge basins.

The DHS soil criteria are presented for soluble materials, expressed as a Soluble Threshold Limit Concentration (STLC), and for solid materials, expressed as a Total Threshold Limit Concentration (TTLC). Because of the nature of soil and plant tissue samples analyzed in this study, and the complete digestion method of analysis used to determine contaminant concentrations in the samples, the TTLC values established by the DHS are appropriate to use for initial evaluations. Data on metal and organic concentrations from regular samples for the five test basins summarized in Chapter 5 are presented in Table 7-4 along with TTLC values for comparison. The following observations can be made:

1. Maximum lead and chlordane concentrations measured in the soil surface (0.00 to 0.02 m) were above TTLC values. Median concentrations were less than TTLC values.

2. Maximum and median surface concentrations of the other metals and organic contaminants were less than TTLC values.

3. Concentrations of all metal and organic contaminants averaged over the surface 0.3 m of the soil column were well below TTLC values (on the order of 1/100th of TTLC values).

The data contained in Table 7-4 are based on soil sampling at a single point in each of the five test basins. The data collected in the spatial survey for lead conducted in Basins F and B/E (see Figure 5-4) provides an indication of how concentrations vary over the entire basin surface. The highest lead concentrations occurred in low spots or close to the outfalls. Cores of the upper 8 cm of soil were collected in the spatial survey. Concentrations for the 0 to 2 cm depth can be estimated using soil profile data collected in this project. It is estimated that the mean and maximum lead concentrations in the 0 to 2 cm depth for the spatial survey would be as follows:

	Lead concentration, mg/kg	
Basin	Mean	Maximum
Basin F		
Upper recreation basin	670	2,500
Lower recharge basin	420	1,600
Basin B/E		
Upper recreation basin	210	2,300
Lower recharge basin	3,500	6,800

The spatial survey data clearly show that there are localized areas within the recreation basins that significantly exceed the TTLC for lead. The highest lead concentration occurred in the low-flow basin in Basin B/E. The low-flow areas in both basins are fenced off and are not used for recreational purposes.

Table 7-4. Comparison of Toxic Constituent Concentrations in Soil Samples with Hazardous Wastes Criteria

Constituent	Sample depth, meters	Concentration[a], mg/kg				TTLC,[b] mg/kg
		Control samples		Basin samples		
		Median	Maximum	Median	Maximum	
Arsenic	0.00 - 0.02	5.4	12.0	11.5	48.0	500
	0.24 - 0.30	2.0	3.2	3.4	8.4	
	2.7 - 3.0	2.5	4.9	2.6	28.0	
Nickel	0.00 - 0.02	20.0	35.0	35.5	83.0	2,000
	0.24 - 0.30	10.0	45.0	10.5	42.0	
	2.7 - 3.0	9.2	23.0	8.2	190.0	
Copper	0.00 - 0.02	16.0	49.0	26.5	79.0	250
	0.24 - 0.30	8.2	25.0	5.4	15.0	
	2.7 - 3.0	13.0	17.0	6.1	49.0	
Lead	0.00 - 0.02	37.0	107.0	740.0	1,600.0	1,000
	0.24 - 0.30	5.1	5.6	6.2	28.0	
	2.7 - 3.0	2.9	6.7	2.6	8.9	
Mercury	0.00 - 0.02	—	—	0.07	0.10	20
Chlordane	0.00 - 0.02	<0.03	<0.03	0.93	2.90	2.5
	0.24 - 0.30	<0.03	0.04	<0.03	<0.03	
	2.7 - 3.0	<0.03	<0.03	<0.03	<0.03	
Lindane	0.00 - 0.02	<0.01	<0.01	<0.01	0.02	4.0
	0.24 - 0.30	<0.01	<0.01	<0.01	<0.01	
	2.7 - 3.0	<0.01	<0.01	<0.01	<0.01	
DDT,DDE	0.00 - 0.02	<0.03	<0.03	<0.03	0.47	1.0
	0.24 - 0.30	<0.03	<0.03	<0.03	<0.03	
	2.7 - 3.0	<0.03	<0.03	<0.03	<0.03	
PCB	0.00 - 0.02	—	—	0.30	0.43	50

[a]Based on samples from all five test basins.
[b]Total threshold limit concentration.

The TTLC of 1,000 mg/kg for lead is for inorganic lead. Apparently, organic lead is much more toxic and thus has a much lower TTLC, 13 mg/kg. Several samples in the spatial survey were checked for organic lead. All samples were less than 1 mg/kg.

Soils samples were not collected from any basins that receive significant drainage from industrial areas. In the runoff monitoring program, USGS did monitor runoff from an industrial area. As reported in Chapter 4, runoff concentrations of several of the heavy metals were higher at the industrial site than the other three sites. It is likely that the concentrations of these metals in the basin soils would be similarly higher.

Impacts on Recreation

Assessing the impacts of contaminated surface soils in recharge basins on recreation is considerably more difficult than assessing the impacts of runoff on groundwater. The drinking water criteria have evolved through extensive research conducted over the past few decades. The DHS soils criteria have been developed quite recently as part of the program to manage hazardous wastes and are continuing to be refined as further research is conducted. Although DHS soil criteria do not directly apply to the recharge basin situation, they are a useful means for judging the relative magnitude of the problem.

Present Impacts. Of all the constituents evaluated, the only two constituents of any real concern are lead and to a lesser degree, chlordane. The primary health impact of these contaminants is through ingestion of soil by children. The potential for soil ingestion during activities in the recreational basins is quite limited, since most of the area is turfed. The infield area in the baseball diamonds is the only significant unturfed area and this soil is periodically removed as part of park maintenance. There are children's playgrounds at some of the recreational basin sites. However, these facilities are located along the outer perimeter of the basin which does not normally receive recharge water.

A second method by which health effects could occur is through dust inhalation. Discussions with DHS staff indicate that inhalation of contaminants such as lead in this situation is of less concern than ingestion. It is difficult to quantitatively estimate the concentrations of contaminants that would be present in the air if the soil in a recharge basin is disturbed. Using a set of fairly conservative assumptions, we have computed the potential atmospheric lead level. Using the maximum lead soil concentration of 1,600 mg/kg, we estimated that dust created from disturbing bare soil would contain a lead concentration in the air of 16 ug/m^3. The OHSA standard for lead exposure for an eight hour occupational exposure is 50 ug/m^3. Thus, the estimated lead level is well within the standard that OSHA uses for worker exposure. The potential risk would be further reduced due to the much shorter exposure period that would occur during recreational activities as compared to continuous worker exposure.

The comparison of soil contaminant concentrations with the soil criteria indicates some potential concern with lead levels. The potential for significant ingestion of soil is remote given the relatively small unturfed area in the recreational basins and the fact that the unturfed areas are not normally used by small children. However, a potential problem does exist, and the District should manage and operate the basins in a manner that minimizes the health risk. These issues are further discussed in Chapter 8.

Future Impacts. Future impacts on recreational use will be affected by runoff loading changes, as discussed in the section on drinking water impacts. The runoff concentrations of the two constituents of primary concern to recreation, lead and chlordane, have been decreasing and will continue to decrease in the future. A reduction in the number of automobiles using unleaded gasoline will reduce lead concentrations in runoff. The restricted use of chlordane will similarly reduce chlordane concentrations in runoff as compared to historic levels. Thus, the impacts of soil contaminants on recreation are not likely to increase in the future.

CHAPTER 8

MANAGEMENT PRACTICES

The Nationwide Urban Runoff Program (NURP) was designed to evaluate a range of best management practices for dealing with stormwater runoff. Each NURP project analyzed one or more specific management practices. Several projects evaluated the effectiveness of street sweeping. Other projects investigated catch basin cleaning, detention basins, grassed swales, overland flow wetlands, and other treatment methods. The management practice being tested in the Fresno NURP project is the use of recharge basins as a method for management of stormwater. Thus, the existing system of retention/recharge basins has served as a management practice, in contrast to many of the other projects where special facilities were constructed and operated or where drainage and runoff conditions were controlled to test a particular methodology.

This chapter evaluates the current operation of the retention/recharge system in view of the results found in this investigation. Since our assessment concluded that there is some potential for adverse environmental impacts, several modifications to the present operation and some source control methods are also discussed.

CURRENT PRACTICE

Stormwater management in the Fresno metropolitan area is complicated by the fact that there are no significant watercourses passing through the area to which storm runoff can be discharged. Therefore, the Fresno Metropolitan Flood Control District (District) has developed a system of retention/recharge basins to handle runoff during storm periods. The system has a dual purpose: it services drainage needs, and at the same time water is recharged to the groundwater, which is the sole source of water supply for the region.

The District currently has 74 basins that are completed or are in various stages of excavation. The land has been purchased for twelve additional basins. More basins will be added to the system as new areas develop. Key features of the existing basins are summarized in Table 8-1. The table includes all acquired basin sites that will, in the future, be used for recreation, have a low-flow area, or have on-peak pumping relief.

Table 8-1. Features of Existing Retention/Recharge Basins

Basin feature	Number of basins[a]			
	Existing recreation	Future recreation	Non-recreation	Total
All basins	13	37	36	86
Existing turfed basins	13	0	1	14
Low-flow area				
Existing	10	13	2	25
Future	0	23	3	26
Existing pumpout capability[b]				
To canal	5	2	3	10
To another basin	3	2	2	7
Proposed pumpout capability				
To canal	(1)[c]	2	4	5
To another basin	4	3	7	14
More than half of drainage area is zoned industrial	1	5	15	21

[a]Includes all basins acquired to date of this report.

[b]Pumpout capability refers only to those basins requiring on-peak pumping.

[c]The water from one basin that is currently pumped to a canal will be pumped to another basin when construction of the basin is completed.

There are two primary types of basins: turfed and unturfed basins. There are 14 turfed basins, and 13 of these basins are used for recreation during the dry weather season. Three of the turfed basins have improved baseball diamonds, while the other turfed basins are used for soccer and passive recreation. The remaining 73 basins are currently unturfed and are used strictly for recharge. A number of the non-recreational basins also receive irrigation water from the Kings River during the summer for recharge. Kings River water is diverted into the Fresno Irrigation District canal system and is then conveyed into the recharge basins that are located adjacent to the irrigation canals. As much as 12,000 acre-feet of irrigation water is recharged annually.

There are two particular features of some of the recharge basins that significantly affect system operation and in turn have important water quality implications: the low-flow basin and pumpout capability.

Low-Flow Basin

Twenty-five basins now have a low-flow basin at the recharge site. There are plans to provide an additional 26 basins with a low-flow area. The low-flow basin is generally at least 10 feet below the elevation of the upper basin. The low-flow basin concept was primarily developed for use with the recreational basins. During the summer, runoff water from lawn sprinkling, or nuisance runoff, that enters the drainage system can be contained in the small low-flow basin. Thus, it is possible to keep the upper basin dry and available for recreation.

During the winter, the low-flow basin receives runoff water first. As the low-flow basin fills, the influent drainage pipe will surcharge and water will eventually back-up and flow into the upper basin. Thus, in small winter storms, the low-flow basin may capture a large portion of the storm volume. The exact volume that the low-flow basin can handle will depend on the recharge characteristics as well as the design size of the specific basin.

The low-flow basin is very important from a water quality standpoint. As discussed in Chapter 4, many contaminants in storm runoff are at their highest concentrations during the beginning of a storm when the "first flush" occurs. Thus, the most concentrated material is contained in the low-flow basin, while the flow reaching the upper recreation basin is considerably less contaminated.

In Chapter 4, a tabulation of the portion of the metals in runoff occurring in the particulate and dissolved forms was developed (Table 4-9). The particulate fraction of most metals was generally much larger than the dissolved fraction. For example, more than 75 percent of the aluminum, chromium, iron, and lead was in the particulate form at all four sampling sites. Thus, it would be expected that metals concentrations in the surface soils in the low-flow basin would be higher than the levels found in the upper basin. The results of the spatial lead survey presented on Figure 5-4 confirm this relationship. In Basin B/E, lead concentrations in the soil of the low-flow basin were at least several times higher than the concentrations in the upper basin. This difference in lead concentration did not occur in Basin F, probably because there is only a 2-foot differential in elevation between the upper and lower basins.

Some of the low-flow basins, as well as other recharge basins in the system, have man-made sandy recharge areas. These areas were added to increase the recharge rate. However, these sandy soils are less capable of removing most contaminants than soils with a higher proportion of silt and clay or soils with more organic material.

Pumpout Capability

Fifteen basins now have, or there are plans to provide, capability to pump runoff water on peak from the basin into a nearby irrigation canal. For 21 other basins, on-peak runoff can now be pumped, or will be able to be pumped in the future, to another recharge basin. Pumping has been provided to improve flood control capability and facilitate dewatering. The extent of pumping is limited by the available capacity in irrigation canals and other District basins to which flow can be transferred. Generally, pumps are activated as soon as runoff reaches the basin. There are no records of the pumping volumes, but District staff indicate that the portion of the runoff that is pumped out can range from as little as 1 percent in Basin MM to as much as 20 percent in Basin F.

Like the low-flow basin, on-peak pumping has significant water quality implications. If pumping is initiated when runoff first occurs, the "first flush" material with the highest contaminant concentrations is being removed, although some material may settle to the basin bottom. This material is either being transferred to another basin or is being conveyed to irrigation canals. The potential impact of the water pumped from the recharge basins to the irrigation canal system has not been evaluated as part of the Fresno NURP project.

Other Operational Practices

The District now removes deposited material from the basins on an as-needed basis. A number of the basins have periodically had material removed primarily for the purpose of improving the recharge rate. For example, the low-flow area in Basin M has been dewatered and cleaned out on two occasions during the 15 years it has been in operation. The material removed has generally been used for fill on site in the freeboard area or on nearby lands.

The unturfed basins that receive summer irrigation water have sometimes been subject to surface sealing of the basin bottom due to erosion of fine material from the side slopes. Therefore, these basins are scraped approximately once per year to improve percolation. In addition, the side slopes are disked for weed control.

MODIFIED PRACTICES

The impacts of the current operation of the retention/ recharge system were discussed in Chapter 7. In terms of the groundwater underlying the five basins tested, stormwater recharge has had no adverse effects. All measurements of soil water and groundwater were within the drinking water standards. However, no groundwater measurements were made at basins receiving a significant amount of drainage from industrial areas. Runoff in these two cases theoretically would pose a greater threat to the groundwater than the five basins which were sampled.

In terms of recreational uses of the basins, quantifying impacts are difficult. The Department of Health Services (DHS) soil criteria for hazardous wastes can be used as a general guideline. Comparison of surface soil concentrations with these soil criteria indicates that in localized areas (low spots, near outfalls, and in the low-flow basins) there are some surface soils that exceed the DHS criteria for lead and chlordane. The significance of these concentrations is uncertain, since exposure is minimal due to the turf layer in the recreational basin.

Although there are no apparent impacts on water supply and the significance of the limited violations of the soil criteria are uncertain, some modifications to the District's current system procedures are warranted to insure a future which continues to be free of impacts. Certain operational modifications and management practices can be implemented to minimize the risk of future impacts. This section describes modifications to current practices, and the next section describes source controls.

Table 8-2 summarizes the management practices that have been evaluated. The following basin modifications have been considered:

1. Providing additional low-flow basins.
2. Removing basin soils.
3. Providing additional pumpout capability.
4. Turfing unturfed areas.

The need for continued monitoring is identified in Table 8-2. Recommended areas of future monitoring are delineated in Chapter 9.

Low-Flow Basins

The low-flow basin concept provides an excellent means of containing the "first flush" from urban runoff. Twenty-five recharge sites now have low-flow basins. Additional low-flow facilities should be provided in two particular situations. First, any recreational basins that do not currently have a low-flow basin should be provided with one. This will provide considerable protection for the portion of the basin that is

Table 8-2. Alternative Management Practices

Practice	Needed to protect: Drinking water	Needed to protect: Recreation	Purpose	Advantages and disadvantages	Recommendation
I. Basin Modifications					
A. Add low-flow basin to all present and future recreation basins.		X	"First flush" will go to low-flow basin. Thus, contaminant concentration in recreational basin will be lower.	Practical to provide since low-flow basins are also desirable to prevent summer irrigation runoff from entering recreational basin.	This measure is highly cost-effective and should be implemented.
1. Periodically cleanout solids accumulation.	X		Cleaning will reduce potential leaching of concentrated material to groundwater.	Material will have to be hauled to hazardous waste disposal area.	Periodic basin cleaning should be done on a frequency dictated by periodic sampling and buildup curve data.
B. Provide low-flow basin for areas with significant industrial development.			Provide means of containing potentially hazardous material.	These measures are highly desirable to protect against a significant potential hazard.	Implement.
1. Periodically cleanout solids accumulation.	X		Prevent percolation of hazardous material.	These measures are highly desirable to protect against a significant potential hazard.	Implement.
2. Line low-flow basin if warranted based on soil and water sampling data.	X		Prevent percolation of hazardous material.	Expensive, so should be based on sampling results and compared to upstream source controls.	Assess the need on a case-by-case basis
C. Seal off recharge wells located in low-flow basins.	X		Prevent percolation of hazardous material.	Some loss in recharge capability. Desirable to protect water supply.	Implement.
D. Periodically remove surface soils from all basins.	X	X	Remove contaminants that may leach to groundwater.	High cost (approximately $50,000 per basin). May be removing organic material that helps remove contaminants.	Implement for recreational basins only in accordance with additional soils sampling.
E. Periodically remove solids that deposit near outfalls in recreation basins.	X	X	Remove material that is likely to have highest contaminant levels.	Could be easily added to annual maintenance of basins, although disposal would be to hazardous waste disposal site.	Implement.

Table 8-2. Alternative Management Practices, continued

Practice	Needed to protect: Drinking water	Needed to protect: Recreation	Purpose	Advantages and disadvantages	Recommendation
F. Provide ability to pump out low-flow basin to irrigation canal where location allows.	X	X	Prevent "first flush" material from accumulating in recharge basins.	Not desirable to pump out "first flush" material since this would just move the material to downstream waters.	Evaluate ways of modifying pumping operation to minimize "first flush" pump-out.
G. Turf all unturfed basins.	X		Improve contaminant removal capability.	Cost would be significant. There may be some reduction in percolation rate.	Not justified at this time.
H. Turf unturfed areas of recreational basins or remove soil regularly.		X	Minimize opportunity for solids ingestion and inhalation.	Minimal cost. Turfing baseball diamonds would lessen desirability to play.	Implement regular soil removal based on contaminant buildup curve.
<u>II. Source Controls</u>					
A. Late summer street sweeping.	X	X	Remove street accumulation prior to initial fall storms.	Other NURP projects had mixed opinions of effectiveness of street sweeping. Current sweeping in the metropolitan area is quite limited.	Not recommended except as an incremental benefit of any sweeping done for aesthetic purposes.
B. Have industry contain and/or pretreat runoff from portions of their site that may contain toxic material.	X		Remove contaminants at the point of origination.	Requires monitoring to be sure upstream controls are working.	This approach should be adopted as a policy, but implemented on a case-by-case basis in accordance with sampling data.
<u>III. Monitoring</u>					
A. Long-term monitoring of basin soils and groundwater.	X	X	Early detection of contaminant buildup.	Essential to environmental protection.	Implement.
B. Hazardous spills.	X	X	Prevent contaminants from reaching basins.	Highly desirable to protect against potential health hazard.	Participate in county spill control program.

used for recreation. Secondly, a low-flow facility should be provided or more frequent basin cleaning should be implemented in drainage areas where a significant amount of the contributing area will be developed for heavy industrial purposes (e.g., chemical storage or transfer, petroleum, and some manufacturing operations). In terms of existing basins serving industrial areas, the need for a low-flow basin should be assessed by either a detailed field inspection of the land area or a runoff monitoring program. In some industrial situations, it may be necessary to provide the low-flow basin with a protective lining, so industrial contaminants will not percolate into the groundwater. The need for lining should be based on runoff monitoring.

The solids accumulations in the bottom of the low-flow basins should be periodically removed to prevent the leaching of this concentrated material into the deeper soils and ultimately to the groundwater. It is likely that concentrations of some constituents in the soil will exceed DHS soil criteria and, therefore, the soil will have to be hauled to a hazardous waste disposal site. Alternatively, the material could be removed and used as fill material before it reaches hazardous levels. Consideration should also be given to sealing off recharge wells in low-flow basins.

Removing Basin Soils

The sampling conducted in this project showed that many of the metals and organic compounds present in urban runoff were detected in the surface soil layer in the recharge basins. Lead and chlordane were the only two constituents that were found to exceed the DHS soil criteria in a limited number of samples. The spatial survey performed in Basin F gives a good indication of the distribution of lead in the surface soils. Figure 8-1 denotes the areas within the basin where the lead concentration exceeded the DHS total threshold limit concentration (TTLC) for lead. Approximately 1 acre or about 16 percent of the combined area of the upper and lower basins had lead concentrations that exceeded the TTLC. An elevation profile for this basin was presented in Chapter 5.

Based on the lead distribution on Figure 8-1, a preliminary estimate of the cost to remove the contaminated soil has been prepared to illustrate the range of cost for this management practice. Costs were developed for two alternative methods of soil removal. The first alternative deals only with the affected areas down to the depth where the lead exceeds 1,000 mg/kg. Costs include excavation, hauling, disposal (as hazardous waste), refill, leveling, sprinkler installation, and revegetation. Construction cost by this method would be about $20,000. It is probably not practical to excavate such exact

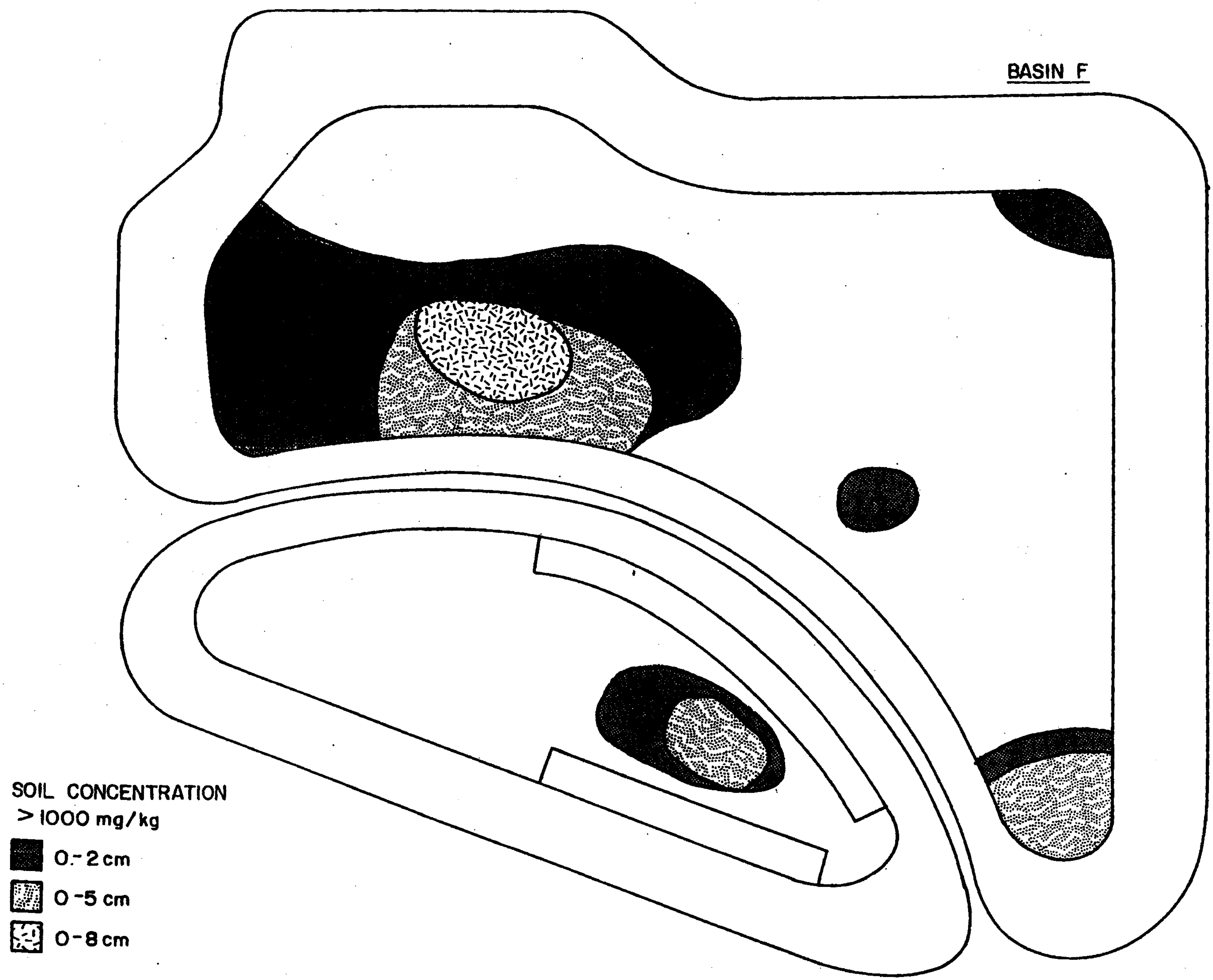


Figure 8-1 Comparison of Lead Concentration with Soil Criterion

volumes, so a second approach was considered. This approach is similar to the first, except that 1 inch is removed from the entire site in addition to the affected areas. This alternative produces a construction cost of approximately $75,000. In both cases, the disposal cost of contaminated soil is over 50 percent of the total construction cost.

Based on the spatial survey results for Basin F and Basin B/E, it is likely that there are at least some limited areas where lead exceeds the TTLC in the other recreational basins. Thus, it is recommended that the turf and upper soil layer from the recreation basins be removed as required to maintain soil standards. Spatial sampling of the type conducted in Basin F and Basin B/E should be performed to define the extent of soil removal required. Basins with the highest contaminant levels should be dealt with first. It is expected that the greatest amount of material will have to be removed from the oldest recreational basins that do not have a low-flow area. Newer recreational basins that have a low-flow area will likely have the smallest areas of soil contamination. Based on the sharp reduction in the use of chlordane and the amount of lead in gasoline, the two elements of most concern, it is possible that removal of surface soils may not be required again in the future. It would be prudent to study basin maintenance practices to determine which scraping techniques are most effective in removing basin contaminants, and which are best able to remove silts, and, thus, improve percolation.

We do not believe removal of surface soils from non-recreation basins need be mandatory at this time. There has been no deterioration of groundwater quality underlying any of the recharge basins tested. If future monitoring indicates a downward trend in groundwater quality, removal of surface soils could be considered at that time.

Pumping Capability

The pumpout capability that now exists in some basins provides a means of removing "first flush" runoff material from those basins. This is a positive step in terms of minimizing impacts on both water supply and recreation. However, the material pumped out of the basin eventually reaches the San Joaquin River. The possible impacts of urban runoff on the San Joaquin River have not been evaluated as part of this study.

From a standpoint of managing stormwater runoff contaminants, containment of "first flush" materials in low-flow basins is better than discharging the materials to the river system. However, pumping capability is very important to the District for drainage control purposes. There are a number of ways that current pumping operations could be modified to reduce potential downstream impacts. The pump intake could be raised or pump settings could be adjusted, so that the first flush material is not pumped. A dual-compartment basin could be designed in future basins. Flow would enter the first basin and then overflow into the second basin. "First flush" solids would accumulate in the first basin, and runoff water could be pumped out of the second basin. Further evaluation of the engineering design features of future recharge basins is needed before specific modifications can be recommended.

Additional Turfing

Turfing over unturfed areas at recreational basins would reduce the potential for public contact with contaminants present in surface soils. Alternatively, the surface soil layer could be periodically removed, since the unturfed areas are quite small. The frequency of removal should be based on periodic monitoring to define contaminant buildup curves.

SOURCE CONTROLS

There are two source control measures that have been considered: street sweeping and upstream controls at industrial areas.

Street Sweeping

Street sweeping was not evaluated as part of the Fresno NURP project. Limited street particulate data were collected at the four U.S. Geological Survey (USGS) sites which indicated the presence of most heavy metals and several organic constituents. Five of the 28 NURP projects had the evaluation of street sweeping as a central element of their work plans. These projects were at the following locations: Castro Valley, California; Milwaukee, Wisconsin, Champaign-Urbana, Illinois; Winston-Salem, North Carolina; and Bellevue, Washington. Four of these projects concluded that street sweeping was not effective as a management practice to control pollutants in urban runoff. The fifth project (Castro Valley), which has pronounced wet and dry seasons, showed that sweeping just prior to the rainy season could produce some benefit. However, the Final NURP Report by the U.S. Environmental Protection Agency cautions that even in areas with distinct wet and dry seasons, the effectiveness of street sweeping should be closely evaluated on a case-by-case basis.

Since Fresno does have distinct wet and dry seasons, street sweeping in the late summer or early fall could possibly provide some benefit. The current street sweeping program in the

Fresno-Clovis metropolitan area is fairly limited. Because of the uncertainties of street sweeping effectiveness, it would probably not be worthwhile to expand the existing street sweeping program in Fresno for the sole purpose of urban runoff pollutant control. Current sweeping done for aesthetic purposes in the late summer or early fall may provide some limited water quality benefit.

Industrial Controls

The runoff sampling conducted by USGS indicated that for many constituents the concentrations were highest in the runoff from the industrial site. This is not surprising since there are numerous potential contaminant sources in this industrial area which included cotton mills, food processing, petroleum operations, chemical storage, carpet manufacturing, and light trucking. Without additional monitoring, it is impossible to determine the exact source of the various contaminants detected in the runoff.

Industrial areas, such as the one studied in this program, are the most significant potential source of urban runoff contaminants. As recommended previously, the District should provide a low-flow basin at all recharge sites that receive a significant amount of industrial drainage, or existing basins should have soils regularly removed. In addition, consideration should be given to having industries contain or pretreat runoff from portions of their site that may contain toxic material. Decisions to have upstream source control provided at industrial sites need to be developed on a case-by-case basis, since the types and magnitude of contaminants from industrial sites can vary widely. Additional runoff monitoring at existing industrial sites should be conducted cooperatively between the District and the Central Valley Regional Water Quality Control Board.

With regard to future industrial development, the District should work together with other local agencies (e.g., planning and building departments) to be certain that water quality aspects are adequately considered in the review process for industrial developments. In this way, provisions can be made to control potential runoff contaminants at the source.

CHAPTER 9

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are based on the work conducted for the Fresno Nationwide Urban Runoff Program (NURP) project.

CONCLUSIONS

Conclusions are presented in three groups: urban runoff, soils and groundwater, and impacts on water supply and recreation.

Urban Runoff

The following conclusions are based on the results presented in Chapter 4.

1. Urban storm runoff contains significant levels of many contaminants including most heavy metals and some organic compounds.

   All of the priority pollutant metals except cyanide and 19 of the 34 organic constituents tested were detected in at least one runoff sample. Constituents which have runoff concentrations significantly higher than the regional groundwater include lead, zinc, copper, mercury, iron, and manganese.

2. Urban storm runoff is better in quality than the Fresno regional groundwater for some constituents, particularly minerals and nutrients.

   The runoff concentrations of most of the common cations and anions that were measured are less than the concentrations in the regional groundwater. For example, the mean specific conductance in runoff from the residential and commercial sites is about 70 umhos/cm compared to a mean of over 300 umhos/cm in 46 city of Fresno wells. Thus, from the standpoint of mineral quality, recharge of urban storm runoff is improving the regional groundwater quality.

3. <u>Rainfall contributes a significant portion of the pesticides measured in runoff</u>.

   Fourteen organic compounds, including 11 pesticides, were detected in rainfall samples. The most prevalent pesticides were parathion, malathion, and diazinon. Their presence in rainfall is probably due to their use in the agricultural area around Fresno. These pesticides are present in low concentrations and none of them have shown up in the groundwater underlying the recharge basins, except traces of diazinon in a few samples.

4. <u>The industrial area had the worst runoff quality of the four land use types evaluated</u>.

   For the 62 non-pesticide constituents monitored, concentrations were statistically highest in runoff from the industrial site for all but 10 constituents. Concentrations in the industrial runoff fluctuated greatly during storms, and numerous unexplained concentration spikes were monitored. Concentrations at the other three sites (single-family residential, multiple-family residential, and commercial) were very similar for most constituents.

5. <u>Runoff concentrations over the course of a storm event at the non-industrial sites followed the traditional "first flush" concept</u>.

   The highest concentrations for most constituents from the non-industrial sites occurred during the initial storm runoff and then decreased throughout the remainder of the storm, independent of hydraulic conditions. Metal concentrations were also high during initial runoff, but also increased as flow increased.

6. <u>There are significant seasonal variations in runoff quality that must be considered in developing management practices</u>.

   The event mean concentration (EMC) for most constituents for all but the industrial site was highest for the first two or three storms of the year. The EMC was then relatively constant for the remainder of the rain season. (The term EMC refers to either a flow-weighted composite sample or a flow-weighted calculation of sequential discrete samples.) The EMCs at the industrial site were generally high for the first storm, but then declined uniformly throughout the rain season. This seems to indicate that an entire rain season is required to wash off dry season pollutant buildup from the industrial site, while wash off occurs during the first two or three storms at the other sites.

Soils and Groundwater

The following conclusions are based on the results presented in Chapter 5.

1. During recharge, basin soils provide a high degree of removal of storm runoff contaminants, thus protecting groundwater quality.

   Heavy metals and organic compounds present in runoff appear to be removed by basin soils, although there is some limited evidence of migration of some metals to deeper soils. No contamination of soil water or groundwater underlying the recharge basins has occurred in any of the five basins studied. The concentrations of all heavy metals in groundwater samples were similar to the levels found in the regional groundwater quality. None of the pesticides and other organic compounds, for which water samples were analyzed, were detected except diazinon which was found in trace amounts in three samples. This means that any other organic compounds, if they were present at all, were present at levels less than the analytical detection limits employed. Detection limits for specific compounds are listed in Appendix B.

2. Contaminants accumulate in the surface soils and lead concentrations vary spatially as a function of basin topography and outfall locations.

   The surface distribution of lead was determined through a spatial survey of two recharge basins. The highest lead concentrations occurred at low spots in the basin close to the basin outfalls. In the basin that has a low-flow area located 20 feet lower than the upper basin, lead concentrations in the soil were several times higher in the lower basin. Spatial surveys of other metals were not conducted.

3. Recharge of imported surface water is not presently having any adverse effect on groundwater quality, although some leaching of the basin soils is occurring.

   Imported surface water from the Kings River, which is recharged in a number of basins during the spring and summer months, is of excellent quality and thus improves the regional groundwater quality. The soil data were analyzed to determine whether the movement of large volumes of water could be leaching any compounds from the soils. For most of the cations and anions, concentrations tended to be slightly less in basins receiving summer recharge, possibly indicating some leaching. Comparison of soils samples collected before and after the summer recharge period indicates the possibility of some slight downward migration of lead due to summer recharge. Additional data are needed to confirm whether this is true.

4. There appears to be a correlation between the degree of removal of metals and the proportion of silt plus clay and organic matter in the surface soils.

   Soils containing a higher percentage of silt plus clay and organic matter have higher cation exchange capacities and should be able to better attenuate migrating contaminants. This appears to be true in the basins studied, although it cannot be conclusively proven because of variations in basin age and the fact that the two unturfed basins evaluated are the ones that receive summer irrigation water.

Impacts of Runoff

The following conclusions are based on the results presented in Chapter 7.

1. Currently, there are no apparent adverse impacts on the groundwater resulting from recharge of urban storm runoff.

   Concentrations of all metals and pesticides in the soil water and groundwater underlying the five test basins are within the Safe Drinking Water Act criteria. Two of the basins tested have been in operation for more than 20 years. Similar water quality conditions are probably present in most of the other recharge basins operated by the Fresno Metropolitan Flood Control District (District). However, one situation where storm recharge could pose a potential threat to the groundwater was not evaluated in this program: a basin serving an area that has a significant amount of industrial development.

2. It is unlikely that recharge to basins similar to those tested in this program will cause adverse impacts on the groundwater supply in the near future.

   Levels of heavy metals are currently several times less than SDWA criteria, and none of the organics for which criteria exist were ever detected. Thus, there is a significant margin of safety at present. Continued monitoring of the groundwater underlying the recharge basins would detect changes in groundwater quality well in advance of a problem occurring.

3. <u>Lead levels in the surface soils of localized areas in some of the recharge basins exceed Department of Health Services (DHS) soil criteria and thus require appropriate management in basins used for recreation</u>.

   In low spots in the basins close to outfalls, lead concentrations in the surface soils (upper 1 to 2 inches) exceed the DHS criteria of 1,000 mg/kg for lead. For the two recreational basins in which spatial testing was done, the maximum lead concentration was between 1,600 and 2,300 mg/kg. Lead concentrations throughout most of the recreational basins are well under 1,000 mg/kg. The primary public health concern for lead is ingestion of soil. The opportunity for soil ingestion in the District's recreational basins is limited, since the recreational basins are entirely turfed with the exception of the baseball diamond infields in three basins. Also, the maximum concentration areas are not in the high exposure area of the infield. The impact of inhalation of dust particles containing lead was preliminarily assessed and this does not appear to be a problem based on comparison with the worker exposure criterion for lead.

4. <u>Certain modifications to the District's current procedures are warranted to insure a future which continues to be free of adverse impacts</u>.

   Although there are no identified health problems associated with current basin operation, the potential for future impacts does exist provided there is an absence of appropriate system management. Thus, the District should continue to manage and operate the basins in a manner that minimizes the risk to both groundwater quality and recreation. Certain suggested modifications to current practices can improve the degree of protection provided. Specific recommendations are developed in this next section.

RECOMMENDATIONS

Recommendations have been developed based on the conclusions just described. Our recommendations include several specific modifications to current operation of the retention/recharge system. There are some areas where a firm course of action cannot be recommended until further research or engineering is conducted.

Recommended Management Practices

A range of management practices were evaluated in Chapter 8. Specific recommendations are summarized in Table 9-1 and are briefly described below.

Table 9-1. Recommended Management Practices

1. Maintain the basic practice of retention and recharge of urban storm runoff subject to certain modifications.

2.[a] Provide low-flow basins for all recreational basins and evaluate low-flow basins for basins serving industrial areas. Periodically remove solids from the bottom of low-flow basins and from basins serving principally industrial areas.

3.[a] Remove the portion of the turf and upper soil layer from the recreational basins as necessary.

4.[a] Monitor soil from unturfed areas in recreational basins and remove as necessary.

5. Consider having industrial developments contain or pretreat runoff from portions of their site that may contain toxic material.

6. Have the District work together with other local agencies to be certain that water quality aspects are adequately considered in the review process for future industrial developments.

7. Develop a management plan to determine the best means of disposing of hazardous soil removed from the basins.

8. Continue the practice of recharging high quality imported surface water.

9. Implement a long-term monitoring program of basin soils and groundwater.

[a]The need for soil removal should be based on further soils monitoring and contaminant buildup curves relative to public contact and drinking water standards.

1. The District should maintain its system of retention and recharge of urban storm runoff and make certain modifications to minimize health risks.

   The current system of retention and recharge is basically a very sound methodology for meeting its two goals: stormwater management and recharge of the groundwater supply. The fact that the system has operated successfully with proven water quality and recreational benefits for over 20 years is a credit to original design concept. The Fresno NURP project has enabled the operation to be scrutinized to assure that maximum protection to the groundwater supply and recreational uses of the basins is maintained in the future.

2. Low-flow basins should be provided for all recreational basins and for drainage areas where a significant amount of the contributing area will be developed for heavy industrial use.

The low-flow basin concept that the District currently uses to contain summer runoff water from lawn sprinkling is an excellent means of containing the "first flush" of runoff and can thereby reduce the contaminant load that reaches the upper recreational basin, or the larger recharge basin in the industrial situation. In terms of existing basins serving industrial areas, the need for a low-flow basin should be assessed by either a detailed field inspection or a runoff monitoring program. The solids accumulations in the bottom of the low-flow basin should be periodically removed to prevent the leaching of this concentrated material into the deeper soils and ultimately to the groundwater. An alternative to a low-flow basin would be regular removal of existing basin soils.

3. A program to periodically remove the turf and upper soil layer from the recharge basins used for recreation should be initiated.

At a minimum, the portions of the basin area that exceed the DHS soil criterion for lead should be periodically removed. The basin should then be returfed. Spatial sampling of the type conducted in this study for Basin F and Basin B/E should be performed to define the extent of soil removal requirements. Regular monitoring should be conducted to help define contaminant buildup curves. This program does not require urgent implementation, so it can be incorporated into the District's maintenance operations over the next few years. Basins with the highest contaminant levels should be dealt with first.

4. Unturfed areas at the recreational basins should be turfed over or alternatively the surface soil layer could be periodically removed.

The unturfed portions of the recreational basins offer the greatest chance of public contact with the soil. Turfing or periodic soil removal, will minimize the potential problem.

5. Consideration should be given to having industrial developments contain or pretreat runoff from portions of their site that may contain toxic material.

   Industrial areas, such as the ones studied in this program, are the most significant potential source of urban runoff contaminants. Decisions to have upstream source control provided at existing industrial sites need to be developed on a case-by-case basis, since the types and magnitude of contaminants from industrial sites can vary widely.

6. The District should work together with other pertinent local agencies (e.g., planning and building departments) to be certain that water quality aspects are adequately considered in the review process for future industrial developments.

   Through this approach, provisions can be made during the design of industrial developments to control potential runoff contaminants at the source.

7. Develop a management plan to determine the best means of disposing of soil removed from the basins.

   Theoretically, soil that is removed from the basins that contains contaminants at concentrations exceeding DHS soil criteria will need to be hauled to a hazardous waste landfill. Disposal costs will be very expensive. Alternatives such as removing the soil before it reaches criteria levels or mixing contaminated soil with clean soil need to be evaluated.

8. Continue the practice of recharging high quality imported surface water.

   Recharge of high quality surface water has a beneficial effect on the regional groundwater quality. Although the imported water may gradually leach storm-produced pollutants from the soil, the large volumes of high quality water should adequately dilute contaminants to background levels. Also, periodic removal of surface soils will reduce the amount of contaminants that could be leached.

Areas Requiring Additional Work

The Fresno NURP project has met its primary objective of determining whether recharge of urban runoff is adversely affecting the groundwater supply. The secondary objective of assessing the impacts on recreational uses of the basins has also been addressed, although the recreational impacts are more difficult to define. The work conducted in this project has provided a basis for developing several recommendations. In the case of some of the recommendations, a detailed course of action cannot be implemented without further research or engineering. Also, some future monitoring is recommended in order to develop a continuing record of soil and groundwater quality and to assess the effectiveness of recommended control measures. Additional work requirements are listed below.

1. Long term annual soil and groundwater monitoring utilizing vacuum extractors at two or more of the existing test sites.

2. Long term soils and groundwater monitoring at a recharge basin serving an industrial area.

3. Continuing spatial surveys of the surface soils of the recreational basins to provide a basis for determining the timing and extent of soil removal.

4. Field inspection and/or runoff monitoring program of existing industrial sites (conducted cooperatively with the Central Valley Regional Water Quality Control Board).

5. Continuing assessment of downstream impacts of runoff water discharged into the San Joaquin River.

6. Evaluation of the engineering design standards of future recharge basins to consider pumpout arrangements, dual-compartment low-flow basins, bottom lining requirements, hydraulic controls for containment of chemical spills, etc.

APPENDIX A

REFERENCES

REFERENCES

1. California Department of Health Services. A summary of the Draft California Regulatory Criteria for Identification of Hazardous and Extremely Hazardous Wastes. October 1982.

2. County of Fresno. Interim Best Management Plan for Water Quality Fresno-Clovis Urban and Northeast Fresno County. June 1979.

3. Fresno Metropolitan Flood Control District. Work Plan for Determination of the Potential Adverse Environmental Impacts Associated with the Retention and Recharge of Urban Storm Runoff. October 1979.

4. Oltmann, Richard N. and Shulters, Michael V. Rainfall and Runoff Characteristics of Four Urban Land Use Catchments in Fresno, California, October 1981 - April 1983. U.S. Geological Survey. November 1983.

5. U.S. Department of Agriculture--Water Management Research Laboratory. Final Report for Fresno Nationwide Urban Runoff Program. September 1983.

6. U.S. Environmental Protection Agency. Final Report of the Nationwide Urban Runoff Program. September 1983.

APPENDIX B

CONSTITUENT LIST

AND ANALYTICAL DETECTION LIMITS

Table B-1. USGS Constituent List

	Runoff	Rainfall	Atmospheric dry deposition[a]	Street particulates[b]	Dry weather runoff
INORGANICS					
Field Measurements					
Specific conductance	X	X	X	-	3
pH	X	X	X	-	3
Major Ions					
Alkalinity (Bicarbonate and Carbonate	X	X	X	-	3
Sulfate, dissolved	X	X	X	-	3
Chloride, dissolved	X	X	X	-	3
Silica, dissolved	X	X	X	-	3
Calcium, dissolved	X	X	X	X	3
Magnesium, dissolved	X	X	X	X	3
Sodium, dissolved	X	X	X	X	3
Potassium, dissolved	X	X	X	X	3
Nutrients					
Nitrogen, Nitrite, dissolved (as N)	1	1	1	X	3
Nitrogen, Nitrite + Nitrate, dissolved (as N)	X	X	X	X	3
Phosphorus, dissolved (as P)	X	X	-	-	3
Phosphorus, total (as P)	X	-	X	X	3
Phosphorus, Orthophosphate, dissolved (as P)	X	X	-	-	3
Phosphorus, Orthophosphate, total (as P)	X	-	X	-	3
Nitrogen, Ammonia, dissolved, (as N)	X	X	X	X	3
Nitrogen, Ammonia + Organic, dissolved (as N)	X	X	X	-	3
Nitrogen, Ammonia + Organic, total (as N)	X	-	-	X	3
Metals					
Aluminum, dissolved and total	2	2	2	2	-
Arsenic, dissolved and total	X	2	2	X	3
Cadmium, dissolved and total	1	-	-	1	3
Chromium, dissolved and total	X	2	2	X	3
Copper, dissolved and total	X	2	2	X	3
Cyanide, dissolved and total	2	-	-	-	-
Iron, dissolved and total	X	2	2	X	3
Lead, dissolved and total	X	X	X	X	3
Manganese, dissolved and total	2	2	2	2	-
Mercury, dissolved and total	X	2	2	X	3
Nickel, dissolved and total	X	2	2	X	3
Zinc, dissolved and total	X	2	2	X	3
BIOLOGICAL					
Fecal coliform bacteria	X	-	-	-	3
OXYGEN DEMAND					
Five-day biochemical oxygen demand (B.O.D.)	X	-	-	-	-
Ultimate biochemical oxygen demand	1	-	-	-	-
Chemical Oxygen Demand (C.O.D.)	X	X	X	X	3
PHYSICAL PROPERTIES					
Turbidity	X	-	-	-	3
Solids, dissolved (180°C.)	X	-	-	-	3
Solids, total (105-110°C.)	-	-	X	-	-
Suspended sediment	X	-	-	-	3
Paricle size analysis	1	-	-	-	-

Table B-1. USGS Constituent List, continued

	Runoff	Rainfall	Atmospheric dry deposition[a]	Street particulates[b]	Dry weather runoff
ORGANICS					
Gross Measures					
Dissolved organic carbon	X	X	X	-	3
Suspended organic carbon	X	-	-	-	3
Oil and grease, total	X	-	-	-	-
Polychlorinated biphenyls, total	X	X	2	X	3
Polychlorinated napthalenes, total	X	X	2	X	3
Dibromochloropropane (DBCP)	1	-	-	-	-
Phenols, total recoverable	2	2	-	-	-
Volatile Organics					
Benzene, total recoverable	2	-	-	-	-
Chlorobenzene, total recoverable	2	-	-	-	-
Ethylbenzene, total recoverable	2	-	-	-	-
Organochlorine Compounds					
Aldrin, total	X	X	2	X	3
Chlordane, total	X	X	2	X	3
DDD, total	X	X	2	X	3
DDE, total	X	X	2	X	3
DDT, total	X	X	2	X	3
Dieldrin, total	X	X	2	X	3
Endosulfan, total	X	X	2	X	3
Endrin, total	X	X	2	X	3
Heptachlor, total	X	X	2	X	3
Heptachlor epoxide, total	X	X	2	X	3
Lindane, total	X	X	2	X	3
Methoxychlor, total	X	X	2	X	3
Mirex, total	X	X	2	X	3
Perthane, total	X	X	2	X	3
Toxaphene, total	X	X	2	X	3
Organophosphorus Compounds					
Diazinon, total	X	X	2	X	3
Ethion, total	X	X	2	X	3
Malathion, total	X	X	2	X	3
Methyl parathion, total	X	X	2	X	3
Methyl trithion, total	X	X	2	X	3
Parathion, total	X	X	2	X	3
Trithion, total	X	X	2	X	3
Carbamate Insecticides					
Methomyl, total	1	1	-	-	-
Propham, total	1	1	-	-	-
Sevin, total	1	1	-	-	-
Chlorophenoxy Acid Herbicides					
2,4-D, total	X	X	2	X	3
2,4-DP, total	X	X	2	-	3
2,4,5-T, total	X	X	2	-	3
Silvex, total	X	X	2	-	3

[a]Dry deposition material is washed from collection bucket with deionized water and then analyzed as a water sample.
[b]All constituents are total recoverable from a dry sample, therefore, disregard "dissolved" notation after constituent name.

Chart Symbols

X - Analyzed for during both rain seasons.
1 - Analyzed for during 1981-82 rain season only.
2 - Analyzed for during 1982-83 rain season only.
3 - Analyzed for September 3, 1982 samples.

Table B-2. Detection Limits for Various Organic Constituents in Water Samples (USGS Laboratory)

Constituent	Detection limit,[a] ug/l
Aldrin	0.01
Chlordane	0.1
Diazinon	0.01
Dieldrin	0.01
DDD	0.01
DDE	0.01
DDT	0.01
Endosulfan	0.01
Endrin	0.01
Ethion	0.01
Heptachlor	0.01
Heptachlor epoxide	0.01
Lindane	0.01
Malathion	0.01
Methomyl	0.5-2
Methoxychlor	0.01
Methyl parathion	0.01
Methyl trithion	0.01
Mirex	0.01
Parathion	0.01
Perthane	0.1
Phenol	2
Polychlorinated naphthalenes	0.1
Propham	0.5-2
PCB	0.1
Sevin	0.5-2
Silvex	0.01
Toxaphene	1
Trithion	0.01
2,4-D	0.01
2,4-DP	0.01
2,4,5-T	0.01

[a]Detection limit varies with the size of available water sample.

Table B-3. Detection Limits for Various Organic Constituents in Soils and Groundwater Samples (Brown and Caldwell Laboratory)

Constituent	Detection limit	
	Water,[a] ug/l	Soil, mg/kg
Aldrin	0.05 - 0.22	0.01
Chlordane	0.11 - 1.4	0.03
DDT (mixed isomers)	0.1 - 0.50	0.03
DDE (mixed isomers)	0.05 - 0.22	0.01
DDD (mixed isomers)	0.05 - 0.22	0.01
Endosulfan I and II	0.05 - 0.22	0.01
Endosulfan sulfate	0.02 - 0.50	0.03
Gamma BHC (lindane)	0.05 - 0.22	0.01
Methoxychlor	0.2 - 1.0	0.07
2,4-D	0.25 - 2.2	0.02
Diazinon	0.02 - 0.5	0.02
Malathion	0.03 - 1.0	0.04
Parathion	0.02 - 1.0	0.04
Methyl parathion	0.03 - 1.0	0.04
Semivolatiles[b]		
Hexachlorocyclopentadiene	200	0.05
2,4-dinitrophenol	200	0.05
4-chlorophenylphenyl ether	400	0.20
All others	10 - 25	0.04
Purgeables[c]	-	0.001

[a]Detection limit varies with the size of available water sample.
[b]Complete list shown in Table B-4.
[c]Complete list shown in Table B-5.

Table B-4

SEMIVOLATILE PRIORITY POLLUTANTS - EPA METHOD 625

Group I: Base Neutrals	Characteristic Ions
D_8-Naphthalene (I.S.)	136
N-Nitrosodimethylamine	42, 44, 74
bis-(2-chloroethyl)ether	63, 93, 95
1,3-Dichlorobenzene	113, 146, 148
1,4-Dichlorobenzene	113, 146, 148
1,2-Dichlorobenzene	113, 146, 148
bis-(2-chloroisopropyl)ether	45, 77, 79, 121
Hexachloroethane	117, 199, 201
n-Nitroso-di-n-propylamine	42, 70, 101, 130
Nitrobenzene	65, 77, 123
Isophorone	82, 95, 138
bis(2-chloroethoxy)methane	93, 95, 123
1,2,4-Trichlorobenzene	145, 180, 182
Naphthalene	127, 128, 129
Hexachlorobutadiene	223, 225, 227
Hexachlorocyclopentadiene	235, 237, 239, 272
2-Chloronaphthalene	127, 162, 164
Acenaphthylene	151, 152, 153
Dimethylphthalate	163, 164, 194
2,6-Dinitrotoluene	63, 165, 121
D_{10}-Anthracene (I.S.)	80, 94, 188
Acenaphthene	152, 153, 154
2,4-Dinitroltoluene	89, 163, 165
Fluorene	165, 166, 167
Diethylphthalate	149, 150, 177
4-Chlorophenylphenyl ether	141, 204, 206
n-Nitrosodiphenylamine	167, 168, 169
1,2-Diphenylhydrazine	77, 93, 105
4-Bromophenoxybenzene	141, 248, 250
Hexachlorobenzene	142, 249, 284

Group I (continued)	Characteristic Ions
Butylbenzylphthalate	91, 149
Benzo(a)anthracene	226, 228, 229
3,3-Dichlorobenzidine	126, 252, 254
Chrysene	226, 228, 229
bis(2-ethylhexyl)phthalate	149, 167, 279
di-n-octyl phthalate	149
Benzo(b)fluoranthene	125, 252, 253
Benzo(k)fluoranthene	125, 252, 253
Benzo(a)pyrene	125, 252, 253
Indeno(1,2,3-cd)pyrene	138, 276, 277
Dibenzo(ah)anthracene	139, 278, 279
Benzo(ghi)perylene	138, 276, 277
Benzidine	92, 184, 185
Pyrene	100, 101, 202
Fluoranthene	100, 101, 202
di-n-butylphthalate	104, 149, 150
Anthracene	176, 178, 179
Phenanthrene	176, 178, 179
Group II: Acids	
2-Chlorophenol	64, 128, 130
2-Nitrophenol	65, 109, 139
Phenol	65, 66, 94
2,4-Dimethylphenol	107, 121, 122
2,4-Dichlorophenol	98, 162, 164
2,4,6-Trichlorophenol	196, 198, 200
4-Chloro-3-methylphenol	107, 142, 144
2,4-Dinitrophenol	63, 154, 184
2-Methyl-4,6-dinitrophenol	77, 182, 198
Pentachlorophenol	264, 266, 268
4-Nitrophenol	65, 109, 139

I.S. = Internal Standard.

Table B-5

PURGEABLE PRIORITY POLLUTANTS - EPA METHOD 624

Compound	Characteristic Ions	Compound	Characteristic Ions
Bromochloromethane (I.S.)	49, 51, 130, 128	Dibromochloromethane	129, 127, 208, 206
Chloromethane	50, 52	Bromoform	171,173,175,250,252,254,256
Dichlorodifluoromethane	85, 87	1,1,2,2-Tetrachloroethylene	129, 131, 164, 166
Bromomethane	94, 96	1,12,2-Tetrachloroethane	83, 85, 131, 133, 166, 168
Vinyl chloride	62, 64	Toluene	91, 92
Chloroethane	64, 66	Chlorobenzene	112, 114
Methylene chloride	49, 51, 84, 86	Ethylbenzene	91, 106
Trichlorofluoromethane	101, 103	2-Bromo-1-chloropropane (I.S.)	77, 79, 156
1,1-Dichloroethylene	61, 96, 98	2-Chloroethylvinyl ether	63, 65, 106
1,1-Dichloroethane	63, 65, 83	Xylene	91, 106
trans-1,2-Dichloroethylene	61, 96, 98	Xylene	91, 106
Chloroform	83, 85	n-Butyl acetate*	56, 73
1,2-Dichloroethane	62, 64, 98, 100	Bromochloromethane (I.S.)	49, 130, 128, 51
1,1,1-Trichloroethane	97, 99, 117, 119	Acrolein	55, 56
Carbon tetrachloride	117, 119, 121	Acrylonitrile	50, 51, 32, 53
Bromodichloromethane	83, 85, 127, 129	Acetone*	58
1,4-Dichlorobutane (I.S.)	55, 90, 92	Acetonitrile*	41, 42, 38, 39, 30
1,2-Dichloropropane	63, 65, 112, 114	Isopropanol*	45, 43, 59
trans-1,3-Dichloropropene	75, 77	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)*	151
Trichloroethylene	95, 97, 130, 132		
Benzene	78	Methyl ethyl ketone*	43, 57, 72
cis-1,3-Dichloropropene	75, 77	Ethyl acetate*	43, 88, 70, 73, 61
		1,1,2-Trichloroethane	83, 85, 97, 99, 132, 134

*Not a priority pollutant or an internal standard. Included due to interest by some California regulatory authorities. The underlined characteristic ions are used for quantitation.

I.S. = Internal Standard.

APPENDIX C

SUPPORTING DOCUMENTS

SUPPORTING DOCUMENTS

A very large data base was developed as part of the Fresno NURP project. These data were compiled in the following supporting documents:

Quarterly Report No. 6, May 18, 1982

Quarterly Report No. 7, August 20, 1982

Quarterly Report No. 8, November 22, 1982

Quarterly Report No. 9, March 8, 1983

Quarterly Report No. 10, May 31, 1983

Quarterly Report No. 11, August 9, 1983

First Annual Report, October 20, 1982

Second Annual Report, September 20, 1983

U.S. Geological Survey draft NURP report entitled "Rainfall and Runooff Characteristics of Four Urban Land Use Catchments in Fresno, California, October 1981 to April 1983", dated November 1983 (the final report is in preparation).

U.S. Department of Agriculture, Water Management Research Laboratory Final NURP Report and Appendices, September 1983.

These reports are all available through the Fresno Metropolitan Flood Control District, Rowell Building, Suite 300, 2100 Tulare Street, Fresno, California, 93721. The USGS and USDA final reports are also available directly from those agencies: USGS, 2800 Cottage Way, Sacramento, California, 95825; USDA, 5544 East Air Terminal Drive, Fresno, California, 93727.

APPENDIX 4.9

Solid Waste Disposal Data

CALIFORNIA INTEGRATED WASTE MANAGEMENT BOARD

MODEL ORDINANCE

RELATING TO AREAS FOR COLLECTING AND LOADING RECYCLABLE MATERIALS IN DEVELOPMENT PROJECTS

MARCH 31, 1993

SECTION I

PURPOSE

Cities and counties must divert 50 percent of all solid waste by January 1, 2000, through source reduction, recycling, and composting activities.

Diverting 50 percent of all solid waste requires the participation of the residential, commercial, industrial, and public sectors.

The lack of adequate areas for collecting and loading recyclable materials that are compatible with surrounding land uses is a significant impediment to diverting solid waste and constitutes an urgent need for state and local agencies to address access to solid waste for source reduction, recycling, and composting activities. This ordinance has been developed to meet that need.

SECTION II

DEFINITIONS

The following definitions shall apply to the language contained in this ordinance:

A. **DEVELOPMENT PROJECT** - Means any of the following:

1) A project for which a building permit is required for a commercial, industrial, or institutional building, marina, or residential building having five or more living units, where solid waste is collected and loaded and any residential project where solid waste is collected and loaded in a location serving five or more living units.

2) Any new public facility where solid waste is collected and loaded and any improvements for areas of a public facility used for collecting and loading solid waste.

3) The definition of development project only includes subdivisions or tracts of single-family detached homes if, within such subdivisions or tracts there is an area where solid waste is collected and loaded in a location which serves five or more living units. In such instances, recycling areas as specified in this ordinance are only required to serve the needs of the living units which utilize the solid waste collection and loading area.

B. **IMPROVEMENT** - An improvement adds to the value of a facility, prolongs its useful life, or adapts it to new uses. Improvements should be distinguished from repairs. Repairs keep facilities in good operating condition, do not materially add to the value of the facility, and do not substantially extend the life of the facility.

C. **FLOOR AREA OF A MARINA** - The floor area of a marina shall be defined as the space dedicated to the docking or mooring of marine vessels.

D. **PUBLIC FACILITY** - The definition of public facility includes, but is not limited to buildings, structures, marinas, and outdoor recreation areas owned by a local agency.

E. **RECYCLING AREA (AREAS FOR RECYCLING)** - Space allocated for collecting and loading of recyclable materials. Such areas shall have the ability to accommodate receptacles for recyclable materials. Recycling areas shall be accessible and convenient for those who deposit as well as those who collect and load any recyclable materials placed therein.

SECTION III

GENERAL REQUIREMENTS

A. Any new development project for which an application for a building permit is submitted on or after September 1, 1994, shall include adequate, accessible, and convenient areas for collecting and loading recyclable materials.

B. Any improvements for areas of a public facility used for collecting and loading solid waste shall include adequate, accessible, and convenient areas for collecting and loading recyclable materials.

C. Any existing development project for which an application for a building permit is submitted on or after September 1, 1994 for a single alteration which is subsequently performed that adds 30 percent or more to the existing floor area of the development project shall provide adequate, accessible, and convenient areas for collecting and loading recyclable materials.

D. Any existing development project for which an application for a building permit is submitted on or after September 1, 1994 for multiple alterations which are conducted within a twelve month period which collectively add 30 percent or more to the existing floor area of the development project shall provide adequate, accessible, and convenient areas for collecting and loading recyclable materials.

E. Any existing development project for which multiple applications for building permits are submitted within a twelve month period beginning on or after September 1, 1994 for multiple alterations which are subsequently performed that collectively add 30 percent or more to the existing floor area of the development project shall provide adequate, accessible, and convenient areas for collecting and loading recyclable materials.

F. Any existing development project occupied by multiple tenants, one of which submits on or after September 1, 1994, an application for a building permit for a single alteration which is subsequently performed that adds 30 percent or more to the existing floor area of that portion of the development project which said tenant leases shall provide adequate, accessible, and convenient areas for collecting and loading recyclable materials. Such recycling areas shall, at a minimum be sufficient in capacity, number, and distribution to serve that portion of the development project which said tenant leases.

G. Any existing development project occupied by multiple tenants, one of which submits on or after September 1, 1994 an application for a building permit for multiple alterations which are conducted within a twelve month period which collectively add 30 percent or more to the existing floor area of that portion of the development project which said tenant leases shall provide adequate, accessible, and convenient areas for collecting and loading recyclable materials. Such recycling areas shall, at a minimum be sufficient in capacity, number, and distribution to serve that portion of the development project which said tenant leases.

H. Any existing development project occupied by multiple tenants, one of which submits within a twelve month period beginning on or after September 1, 1994 multiple applications for building permits for multiple alterations which are subsequently performed that collectively add 30 percent or more to the existing floor area of that portion of the development project which said tenant leases shall provide adequate, accessible, and convenient areas for collecting and loading recyclable materials. Such recycling areas shall, at a minimum be sufficient in capacity, number, and distribution to serve that portion of the development project which said tenant leases.

I. Any costs associated with adding recycling space to existing development projects shall be the responsibility of the party or parties who are responsible for financing the alterations.

SECTION IV

GUIDELINES FOR ALL DEVELOPMENT PROJECTS

A. Where local standards exist, recycling areas should be designed to be architecturally compatible with nearby structures and with the existing topography and vegetation, in accordance with such standards.

B. The design and construction of recycling areas shall not prevent security of any recyclable materials placed therein.

C. The design, construction, and location of recycling areas shall not be in conflict with any applicable federal, state, or local laws relating to fire, building, access, transportation, circulation, or safety.

D. Recycling areas or the bins or containers placed therein must provide protection against adverse environmental conditions, such as rain, which might render the collected materials unmarketable.

E. Driveways and/or travel aisles shall, at a minimum, conform to local building-code requirements for garbage collection access and clearance. In the absence of such building-code requirements, driveways and/or travel aisles should provide unobstructed access for collection vehicles and personnel.

F. A sign clearly identifying all recycling and solid waste collection and loading areas and the materials accepted therein shall be posted adjacent to all points of direct access to the recycling areas.

G. Developments and transportation corridors adjacent to recycling areas shall be adequately protected for any adverse impacts such as noise, odor, vectors, or glare through measures including, but not limited to maintaining adequate separation, fencing, and landscaping.

SECTION V

ADDITIONAL GUIDELINES FOR SINGLE TENANT DEVELOPMENT PROJECTS

A. Areas for recycling shall be adequate in capacity, number, and distribution to serve the development project.

B. Dimensions of the recycling area shall accommodate receptacles sufficient to meet the recycling needs of the development project.

C. An adequate number of bins or containers to allow for the collection and loading of recyclable materials generated by the development project should be located within the recycling area.

SECTION VI

ADDITIONAL GUIDELINES FOR MULTIPLE TENANT DEVELOPMENT PROJECTS

A. Recycling areas shall, at a minimum be sufficient in capacity, number, and distribution to serve that portion of the development project leased by the tenant(s) who submitted an application or applications resulting in the need to provide recycling area(s) pursuant to Section III of this ordinance.

B. Dimensions of recycling areas shall accommodate receptacles sufficient to meet the recycling needs of that portion of the development project leased by the tenant who submitted an application or applications resulting in the need to provide recycling area(s) pursuant to Section III of this ordinance.

C. An adequate number of bins or containers to allow for the collection and loading of recyclable materials generated by that portion of the development project leased by the tenant(s) who submitted an application or applications resulting in the need to provide recycling area pursuant to Section III of this ordinance should be located within the recycling area.

SECTION VII

LOCATION

A. Recycling areas shall not be located in any area required to be constructed or maintained as unencumbered, according to any applicable federal, state, or local laws relating to fire, access, building, transportation, circulation, or safety.

B. Any and all recycling area(s) shall be located so they are at least as convenient for those persons who deposit, collect, and load the recyclable materials placed therein as the location(s) where solid waste is collected and loaded. Whenever feasible, areas for collecting and loading recyclable materials shall be adjacent to the solid waste collection areas.

SECTION VIII

DECLARATION OF SEVERABILITY

All provisions of this Ordinance are severable and, if for any reason any sentence, paragraph, or section of this Ordinance shall be held invalid, such decision shall not affect the validity of the remaining parts of the Ordinance.

Riverpark Solid Waste - Existing

Land Use	Quantity	Units	Generation Rate		Total Waste Generated	
			(tpy) (1)	(lbs./day)	(tpy)	(lbs./day)
Commercial Office	5,566	sq. ft.	0.0014	0.01	8	43
				Totals	**8**	**43**

sq.ft. - square feet; tpy = tons per year; lbs. = pounds

(1) The solid waste daily generation rates in tons per year are derived from the Ventura County Solid Waste Management Department's Guidelines for Preparation of Environmental Assessments for Solid Waste Impacts,

Santa Clarita Valley
Solid Waste Generation
(No Recycling) Impact Analysis

Rivepark Solid Waste - Project Only

Land Use	Quantity	Units	Generation Rate		Total Waste Generated	
			(tpy) (1)	(lbs./day)	(tpy)	(lbs./day)
Residential Units:						
Single-Family Detached	439	du	2.0400	11.18	896	4,907
Multi-Family or Attached	744	du	1.1700	6.41	870	4,770
Commercial						
Commercial Retail	40,000	sq. ft.	0.0024	0.01	96	526
				Totals	**1,862**	**10,203**

du = dwelling unit; sq.ft. - square feet; tpy = tons per year; lbs. = pounds

(1) The solid waste daily generation rates in tons per year are derived from the Ventura County Solid Waste Management Department's Guidelines for Preparation of Environmental Assessments for Solid Waste Impacts. These figures do not reflect any recycling activities on the part of the generator.

Riverpark Solid Waste = Cumulative + Project

Land Use	Quantity	Units	Generation Rate		Total Waste Generated	
			(tpy) (1)	(lbs./day)	(tpy)	(lbs./day)
Residential Units:						
Single Family Detached	93,720	du	2.0400	11.18	191,189	1,047,610
Multi-Family or Attached	48,747	du	1.1700	6.41	57,034	312,515
Mobile Home	2,699	du	1.1700	6.41	3,158	17,303
Commercial/Industrial						
Commercial Retail	19,899,030	sq. ft.	0.0024	0.01	47,758	261,686
Sit Down Restaurant	283,790	sq. ft.	0.0108	0.06	3,065	16,794
Fast Food Restaurant	23,600	sq. ft.	0.0108	0.06	255	1,397
Car Dealership	411,000	sq. ft.	0.0051	0.03	2,096	11,485
Hotel	2,071	sq. ft.	0.0053	0.03	11	60
Movie Theater (2)	3,300	seats	0.2000	1.10	660	3,616
Health Club (2)	54,000	sq. ft.	0.0056	0.03	302	1,657
Medical Offices	133,730	sq. ft.	0.0027	0.01	361	1,978
Hospital	247,460	sq. ft.	0.0055	0.03	1,361	7,458
Business Park	8,424,330	sq. ft.	0.0014	0.01	11,794	64,625
Commercial Office	6,380,520	sq. ft.	0.0014	0.01	8,933	48,946
Elem./Middle Schools (3)	279,340	students	0.1090	0.60	30,448	166,839
High School (3)	12,958	students	0.1090	0.60	1,412	7,739
College (3)	29,948	students	0.1090	0.60	3,264	17,887
Day Care	785,000	sq. ft.	0.0013	0.01	1,021	5,592
Trans., Comm., Utilities	1,150,240	sq. ft.	0.0079	0.04	9,087	49,791
Special Generator (4)	413	sq. ft.	0.0079	0.04	3	18
Golf Course	1,209	acres	0.2000	1.10	242	1,325
Parkland	493	acres	0.2000	1.10	99	541
Library (5)	171,790	sq. ft.	0.0014	0.01	241	1,318
Manufacturing/Warehouse	3,932,470	sq. ft.	0.0050	0.03	19,662	107,739
Church (5)	501,190	sq. ft.	0.0014	0.01	702	3,845
Industrial Park (6)	501,190	sq. ft.	0.0010	0.01	501	2,746
Undeveloped Parkland	1,000	acres				
				Totals	**393,455**	**2,155,919**

du = dwelling unit; sq.ft. - square feet; tpy = tons per year; lbs. = pounds

(1) The solid waste daily generation rates in tons per year are derived from the Ventura County Solid Waste Management Department's Guidelines for Preparation of Environmental Assessments for Solid Waste Impacts, unless otherwise noted. These figures do not reflect any recycling activities on the part of the generator.

(2) California Integrated Waste Management Website, November 2002, which cites SWANA Technical Bulletin 85-6, Recovery Sciences 1987 and Santa Clarita SRRE, 1990.

(3) California Integrated Waste Management Website, November 2002, which cites SWANA Technical Bulletin 85-6, Recovery Sciences 1987 and Matrix Management Group "Best Management Practices Analysis for Solid Waste."

(4) Conservatively assumes same generation rate as utilities.

(5) Assumes same generation rate as for office.

(6) California Integrated Waste Management Website, November 2002, which cites City of Los Angeles Bureau of Solid Waste 1989.

APPENDIX 4.10

Student Generation Calculations and School Facilities Funding Agreements

Student Generation Calculations

Santa Clarita Valley
Net Increase in
Student/Classroom/School Generation Using
Theoretical Student Generation Rates
River Park EIR

District	Housing Units by Type			Student Generation Rate			Class Size	School Size	Students	Classes	Schools
	Single Fam.	Multi-Fam.	Apartment	Single Fam.	Multi-Fam.	Apartment					
Saugus Union Elementary	439		744	0.431	0.0556	0.1326	30	770	288	9.60	0.37
Hart Junior High	439		744	0.104	0.037	0.038	32	930	74	2.31	0.08
Hart High School	439		744	0.179	0.064	0.054	32	2,764	119	3.71	0.04
								Totals	**481**	**15.62**	**0.50**

Prepared By Impact Sciences, Inc.
S. Tebo
12/16/03

William S. Hart Union High School District
January 2003

		Enrollment Capacity			Classrooms			Oct. 2002	Capacity Minus
Existing Schools	Location	Permanent	Temporary	Total	Permanent	Temporary	Total	Enrollment	Enrollment
Arroyo Seco JHS (7-8)	27171 Vista Delgado Dr., Valencia 91354	930	659	1,589	35	26	61	1,568	21
La Mesa JHS (7-8)	26623 May Way, Santa Clarita, 91351	1,026	368	1,394	37	20	57	1,568	-174
Placerita JHS (7-8)	25015 N. Newhall Ave., Newhall 91321	846	390	1,236	34	25	59	1,601	-365
Sierra Vista JHS (7-8)	19425 West Stillmore St., Cyn Country 91351	916	305	1,221	35	25	60	1,572	-351
Canyon HS (9-12)	19300 West Nadel St., Cyn Country 91351	1,604	934	2,538	63	32	95	2,825	-287
W.S. Hart HS (9-12)	24825 N. Newhall Ave., Newhall 91321	1,392	923	2,315	55	40	95	2,900	-585
Saugus HS (9-12)	21900 Centurion Way, Saugus 91350	1,624	649	2,273	63	26	89	2,683	-410
Valencia HS (9-12)	27801 N. Dickason Dr., Valencia 91355	1,924	840	2,764	74	32	106	3,253	-489
Future Schools									
Rio Norte JHS (7-8)	28771 Rio Norte Dr., Valencia 91354 (opening Fall 2003)	1,200		1,200	29		29		
Golden Valley HS (9-12)	20501 Golden Valley Road, Sta Clarita 91321 (opening Fall 2004)	2,600		2,600	59		59		
Rancho Pico JHS (7-8)	Valencia Blvd w/o I-5 (opening Fall 2005)	1,200		1,200	29		29		
West Ranch HS (9-12)	Valencia Blvd w/o I-5 (opening Fall 2006)	2,600		2,600	63		63		
	Totals - Existing	10,262	5,068	15,330	396	226	622	17,970	-2,640
	Totals - Future	17,862		22,930	576		802		

Source: Baril, Lorna. William S. Hart Union High School District, Santa Clarita, California. Correspondence to Impact Sciences, Inc., January 20, 2003.

Impact Sciences, Inc.
Prepared by R. Mamaghani
3/25/03

River Park
Student Generation Under the DMS Scenario

Land Use	Project	District Bldout Without Project: Saugus	Hart Jr.	Hart Sr.
Single Family Residential (SFD)	439	10,437	18,594	23,343
Multi-Family Residential (SFA)				
Apartments (MF)	744	4,087	9,440	12,196

Student Generation Without Project

	Generation Rates			Students			Total
	SFD	SFA	MF	SFD	SFA	MF	Students
Saugus Union School District (1)	0.4982	0.0556	0.1326	5,200	0	542	5,742
W.S. Hart (Junior High School) (3)	0.1671	0.0311	0.0137	3,107	0	129	3,236
W.S. Hart (High School) (3)	0.2426	0.0789	0.0315	5,663	0	384	6,047
						Total	**15,025**

Student Generation With Project

	Generation Rates			Students			Total
	SFD	SFA	MF	SFD	SFA	MF	Students
Saugus Union School District (1)	0.4982	0.0556	0.1326	219	0	99	6,059
W.S. Hart (Junior High School) (2)	0.0980	0.0370	0.0380	43	0	28	3,308
W.S. Hart (High School) (2)	0.1710	0.0640	0.0540	75	0	40	6,162
						Total	**15,529**

(1) Harold J. Pierre, P.E., Saugus Union School District, correspondence to Impact Sciences, Inc., 30 October 2002.
(2) Davis Demographics and Planning (December 12, 1995). These represent actual student generation rates and are from the October 1998 School Facilities Funding Agreement between The Newhall Land and Farming Company and the Hart District.
(3) David Taussig & Associates, Inc. School Facilities Needs Analysis for Consideration of Alternative School Facility Fees. David Taussig & Associates, Inc.: Newport Beach, California, March 8, 2002. P. 7.

Impact Sciences, Inc.
Prepared by R. Mamaghani
3/25/03

School Facilities Funding Agreement Between
The Saugus Union School District and
The Newhall Land and Farming Company

SCHOOL FACILITIES FUNDING AGREEMENT BETWEEN THE SAUGUS UNION SCHOOL DISTRICT AND THE NEWHALL LAND AND FARMING COMPANY

This School Facilities Funding Agreement ("Agreement") is made at Valencia, California, as of February 18, 1997, between the **SAUGUS UNION SCHOOL DISTRICT** ("District"), a school district organized and existing under the laws of the State of California, on the one hand, and **THE NEWHALL LAND AND FARMING COMPANY** ("NLF"), a California limited partnership, on the other hand, with respect to the following facts:

A. NLF, the owner, has been developing and continues to develop the master planned Valencia Community ("Valencia"), which is located in part within the District's boundaries, a portion of which is subject to the provisions of this Agreement ("NLF Property"). The NLF Property, which is described in Exhibit"A," attached and herein incorporated to this Agreement, excluding those areas depicted as exclusions ("Excluded Areas") as described in Exhibit "A," attached and herein incorporated to this Agreement. The Excluded Areas are further identified and described in Exhibit "B" which is attached and herein incorporated to this Agreement.

B. NLF Property is a mixed use development which will include approximately fifteen thousand (15,000) dwelling units in addition to commercial facilities. Total buildout of the NLF Property will take approximately ten (10) more years and the final details of development of the NLF Property, including the location and extent of land uses, the number and product mix of dwelling units is expected to change over time to meet the needs of the market. Corresponding changes in governmental approvals are also expected.

C. Historically, the State of California has provided a substantial portion of the money necessary to build new School Facilities ("State Funding"). However, over the last several years sufficient funds have not been available from the State for this purpose and the District does not believe that sufficient funds will be available from the State for this purpose in the near future.

D. The District and NLF have estimated the amount of money which would be necessary to completely mitigate the impacts of the development of the NLF Property on the District's educational facilities in the absence of State funding ("Mitigation Payments").

E. Both the District and NLF desire to provide a financing schedule ("Financing Schedule") and a financing plan ("Financing Plan"), as set out in this Agreement, in lieu of Mitigation Payments, which will provide permanent School Facilities, including land, buildings, furnishings and equipment ("School Facilities"), to house the NLF K-6 Students who will be generated by the development of the NLF Property, including those students from NLF Property which may attend District School Facilities pursuant to paragraph 1 of this Agreement ("NLF Students"), and which will completely mitigate the direct and cumulative impacts on the District's educational facilities. Temporary facilities to house NLF Students inclusive of Castaic

NLF Students as hereinafter defined, while new School Facilities are being constructed, will be provided, and paid for, by the District. School Facilities will be constructed in accordance with the requirements and specifications contained in the Education Code and the Applicant Handbook for State School Building Lease-Purchase Program put out by the Office of Public School Construction as those requirements and specifications exist at any given time ("State Requirements and Specifications"). A copy of the State Requirements and Specifications as they exist on the date of this Agreement is attached as Exhibit "C" and herein incorporated to this Agreement.

F. The construction of School Facilities will be accomplished through the use of funds advanced by NLF in response to requests from the District, hereinafter defined as Construction Draws. The Financing Schedule will ensure that the District will always have sufficient capacity to house every NLF student. The Financing Plan is intended to minimize the financial impacts on NLF while at the same time maximizing the opportunity to obtain State Funding for School Facilities or the repayment, without interest, from State Funding of the funds advanced by NLF for the cost of School Facilities necessary to house NLF Students.

G. The Financing Schedule and the Financing Plan will ensure that the development of the NLF Property, either individually or cumulatively with other projects within the District's boundaries, will have no adverse impacts on the District's ability to provide adequate educational opportunities to every student in the District. In particular, the Financing Schedule and the Financing Plan guarantee to the District that there will be adequate School Facilities available to house every NLF Student.

H. The District has determined that the development of the NLF Property, as a part of the planned community of Valencia, presents a unique opportunity for the District to provide for complete mitigation of the impact that this development is likely to have on the District's educational facilities, that the Financing Schedule and the Financing Plan will provide all of the land and money necessary to provide all needed School Facilities without the need to collect any fees which might otherwise be available to the District in connection with the construction of commercial or industrial buildings within the NLF Property. The District has also determined that the number of additional students who might be entitled to attend the District's schools because of their parents' or guardians' employment in those buildings is less than, or equal to, the number of NLF Students who will not attend the District's schools because they will be attending schools in other districts or private schools. The District's determination is limited to the NLF Property and does not represent a precedent applicable to any other property within the District.

I. Each future permanent elementary school to house NLF Students will be built to the State Requirements and Specifications and will contain at least 30% relocatable classrooms, which, together with permanent School Facilities, will house seven hundred seventy-five (775) students on a traditional, single track, nine month school schedule and that each represents the appropriate size elementary school to house NLF Students ("New Elementary School"). The

District will operate each New Elementary School to house nine hundred thirty (930) NLF Students by housing the additional one hundred fifty-five (155) NLF Students at any New Elementary School or at any other District school by either, in its sole discretion, adding relocatable classrooms or, without adding relocatable classrooms, by operating any New Elementary School on a multi-track, year-round schedule.

J. Each New Elementary School will be built on a net (10) ten acre school site exclusive of slope areas in excess of two percent (2%) ("Slope Areas") or, in NLF's sole discretion, on a net six and one-half (6.5) acre school site exclusive of Slope Areas for joint use with an adjoining local public park containing at least a net of five (5) acres exclusive of Slope Areas ("New Elementary School Site"), provided the District has entered into a joint use agreement ("JUA") acceptable to the District. The operation and relationship of the joint use school and park shall be contained in such JUA. Any adjoining local park shall be improved and available as provided in the JUA for use by the District at the time the adjoining New Elementary School is open for operation and for as long afterwards as the New Elementary School remains in operation.

IN LIGHT OF THE FOREGOING FACTS, IT IS MUTUALLY AGREED THAT:

1. The District shall use its best efforts to enter into an agreement with the Castaic Union School District ("Castaic") whereby District can provide classrooms and educational services to the students from that portion of the NLF Property anticipated to be developed, consisting of approximately 200 dwelling units which presently are within the boundaries of Castaic. This area, hereinafter defined as the Castaic Area ("Castaic Area"), is depicted in Exhibit "A" to this Agreement. This shall occur, if at all, through an interdistrict transfer agreement or some similar agreement to the mutual satisfaction of the District and Castaic. The District also shall not withhold its reasonable cooperation and consent to a reorganization and transfer of that portion of the District's boundaries that are currently in NLF's Westridge project so that the Westridge portion of District will become part of the Newhall School District ("Newhall") and within Newhall's boundaries. The terms of this Agreement shall apply to those portions of the NLF Property which are within the District's boundaries regardless of the outcome of District's best efforts to successfully complete the annexation or reorganization set forth in this Paragraph 1.

2. NLF shall advance all of the funds needed by the District to build the New Elementary Schools pursuant to the terms of this Agreement and the District shall build the New Elementary Schools necessary to house all NLF Students pursuant to the terms of this Agreement.

3. The District shall provide NLF with written notice ("District Notice") for the first New Elementary School when the District reasonably determines that at least three hundred (300) NLF Students, including any NLF students from the Castaic Area ("Castaic NLF Students"), are estimated to exist for the next succeeding school year and that a New Elementary School is

reasonably required to house NLF Students, including any Castaic NLF Students. Thereafter the District shall provide NLF with a District Notice whenever it reasonably determines that all existing New Elementary Schools will house at least nine hundred thirty (930) NLF Students, including Castaic NLF Students, except when the last constructed new elementary school which will house at least seven hundred seventy-five (775) NLF students, including Castaic NLF Students, in the next succeeding school year and when at least three hundred ninety (390) additional NLF Students including Castaic NLF Students are reasonably estimated by the District to exist for the next two succeeding school years. The District Notice shall contain a description of the New Elementary School and a schematic footprint showing the location of all proposed buildings, parking lots, and other improved areas ("Project Layout") and shall state the District's estimated cost to construct the New Elementary School and the amount needed for the first Construction Draw.

4. The District shall use its best efforts to provide each New Elementary School, open for operation, at the time when four hundred fifty (450) additional NLF Students including any Castaic NLF Students are available to be housed in the New Elementary School. NLF shall advance to the District the funds required to construct each New Elementary School to a maximum of Six Million Nine Hundred Sixty-Seven Thousand Two Hundred Ninety Dollars ($6,967,290.00) (as shown on Exhibit D) adjusted beginning on January 1, 1998 and annually thereafter on January 1st to account for inflation based on the statewide cost index for Class D construction as determined by the State Allocation Board at its quarterly meetings ("Index"), which adjustment shall be effective as of the date of each meeting ("Maximum Construction Cost"). If the State Allocation Board stops determining the adjustments, the adjustments shall be made using the Marshall & Swift Class D Wood Frame Cost Index for the Western United States, or another mutually agreed upon index. NLF may, in its sole discretion, post an improvement bond, or a letter of credit in favor of the District in a form and from a source reasonably acceptable to the District, in the lesser of the amount of the cost of construction set forth in the District Notice or the Maximum Construction Cost and shall advance the funds required for the first Construction Draw to the District within sixty (60) calendar days of receipt of the District Notice. Thereafter, the District shall submit subsequent written Construction Draw requests to NLF and NLF shall advance the funds required by each subsequent Construction Draw request to the District within thirty (30) calendar days of receipt of the Construction Draw request up to the lesser of the amount of the Construction Draw or Maximum Construction Cost set forth in the District Notice, plus any change orders or actual reasonable extra costs. The District shall confer with NLF as to any change orders involving extra costs in excess of five percent (5%) of the Maximum Construction Cost.

5. The District shall be responsible for obtaining, paying for, and installing any permanent or temporary relocatable classrooms which are to be used to house NLF Students inclusive of any Castaic NLF Students while a New Elementary School is being built.

6. The District and NLF shall consult with each other on the planning, design, layout, and grading of each New Elementary School and each New Elementary School Site to maximize architectural compatibility with surrounding development and to minimize construction and maintenance costs to the District to the greatest extent possible while still conforming to the State Requirements and Specifications. All decisions regarding the planning, design, layout, and grading of New Elementary Schools and New Elementary School Sites shall be in the District's sole discretion and it is not intended that the District be required to do anything that will increase its current or future costs of operation or maintenance.

7. NLF shall provide each New Elementary School Site to the District in a construction ready condition within one hundred eighty (180) calendar days of receipt of the District Notice. It is the intent of the District and NLF that plans, drawings, and construction documents will have been prepared and approved by the Office of the State Architect and the State Allocation Board and that a construction contract will be concurrently awarded upon completion of a New Elementary School Site by NLF in the herein described construction ready condition, so that construction of each New Elementary School can begin at the time each New Elementary School Site is provided to the District.

8. Each New Elementary School Site shall be provided to the District in a construction ready condition with all-weather access to public roads and utilities, including storm water and drainage facilities. This shall consist of one (1) potable water line, one (1) fire water line, one (1) electrical line, one (1) natural gas line, one (1) telephone line, and up to two (2) sewer lines, stubbed to the hook-up location indicated for each utility on pages 3-B-40-41 of The State Requirements and Specifications attached as Exhibit "C", and shown on the Project Layout, sufficient to service a New Elementary School, in place. Each New Elementary School Site shall have no more than two (2) pads with no more than a two percent (2%) grade as to each pad. The Maximum Construction Cost shall be increased by any additional costs of service-site development over that which would otherwise be incurred if the difference in elevation of two pads on a New Elementary School Site exceeds four (4) feet. Every pad shall be compacted to the degree required by a geotechnical engineer to support the uses shown on the Project Layout without additional cost to the District.

9. NLF shall provide, a maximum of four (4) New Elementary Schools and four (4) New Elementary School Sites, pursuant to paragraph 13 below, which shall be funded by NLF pursuant to this Agreement. The location of each New Elementary School Site is to be reasonably determined by NLF subject to the consent of the District, which consent shall not be unreasonably withheld, the concurrence of the State Department of Education and, if required, the County of Los Angeles or a successor City.

10. NLF shall lease New Elementary School Sites to the District as needed by the District on the terms and conditions of this Agreement. Each lease shall commence sixty (60) calendar days after receipt of the District Notice. Each net five (5) acre local public park,

exclusive of Slope Areas, adjacent to a net six and one half (6.5) acre, exclusive of Slope Areas, New Elementary School Site, shall be improved and available for joint use in connection with the operation of the New Elementary School at the time that it opens for operation and shall remain available for as long afterwards as it remains in operation. NLF shall make all reasonable efforts to place the landscaped area, if any, on the frontage of the New Elementary School Sites within the boundary of a landscaping and lighting maintenance district. Each lease for a New Elementary School Site shall be for a period of thirty (30) years ("Lease Term") at a rental of One Dollar ($1) per year. Each lease shall terminate if the New Elementary School is not open for operation within five (5) years of the commencement of the lease, provided that NLF has advanced all required funds for the New Elementary School to the District, or if, after the New Elementary School has opened for operation, it fails to operate as an elementary school for five (5) years in any seven (7) year period. The District, upon termination of any lease, shall, at the District's sole expense, demolish all improvements constructed by it on the New Elementary School Site and return it to the condition it was in at the commencement of the lease and shall refund to NLF any funds advanced to the District, together with interest actually earned by the District, for the construction of the New Elementary School which have not been paid, irrevocably committed, or required to terminate any applicable contract.

11. Each lease shall contain an option which allows the District to purchase the New Elementary School Site and which the District shall exercise immediately if the District is able to obtain money for construction or land acquisition from any State or federal agency. The purchase price shall be the appraised value at the time of the exercise of the option or at such other time as required by applicable State or federal law and shall be determined in accordance with applicable policies and regulations of the office of Public School Construction and the State Allocation Board. If the money received from any State or federal agency is less than the purchase price, then the District shall pay NLF the amount received and any additional amounts received for the New Elementary School Site from any State or federal agency thereafter. If the District is unable to exercise the purchase option during Lease Term, the District shall purchase the New Elementary School Site for One Dollar ($1) at the end of the Lease Term. Any purchase of a New Elementary School Site which does not include the payment of the full amount of the appraised value shall be subject to a power of termination, as that term is defined in Civil Code 885.010, in favor of NLF which will require the District to deed all improvements constructed by it on the New Elementary School Site, and to return it to the condition it was in at the commencement of the lease if the New Elementary School fails to operate as an elementary school for five (5) years in any seven (7) year period. Upon exercise of the power of termination, NLF shall pay the District the amount of the purchase price, without interest, paid to NLF. The power of termination shall become ineffective at such time as NLF receives the full amount of the appraised value of a New Elementary School Site.

12. If the District determines that a fourth New Elementary School Site and a New Elementary School is needed by District, then NLF shall provide the fourth New Elementary School Site pursuant to the provisions set out in Paragraphs 10 and 11 above.

13. The District shall state in the District Notice for the last school needed to house NLF Students including Castaic NLF Students ("Last School") the number of NLF Students that exceed two thousand seven hundred ninety (2,790) that will be housed in the Last School.

a. If the District reasonably determines that the Last School will house less than nine hundred thirty (930) NLF Students, including Castaic NLF Students, but more than four hundred sixty-five (465) NLF Students, including Castaic NLF Students, then the District shall build the Last School on a New Elementary School Site to be provided by NLF. The Last School shall be built to the State Requirements and Specifications and shall be large enough to house the number of NLF Students, including Castaic NLF Students, if the school were operated on a multi-track, year round schedule. NLF shall only be required to advance funds to the District equal to the construction cost of the Last School up to the Maximum Construction Cost. Alternatively, the District, in its sole discretion, may build a New Elementary School in which case NLF shall be required to advance funds to the District equal to the lesser of the construction cost of the New Elementary School multiplied by the ratio of the number of NLF Students and Castaic NLF Students to be housed to the nine hundred thirty (930) or the Maximum Construction Cost multiplied by the ratio of the number of NLF Students and Castaic NLF Students to be housed to nine hundred thirty (930).

b. If the District determines that the Last School will house four hundred sixty-five (465) NLF Students, including Castaic NLF Students, or less, then the District shall not be required to build the Last School and NLF shall only be required to advance funds to the District equal to the construction cost of a school large enough to house such number of NLF Students, including Castaic Students. This amount, shall be equal to the construction cost of a New Elementary School, up to the Maximum Construction Cost, to be adjusted by the Index, multiplied by the ratio of the number of NLF Students, including Castaic NLF Students, to be housed to nine hundred thirty (930). Alternatively, the District, in its sole discretion, may build the Last School in which case it shall be large enough to house a minimum of seven hundred seventy-five (775) students if operated on a traditional, single track, nine month school schedule and shall be built to the State Requirements and Specifications. If the District constructs the Last School and if it becomes obligated to purchase land for the Last School within five (5) years of the time that NLF advances the funds called for under this subparagraph, then NLF shall advance additional funds to the District equal to the construction cost of the Last School plus the District's actual out-of-pocket purchase price of the land . This amount shall be multiplied by the ratio determined by dividing the number of NLF Students, including Castaic NLF Students to be housed, by the number of students that the Last School will be able to house if the Last School were to operate on a multi-track, year round schedule. This amount shall not exceed the Maximum Construction Cost, less the amount of funds previously advanced for the Last School. The District shall reimburse NLF for the funds advanced for the purchase of the land for the Last School if the District later receives funds for the purchase of the land from any State or federal agency. NLF shall have no obligation to advance additional funds for the construction cost or the purchase of the land for the Last School if the District does not become obligated to purchase the land within five (5) years of the time that NLF advances the funds called for under this subparagraph.

c. If the District determines that the total number of NLF Students, including Castaic NLF Students, generated by the NLF Property will be greater than three thousand seven hundred twenty (3,720), i.e. the number of students that would be in four (4) New Elementary Schools, then District shall notify NLF at such time. Beginning at such time that there are three thousand seven hundred twenty-one (3,721) NLF Students, including Castaic NLF Students, in four (4) New Elementary Schools, then NLF shall be required to pay a mitigation fee to District for each single family and multi-family dwelling unit at the time of issuance of a building permit for each such unit. The mitigation fee shall be calculated by multiplying the student generation rate ("SGR") of a single family and/or multi-family dwelling unit times the Maximum Construction cost of a New Elementary School and the cost of land acquisition of ten (10) net acres, at the then appraised value and dividing that amount by nine hundred thirty (930) students. The SGRs shall be calculated by dividing the actual total number of District students from each of the two types of dwelling units by the actual total number of the respective type of dwelling units within the District.

14. The District shall use its best efforts to maximize its eligibility to obtain funding for each New Elementary School and each New Elementary School Site from any State or federal agency and shall take all reasonable efforts to obtain such funding. Toward this end, the District and NLF may, upon NLF's request, revise this Agreement to provide a different procedure, including design/build and Public/Private Partnership concepts which will increase the opportunity to obtain funding from any State or federal agency as long as there is no increased cost to either the District or NLF. The District shall, in any event, use its best efforts to ensure that NLF receives any funds received from any State or federal agency in connection with the acquisition of a New Elementary School Site or the construction of a New Elementary School. The District shall be entitled to retain funds received from any State or federal agency up to the cost of five (5) permanent relocatable classrooms for each New Elementary School. If the law is changed to allow local bond issues to be approved by a majority of the voters, the District shall use its best efforts to put a local bond issue on the ballot and have it approved. District shall not be obligated to put a local bond issue on the ballot in those areas of the District in which a Community Facilities District (Mello-Roos) has been or will be established to fund School Facilities. If such a local bond issue passes, then NLF shall be reimbursed for the appraised value of the New Elementary School Sites before the District retains funds received from the State or any federal agency for permanent relocatable classrooms.

15. The District shall provide the County of Los Angeles with information for the County's Development Monitoring System based on a capacity of nine hundred thirty (930) students for each New Elementary School.

Newhall/Saugus Union School District

16. To the extent that the dwelling units in Tentative Tract Maps of the County of Los Angeles designated as Tentative Tract Map Nos. 46389-07, 46389-08, 46389-09, 46389-10, 46389-11, 46389-12, 46389-13 and 52206, designated in Exhibit "A" to this Agreement, are constructed and pay school fees or other amounts pursuant to the Joint Valley-Wide Agreement to District for School Facilities, the District shall credit against the first Construction Draw for any New Elementary School such school fees or other amounts received by District pursuant to any Joint Valley-Wide Agreement entered into within the District. Such amounts may be used for architectural and additional costs preliminary to commencement of construction of the First New Elementary School.

17. Provided, NLF is not in default hereunder, the District shall not, under any circumstances:

a. Exercise any power or authority under current or future law without the consent of NLF to levy or impose an exaction of land, goods, money or services, whether denominated a fee, charge, dedication, or tax, against any development of the NLF Property except as to any District-wide general tax, special tax, or assessment for School Facilities;

b. Require, request, or cooperate with the County of Los Angeles, the City of Santa Clarita, or any other governmental entity to exercise its power or authority to levy or impose an exaction of land, goods, money, or services, whether denominated a fee, charge, dedication, or tax as to the NLF Property, for the benefit of the District;

c. Oppose the development of the NLF Property, any governmental approval, whether legislative or administrative, of these projects, or any change in any governmental approval of these projects on any basis whatsoever; or

d. Sponsor, or require the formation of, a Communities Facilities District which includes the NLF Property, except on a District-wide basis, without the express, written consent of NLF which consent may be given or withheld in NLF's sole discretion. The District shall not unreasonably refuse to act as sponsor for a Community Facilities District if requested to do so by NLF.

18. The funds and land to be provided to the District by NLF pursuant to the terms of this Agreement constitute the entire extent of NLF's obligation to provide School Facilities for development of the NLF Property. The District shall not require or accept any fees, except as provided for in Paragraph 16 above, in connection with the development of the NLF Property which might otherwise be available to it under current or future State law, the Joint Valley-Wide ~~Joint School Fee Resolution~~ Agreement (which the District is no longer a party to), or by any other means. The District shall inform the William S. Hart Union High School District that the amount of any such fees that would be otherwise available to the District shall not be collected.

19. The District shall provide written certification upon written request from NLF that adequate School Facilities for the District's K-6 needs either exist, or that the Financing Schedule and the Financing Plan provided by this Agreement guarantee their availability as needed, to house NLF Students from the NLF Property. This written certification shall be given to the County of Los Angeles, the City of Santa Clarita, or any other governmental entity which may have development approval authority over the NLF Property as requested by NLF.

20. Provided NLF is not in default under this Agreement, no development, change of development, governmental approval, nor change in any governmental approval of the NLF Property shall constitute the basis for any change or termination of this Agreement because this Agreement provides for the complete mitigation of all impacts, direct and cumulative, of the NLF Property on the District's ability to provide adequate educational opportunities to every student in the District.

21. The District, immediately upon request by NLF, shall provide any written certification required to obtain building permits or other development approvals for development of the NLF Property. The written certifications shall be provided for whatever number of residential dwelling units or commercial or industrial buildings are requested by NLF at any time.

22. NLF shall have the right, in its sole discretion, to sell or encumber the NLF Property, improved or unimproved and in whole or in part, by any deed, mortgage, deed of trust, or other security device. No sale, transfer, or encumbrance of the NLF Property shall affect NLF's obligations under this Agreement. Neither this Agreement nor any breach of this Agreement shall defeat, invalidate, diminish, or impair the lien or priority of any deed, mortgage, deed of trust, or other security device.

23. The District and NLF, within thirty (30) calendar days of the written request, shall perform any acts and prepare, sign, deliver, file, and record any documents reasonably required to obtain the goals, and to satisfy the conditions, contained in this Agreement. This includes, but is not limited to, providing the requesting party with a written statement certifying that:

a. This Agreement is unmodified and in full force and effect or, if there have been modifications, that this Agreement, as modified, is in full force and effect, stating the date and nature of any modifications; and

b. There are no current uncured defaults under this Agreement or, if there are any, the dates and natures of the defaults.

24. Any District Notice, request for a Construction Draw or other document which would impose a duty on NLF or change the extent of NLF's obligations under this Agreement shall be accompanied by reasonable supporting documentation at the time that it is provided to NLF by the District.

25. This Agreement is entered into solely for the benefit of the District and NLF and their successors, transferees, and assigns. Other than the District and NLF and their successors, transferees and assigns, no third person shall be entitled, directly or indirectly, to base any claim or to have any right arising from, or related to, this Agreement.

26. This Agreement contains the entire agreement and understanding concerning the funding of School Facilities to house NLF Students and except as to the portion of the NLF Property described in Paragraph 16 of this Agreement supersedes and replaces all prior negotiations and reposed agreements, written or oral. The District and NLF acknowledge that neither the other party nor its agents or attorneys have made any promise, representation, or warranty whatsoever, express or implied, not contained herein to induce the execution of this Agreement and acknowledges that this Agreement has not been executed in reliance upon any promise, representation, or warranty not contained herein.

27. This Agreement may not be amended except in writing and signed by the District and NLF.

28. The District and NLF acknowledge that each has conducted an independent investigation of the facts concerning the development of the NLF Property, the impact that NLF Students will have on the District's educational facilities, and the costs of housing NLF Students.

29. The District and NLF desire to resolve any disputes as to the meaning of any portion of this Agreement or the rights or obligations of the District or NLF under it as quickly as possible. Therefore any such disputes shall be resolved by binding arbitration conducted by a mutually agreed upon retired judge of the Los Angeles Superior Court. If the District and NLF are unable to agree on the arbitrator within thirty (30) calendar days of the receipt of a request for arbitration, they shall request that the presiding judge of the Los Angeles Superior Court designate one. The District and NLF shall each pay half of the cost of the arbitration and each shall be responsible for its own costs as to any such arbitration.

30. Except as provided in paragraph 29, if it becomes necessary to enforce any of the terms of this Agreement, the prevailing party shall be entitled to reasonable attorneys' fees and other costs of litigation in addition to any other relief to which it may be entitled.

31. In interpreting this Agreement, it shall be deemed that it was prepared by the parties jointly and no ambiguity shall be resolved against either party on the premise that it or its attorneys was responsible for drafting this Agreement or any provision hereof.

32. Each individual signing this Agreement warrants and represents that he or she has been authorized by appropriate action of the party which he or she represents to enter into this Agreement on behalf of the party.

33. All notices, demands, and communications between the District and NLF shall be given by personal delivery, registered or certified mail, postage prepaid, return receipt requested, Federal Express or other reliable private express delivery, or by facsimile transmission. Such notices, demands, or communications shall be deemed received upon delivery if personally served or sent by facsimile or after three business days if given by other approved means as specified above. Notices, demands, and communications shall be sent:

To the District:

Saugus Union School District
24930 Avenue Stanford
Santa Clarita, CA 91355
Fax No.: (805) 295-7525

With a copy to:

Alexander Bowie, Esq.
BOWIE, ARNESON, KADI, WILES & GIANNONE
4920 Campus Drive, Suite A
Newport Beach, CA 92660
Fax No.: (714) 851-2014

To NLF:

The Newhall Land and Farming Company
Attention: President
23823 Valencia Blvd.
Valencia, CA 91355
Fax No.: (805) 255-3960

With a copy to:

Steven D. Zimmer
RUPP, HOLMBERG & ZIMMER
P. O. Box 1426
Oxnard, CA 93032
Fax No.: (805) 385-8891

The foregoing names, addresses and fax numbers may be changed at any time by a written notice given as provided above.

Newhall/Saugus Union School District

34. This Agreement and all rights and obligations arising out of it shall be construed in accordance with the laws of the State of California.

35. Any litigation arising out of this Agreement shall be conducted only in Los Angeles County, California.

36. This Agreement may be signed in one or more counterparts at which, taken together, shall constitute one original documents.

37. Recitals A through J are true and correct and are hereby incorporated.

38. The terms and conditions of this Agreement shall be incorporated in every environmental impact report, environmental monitoring program, general plan amendment, specific plan, and tentative subdivision map approval given by Los Angeles County for NLF Property .

DATED: February 18, 1997

BOARD OF TRUSTEES OF THE SAUGUS UNION SCHOOL DISTRICT

By: ______________________

PRESIDENT OF THE BOARD OF TRUSTEES OF THE SAUGUS UNION SCHOOL DISTRICT

ATTEST:

____

CLERK OF THE BOARD OF TRUSTEES OF THE SAUGUS UNION SCHOOL DISTRICT

Newhall/Saugus Union School District

DATED: February 18, 1997

THE NEWHALL LAND AND FARMING COMPANY (A California Limited Partnership)

By: NEWHALL MANAGEMENT LIMITED PARTNERSHIP

Managing Partner

By: NEWHALL MANAGEMENT CORPORATION

Managing General Partner

By: ______________________
Its: President

By: ______________________
Its: SR. V.P.

APPROVED AS TO FORM:

BOWIE, ARNESON, KADI, WILES & GIANNONE

By: ______________________
Alexander Bowie
Attorneys for THE SAUGUS UNION SCHOOL DISTRICT

RUPP, HOLMBERG& ZIMMER

By: ______________________
Steven D. Zimmer
Attorneys for THE NEWHALL LAND AND FARMING COMPANY

Exhibit B

Excluded Areas

Northbridge

MAP 1		MAP 2	MAP 3
TM44481	TM44488	TM44689	TM44695
TM44482	TM44489	TM44690	TM44696
TM44483	TM44490	TM44691	TM44697
TM44484	TM44491	TM44692	TM44698
TM44485	TM44687	TM44693	TM44699
TM44486	TM44688	TM44694	TM44821
TM44487			TM44823
			TM44823-01
			TM44848
			TM44849
			TM44850
			TM44851

Northpark I and II

TM45440
TM45440-02
TM46389-01
TM46389-02
TM46389-03
TM46389-04
TM46389-05
TM46389-06
TM51874
TM51875

**School Facilities Funding Agreement Between
The William S. Hart Union High School District and
The Newhall Land and Farming Company**

SCHOOL FACILITIES FUNDING AGREEMENT BETWEEN

THE WILLIAM S. HART UNION HIGH SCHOOL DISTRICT AND

THE NEWHALL LAND AND FARMING COMPANY

This School Facilities Funding Agreement ("Agreement") is made as of Dec. 16, 1997, between the WILLIAM S. HART UNION HIGH SCHOOL DISTRICT ("Hart"), a school district organized and existing under the laws of the State of California, on the one hand, and THE NEWHALL LAND AND FARMING COMPANY ("Newhall"), a California limited partnership, on the other hand, with respect to the following facts:

RECITALS:

A. Newhall is the owner of the following projects located within Hart's district boundaries:

1. Vesting Tentative Tract Map No. 51931, currently pending before the City of Santa Clarita ("City") ("North Valencia Annexation Project");

2. Vesting Tentative Tract Map No. 48202, currently pending before the County of Los Angeles ("County") ("Decoro Highlands Project");

3. Tentative Tract Map Nos. 46389-07 through -16 inclusive, pursuant to a parent map approved by the County on January 3, 1996 ("North Park Project"); and

4. Tentative Tract Map No. 44374, approved by the City on February 4, 1997 ("Woodlands Project");

collectively referred to herein as the "Projects" or, individually, a "Project".

The Projects are being developed or are planned for development by Newhall or, after sale, by one or more merchant builders.

B. Newhall is the owner also of an approximately thirty-four and two-tenths (34.2) acre unimproved site, located at the northwest corner of Newhall Ranch Road and McBean

Parkway, as generally described in Exhibit "A" attached hereto and incorporated herein ("Newhall Ranch Road/McBean Site"). For purposes of this Agreement, the Newhall Ranch Road/McBean Site is divided for reference into two (2) separate parcels which are: a portion of a proposed junior high school site of twenty (20) acres ("Parcel A"); and an approximately fourteen and two-tenths (14.2) acre park site ("Parcel B") to be dedicated to the City, subject to a deed restriction providing that the conveyance of Parcel B is conditioned upon the City concurrently conveying five (5) acres of Parcel B ("Parcel C") to Hart, reserving to the City a perpetual easement for purposes of park and recreation, all as generally described in Exhibit "A." Exhibit "A" is intended only to generally describe such property. The exact locations, boundaries, and sizes of Parcel A, Parcel B and Parcel C shall be formally depicted on a separate Exhibit "B" which will be incorporated into the Agreement by amendment subsequent to execution of this Agreement. Newhall is willing to consent to annex the Newhall Ranch Road/McBean Site to the City.

C. Newhall and the County are party to the North River Park and Trail Agreement, entered into on June 2, 1992, providing a master plan for parks in the approximately two thousand three hundred (2,300) acre North River Community as defined in that agreement ("County Parks Agreement"). Pursuant to Section 1.B of the County Parks Agreement, Newhall is obligated to dedicate approximately twenty (20) acres of park area within Tentative Tract No. 44831 and Tentative Tract 45440, respectively, in some instances referred to as Duplex I and Duplex II. Newhall desires to satisfy a portion of its obligations to the County as set forth in the County Parks Agreement, by conveying Parcel B to the City.

D. Hart and Newhall recognize that the planned development of residential units of the Projects will generate additional grades 7 through 12 students ("Project Students") within Hart which will, in turn, require additional junior high and senior high school capacity. Newhall and Hart desire to enter into this Agreement for the purpose of setting forth Newhall's obligations to mitigate the impact of the development of the Projects on the school facilities of Hart, and the obligations of Hart relative to school facilities for the Project Students.

E. Performance by Newhall of the provisions set forth in this Agreement satisfy all of Newhall's obligations to Hart with respect to the impacts of the development of the Projects, and insure that, either individually or cumulatively with other development projects within Hart, the Projects will have no adverse impacts on Hart's ability to provide adequate school facilities for Project Students.

IN LIGHT OF THE FOREGOING FACTS, IT IS MUTUALLY AGREED THAT:

NEWHALL OBLIGATIONS

1. Newhall, on or before February 1, 1998, or such later date as the parties may agree, shall convey Parcel A to Hart in fee and Hart shall accept the conveyance of Parcel A from Newhall. Concurrent with the conveyance of Parcel A from Newhall to Hart, Newhall shall convey Parcel B to the City in fee, subject to a deed restriction providing that the conveyance is conditioned upon the City concurrently conveying in fee five (5) acres of Parcel B, previously defined herein as Parcel C, to Hart, reserving to the City a perpetual easement for purposes of park and recreation use which will be operated pursuant to a duly executed joint use agreement between Hart and the City. The form of the deeds for Parcel A to Hart, and Parcel B to the City are as set forth on Exhibits "C" and "D."

2. Newhall further, at its own expense, shall grade and improve Parcel A and Parcel C (collectively referred to as the "Proposed Junior High School Site"), to a construction ready condition consisting of a graded pad with dedicated and improved public roads and utilities, including storm drainage facilities, stubbed into the Proposed Junior High School Site, and with a cross-fall of no more than two percent (2%) and within one (1) foot of the elevation shown on grading plans to be approved by both parties ("Site Improvements"), all as generally provided for in the Applicant Handbook for the State School Building Lease Purchase Program promulgated by the Office of Public School Construction ("OPSC"). Newhall, subsequent to conveyance of Parcel A to Hart and the concurrent conveyance of Parcel C by the City to Hart, shall initiate and diligently pursue to completion the Site Improvements and shall make all reasonable efforts necessary to complete the Site Improvements by September 30, 1998, subject, however, to the provisions of Section 4, below.

3. If any one of the following events occurs prior to Newhall's conveyance of Parcel A to Hart and the conveyance of Parcel C by the City to Hart, Newhall shall, subject to the terms of this Agreement, identify and dedicate to Hart another mutually acceptable junior high school site, in the same general vicinity and of equivalent value, consisting of twenty (20) net usable acres, and identify and dedicate to the City a contiguous parcel consisting of a minimum of five (5) net usable acres, subject to a deed restriction as provided in Section 1 of this Agreement, instead of the dedication of Parcel A and Parcel B:

a. The State Department of Education fails to approve Parcel A for use as a junior high school site or to approve Parcel C for recreational, athletic field, open space, park, landscaping, parking, and like uses in conjunction with a school on the adjacent Parcel A;

b. After an environmental analysis conducted pursuant to the California Environmental Quality Act, Public Resources Code Section 21000 et seq., the Proposed Junior High School Site is deemed infeasible for purposes of school facilities;

c. After an environmental analysis conducted pursuant to Education Code Section 39001 et seq., Education Code Section 39101 et seq. and Title 5 of the California Code of Regulations, the Proposed Junior High School Site is deemed infeasible for purposes of school facilities; or

d. Hart fails to obtain the requisite local land use approvals or concurrence from the City or County pursuant to Government Code Section 65402 and Public Resources Code Section 21151.2 or the City or County disputes any action taken by Hart pursuant to Section 53094 of the Government Code.

4. Newhall shall deliver to Hart and its legal counsel, Bowie, Arneson, Kadi, Wiles & Giannone ("Legal Counsel") within twenty (20) calendar days after the opening of an escrow to consummate the transfer of Parcel A to Hart and Parcel B to the City, subject to the terms of this Agreement, a Preliminary Title Report covering Parcel A and Parcel B issued by Chicago

Title Insurance Company ("Title Insurer"), together with complete and legible copies of all underlying documents referred to in the Title Report as evidencing exceptions to title, and a complete map plotting all such exceptions and easements disclosed in the Title Report (collectively "PTR").

Hart shall have twenty (20) calendar days following receipt of the PTR within which to notify Newhall in writing of Hart's approval or disapproval of any exception to title disclosed in the PTR. In the event the PTR is supplemented ("Supplemental PTR"), Hart shall have twenty (20) calendar days after its receipt by Hart and Legal Counsel of such Supplemental PTR, and complete and legible copies of all additional documents described therein, and a plotting thereof, within which to approve or disapprove of any new matters disclosed in such Supplemental PTR.

Hart's failure to approve or disapprove of a matter by a writing delivered to Newhall within the time periods specified above shall be deemed to be Hart's disapproval of the PTR or Supplemental PTR, in which case all dates for performance of Newhall's obligations and duties under this Agreement shall be suspended and tolled for a period of time equal to the number of calendar days between the date that is twenty (20) days after the PTR or Supplemental PTR, as the case may be, is delivered to Hart and the date that Hart delivers to Newhall in writing specific disapproval or approval of title exceptions.

In the event Hart specifically disapproves a matter disclosed in the PTR or any Supplemental PTR, Newhall shall have twenty (20) calendar days from receipt of Hart's written notice of disapproval to inform Hart in writing whether Newhall will use its best efforts to remove such disapproved exception. In the event Newhall agrees that it shall use its best efforts to remove a disapproved exception prior to the conveyance of Parcel A to Hart and Parcel B to the City, such removal shall be a condition to the "Closing," as that term is defined in the escrow agreement, and the condition of title as disclosed in the PTR and Supplemental PTR otherwise shall be deemed to be approved by Hart. In the event Newhall gives notice that it will not cause the removal of a disapproved matter or fails to give timely notice of its election to correct a disapproved matter, and if Hart thereupon shall fail to waive its disapproval of the matter within twenty (20) calendar days after receipt of Newhall's written notice that it will not correct the disapproved matter (or the expiration of Newhall's twenty (20) calendar day period for response to Hart's disapproval in the event Newhall has failed to make a timely response), then either Hart or Newhall may terminate this Agreement.

All matters shown in the PTR and any Supplemental PTR which are not disapproved by Hart (or as to which Hart waives its disapproval) or are otherwise approved by Hart prior to the conveyances of Parcel A and Parcel B shall be deemed to be "Permitted Exceptions." Newhall shall convey Parcel A to Hart in fee simple and Parcel B to the City in fee simple subject to a deed restriction providing that the conveyance is conditioned upon the City concurrently conveying Parcel C to Hart, excepting mineral and water rights, free and clear of all mortgages, liens, charges, encumbrances, encroachments, easements, conditions, exceptions and other defects of title, except for the Permitted Exceptions.

5. Newhall agrees to consent to and support annexation of Parcel A and Parcel B to the City. If the annexation is not completed, it shall not affect the terms of this Agreement. Hart as the owner of Parcel A and (when subsequently conveyed by the City) Parcel C agrees to affirmatively support the annexation of Parcel A and Parcel B to the City. All out-of-pocket costs of the annexation of Parcel A and Parcel B, if any, shall be borne or satisfied by Newhall and Hart in equal shares.

6. Newhall and Hart shall equally share in all costs of escrow; provided, however, that Hart's share of such closing costs shall not exceed one thousand five hundred dollars ($1,500.00) and any escrow costs in excess of three thousand dollars ($3,000.00) shall be the sole responsibility of Newhall.

HART OBLIGATIONS

7. In consideration of the dedications and other obligations of Newhall in the Agreement, Hart agrees that the Projects shall be deemed to have fully mitigated their impacts or to have fully satisfied their obligations or requirements for development, as to school facility construction pursuant to State School Facilities Act (Government Code sections 53080 et seq. and 65995 et seq.), the California Environmental Quality Act (Public Resources Code

section 21000 et seq.), the Planning and Zoning Law (Government Code sections 65000 et seq.), the Subdivision Map Act [Government Code section 66410], the County general plan (including without limitation the County Development Monitoring System ("DMS")) and any other applicable County plans, ordinances, or regulations, as well as the City general plan and any other applicable City plans, ordinances, or regulations, and any other law or policy which would otherwise require Newhall to pay fees or incur obligations with respect to Hart concerning the following specified dwelling units ("Dwelling Units") in the Projects, specifically as follows:

	Total	Single Family	Multi-Family
North Valencia Annexation (Lago de Valencia and South River)	2,000	750	1,250
Decoro Highlands	460	301	159
Woodlands	335	265	70
North Park III & IV/ (Tentative Tract 46389-07 through -16, inclusive)	240	240	____
	3,035	**1,556**	**1,479**

a. The location, number and types of units in each individual Project and the timing of development in the Projects are subject to change. In the event that one (1) or more of the Projects, as actually built, consists of more residential units in a given category (single family ("SF") or multi-family ("MF")) than specified above ("Additional Units"), Newhall may reallocate the herein specified Dwelling Unit credits among the above-described individual Projects as set forth in subsection 7(b) below. If the total number of Dwelling Units in the Projects exceeds the total credits provided under this Agreement ("Excess Units"), then Newhall shall pay mitigation payments to Hart in an amount to be determined by Newhall and Hart to reasonably mitigate the impacts of the Excess Units. If the parties cannot agree on the amount of reasonable mitigation, the dispute will be resolved pursuant to the provisions of Section 24 below.

b. In the event one (1) or more of the Projects as actually built consists of fewer Dwelling Units in a given category (i.e., SF or MF) than specified in this section, Newhall shall have the right to transfer credits for such unbuilt Dwelling Units to another category (i.e., SF or MF) for that individual Project, to other Projects as specified in this Agreement or to other future residential developments of Newhall within the boundaries of Hart. The number of unbuilt Dwelling Units for which such credit will be given shall be based upon the difference between the total number of Dwelling Units per category (i.e., SF or MF) as specified in this section and the number of Dwelling Units actually built in the Projects. For purposes of such transfers of credits, each credit given for a SF Dwelling Unit shall be considered equivalent to 2.745 credit for MF Dwelling Units and each MF Dwelling Unit credit shall be equivalent to 0.364 SF Dwelling Unit credits.

8. Upon performance of Newhall's obligations as set forth in Sections 1-6 of this Agreement, Hart, for each residential unit in the Projects, shall provide any written certification required to obtain building permits or other development approvals from the County, the City, or any other governmental entity which requires such certification. The certification shall be in writing and shall be provided for whatever number of residential units are requested, as provided in this Agreement, by Newhall or any assignee of Newhall at any time.

9. Upon performance of Newhall's obligations as set forth in Sections 1-6, Hart shall, immediately upon request by Newhall or any of its assignees and without the payment of any fees whatsoever, provide any written certification required to obtain building permits or other development approvals for the construction of commercial/retail or industrial/business park buildings in the Projects to the County, the City, or any other governmental entity which requires such certification. The certification shall be in writing and shall be provided for whatever number of commercial or industrial buildings within the Projects are requested by Newhall or any of its assignees at any time.

STATE FUNDING PROVISIONS

10. Hart, if it has not already done so, shall submit to OPSC, within thirty (30) days of the signing of this Agreement, applications for State funding for the new junior high school to be constructed on the Proposed Junior High School Site ("New Junior High School"). In consideration of Newhall's obligations provided for in the Agreement, Hart shall take all reasonable steps to maximize its priorities for obtaining State and federal funding for school

facility construction necessary to accommodate Project Students. In particular, Hart under existing applicable law and procedures, shall maintain an active, up-to-date "Priority One" application with OPSC for the New Junior High School pursuant to the Leroy F. Greene State School Building Lease - Purchase law (Education Code Section 17700 et. seq.). Further, Hart shall obtain any interim or temporary school facilities, including, but not limited to, relocatable and portable classrooms in such manner so as not to jeopardize or reduce its State funding priority at any time. The costs of interim or temporary school facilities to house Project Students will be funded from Hart's new capital facilities construction account.

11. In the event Hart qualifies for and receives State funding for all or any portion of the construction costs of the New Junior High School and the first new senior high school, Hart shall credit Newhall for Newhall's pro-rata share of such State funding, which shall be 17.3% for the New Junior High School and 14.8% for the first new senior high school ("State Funding Credit"). Upon receipt of State funding by Hart, the amount of such State Funding Credit due to Newhall shall be increased annually on the anniversary date of the receipt of such funds by an amount equal to the annual percentage increase in the Marshall and Swift Class D Wood Frame Index. Newhall may apply such State Funding Credit to any future school facilities mitigation obligation owed to Hart.

12. If an agreement is reached by Newhall and Hart prior to July 1, 1999 concerning the mitigation of school facilities impacts on Hart for those residential development projects proposed by Newhall and which are the subject of current negotiation between Newhall and Hart, as described on Exhibit "E" attached hereto and incorporated herein, such agreement shall provide that Newhall, notwithstanding any other provision of the Agreement, shall not receive State Funding Credits for its pro-rata share of State funding for the New Junior High School and the first new senior high school.

HART COOPERATION

13. Upon performance of Newhall's obligations as set forth in Sections 1-6, Hart shall, within twenty (20) days of receipt of written request from Newhall, support, orally and in writing, any request for a land use approval, whether legislative or administrative, sought for the

development of any portion of the Projects from the County, the City, or any other governmental entity which has the right to grant such an approval.

14. Upon performance of Newhall's obligations as set forth in Sections 1-6, Hart shall thereafter, for purposes of state reporting or funding applications, reporting under the County DMS, comments on future Environmental Impact Reports, or any calculation of school capacity in any context, designate the capacity of the New Junior High School as one thousand two hundred (1200) students and designate the capacity of the first new senior high school as two thousand four hundred students (2400).

15. Upon satisfaction of Newhall's obligations herein, Hart shall not, under any circumstances:

a. Exercise any power or authority under current or future law to levy or impose an exaction of land, goods, money, or services, whether denominated a fee, charge, dedication, or tax, against any Project except for any general tax, special tax, or assessment for educational facilities levied against all of the land within Hart's boundaries or a school facilities improvement district ("SFID") to finance additional facilities at the New Junior High School provided that such SFID does not affect Hart's "Priority One" status;

b. Require, request, or cooperate with the County, the City, or any other governmental entity to exercise any power or authority to levy or impose an exaction of land, goods, money, or services, whether denominated a fee, charge, dedication, or tax, for Hart's benefit;

c. Oppose the development of any portion of the Projects or any governmental approval, whether legislative or administrative, or any change in any governmental approval on any basis whatsoever; or

d. Sponsor, or require the formation of, a Community Facilities District, except for one which includes all of the land within the boundaries of Hart, for any of the Projects without the express, written consent of Newhall which consent may be given or withheld in Newhall's sole discretion. Hart shall not unreasonably refuse to act as a sponsor for a Community Facilities District or similar public financing procedure if requested to do so by Newhall.

e. Initiate, participate, cooperate with, or support any legal action brought to challenge governmental approvals of the Projects.

GENERAL PROVISIONS

16. No development, change of development, governmental approval, nor change in any governmental approval of any portion the Projects shall constitute the basis for any change or termination of this Agreement.

17. Newhall shall have the right, in its sole discretion, to sell or encumber the Projects, improved or unimproved and in whole or in part, by any deed, mortgage, deed of trust, or other security device. No sale, transfer, or encumbrance of any portion of the Projects shall affect Newhall's obligations under this Agreement. Neither this Agreement nor any breach of this Agreement shall defeat, invalidate, diminish, or impair the lien or priority of any deed, mortgage, deed of trust, or other security device.

18. Unless this Agreement provides to the contrary, Hart and Newhall shall, within twenty (20) days of receipt of a written request from the other party, perform any acts and prepare, sign, deliver, file and record any documents reasonably required to obtain the goals, and to satisfy the conditions, contained in this Agreement. This includes, but is not limited to, providing the requesting party with a written statement certifying that:

a. This Agreement is unmodified and in full force and effect, or, if there have been modifications, this Agreement, as modified, is in full force and effect, stating the date and nature of any modification; and

b. There are no current uncured defaults under this Agreement or, if there are any, the dates and nature of the defaults.

19. Newhall is acting as the master developer of the Projects and intends to sell portions of the Projects to builders who will construct and sell residential, commercial, and industrial buildings to the public. Newhall shall have the unconditional right to assign any right or obligation under this Agreement to anyone at any time. Whenever this Agreement provides Newhall with a right, that right may be exercised by an assignee of that right to the same extent that Newhall could have exercised that right. Newhall shall determine and advise Hart in writing as to the number of credits by housing product type assigned to any such assignee and the resulting remaining credits existing under this Agreement after such assignment. This shall occur prior to each assignment by Newhall under this Agreement. The assignment of any right or obligation under this Agreement shall be in writing and a copy of the assignment shall be provided to Hart. No such assignments shall relieve Newhall of any of its obligations under this Agreement without Hart's written consent which consent shall not unreasonably be withheld.

20. This Agreement is entered into solely for the benefit of Hart and Newhall and their successors, transferees, and assigns. Other than Hart and Newhall and their successors, transferees, and assigns, no third person shall be entitled, directly or indirectly, to base any claim or to have any right arising from, or related to, this Agreement.

21. This Agreement contains the entire agreement and understanding concerning the funding of school facilities to house Project Students and supersedes and replaces all prior negotiations and proposed agreements, written or oral with respect to the Projects. Hart and Newhall acknowledge that neither the other party nor its agents nor attorneys has made any promise, representation, or warranty whatsoever, express or implied, not contained herein to induce the execution of this Agreement and acknowledge that this Agreement has not been executed in reliance upon any promise, representation, or warranty not contained herein.

22. This Agreement may not be amended except by a writing signed by Hart and Newhall.

23. Hart and Newhall acknowledge that each has conducted an independent investigation of the facts concerning the development of the Projects, the impacts that Projects Students will have on Hart's educational facilities, and the costs of housing Project Students.

24. Hart and Newhall desire to resolve any disputes as to the meaning of any portion of this Agreement, the validity of any determination or calculation, or the rights or obligations of Hart or Newhall under it as quickly as possible. Therefore, except as provided in Section 25, any such disputes shall be resolved by binding arbitration conducted by a mutually agreed upon retired judge of the Los Angeles Superior Court. If Hart and Newhall are unable to agree on the arbitrator within twenty (20) days of the receipt of a request for arbitration, they shall request that the presiding judge of the Los Angeles Superior Court designate one. Hart and Newhall shall each pay one-half (½) the cost of the arbitration and each shall be responsible for its own attorneys' fees and costs as to any such arbitration.

25. Notwithstanding any other provision of this Agreement, either party shall be entitled to seek declaratory and injunctive relief in any court of jurisdiction to enforce the terms of this Agreement, or to enjoin the other party from an asserted breach thereof, pending arbitration as provided in Section 24, on a showing that the moving party would otherwise suffer irreparable harm.

26. If it becomes necessary to enforce any of the terms of this Agreement by actions as provided in Section 25, the prevailing party shall be entitled to reasonable attorneys' fees and other costs of litigation in addition to any other relief to which it may be entitled.

27. In interpreting this Agreement, it shall be deemed that it was prepared by the parties jointly and no ambiguity shall be resolved against either party on the premise that it or its attorneys was responsible for drafting this Agreement or any provision hereof.

28. Each individual signing this Agreement warrants and represents that he or she has been authorized by appropriate action of the party which he or she represents to enter into this Agreement on behalf of the party.

29. All notices, demands, and communications between Hart and Newhall shall be given by personal delivery; registered or certified mail, postage prepaid, return receipt requested; Federal Express or other reliable private express delivery; or by facsimile transmission. Such notices, demands, or communications shall be deemed received upon delivery if personally

served or sent by facsimile or after three (3) business days if given by other approved means as specified above. Notices, demands, and communications shall be sent:

To Hart:	William S. Hart Union High School District Attn: Superintendent 21515 Redview Drive Santa Clarita, CA 91350 Fax No.: (805) 254-8635
With a copy to:	Alexander Bowie, Esq. Bowie, Arneson, Kadi, Wiles & Giannone 4920 Campus Drive, Suite A Newport Beach, CA 92660 Fax No.: (714) 851-2014
To Newhall:	The Newhall Land and Farming Company Attn: President 23823 Valencia Boulevard Valencia, CA 91355 Fax No.: (805) 255-3960
With a copy to:	Robert I. McMurry, Esq. Nossaman, Guthner, Knox & Elliott, LLP 18101 Von Karman Avenue, Suite 1800 Irvine, CA 92612 Fax No.: (714) 833-7878

The foregoing names, addresses, and fax numbers may be changed at any time by a written notice given as provided above.

30. This Agreement and all rights and obligations arising out of it shall be construed in accordance with the laws of the State of California.

31. Any arbitration or litigation arising out of this Agreement shall be conducted only in Los Angeles County, California.

32. This Agreement may be signed in one or more counterparts which, taken together, shall constitute one original document.

33. Recitals A through E are true and correct and are hereby incorporated.

34. All Exhibits attached hereto are incorporated into this Agreement.

35. The terms of this Agreement shall be incorporated in every environmental impact report, environmental monitoring program, report provided to the County for inclusion in its DMS, general plan amendment, specific plan, and tentative subdivision map approval given by the County, the City, or any other governmental entity responsible for the approval of the development of the Projects.

DATED: Dec. 17, 1997

BOARD OF TRUSTEES OF THE
WILLIAM S. HART UNION HIGH
SCHOOL DISTRICT

By: ______________________

President of the Board of Trustees of the
WILLIAM S. HART UNION HIGH
SCHOOL DISTRICT

Attest:

____

Superintendent
WILLIAM S. HART UNION HIGH
SCHOOL DISTRICT

DATED: Dec 16, 1997

THE NEWHALL LAND AND FARMING COMPANY (A California Limited Partnership)

By: NEWHALL MANAGEMENT LIMITED PARTNERSHIP
Managing General Partner

By: NEWHALL MANAGEMENT CORPORATION
Managing General Partner

By: Gary M Cusumano
Its: President

By: James M Hunter
Its: Senior Vice President

APPROVED AS TO FORM:

BOWIE, ARNESON, KADI, WILES & GIANNONE

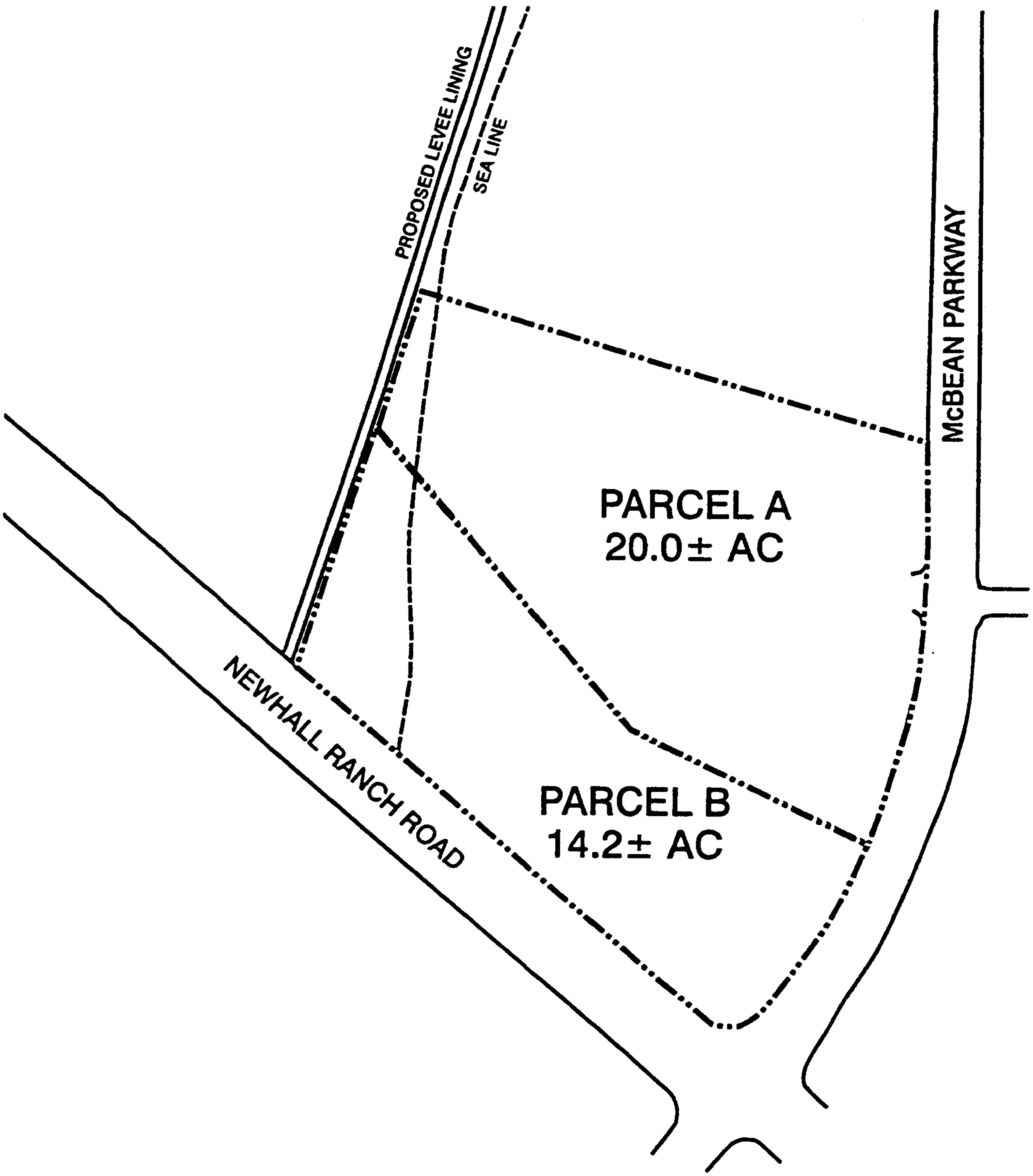
By: [signature]
ALEXANDER BOWIE, ESQ.
Attorneys for the WILLIAM S. HART UNION HIGH SCHOOL DISTRICT

NOSSAMAN, GUTHNER, KNOX & ELLIOTT, LLP

By: R I McMurry
ROBERT I. McMURRY
Attorneys for THE NEWHALL LAND AND FARMING COMPANY

Definitions

EXHIBIT A



Note: Exhibit A is intended only to generally describe such property.

Exhibit A

EXHIBIT B

EXHIBIT B
TO BE SUPPLIED LATER PURSUANT TO THE AGREEMENT.

EXHIBIT C

RECORDING REQUESTED BY AND
RETURN TO:

WILLIAM S. HART UNION HIGH SCHOOL
DISTRICT
21515 Redview Drive
Santa Clarita, CA 91350
Attn: Superintendent

(Space Above for Recorder's Use)

NO RECORDING FEE AND NO DOCUMENTARY TRANSFER TAX DUE PURSUANT TO GOVERNMENT CODE SECTION 6103 AND REVENUE AND TAX CODE SECTION 11922.

PARTNERSHIP GRANT DEED

FOR GOOD AND VALUABLE CONSIDERATION, the receipt and sufficiency of which is hereby acknowledged, THE NEWHALL LAND AND FARMING COMPANY (A CALIFORNIA LIMITED PARTNERSHIP), a limited partnership ("Grantor"), hereby grants to WILLIAM S. HART UNION HIGH SCHOOL DISTRICT, a school district organized and existing under the laws of the State of California ("Grantee"), that certain real property in the County of Los Angeles, State of California, more particularly described in Exhibit "A" attached hereto and incorporated herein by this reference ("Property").

EXCEPTING AND RESERVING UNTO GRANTOR, its successors and assigns, together with the right to grant and transfer all or a portion of the same, as follows:

A. All oil, oil rights, minerals, mineral rights, natural gas rights and other hydrocarbons by whatsoever name known, geothermal steam and all products derived from any of the foregoing, that may be within or under the parcel of Property hereinabove described, together with the perpetual right of drilling, mining, exploring and operating therefor and storing in and removing the same from said Property or any other property, including the right to whipstock or directionally drill and mine from properties other than those hereinabove described, oil or gas wells, tunnels and shafts into, through or across the subsurface of the Property hereinabove described, and to bottom such whipstocked or directionally drilled wells, tunnels and shafts under and beneath or beyond the exterior limits thereof, and to redrill, retunnel, equip, maintain, repair, deepen and operate any such wells or mines without, however, the right to drill, mine, store, explore or operate through the surface or the upper 500 feet of the subsurface of the Property hereinabove described.

B. The right to place on, under or across the Property conveyed hereby, transmission lines and other facilities for a community antenna television system and thereafter to own and convey such lines and facilities and the right to enter upon said Property to service, maintain, repair, reconstruct and replace said lines and facilities; provided, however, that the exercise of such rights shall be as least intrusive upon Grantee's proposed development and use of the Property for school facilities purposes as practicable and not unreasonably interfere with Grantee's reasonable use and enjoyment of said Property conveyed hereby for school facilities purposes.

C. Any and all water, water rights or interests therein appurtenant or relating to the Property hereinabove described or owned or used by Grantor in connection with or with respect to said Property (no matter how acquired by Grantor), whether such water rights shall he riparian, overlying appropriative, littoral, percolating, prescriptive, adjudicated, statutory or contractual, together with the right and power to explore, drill, redrill, remove and store the same from or in the Property hereinabove described or to divert or otherwise utilize such water, rights or interests on any other property owned or leased by Grantor; but without, however, any right to enter upon the surface or upper fifty (50) feet of the subsurface of the Property described herein in the exercise of such rights.

D. Easements over the Property conveyed hereby for the construction, installation and maintenance of electric, gas, telephone, water, sewer and drainage facilities, provided that the construction and installation of such facilities shall not unreasonably interfere with Grantee's development and use of the Property conveyed hereby for school facilities purposes.

SUBJECT TO:

1. Nondelinquent general, special and supplemental real property taxes and assessments, if any, for the current fiscal year.

2. All other covenants, conditions, restrictions, reservations, rights, rights-of-way, dedications, offers of dedication, easements and other matters of record or otherwise known to Grantee as of the date hereof.

[signature page follows]

IN WITNESS WHEREOF, the Grantor has executed this Partnership Grant Deed as of the date written below.

Dated: ____________________ **GRANTOR:**

THE NEWHALL LAND AND FARMING COMPANY (A CALIFORNIA LIMITED PARTNERSHIP), a limited partnership

By: NEWHALL MANAGEMENT LIMITED PARTNERSHIP, a California limited partnership
Its managing general partner

By: NEWHALL MANAGEMENT CORPORATION, a California corporation
Its managing general partner

By: ______________________________
Its: ______________________________
By: ______________________________
Its; ______________________________

EXHIBIT "A"

LEGAL DESCRIPTION

STATE OF CALIFORNIA)
) ss.
COUNTY OF ________________)

On ________________ before me, ____________________, a Notary Public, personally appeared ________________________ personally known to me or proved to me on the basis of satisfactory evidence to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

WITNESS my hand and official seal.

____
Signature of Notary

[Seal]

EXHIBIT D

RECORDING REQUESTED BY AND
RETURN TO:

CITY OF SANTA CLARITA
____
Santa Clarita, CA 91350
Attn: ______________________

(Space Above for Recorder's Use)

NO RECORDING FEE AND NO DOCUMENTARY TRANSFER TAX DUE PURSUANT TO GOVERNMENT CODE SECTION 6103 AND REVENUE AND TAX CODE SECTION 11922.

PARTNERSHIP GRANT DEED

FOR GOOD AND VALUABLE CONSIDERATION, the receipt and sufficiency of which is hereby acknowledged, THE NEWHALL LAND AND FARMING COMPANY (A CALIFORNIA LIMITED PARTNERSHIP), a limited partnership ("Grantor"), hereby grants to THE CITY OF SANTA CLARITA, a municipal corporation ("Grantee"), that certain real property in the County of Los Angeles, State of California, more particularly described in Exhibit "A" attached hereto and incorporated herein by this reference ("Property").

EXCEPTING AND RESERVING UNTO GRANTOR, its successors and assigns, together with the right to grant and transfer all or a portion of the same, as follows:

A. All oil, oil rights, minerals, mineral rights, natural gas rights and other hydrocarbons by whatsoever name known, geothermal steam and all products derived from any of the foregoing, that may be within or under the parcel of Property hereinabove described, together with the perpetual right of drilling, mining, exploring and operating therefor and storing in and removing the same from said Property or any other property, including the right to whipstock or directionally drill and mine from properties other than those hereinabove described, oil or gas wells, tunnels and shafts into, through or across the subsurface of the Property hereinabove described, and to bottom such whipstocked or directionally drilled wells, tunnels and shafts under and beneath or beyond the exterior limits thereof, and to redrill, retunnel, equip, maintain, repair, deepen and operate any such wells or mines without, however, the right to drill, mine, store, explore or operate through the surface or the upper 500 feet of the subsurface of the Property hereinabove described.

B. The right to place on, under or across the Property conveyed hereby, transmission lines and other facilities for a community antenna television system and thereafter to own and convey such lines and facilities and the right to enter upon said Property to service, maintain, repair, reconstruct and replace said lines and facilities; provided, however, that the exercise of such rights shall be as least intrusive upon Grantee's proposed development and use of the Property for park and recreation and school facility purposes as practicable and not unreasonably interfere with Grantee's reasonable use and enjoyment of said Property conveyed hereby for park and recreation and school facility purposes.

C. Any and all water, water rights or interests therein appurtenant or relating to the Property hereinabove described or owned or used by Grantor in connection with or with respect to said Property (no matter how acquired by Grantor), whether such water rights shall he riparian, overlying appropriative, littoral, percolating, prescriptive, adjudicated, statutory or contractual, together with the right and power to explore, drill, redrill, remove and store the same from or in the Property hereinabove described or to divert or otherwise utilize such water, rights or interests on any other property owned or leased by Grantor; but without, however, any right to enter upon the surface or upper fifty (50) feet of the subsurface of the Property described herein in the exercise of such rights.

D. Easements over the Property conveyed hereby for the construction, installation and maintenance of electric, gas, telephone, water, sewer and drainage facilities, provided that the construction and installation of such facilities shall not unreasonably interfere with Grantee's development and use of the Property conveyed hereby for park and recreation and school facility purposes.

E. A power of termination and right of re-entry in favor of the County of Los Angeles, should the Property ever cease to be used for park and recreation purposes as further provided herein.

SUBJECT TO:

1. Nondelinquent general, special and supplemental real property taxes and assessments, if any, for the current fiscal year.

2. All other covenants, conditions, restrictions, reservations, rights, rights-of-way, dedications, offers of dedication, easements and other matters of record or otherwise known to Grantee as of the date hereof.

The grant of the Property by Grantor to Grantee is further subject to the following express covenants, conditions and restrictions:

a. By acceptance of the grant of the Property pursuant to this Partnership Grant Deed, City covenants and agrees, on behalf of itself and its successive owners and assigns, that the Property is being granted to the City pursuant to the dedication requirements of Government Code section 66477 of the Subdivision Map Act, and shall be operated consistent with such dedication requirements and only for park and recreation purposes ("Conditions"), which Conditions shall inure to the benefit of and be enforceful by the County of Los Angeles and Grantor as against the City or any successive owners and assigns, the covenants and the Conditions as set forth herein being for the benefit of the County of Los Angeles and Grantor and all property owned by the County of Los Angeles and Grantor within the County of Los Angeles.

The Property shall only be used for park and recreation purposes, and shall be open and available without discrimination as to all residents of the incorporated and unincorporated territory of the County of Los Angeles without discrimination against, or preference, gratuity or bonus or other benefit given to residents of incorporated areas not equally given to residents of unincorporated territory ("Non-Discrimination Covenant"). If for any reason Grantee fails to operate the Property for park and recreational purposes pursuant to the Conditions and other restrictions set forth herein, then the County of Los Angeles shall have the power to terminate the interests of Grantee or any successor in interest thereto and a right to re-enter and take possession of the Property.

b. Concurrent with the recordation of this Partnership Grant Deed, Grantee shall convey to the William S. Hart Union High School District ("Hart") by Grant Deed an approximate five (5) acre parcel as more particularly shown and described on Exhibit "B", attached hereto and incorporated herein by this reference ("Five Acre Parcel"), but reserving therefrom unto Grantee a nonexclusive perpetual easement for park and recreation purposes, and to be operated pursuant to that certain Joint Use Agreement between Grantee and Hart dated _______, 199__ ("Joint Use Agreement"). The Grant Deed conveying the Five Acre Parcel shall also incorporate the Non-Discrimination Covenant set forth above, shall acknowledge that the Conditions are for the benefit of Grantee, Grantor and the County of Los Angeles, shall acknowledge the power of termination and right of re-entry in favor of the County of Los Angeles, and shall separately provide for a power of termination and right of re-entry by City if Hart ceases to use the Five Acre Parcel for park and recreation and school facility purposes.

[signature page follows]

IN WITNESS WHEREOF, the Grantor and Grantee have executed this Partnership Grant Deed as of the date written below.

Dated: ____________________

GRANTOR:

THE NEWHALL LAND AND FARMING COMPANY (A CALIFORNIA LIMITED PARTNERSHIP), a limited partnership

By: NEWHALL MANAGEMENT LIMITED PARTNERSHIP, a California limited partnership
Its managing general partner

By: NEWHALL MANAGEMENT CORPORATION, a California corporation
Its managing general partner

By: ______________________________
Its: ______________________________
By: ______________________________
Its; ______________________________

Dated: ____________________

GRANTEE:

CITY OF SANTA CLARITA, a California municipal corporation

By: ______________________________
Mayor

ATTEST:

By: ______________________________

APPROVED AS TO FORM:

By: ______________________________

EXHIBIT "A"

LEGAL DESCRIPTION

EXHIBIT "B"

<u>**FIVE ACRE PARCEL**</u>

STATE OF CALIFORNIA)
) ss.
COUNTY OF ________________)

On ________________ before me, ____________________, a Notary Public, personally appeared ________________________ personally known to me or proved to me on the basis of satisfactory evidence to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

WITNESS my hand and official seal.

____
Signature of Notary

[Seal]

STATE OF CALIFORNIA)
) ss.
COUNTY OF ________________)

On ________________ before me, ____________________, a Notary Public, personally appeared ________________________ personally known to me or proved to me on the basis of satisfactory evidence to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

WITNESS my hand and official seal.

____
Signature of Notary

[Seal]

EXHIBIT E

Exhibit E

Residential development projects which are the subject of current negotiation and which are referred to in Paragraph 11 of the Agreement are those properties owned by The Newhall Land and Farming Company shown on the attached Exhibits E-1 (Valencia), E-2 (Newhall Ranch Specific Plan) and E-3 (Castaic area), not including the Projects as defined in the Agreement and the following excluded areas:

Excluded Areas:

Northbridge

TM44481
TM44482
TM44483
TM44484
TM44485
TM44486
TM44487
TM44488
TM44489
TM33390
TM44491
TM44687
TM44688
TM44689
TM44690
TM44691
TM44692
TM44693
TM44694
TM44695
TM44696
TM44697
TM44698
TM44699
TM44821
TM44823
TM44823-01
TM44848
TM44849
TM44850
TM44851

Northpark I and II

TM45440
TM45440-02
TM46389-01
TM46389-02
TM46389-03
TM46389-04
TM46389-05
TM46389-06
TM51874
TM51875

Other

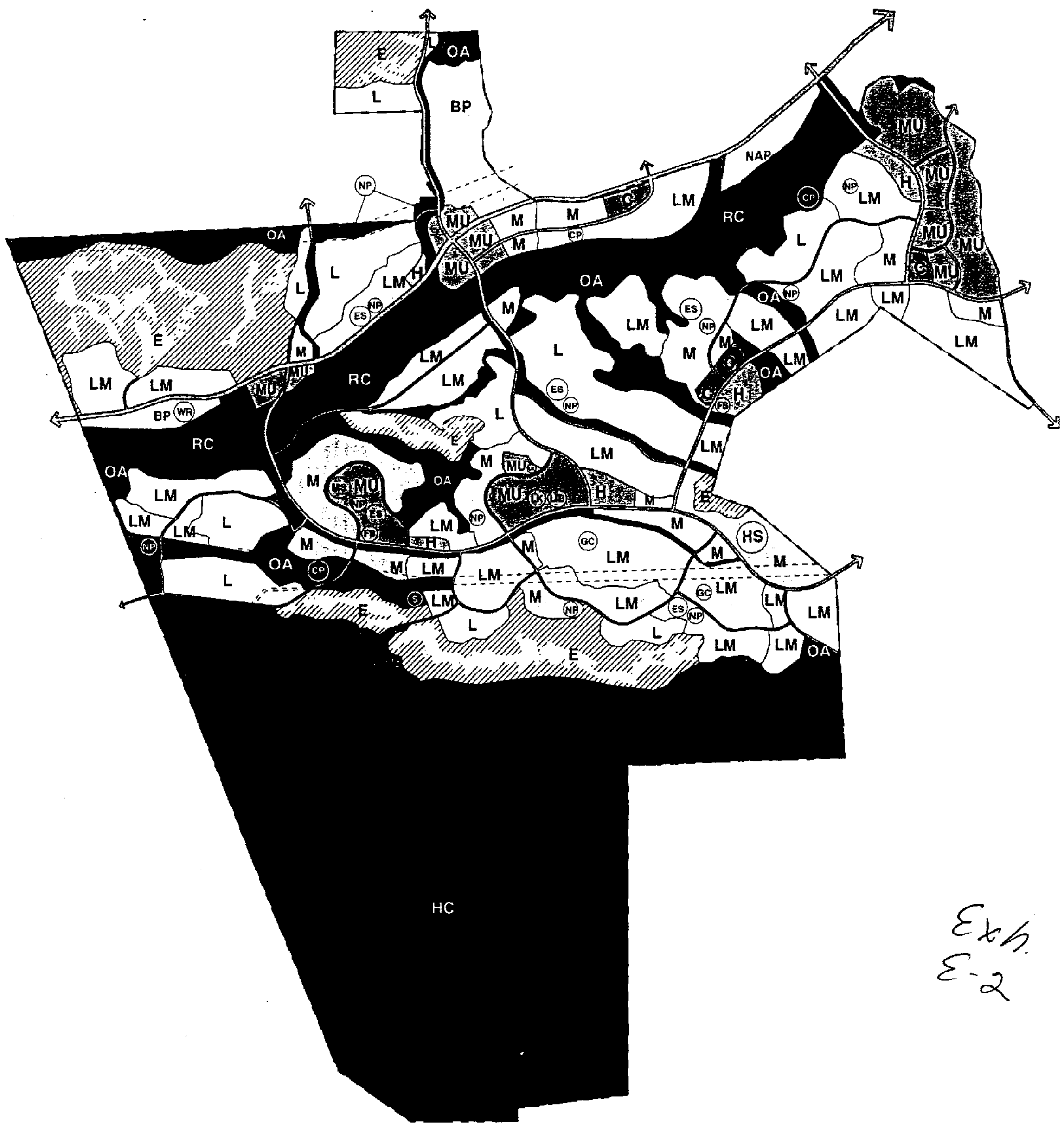
TM36668 (Hasley)
TM44800 (Hasley)
TM44800-01 (Hasley)
TM44800-02 (Hasley)
TM44800-03 (Hasley)
TM45084 (Hasley)
TM52206 (Avignon)

EXHIBIT E-3

"Castaic area"

NLF Common Name	APN
Teardrop parcel	2865-17-1
Van Gorder	2865-3-23
	2865-3-27
Castaic Lagoon	2865-3-11
Mesa	2865-4-1
	2865-5-12
	2865-5-13
	2865-5-14
	2865-7-8
	2865-7-9
	2865-11-15
Lelles	2865-5-23
	2865-4-14
	2865-4-15
	2865-4-16
	2865-4-17
Castaic Commercial	2865-36-29
	2865-36-33
	2865-36-34
	2865-36-35
	2865-36-36
	2865-36-37
	2865-36-38

The attached map shows their approximate locations.



NEWHALL RANCH™
SPECIFIC PLAN
Prepared For: Newhall Ranch Company

- E — ESTATE RESIDENTIAL
- L — LOW RESIDENTIAL
- LM — LOW-MEDIUM RESIDENTIAL
- M — MEDIUM RESIDENTIAL
- H — HIGH RESIDENTIAL
- MU — MIXED USE
- C — COMMERCIAL (RETAIL/OFFICE)
- BP — BUSINESS PARK
- VS — VISITOR SERVING
- OA — OPEN AREA
- RC — RIVER CORRIDOR SPECIAL MANAGEMENT AREA (SEA #23)
- HC — HIGH COUNTRY SPECIAL MANAGEMENT AREA (SEA #20)
- ROADS
- SCE/UTILITY EASEMENTS

LAND USE OVERLAYS (POTENTIAL LOCATIONS):

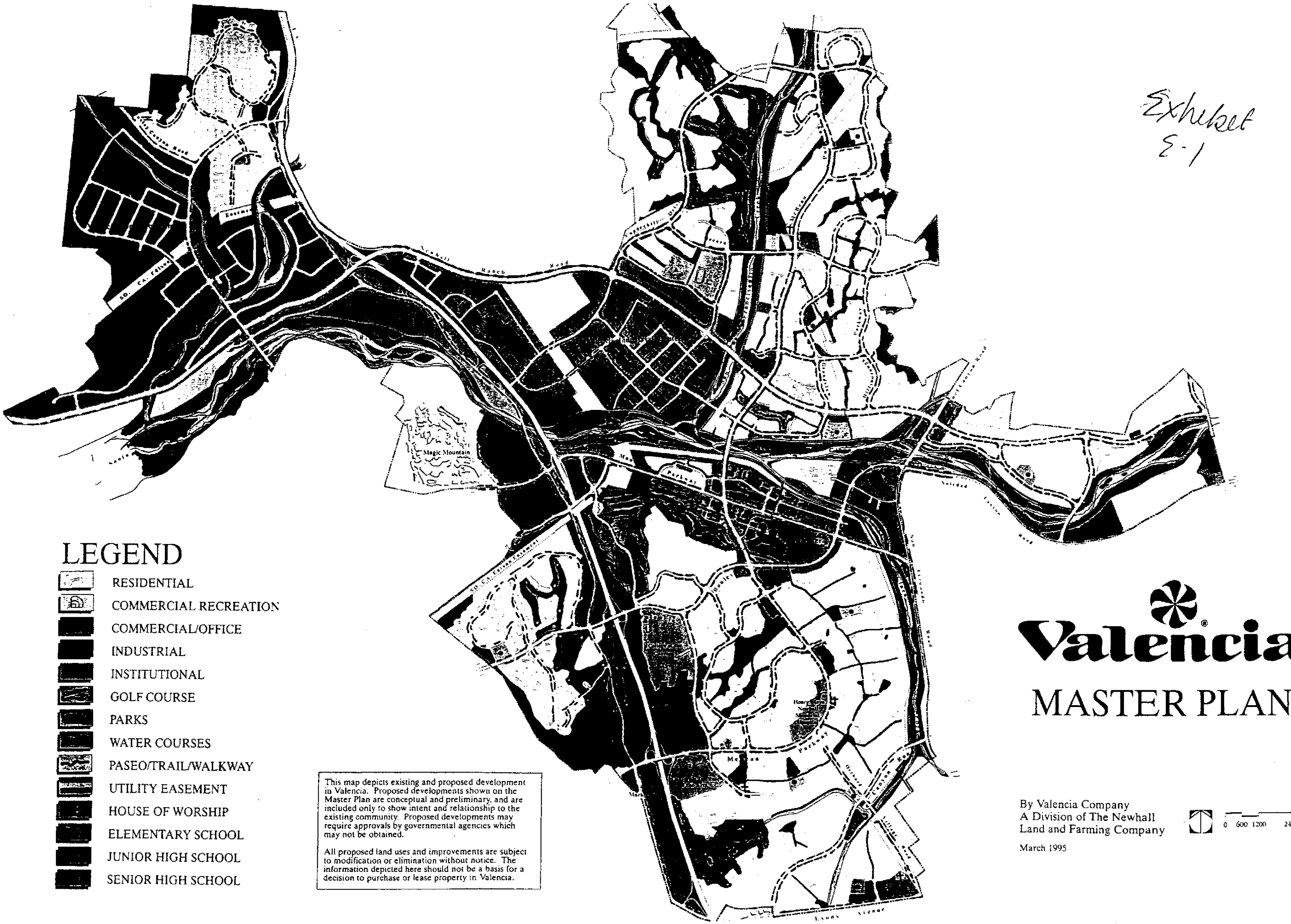
- CP — COMMUNITY PARK
- NP — NEIGHBORHOOD PARK
- ES — ELEMENTARY SCHOOL
- MS — MIDDLE SCHOOL
- HS — HIGH SCHOOL
- GC — GOLF COURSE
- LK — COMMUNITY LAKE
- FS — FIRE STATION
- S — ELECTRICAL SUBSTATION
- LIB — LIBRARY
- WR — WATER RECLAMATION PLANT

English 0 1000' 2000'
Metric 0 225m 450m 900m
10 ACRES 40 ACRES
NORTH
Computer Mapping by FORMA Systems

EXHIBIT 2.3-1
LAND USE PLAN

7/97

Exhibit E-1



This map depicts existing and proposed development in Valencia. Proposed developments shown on the Master Plan are conceptual and preliminary, and are included only to show intent and relationship to the existing community. Proposed developments may require approvals by governmental agencies which may not be obtained.

All proposed land uses and improvements are subject to modification or elimination without notice. The information depicted here should not be a basis for a decision to purchase or lease property in Valencia.

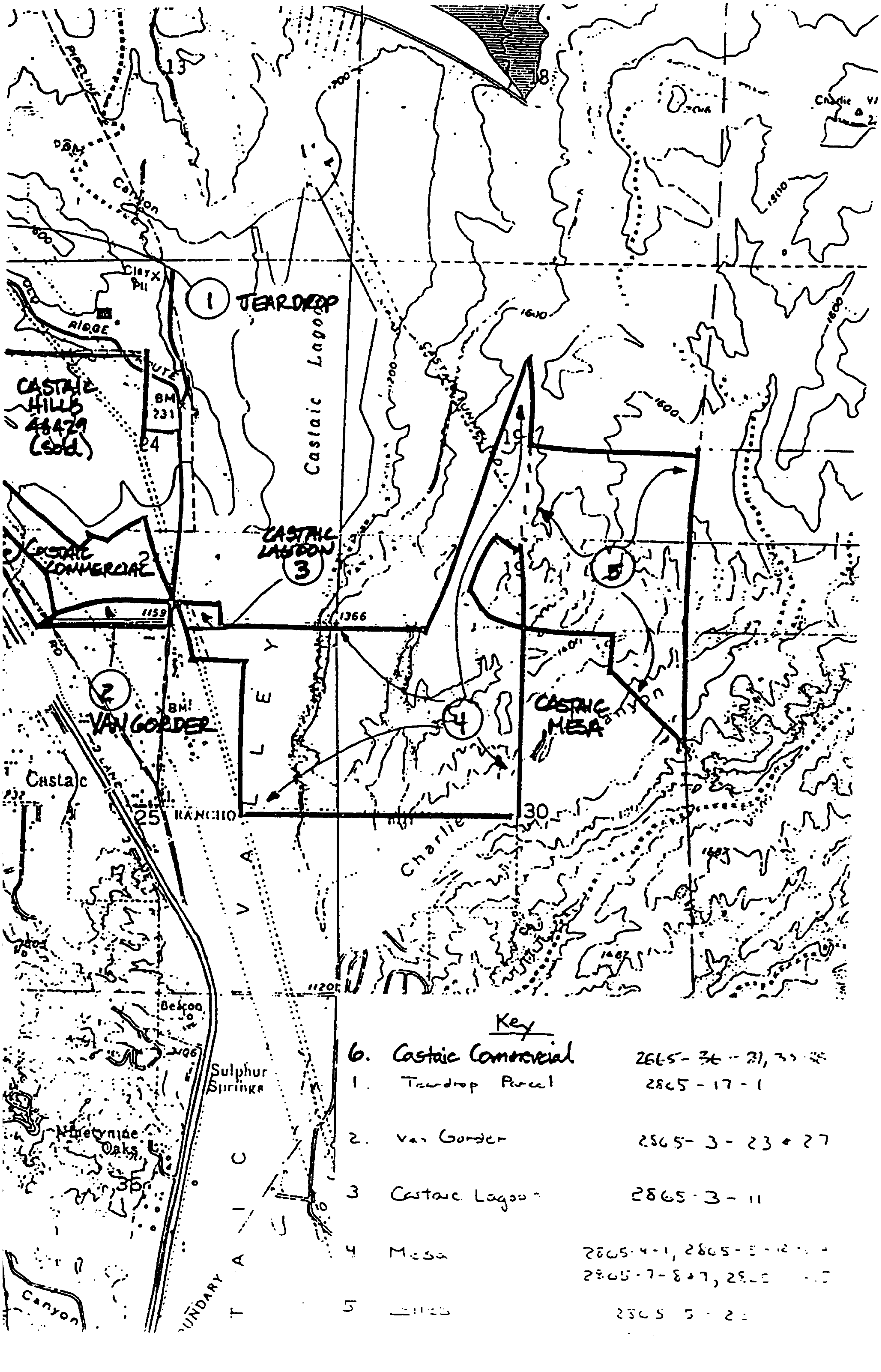
Valencia®

MASTER PLAN

By Valencia Company
A Division of The Newhall
Land and Farming Company

March 1995

EXHIBIT E-4



Key

6.	Castaic Commercial	2865-36-21, [illegible]
1.	Teardrop Parcel	2865-17-1
2.	Van Gorder	2865-3-23 & 27
3	Castaic Lagoon	2865-3-11
4	Mesa	2865-4-1, 2865-[illegible] 2865-7-8 & 7, 28[illegible]
5	[illegible]	2865 5-2[illegible]

23920 Valencia Blvd.
Suite 300
Santa Clarita
California 91355-2196

Phone
(805) 259-2489
Fax
(805) 259-8125

**City of
Santa Clarita**

December 10, 1997

Mr. Robert Lee
Superintendent
William S. Hart Union High School District
21515 Redview Drive
Santa Clarita, CA 91350-2948

Re: North Valencia Annexation Project

Dear Mr. Lee:

As you know, the City is processing development approvals, including a General Plan Amendment, a Specific Plan, an Annexation and Development Agreement, a tentative tract map and oak tree permit for a proposed development known as the North Valencia Annexation Project ("Project"). The developer of the Project, the Newhall Land and Farming Company ("Newhall") has negotiated with the William S. Hart Union High School District ("Hart"), with the assistance of the City, a School Facilities Funding Agreement ("Agreement"). The Agreement has been negotiated between Newhall and Hart, with the assistance of the City, based upon certain understandings with respect to the intentions of the City to convey certain property to Hart after it has been dedicated to the City by Newhall in partial satisfaction of Newhall's park dedication requirements in connection with the Project, together with a portion of Newhall's park dedication requirements under the North River Park and Trail Agreement, a master plan for parks in the entire North River community.

The property proposed for conveyance by the City to Hart consists of a five (5) acre parcel, which is identified in the Agreement as "Parcel C" and is a portion of the fourteen and two-tenths (14.2) acre park site to be dedicated to the City, identified in the Agreement as "Parcel B," which is adjacent to the proposed junior high school site of twenty (20) acres, identified in the Agreement as "Parcel A."

It is the City's understanding that in the partial discharge of Newhall's obligations under the Agreement, Newhall will dedicate to the City for park purposes the fourteen and two-tenths (14.2) acre property, identified in the Agreement as "Parcel B," which will include the five (5) acre parcel, identified in the Agreement as "Parcel C." The dedication by Newhall to the City of "Parcel B" in fee will be subject to a deed restriction providing that the conveyance is conditioned upon the City concurrently conveying the five (5) acre parcel, "Parcel C," to Hart in fee, reserving to the City a perpetual easement for park and recreation purposes, and that said "Parcel C" will be operated pursuant to a joint use agreement to be entered into between Hart and the City.

The foregoing conveyance by the City to Hart of the five (5) acre parcel, "Parcel C," in fee, reserving a perpetual easement for park and recreation purposes is consistent with the City's understanding and intention in connection with the proposed processing and approval of the Project and the implementation of the Agreement between Newhall and Hart. It is further the City's understanding that said "Parcel C" will be the subject matter of a joint use agreement to be entered into between the City and Hart subsequent to the conveyances mentioned above.

If the foregoing intentions and understandings of the City confirmed in this letter are consistent with the intentions and understandings of Hart, please confirm that by signing a copy of this letter and returning a copy to me.

If you have any further questions relative to this matter, please don't hesitate to contact me.

Sincerely,

George A. Caravalho
City Manager

cc: Carl K. Newton, Esq., City Attorney
Robert I. McMurry, Esq., of Nossaman, Guthner, Knox & Elliot, LLP
Alexander Bowie, Esq., of Bowie, Arneson, Kadi, Wiles & Giannone

Confirmed and Approved:

By____
Robert Lee
Superintendent, William S. Hart Union High School District

APPROVED AS TO FORM:

NOSSAMAN, GUTHNER, KNOX & ELLIOT, LLP

By:______________________________
Robert I. McMurry
Attorneys for THE NEWHALL LAND AND FARMING COMPANY

BOWIE, ARNESON, KADI, WILES & GIANNONE

By:______________________________
Alexander Bowie
Attorneys for WILLIAM S. HART UNION HIGH SCHOOL DISTRICT

SCHOOL FACILITIES FUNDING AGREEMENT BETWEEN THE WILLIAM S. HART UNION HIGH SCHOOL DISTRICT AND THE NEWHALL LAND AND FARMING COMPANY

This School Facilities Funding Agreement ("Agreement") is made as of October ____, 1998, between the WILLIAM S. HART UNION HIGH SCHOOL DISTRICT ("Hart"), a school district organized and existing under the laws of the State of California, on the one hand, and THE NEWHALL LAND AND FARMING COMPANY ("Newhall"), a California limited partnership, on the other hand, with respect to the following facts:

RECITALS

A. Newhall is the owner of approximately seventeen thousand (17,000) acres of land, as shown on Exhibit "A", ("Newhall Land") located within Hart's boundaries some of which is located in the City of Santa Clarita ("City") and all of which is in the County of Los Angeles ("County"), which Newhall currently is in the process of master planning for development and obtaining land use Entitlements either by itself or by others.

B. The current plans for development of Newhall Land envision the construction of an estimated thirty five thousand (35,000) residential dwelling units ("DU") and an estimated twenty seven million (27,000,000) square feet of commercial and industrial development ("Commercial/Industrial Development") over approximately thirty (30) years.

C. The provisions herein are applicable to whatever development occurs on Newhall Land, including the proposed Westridge Project (Tentative Map 45433) of County and the Newhall Ranch Project as described in the Specific Plan ("Newhall Ranch Project Specific Plan") now being considered therefor by the County. Subject to the provisions of Section 15 of this Agreement, development which occurs on the Newhall Land in the projects listed on Exhibit "B" ("Excluded Development") are subject to the agreements or conditions of approval or mitigation measures applicable thereto and are excluded from the obligations herein provided as to Fair Share School Impact Mitigation Payments as hereinafter defined.

D. Hart and Newhall recognize that the planned development of DU on Newhall Land will generate additional junior high and senior high school students (collectively, "Newhall Students") which in turn, will require the construction of new junior high schools ("JHS") and senior high schools ("SHS").

E. Historically, the State of California ("State") has provided a substantial portion of the funds necessary to build additional school facilities needed by school districts. However, over the last several years the amount of funds available from the State for the construction of new school facilities has been limited. The method of apportioning such funds to Hart and other school districts has been varied and uncertain, and it is unclear what amount of funds, if any, will be available to Hart in the future from the State for such purposes.

F. Hart does not have school facility capacity to accommodate the Newhall Students. Accordingly, Hart will require, as applicable, substantial additional grade 7-12 interim and permanent school facilities, including land, buildings, furnishings and equipment, as well as interim classrooms, permanent classrooms, central and administration facilities, including such facilities to accommodate students considered as being accommodated in lieu of using the school facilities of Hart on a year-round multi-track ("YRE") basis which presently is required to obtain funding for school facilities from the State ("School Facilities"). Newhall and Hart desire to enter into this Agreement to set forth Newhall's obligations to mitigate the development of Newhall Land as to Hart, and the respective obligations of Hart relating to the provision of additional School Facilities for Newhall Students.

G. Hart and Newhall agree that the present anticipated development of the Newhall Land will result in a need for an estimated three (3) additional JHS and two (2) additional SHS. If, and only if, funding from the State ("State Funding") is received by Hart for the cost of the additional School Facilities to accommodate Newhall Students, the parties intend that Newhall, as herein provided, shall receive reimbursement without interest to the extent provided in this Agreement to be paid only from the herein specified portion of State Funding for a portion of

Newhall's herein specified payment to Hart per DU ("Fair Share School Impact Mitigation Payments") as defined in Section 3 of this Agreement. Newhall hereby assumes the risk that State Funding will not be available to assist in funding School Facilities necessary to mitigate the impact of development of Newhall Land. In such case, Newhall will have contributed one hundred percent (100%) of the cost to mitigate the impact of development of the Newhall Land on the School Facilities of Hart. In consideration of Newhall's obligations provided for in this Agreement, to the extent herein specified, Hart will take all reasonable actions to seek to maximize its priorities for obtaining State Funding for needed School Facilities. If Hart determines that it would be advantageous to do so in order to obtain State Funding for additional School Facilities, Hart may request that Newhall advance funds to Hart but Newhall shall have no obligation to advance such funds.

H. Hart has determined that the Fair Share School Impact Mitigation Payments which Newhall will pay to Hart pursuant to this Agreement will allow Hart to fully mitigate any adverse impacts which might otherwise result from the development of Newhall Land. Hence, except as to Excluded Development, there will be no need to collect any fees from development of the Newhall Land which might otherwise be collected by Hart in connection with the construction of DU which meet the requirements of Government Code §65995.1 ("Age-Restricted DU") or Commercial/Industrial Development.

I. The procedure set forth in this Agreement will ensure that the development of Newhall Land, either individually or cumulatively with other projects within Hart's boundaries, will have no adverse impacts on Hart's ability to provide adequate School Facilities to all students of Hart.

IN LIGHT OF THE FOREGOING FACTS, IT IS MUTUALLY AGREED THAT:

1. ***Incorporation of Recitals.*** Recitals A through I are hereby incorporated in this Agreement.

2. ***Mitigation Requirements.*** The cost of Hart's School Facilities as of January 1, 1997, calculated on a per student basis, is estimated to be as set forth in Exhibit "C". The cost of Hart's School Facilities as of January 1, 1997, through December 31, 1998, as calculated on per DU basis, is set forth in Exhibit "D".

3. ***Mitigation Obligation.*** The Fair Share School Impact Mitigation Payment determined by the impact of future development on the School Facilities of Hart, calculated on a per DU basis as shown on Exhibit "D" as of January 1, 1997, in current dollars, are $5,600 for each such single-family detached DU, ("SFDU") and $2,100 for each multi-family attached DU ("MFDU") located within the boundaries of Hart but outside of the boundaries of the Castaic Union School District ("CUSD"). A SFDU is any DU which is a single family residence with no common walls. A MFDU (including apartments) is a DU in a building or buildings in which all of the DU have one or more supporting, above-ground vertical common walls establishing a substantial connectivity between two (2) or more DU, or a second unit ("Second Unit"). A Second Unit may be either detached or attached construction but shall be only those DUs specified and defined in the Newhall Ranch Project Specific Plan, as the proposed terms thereof exist on the date of this Agreement. All Second Units shall be located within the Newhall Ranch Project portion of the Newhall Land as shown in Exhibit "A." A Second Unit constructed on an attached basis to what otherwise would be a SFDU does not recategorize the basic SFDU as a MFDU by reason of a Second Unit being constructed on an attached basis as to what otherwise would be a SFDU. As to SFDU and MFDU, or a Second Unit, located in the CUSD portion of Hart where Hart provides educational facilities for grades 9-12, the Fair Share School Impact Mitigation Payment as of January 1, 1997, through December 31, 1998, shall be $3,640 for each SFDU and $1,360 for each MFDU and Second Unit.

As previously described herein, Hart intends to seek State Funding for future School Facilities that, prospectively, may allow repayment as a special fund obligation of Hart to Newhall only from such funding as is received by Hart and allocated to Newhall as herein provided as to a portion of the Fair Share School Impact Mitigation Payments required by reason of the residential development of Newhall Land. Newhall acknowledges that Hart has entered, and will enter, into similar agreements with others ("Fair Share Mitigation Payment Participants"). Newhall acknowledges that there is no assurance that such State Funding will be received by Hart and available for allocation to Newhall and other Fair Share Mitigation Payment Participants as provided for in this Agreement. Accordingly, Newhall will be responsible for paying to Hart the entire amount of the Fair Share School Impact Mitigation Payment relative to development of the Newhall Land on the basis provided for in this Agreement. The Fair Share School Impact Mitigation Payment shall be paid to Hart prior to the time that an application for a building permit for the construction of a DU, other than an Age-Restricted DU, a DU in an Excluded Development or a DU subject to the provisions of the Annexation Agreement, as that term is defined in Section 6.c of this Agreement, is submitted to the County, the City, or any other governmental entity which has the authority to issue building permits for the development of Newhall Land.

4. ***Adjustments To Mitigation Obligation***. The Fair Share School Impact Mitigation Payment shall be reviewed and, if appropriate, increased or decreased by Hart, from the base date, at the times, and in accordance with the methodologies set forth in this Section 4. The adjustments shall be based on variations in student generation factors ("SGF"), land value of school sites ("Land Value Component") and costs of construction, furnishings, equipment and related costs ("Non-Land Value Component") as follows:

a. *Student Generation Factors.* As set forth in Exhibit "E", certain initial SGF have been used in determining the initial amounts of the Fair Share School Impact Mitigation Payment. The SGF to be used until January 1, 1999, shall be: 0.171 SHS students for each SFDU, 0.064 SHS students for each MFDU or Second Unit, 0.098 JHS students for each SFDU, and 0.037 JHS students for each MFDU or Second Unit. Effective each January 1, commencing January 1, 1999, as provided in this Section 4, the amount of Fair Share School Impact Mitigation Payments shall be increased or decreased based upon the recalculation of the SGF for Hart determined in accordance with the methodology set forth in Exhibit "E" and the other provisions of this Section 4 of this Agreement, all as set forth in Exhibit "F".

b. *Land Value Component.* A Land Value Component of Three Hundred Seventy-five Thousand Dollars ($375,000) per net usable acre, as of January 1, 1997, assuming a construction-ready condition, with dedicated and improved public roads and utilities, including storm drainage facilities, has been used in calculating the initial Fair Share School Impact Mitigation Payment as of January 1, 1997. The parties acknowledge this value per acre may vary as the Newhall Land is developed. Consequently, effective each January 1st, commencing January 1, 1999, the Fair Share School Impact Mitigation Payment shall be increased or decreased based upon the Land Value Component determined as of a valuation date of the preceding October 15th. This adjustment shall be determined by the appraised per acre value of the sites then under consideration by Hart for the next JHS site and the next SHS site ("Proposed Sites"). If Hart identifies more than one (1) JHS Proposed Site or more than one (1) SHS Proposed Site, the Land Value Components for the JHS and for the SHS shall be based on the average of the appraised per acre values of all JHS Proposed Sites and the average of the appraised per acre values of all SHS Proposed Sites.

Appraisals at Hart's cost payable from Fair Share School Impact Mitigation Payment or interest earned thereon shall be conducted by a member of the Appraisal Institute ("AI") which person shall be selected by Hart ("Hart Appraiser"). The Proposed Sites shall be appraised on the basis that each Proposed Site satisfies the site requirements set forth in Section 7.b. of this Agreement and shall be on the basis of the highest and best use of the Proposed Sites as determined by the Hart Appraiser. If Newhall does not concur as to the Hart Appraiser, or its opinion of value, Newhall may designate, at its own expense, an appraiser that is currently a member of the AI ("Developer Appraiser") to independently appraise the Proposed Sites and prepare a report establishing and supporting the Developer Appraiser's opinion of the fair market value of each of the Proposed Sites. If the opinions of value of the Hart Appraiser and the Developer Appraiser differ by ten percent (10%) or less from each other, the appraised fair market value of the Proposed Sites shall be deemed to be the average of the two (2) appraisals as to each of the Proposed Sites. If the opinions of value of the Hart Appraiser and the Developer Appraiser differ by more than ten percent (10%), the Hart Appraiser and the Developer Appraiser shall be instructed to agree upon a third appraiser who shall be a member of the AI ("Supplemental Appraiser"). The cost of the Supplemental Appraiser shall be shared equally by Hart and Newhall. The Supplemental Appraiser also shall independently appraise the Proposed Sites and prepare a report establishing and supporting his or her opinion of the fair market value of each of the Proposed Sites. In that event, the appraised fair market value of each of the Proposed Sites shall be deemed to be the average of the two (2) appraisals having the closest opinions of value. In the event the appraisal of each of the Proposed Sites conducted by the Supplemental Appraiser equals the average of the Hart Appraiser and the Developer Appraiser, then the appraised fair market value of each of the Proposed Sites shall be deemed to be the value determined by the Supplemental Appraiser. In the event other Fair Share Mitigation Payment Participants also desire to designate a Developer Appraiser, such appraiser shall be the appraiser designated by a majority of Newhall and the other Fair Share Mitigation Payment Participants whose mitigation agreements contain a Land Value Component adjustment substantially similar to the provisions of this Agreement. Newhall agrees to bear its pro rata share of the cost of the Developer Appraiser and the Supplemental Appraiser designated by a majority of the parties executing such mitigation agreements with Hart. If the parties are unable to agree on the Developer Appraiser, Hart shall designate the Developer Appraiser from a list of appraisers submitted by Newhall and other Fair Share Mitigation Payment Participants.

c. *Non-Land Value Component.* Effective January 1, 1999, the Non-Land Value Component shall be increased or decreased based upon the percentage change in the Marshall & Swift Class D Wood Frame Index for the Western United States ("Index"), for the period of November 1,, 1996 to October 31, 1998. Each January 1st subsequent to January 1, 1999, the Non-Land Value Component shall be increased or decreased based on the percentage change in the Index for the prior twelve (12) month period ending on the preceding October 31st. If the Index is no longer published, an equivalent index shall be reasonably determined by Hart.

d. *Adjustment Process.* The annual adjustment of the Fair Share School Impact Mitigation Payment shall be accomplished in the manner set forth in Exhibit "F" and in accordance with the procedure set forth in this Section 4.d.

Not later than November 15th of each year, Hart shall prepare and submit to Newhall an analysis of the proposed Fair Share School Impact Mitigation Payment adjustments described in Subsections (a) through (c) above ("Annual Adjustment Analysis") and Hart shall provide Newhall with all supporting documentation used for the Annual Adjustment Analysis. Hart shall therein state the proposed revised Fair Share School Impact Mitigation Payment to be applicable for the next succeeding calendar year effective on the next January 1st. Hart shall meet with Newhall to review and discuss the Annual Adjustment Analysis not later than December 10th of each year. Hart shall take into account any information provided by Newhall with respect to the Annual Adjustment Analysis, either before or after completion of the Annual Adjustment Analysis, in determining adjustment of the Fair Share School Impact Mitigation Payment. Any disputes between Newhall and Hart with respect to the Annual Adjustment Analysis not resolved to each party's satisfaction shall be resolved in accordance with Section 24 of this Agreement, but only after either Hart or Newhall determine no other alternative is feasible. Pending such resolution, any revised Fair Share School Impact Mitigation Payments that becomes due may be paid under protest and, if any amount subsequently is determined to have been improperly applied by Hart, such additional amount shall be returned by Hart to Newhall with interest at the average rate paid by the Los Angeles County Local Agency Investment Fund accruing from the date of payment to the date of repayment by Hart to Newhall.

5. ***Notice of Annual Adjustment***. No later than November 15th of each year, Hart shall forward to Newhall the Annual Adjustment Analysis provided for in Section 4.d of this Agreement. The Adjustment Analysis shall serve as notice from Hart as to any determination of the Student Generation Rate, Land Value Component, Non-Land Value Component, Fair Share School Impact Mitigation Payment, or any other determination or document which would impose a duty on Newhall or change the extent of Newhall's obligations under this Agreement.

6. ***Reimbursement From State Funding***. Prior to any allocation of State Funding to Newhall as provided for in this Agreement, Hart shall have received State Funding for a JHS and a SHS. This amount as to such JHS and SHS shall be equal to at least one hundred percent (100%) of fifty percent (50%) of the cost of site acquisition and improvement, design inspection,

construction, furnishing and equipment of a JHS and of a SHS for which State Funding is received by Hart. State Funding presently is provided, when available, for site acquisition and planning ("Phase P") and construction ("Phase C") of School Facilities. If only Phase P or Phase C, or however such funding is subsequently designated, is funded by the State, but not both, as to a given JHS or SHS, to be allocated to Hart as herein provided the unfunded portion of Phase P or Phase C, or if a JHS or SHS is designed and constructed at a lesser capacity than designated in Exhibit "C", such unfunded minimum amount as to a JHS or SHS shall carry forward as to State Funding and be reserved for Hart pursuant to this Agreement to the next JHS or SHS for which State Funding is received by Hart, prior to any allocation of State Funding to Newhall. The total amount of State Funding for a JHS and for a SHS to be allocated pursuant to the terms of this Agreement shall be determined on the basis equal to what would be apportioned and funded by the State for the actual completed total cost of such JHS or SHS based on a JHS of 1,000 students and a SHS of 2,000 students on a traditional school year calendar. This amount is not intended to include any cost for accommodating students in lieu of operating such JHS or SHS on a YRE. Subject to the foregoing, State Funding for future JHS and SHS, shall be apportioned to Newhall as follows:

a. Hart shall keep a cumulative total, which shall be adjusted as set forth herein, of JHS and SHS Newhall Students resulting from DU constructed as the result of building permits issued after Hart has received the Fair Share School Mitigation Payments provided for in this Agreement beginning on the day after this Agreement becomes effective based on the SGF in effect at the time each Fair Share School Impact Mitigation Payment for a SFDU, MFDU or Second Unit is paid to Hart ("Newhall Reimbursable Students").

i. If the total number of Newhall Reimbursable Students and students generated by DU subject to agreements with Fair Share Mitigation Payment Participants for a new JHS or SHS, as the case may be, is less than the design capacity of such JHS or SHS herein assumed to be 1,200 for a JHS or 2,400 for a SHS ("Capacity"), Hart shall divide the number of Newhall Reimbursable Students by the Capacity of that school ("Newhall Reimbursement Fraction"). Hart shall then pay an amount equal to the Newhall Reimbursement Fraction times the amount of State Funding received by Hart to Newhall within thirty (30) days of Hart's receipt of such State Funding. Upon payment, Hart shall reduce the number of JHS or SHS Newhall Reimbursable Students, as the case may be, by a number equal to the Capacity of the applicable JHS or SHS multiplied by the Newhall Reimbursement Fraction.

ii. If the total number of Newhall Reimbursable Students and students generated by DUs subject to agreements with Fair Share Mitigation Payment Participants ("Total Number of Reimbursable Students") for a New JHS or SHS, as the case may be, is equal to or exceeds the Capacity of the school, Hart shall divide the number of Newhall Reimbursable Students by the Total Number of Reimbursable Students ("Newhall Adjustment Fraction"). Hart shall then pay an amount equal to the Newhall Adjustment Fraction times the amount of State Funding received by Hart to Newhall within thirty (30) days of Hart's receipt of such State Funding. Upon payment, Hart shall reduce in its records the number of JHS or SHS Newhall Reimbursable Students, as the case may be, by a number equal to the Capacity of that school multiplied by the Newhall Adjustment Fraction.

b. If Hart has requested and received advanced funds from Newhall, Newhall shall designate those funds as advance payment of Fair Share School Impact Mitigation Payments for SFDU, MFDU or Second Unit as it determines in its sole discretion. The number of Newhall Reimbursable Students associated with the number and type of DU specified by Newhall shall be increased immediately upon receipt by Hart of the advanced funds and Newhall shall be credited as herein provided in Section 6c with having paid the Fair Share School Impact Mitigation Payments for the number and type of DU specified.

c. Hart has entered into a school facilities funding agreement with Newhall, dated December 16, 1997, a copy of which is attached as Exhibit "G", which governs the school impact mitigation measures required for land designated therein that is to be annexed to the City ("Annexation Agreement"). At the time that the Proposed Junior High School Site, as that term is defined in the Annexation Agreement, is transferred to Hart and all required improvements completed on a lien-free basis, Newhall shall specify the number and type of DU as to which it will be deemed to have paid the Fair Share School Impact Mitigation Payments. In determining the number of Newhall Reimbursable Students, Hart shall apply the initial SGF set forth on Exhibit "E" to this Agreement and the SFDU or MFDU designated by Newhall at the time of such payment to Hart. The number of Newhall Reimbursable Students associated with the number and type of DU specified by Newhall shall be increased immediately upon receipt by Hart of the Proposed JHS Site provided for in the Annexation Agreement and Newhall shall be credited with having paid the Fair Share School Impact Mitigation Payments for the number and type of DU specified by Newhall.

d. Attached as Exhibit "H" are examples of some possible scenarios of the foregoing which are attached only as explanatory material and are not intended to and do not affect or change any of the provisions of this Section 6 of this Agreement.

7. ***New School Facilities.***

a. *School Size.* Each additional JHS will be considered to have been designed and constructed to accommodate approximately one thousand two hundred (1,200) students on a traditional, single track, nine month school schedule and each additional SHS will be considered to have been designed and constructed to accommodate approximately two thousand four hundred (2,400) students, on a traditional, single track, nine month school schedule.

b. *Site Requirements.* Each additional JHS will be built on a site containing approximately twenty five (25) net usable acres, and each additional SHS will be built on a site containing approximately forty five (45) net usable acres. Net useable acres shall be exclusive of slopes which exceed two percent (2%) assuming a construction-ready condition.

c. *Construction of New Schools.* Hart, subject to availability of funds for such purposes, will build as many additional JHS and SHS as are necessary to house Newhall Students. Hart will use its best efforts to locate only two (2) additional JHS and one (1) additional SHS on Newhall Land. Hart, on a best efforts basis, will seek to locate such additional JHS and SHS as shown on Exhibit "A." The precise location of such JHS and SHS to be built on Newhall Land will be mutually agreed upon between Hart and Newhall and acceptable to the State. In the absence of such mutual agreement, the precise location of such

JHS or SHS shall be determined by Hart subject to approval by the State. In the event Hart reasonably determines that additional JHS or SHS should be located on Newhall Land, it may acquire the sites for the additional schools either through negotiations or by means of an eminent domain action. Hart shall pay Newhall the fair market price for all school sites it acquires from Newhall except for the JHS site transferred to Hart pursuant to the Annexation Agreement as to which the fair market value has been agreed upon and the consideration therefor is as provided for in the Annexation Agreement.

8. ***Certification of Mitigation.***

a. Immediately upon receipt from Newhall or any of its assignees of the required school impact mitigation fee or mitigation payment in the required amount for each DU and Commercial/Industrial Development in an Excluded Development or the Fair Share School Impact Mitigation Payment for each DU subject to this Agreement, Hart shall provide any written certification required to obtain building permits or other approvals for the construction of DU from the County, the City, or any other governmental entity which requires such certification. The certification shall be in writing and shall be provided for whatever number of DU are requested and paid for by Newhall or by any assignee of Newhall at any time.

b. As to the Newhall Land, immediately upon request by Newhall or any of its assignees without the payment of any fees whatsoever, Hart shall provide any written certification required to obtain building permits or other development approvals for the construction of Age-Restricted DU, or Commercial/Industrial Development and the construction of DU subject to the Annexation Agreement specified by Newhall from the County, the City, or any other governmental entity which requires such certification. The certification shall be in writing and shall be provided for whatever number of Age-Restricted DU, or Commercial/Industrial Development and DU subject to the Annexation Agreement are requested by Newhall or any of its assignees at any time. The foregoing is not applicable to the Excluded Development portion of the Newhall Land which is subject to the obligations and requirements applicable thereto .

9. *Maximization of Priorities to Receive State Funding*. If it has not already done so, Hart shall submit applications for State Funding for a JHS and for a SHS to the Office of Public School Construction within thirty (30) days of the signing of this Agreement. Hart shall thereafter take all reasonable steps available to Hart to pursue and obtain State Funding and federal funding, if any, for a JHS and a SHS. Hart may pursue such funding on the basis of what is presently designated as Priority Two for one hundred percent (100%) funding or Priority One for fifty percent (50%) funding of State eligible area and costs of a JHS or SHS. Pending legislation may be enacted providing only for fifty percent (50%) of such funding except for greater amounts under specified circumstances. If Hart elects to not pursue the highest priority for the first JHS or the first SHS for State Funding and the greater amount based on what presently is a Priority Two or hardship basis is not received by Hart and the lesser amount, herein assumed fifty percent (50%), would have been received by Hart on the basis of a Priority One application, such amount, if not received, will be credited against and reduce the priority allocation of State Funding to Hart provided for in Section 6 of this Agreement. As to any subsequent JHS or SHS, Hart shall pursue the highest priority for State Funding unless otherwise agreed by the Parties. Neither Party shall unreasonably withhold such consent. Hart shall take no actions which would deny or delay obtaining State Funding as provided for in this Agreement. Provided Hart has the local matching funds or, as provided for herein, Newhall, in its sole discretion, has advanced the necessary funds, Hart, subject to the foregoing, shall maintain an active, up-to-date application for the first available State Funding. Hart shall pursue similar appropriate action if State law or policy changes in regard to future State Funding. Hart shall not acquire other chargeable space which substantially adversely affects its eligibility for future State Funding except as provided in this Agreement (i.e., facilities for students in lieu of YRE as referred to in Recital F). Newhall and Hart acknowledge that leases of portable classrooms for less than five (5) years prior to an application for State Funding are not existing school building capacity under Chapter 407 of the 1998 Statutes (Section 17071.30(a) of the Education Code) if existent and applicable to Hart at any point in time relevant to the Newhall Land. Further, Hart shall obtain any interim or temporary school facilities, including, but not limited to, relocatable

and portable, classrooms in such manner so as not to unreasonably reduce the number of unhoused students relative to Hart's eligibility for future State Funding. Except as set forth herein, this Agreement shall not in any manner be asserted by Newhall to interfere in any way with, or to limit, Hart's Board of Trustees in determining what educational and school facilities policies will best further the interests of Hart's students or the construction or operation of its educational facilities.

10. ***Support of Land Use Applications***. Hart shall, within ten (10) days of receipt of written request from Newhall as to adequacy of School Facilities for development of the Newhall Land, express, orally and in written form, its support for any request for a land use approval, whether legislative or administrative, sought for the development of any portion of Newhall Land from the County, the City, or any other governmental entity which has the right to grant such an approval. Such action by Hart shall relate only to the adequacy of school facilities for such development and not the desirability or undesirability of approval except as related to adequacy of School Facilities for such proposal.

11. ***Certification of Adequacy of Mitigation***. Hart shall provide written certification within ten (10) days of receipt of a written request from Newhall or any Newhall assignee that adequate educational facilities exist, or that the financing provided by this Agreement guarantees their availability as needed, to house Newhall Students. This written certification shall be given to the California Department of Real Estate, the County, the City, or any other governmental entity which may have development approval authority over any portion of Newhall Land. Each such certification shall be based on each JHS having the capacity to serve the needs of 1200 students and each SHS having the capacity to serve the needs of 2400 students.

12. ***Equal Treatment Provisions***. Not later than November 15th of each year, or upon Newhall's written request at any other time, Hart shall provide Newhall with copies of all mitigation agreements entered into with other developers or landowners that have not previously been provided to Newhall. Hart shall, at the same time, provide any analyses of such agreements prepared by Hart or its consultants and all other materials in Hart's possession reasonably

necessary for the evaluation of the economic terms of such agreements to the extent such documents are not subject to the attorney-client privilege.

If Hart enters into any such agreement which is more economically advantageous than this Agreement, as agreed upon by parties or as determined pursuant to Section 24 of this Agreement, this Agreement shall be modified to make the obligations of this Agreement consistent with, and no greater than, the obligation imposed by any such agreement. Any such modification shall not require an amendment to this Agreement but may be described in an addendum signed by Hart and Newhall. Any modification to the obligations imposed on Newhall by this Agreement shall be effective as of the date of Hart's approval of any such agreement and Newhall shall be entitled to a refund of the amount of the Fair Share School Impact Mitigation Payments in excess of the modified amount plus interest on the refunded amount at the average interest rate paid by the Los Angeles County Local Agency Investment Fund accruing from the date of each payment to the date of refund.

An agreement requiring a lesser mitigation payment per DU, but requiring other consideration of equal or greater value, such as land, shall not be considered a more economically advantageous agreement. A subsequent agreement shall not be deemed more economically advantageous if it is the result of a condition of approval imposed prior to the effective date of this Agreement which explicitly limits the amounts payable to Hart imposed by a prior action of a public agency (other than Hart) or due to a change in applicable law including but not by way of limitation Chapter 407 of the Statutes of 1998.

13. *No Further Exactions*. Hart shall not, under any circumstances:

a. Exercise any power or authority under current of future law to levy or impose an exaction of land, goods, money, or services, whether denominated a fee, charge, dedication, or otherwise, against any development of Newhall Land;

b. Require, request, or cooperate with the County, the City, or any other governmental entity to exercise any power or authority to levy or impose an exaction of land, goods, money, or services, whether denominated a fee, charge, dedication, or otherwise, for Hart's benefit;

c. Oppose the development of any portion of Newhall Land or any governmental approval, whether legislative or administrative, or any change in any governmental approval on any basis whatsoever; or

d. Sponsor or require the formation of a Communities Facilities District ("CFD"), except for a CFD or multiple CFDs which together include all of the land within Hart's boundaries, for any of Newhall Land without the express, written consent of Newhall which consent may be given or withheld in Newhall's sole discretion. Hart shall not unreasonably refuse to act as a sponsor for a CFD or similar public financing procedure if requested to do so by Newhall. Hart may accomplish any general obligation bond election that it desires on a District-wide basis or by one or more school facilities improvement districts.

14. ***Adequacy of Newhall's Mitigation Obligation.*** The school fees and payments as well as the Fair Share School Impact Mitigation Payments to be provided to Hart by Newhall pursuant to the terms of this Agreement constitute the entire extent of Newhall's obligation to provide the funds necessary for Hart to obtain the School Facilities needed to house Newhall Students.

15. ***Changes in Excluded Developments.*** If the number or type of DU, other than Age-Restricted DU, in an Excluded Development is changed ("Changed Project") so that the total number of Newhall Students from a Changed Project is increased, the number of JHS and SHS students generated by the Excluded Development then under consideration, without taking into consideration the Changed Project, shall be determined using the then existing SGF ("Excluded Development Students"). Thereafter, the number of JHS and SHS students from the Changed Project shall be determined by using the then existing SGF ("Changed Project Students"). The difference shall be determined between the total number of Changed Project Students and the Excluded Development Students for both JHS students and SHS students ("Additional JHS Students" and "Additional SHS Students", collectively "Additional Students"). The cost of School Facilities for the Additional Students shall be determined as provided in Exhibit "D" adjusted as provided for in this Agreement. Such cost shall be apportioned proportionately to all DU in the Changed Project in addition to whatever obligation is otherwise

applicable to each such DU. Attached as Exhibit "I" are examples of some possible scenarios of the foregoing which are attached only as explanatory material and are not intended to and do not affect or change any provisions of this Section 15 of this Agreement.

16. ***Agreement Not Terminated By Change In Law.*** No development, change of development, governmental approval, nor change in any governmental approval of any portion of Newhall Land shall constitute the basis for any change or termination of this Agreement because this Agreement provides for the complete mitigation of all impacts, direct and cumulative, to the development of Newhall Land on Hart's ability to provide adequate educational opportunities to every student within Hart's boundaries. The provisions of this Agreement shall not be affected by any existing applicable law or subsequent legislation enacted by the State of California acting through the legislative or initiative process, or any subsequent judicial decisions relating to the matters provided for in this Agreement. The Fair Share School Impact Mitigation Payments provided for in this Agreement are hereby appropriated and dedicated to the costs related to future acquisition, construction and financing of the School Facilities and other such related costs of Hart for purposes of housing Newhall Students.

17. ***Transfer and Encumbrance.*** Newhall shall have the right, in its sole discretion, to sell or encumber Newhall Land, improved or unimproved and in whole or in part, by any deed, mortgage, deed of trust, or other security device. No sale, transfer, or encumbrance of any portion of Newhall Land shall affect Newhall's obligations under this Agreement. Neither this Agreement nor any breach of this Agreement shall defeat, invalidate, diminish, or impair the lien or priority of any deed, mortgage, deed of trust, or other security device.

18. ***Mutual Cooperation.*** Unless this Agreement provides to the contrary, Hart and Newhall shall, within ten (10) days of receipt of a written request from the other party, perform any acts and prepare, sign, deliver, file, and record any documents reasonably required to obtain the goals, and to satisfy the conditions, contained in this Agreement. This includes, but is not limited to, providing the requesting party with a written statement certifying that:

a. This Agreement is unmodified and in full force and effect, or, if there have been modifications, this Agreement, as modified, is in full force and effect, stating the date and nature of any modification; and

b. There are no current uncured defaults under this Agreement or, if there are any, the dates and natures of the defaults.

19. *Assignability of Agreement.* Newhall is acting as the master developer of Newhall Land and intends to sell portions of Newhall Land to builders who will construct and sell residential, commercial, and industrial buildings to the public. Newhall shall have the unconditional right to assign any right or obligation under this Agreement to anyone at any time which assignee shall proportionally assume all applicable provisions of this Agreement. Whenever this Agreement provides Newhall with a right, that right may be exercised by an assignee of that right to the same extent that Newhall could have exercised that right. The assignment of any right or obligation under this Agreement shall be in writing and a copy of the assignment shall be provided to Hart. No such assignment shall relieve Newhall of any of its obligations under this Agreement without Hart's written consent which consent shall not unreasonably be withheld.

20. *No Third Party Beneficiaries.* This Agreement is entered into solely for the benefit of Hart and Newhall and their successors, transferees, and assigns. Other than Hart and Newhall and their successors, transferees, and assigns, no third person shall be entitled, directly or indirectly, to base any claim or to have any right arising from, or related to, this Agreement.

21. *Entire Agreement.* Except as to the Excluded Development this Agreement contains the entire agreement and understanding concerning the funding of School Facilities as to the Newhall Land as described on Exhibit "A" and supersedes and replaces all prior negotiations and proposed agreements, written or oral, except as they are included in this Agreement. Excluded Development, except as herein specified in Section 15 of this Agreement, shall be subject to the applicable fees or Mitigation Payments identified in Exhibit "B". Hart and Newhall acknowledge that neither the other party nor its agents nor attorneys has made any promise, representation, or warranty whatsoever, express or implied, not contained herein to

induce the execution of this Agreement and acknowledge that this Agreement has not been executed in reliance upon any promise, representation, or warranty not contained herein.

22. *Amendments Must Be In Writing.* This Agreement may not be amended except by a writing signed by Hart and Newhall.

23. *Acknowledgment of Independent Investigation.* Hart and Newhall acknowledge that each has conducted an independent investigation of the facts concerning the development of Newhall Land (including the development of the Excluded Projects), the impacts that Newhall Students will have on Hart's educational facilities, and the costs of housing Newhall Students.

24. *Disputes To Be Arbitrated.* Hart and Newhall desire to resolve any disputes as to the meaning of any portion of this Agreement, the validity of any determination or calculation, or the rights or obligations of Hart or Newhall under it as quickly as possible. Therefore, any such disputes shall be resolved by binding arbitration conducted by a mutually agreed upon retired judge of the Los Angeles Superior Court. If Hart and Newhall are unable to agree on the arbitrator within thirty (30) days of the receipt of a request for arbitration, they shall request that the presiding judge of the Los Angeles Superior Court designate one. Hart and Newhall shall each pay one-half the cost of the arbitration and each shall be responsible for its own attorneys' fees and costs as to any such arbitration.

25. *Recovery Of Litigation Expenses.* Except as provided in Section 24 above, if it becomes necessary to enforce any of the terms of this Agreement, the prevailing party shall be entitled to reasonable attorneys' fees and other costs of litigation in addition to any other relief to which it may be entitled.

26. *Venue for Resolving Disputes.* Any arbitration or litigation arising out of this Agreement shall be conducted only in Los Angeles County, California.

27. *Interpretation Guides.* In interpreting this Agreement, it shall be deemed it was prepared by the parties jointly and no ambiguity shall be resolved against either party on the premise that it or its attorneys was responsible for drafting this Agreement or any provision hereof.

28. ***Due Authority of Signatories.*** Each individual signing this Agreement warrants and represents that he or she has been authorized by appropriate action of the party which he or she represents to enter into this Agreement on behalf of the party.

29. ***Notices.*** All notices, demands, and communications between Hart and Newhall shall be given by personal delivery; registered or certified mail, postage prepaid, return receipt requested; Federal Express or other reliable private express delivery; or by facsimile transmission. Such notices, demands, or communications shall be deemed received upon delivery if personally served or sent by facsimile or after three business days if given by other approved means as specified above. Notices, demands, and communications shall be sent:

To Hart:	William S. Hart Union High School District Attn: Superintendent 21515 Redview Drive Santa Clarita, CA 91350 Fax No. (805) 254-8653
With a copy to:	Alexander Bowie, Esq. Bowie, Arneson, Wiles & Giannone 4920 Campus Drive Newport Beach, CA 92660 Fax No. (949) 851-2014
To Newhall:	The Newhall Land and Farming Company Attn: President 23823 Valencia Boulevard Valencia, CA 91355 Fax No. (805) 255-3960
With a copy to:	Kenneth B. Bley, Esq. Cox, Castle & Nicholson LLP 2049 Century Park East, 28th Floor Los Angeles, CA 90067 Fax No. (310) 277-7889

The foregoing names, addresses, and fax numbers may be changed at any time by a written notice given as provided above.

30. *California Law Governs.* This Agreement and all rights and obligations arising out of it shall be construed in accordance with the laws of the State of California.

31. *Counterparts.* This Agreement may be signed in one or more counter-parts which, taken together, shall constitute one original document.

32. *Exhibits.* All Exhibits attached hereto are incorporated into this Agreement.

33. *Incorporation Into Subsequent Approvals.* These obligations shall be deemed to be obligations that relate to the Newhall Land Development Entitlements and shall run with the land as obligations of its future development, including all provisions and requirements hereof relating to any SRDU. This Agreement shall be included in the technical appendices of the EIRs for the Westridge Project and Newhall Ranch Project, and be included in the mitigation measures and monitoring programs of the EIRs for both such projects.

34. *Effective Date.* This Agreement shall become effective on the date of the last signature by a party.

DATED: October 15, 1998

BOARD OF TRUSTEES OF THE WILLIAM S. HART UNION HIGH SCHOOL DISTRICT

By: [signature]

President of the Board of Trustees of the WILLIAM S. HART UNION HIGH SCHOOL DISTRICT

[Signatures continued on following page.]

[Signatures continued from previous page.]

Attest:

____

Clerk of the Board of Trustees of the WILLIAM S. HART UNION HIGH SCHOOL DISTRICT

DATED: October _____, 1998

THE NEWHALL LAND AND FARMING COMPANY (a California Limited Partnership)

By: NEWHALL MANAGEMENT LIMITED PARTNERSHIP Managing General Partner

By: NEWHALL MANAGEMENT CORPORATION
Managing General Partner

By: Gary M Cusumano
Its: President
By: James M. Harter
Its: SR. V.P.

[Signatures continued on following page.]

[Signatures continued from previous page.]

APPROVED AS TO FORM:

DATED: October 12, 1998

BOWIE, ARNESON, WILES & GIANNONE

By: ____________________
ALEXANDER BOWIE, ESQ.
Attorneys for the WILLIAM S. HART UNION HIGH SCHOOL DISTRICT

APPROVED AS TO FORM:

DATED: October 13, 1998

COX, CASTLE & NICHOLSON LLP

By: ____________________
KENNETH B. BLEY
Attorneys for THE NEWHALL LAND AND FARMING COMPANY

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APPENDIX 4.11

Libraries Data and Correspondence

County of Los Angeles Public Library
7400 East Imperial Hwy., P.O. Box 7011, Downey, CA 90241-7011
(562) 940-8461, TELEFAX (562) 803-3032

MARGARET DONNELLAN TODD
COUNTY LIBRARIAN

November 26, 2002

IMPACT SCIENCES
Attn: Julie Berger, Project Planner
30343 Canwood Street, Suite 210
Agoura Hills, CA 91301

DRAFT ENVIRONMENTAL IMPACT REPORT
River Park Project, Santa Clarita, CA

Dear Ms. Berger:

This is in response to your request for information on the above-referenced project. Following are our responses to your questions:

1. **Would you please describe staffing (paid and volunteer, full time and part time) at the Valencia, Newhall, Canyon Country, and mobile libraries? Please provide information about location, hours, size and holdings.**

   Currently, the following is staffing information for the Valencia, Canyon Country and Newhall libraries:

Valencia Library	13 full time employees 40 part time employees 10 volunteers - 35 hrs. per week
Canyon Country Library	5 full time employees 20 part time employees 5 volunteers - 26 hrs. per week
Newhall Library	4 full time employees 11 part time employees 4 volunteers - 21 hrs. per week

The following table provides information about each facility's location, hours, size and holdings:

LIBRARY	LOCATION	HOURS	SIZE (SQ. FT.)	HOLDINGS
Valencia	**23743 W. Valencia Blvd. Santa Clarita, 91355**	**Mon-Thurs: 10 am - 9 pm Friday: 10 am - 6 pm Saturday: 10 am - 5 pm Sunday: 1 pm - 5 pm**	**23,966 sq. ft.**	**272,809**
Newhall	**22704 W. Ninth St. Santa Clarita, 91321**	**Mon-Wed: 10 am - 8 pm Thurs - Fri: 10 am - 6 pm Saturday: 10 am - 5 pm Sunday: Closed**	**4,842 sq. ft.**	**77,693**
Canyon Country	**18601 Soledad Cyn. Rd. Santa Clarita, 91351**	**Mon-Wed: 10 am - 8 pm Thurs - Fri: 10 am - 6 pm Saturday: 10 am - 5 pm Sunday: Closed**	**5,050 sq. ft.**	**91,534**
Santa Clarita Bookmobile	**Various service points. Please see attached**	**Mon-Wed: 9 am - 5 pm Thursday: Closed Friday: 9 am - 5 pm Sat - Sun: Closed**	**N/A**	**15,452**
			33,858	457,488

2. **Are there any plans for other facilities in the service area? Would you please describe the facility and the estimated opening date?**

   Currently, there are no plans for other facilities in this service area.

3. **What are the Library's planning standards for service? Are they adopted County standards or an internal Library planning guide? How many books and square feet of library space per capita does the Library set as its standard? What is the current number of books and square feet of library space per capita in the Santa Clarita Valley?**

   The Public Library has adopted a planning standard of 0.5 gross sq. ft. and 2.0 books and other materials per capita. In the Santa Clarita Valley (excluding the bookmobile) the current number of books and other materials per capita is 2.47 and the number of square feet per capita is 0.23.

4. **Does the Library consider the Santa Clarita Valley adequately served?**

   Based of the County Library's planning standards, the Santa Clarita Valley has an adequate supply of books and other materials, yet is inadequate with regards to library facility space to serve both the present population and increased population generated from this project.

5. **Is the following still accurate? Funding for the County Public Library comes directly from the County General Fund which, in turn, is funded by various forms of taxes(e.g., property taxes, its share of sales taxes, etc.). General Fund dollars are allocated by the County Board of Supervisors annually to all County-funded public services, including the Public Library. Does this funding address library operations, construction of new libraries, and the purchase of new items (books, periodicals, audio cassettes, videos, etc.)?**

   Funding sources for the Public Library consists in descending proportions, property taxes, County General Fund allocation, a special tax, and revenue from fines, fees and other miscellaneous sources. The Board of Supervisors has for several years, made an allocation from the County General Fund. However, there is no guarantee of ongoing funding from the County General Fund as a specific budget allocation. Decisions on funding for the Public Library are made on an annual basis by the Board of Supervisors based on total available funding for all County services. The funding in the Public Library's operating budget does not provide for replacement or the expansion of library facilities.

   Currently, the only funding available for the replacement or expansion of library facilities is that generated from the developer fee program. At the present time the developer fee funds collected in the Santa Clarita planning area to date are insufficient for the construction of new facilities.

6. **Would the revenues collected adequately cover all the costs of serving the project? If not, would there be a significant impact on the Library system if library facilities construction and items are not provided for? Would payment of the library fee of $569.87 per unit of residential development mitigate potentials new development impacts from the proposed project on the County Public Library to a less than significant level?**

   Impact on library services would be significant, unless mitigated. Payment of the current library fee of $640 per residential unit would mitigate the impact on library services as a result of this project. Service impacts would then be reduced to a less than significant level. Please note that the Public Library's mitigation fee is subject to an annual Consumer Price Index (CPI) adjustment.

7. Is there anything else I should know about the Department or the Department's ability to serve the project?

No, there is no additional information to provide.

Thank you for the opportunity to answer your questions regarding this project and its impact on library services. If you have any questions or need additional information please contact me at (562) 940-9455.

Sincerely,

Michele Mathieu

Michele Mathieu
Administrative Assistant

:mm

c: Margaret Donnellan Todd, County Librarian
David Flint, Assistant Director
Josie Reyes, Regional Administrator

River Park EIR

Santa Clarita Valley

Library Impact Analysis

Land Use	Number of Units	Persons/ Household	Library (Sq. Feet)	Library Books
Single Family Res'l	439	3.06	470	2,683
Multi-Family Res'l	744	3.06	796	4,547
Mobile Homes		2.55	0	0
		Totals	**1,265**	**7,230**

L.A. County Public Library Standard: 0.35 s.f./capita
L.A. County Public Library Standard: 2.0 books/capita

Prepared by Impact Sciences, Inc.
S. Tebo
12/16/03

Cumulative = SCV + Project				
	Number	Persons/	Library	Library
Land Use	of Units	Household	(Gross Square Feet)	Books
Single Family Residential	93,720	3.023	141,658	566,631
Multi-Family/Attached Residential	48,757	3.023	73,696	294,785
mobile home	2,699	3.023	4,080	16,318
			0	0
		Totals	**219,434**	**877,734**
L.A. County Public Library Standard: 0.50 g.s.f./capita				
L.A. County Public Library Standard: 2.0 books/capita				

APPENDIX 4.13

Fire Data and Correspondence

December 4, 2002

TO: DAVID LEININGER, ACTING CHIEF
FORESTRY DIVISION

FROM: DEBRA S. AGUIRRE, SUPERVISING ANALYST
PLANNING DIVISION

REQUEST FOR INFORMATION:
RIVER PARK PROJECT, SANTA CLARITA
EIR #1517

The information about fire protection service appearing in the Sand Canyon Joint Venture EIR, which you faxed us on 11/22/02, is still largely valid. Some additions and clarifications are noted below.

- New Fire Station 126 is now in operation. (The first paragraph on page 4.13-4 speaks of it in the future.) It is temporarily located at 27400 Tourney Rd., Valencia, CA 91355 until Spring, 2003, when the permanent fire station will be opened on Citrus Street at Magic Mountain Parkway. Fire Station 126 is staffed by a 4-person engine company. Fire Station 73 now has one 3-person engine company as well as the truck company. All other stations' resources in the Santa Clarita Valley are the same as they were at the time of the Sand Canyon Joint Venture EIR. Station 124 has been relocated to 25870 Hemingway Avenue, Stevenson Ranch, CA 91381.

- The terms "first alarm fire response" (in the Summary) and "primary fire protection service" (page 4.13-2) are undefined and should be avoided. Different kinds of incidents receive different numbers and types of response units in the first alarm. It is not quite accurate to identify specific stations as the ones that will "serve" the project site. The closest available District response units are dispatched as needed to an incident anywhere within the District's territory. It is more accurate to identify certain stations as the closest, and therefore most likely to respond to an incident at the site.

- The information you provided on funding methods of service expansion to new development is correct. Please note that the developer fee is calculated to cover the *full* cost of equipment as well as construction and land for new stations (page 4.13-4). This fee, or an in-lieu donation, constitutes mitigation in full of growth impacts.

The jurisdictional station for this project is Station 111. It is approximately 0.6 miles or 1.7 minutes from the intersection of Bouquet Canyon Road and Newhall Ranch Road. Dependent upon access and estimated response times, the Fire Department may require a site within this tract for fire station at the east-end of their project to adequately protect this tract and the surrounding community. The Fire Department has an existing need for an additional fire station in this area, and this project would exacerbate this need. We would need a detailed map showing the location of proposed land uses and existing and proposed roads to calculate response distances/times from existing stations for a full analysis of impacts.

Nationally recognized response time targets for urban areas are five minutes for a basic life support unit (e.g., engine company) and eight minutes for an advanced life support unit (e.g., paramedic squad). The Fire Department is currently meeting these standards. The average response time in the city of Santa Clarita during 2001 was 5 minutes 40 seconds. It should be noted that the city encompasses rural and undeveloped areas as well as urban areas.

Any development would increase service demand on the existing fire protection resources in the general area. Additional manpower, equipment, and facilities are needed in the area now. Mitigation of this increase in service would be met through the city of Santa Clarita's developer fee program for fire protection facilities and equipment, [redacted]

The Fire Department does not compute ratios of fire fighters to residents or building area.

DSA:DK:fd

EIR-1517

COUNTY OF LOS ANGELES

FIRE DEPARTMENT

5823 Rickenbacker Road
Commerce, California 90040

CONDITIONS OF APPROVAL FOR SUBDIVISIONS - INCORPORATED

ubdivision No: **53425** Map Date **Fire Dept. 09/03/03**

.U.P. City **Santa Clarita**

] **FIRE DEPARTMENT HOLD** on the tentative map shall remain until verification from the Los Angeles County Fire Dept. Plannin Section is received, stating adequacy of service. Contact (323) 881–2404.

] Access shall comply with Section 902 of the Fire Code, which requires all weather access. All weather access may require paving.

] Fire Department Access shall be extended to within 150 feet distance of any exterior portion of all structures.

] Where driveways extend further than 300 feet and are of single access design, turnarounds suitable for fire protection equipment use shall be provided and shown on the final map. Turnarounds shall be designed, constructed and maintained to insure there integrity for Fire Department use. Where topography dictates, turnarounds shall be provided for driveways that extend over 150 feet in length.

] Private driveways shall be indicated on the final map as "Private Driveway and Firelane" with the widths clearly depicted and shall be maintained in accordance with the Fire Code. All required fire hydrants shall be installed, tested and accepted prior to construction.

] Vehicular access must be provided and maintained serviceable throughout construction to all required fire hydrants. All required fire hydrants shall be installed, tested and accepted prior to construction.

] This property is located within the area described by the Fire Department as "Very High Fire Hazard Severity Zone" (formerly Fire Zone 4). A "Fuel Modification Plan" shall be submitted and approved prior to final map clearance. (Contact Fuel Modification Unit, Fire Station #32, 605 North Angeleno Avenue, Azusa, CA 91702-2904, Phone (626) 969-5205, for details).

] Provide Fire Department or City approved street signs and building access numbers prior to occupancy.

] Additional fire protection systems shall be installed in lieu of suitable access and/or fire protection water.

] The final concept map, which has been submitted to this department for review, has fulfilled the conditions of approval recommended by this department for access only.

] These conditions shall be secured by a C.U.P. and/or Covenant and Agreement approved by the County of Los Angeles Fire Department prior to final map clearance.

] The Fire Department has no additional requirements for this division of land.

omments: **REVISED CONDITIONS. A second means of access is required prior to the construction of the 501st dwelling unit. The number of dwelling units includes all single family homes, and all the units within the apartments and town-homes. Please refer to page 3 for additional conditions for access. No fire station is required for development mitigation for th project.**

ISPECTOR **Wally Collins** DATE **September 3, 2003**

Land Development Unit – Fire Prevention Division – (323) 890-4243, Fax (323) 890-9783

rm 266 9/01

COUNTY OF LOS ANGELES
FIRE DEPARTMENT

5823 Rickenbacker Road
Commerce, California 90040

WATER SYSTEM REQUIREMENTS – INCORPORATED

ubdivision No: **53425** Map Date **Fire Dept. 09/03/03**

.U.P. ______ City **Santa Clarita**

☒ Provide water mains, fire hydrants and fire flows as required by the County of Los Angeles Fire Department, for all land shown on map which shall be recorded.

☒ The required fire flow for public fire hydrants at this location is **5000** gallons per minute at 20 psi for a duration of 5 hours, over anc above maximum daily domestic demand. 3 Hydrant(s) flowing simultaneously may be used to achieve the required fire flow.

☒ The required fire flow for private on-site hydrants is **2500** gallons per minute at 20 psi. Each private on-site hydrant must be capable of flowing **2500** gallons per minute at 20 psi with two hydrants flowing simultaneously, one of which must be the furthest from the public water source.

☒ Fire hydrant requirements are as follows:

Install 79 public fire hydrant(s). Upgrade / Verify ____ existing Public fire hydrant(s).
Install 24 private on-site fire hydrant(s).

☒ All hydrants shall measure 6"x 4"x 2-1/2" brass or bronze, conforming to current AWWA standard C503 or approved equal. All on-site hydrants shall be installed a minimum of 25' feet from a structure or protected by a two (2) hour rated firewall.

☒ Location: As per map on file with the office.
☒ Other location: **Please refer to the attached Tentative Tract Map for hydrant locations.**

☒ All required fire hydrants shall be installed, tested and accepted or bonded for prior to Final Map approval. Vehicular access must be provided and maintained serviceable throughout construction.

] The County of Los Angeles Fire Department is not setting requirements for water mains, fire hydrants and fire flows as a condition of approval for this division of land as presently zoned and/or submitted.

] Additional water system requirements will be required when this land is further subdivided and/or during the building permit process.

] Hydrants and fire flows are adequate to meet current Fire Department requirements.

] Upgrade not necessary, if existing hydrant(s) meet(s) fire flow requirements.

JBMIT COMPLETED (ORIGINAL ONLY) FIRE FLOW AVAILABILITY FORM TO THIS OFFICE FOR REVIEW.

OMMENTS: **REVISED CONDITIONS. Please refer to page 3 for additional water system requirements.**

l hydrants shall be installed in conformance with Title 20, County of Los Angeles Government Code and County of Los Angeles Fire Code, or appropriate City regulations. iis shall include minimum six-inch diameter mains. Arrangements to meet these requirements must be made with the water purveyor serving the area.

y Inspector **Wally Collins** Date **September 3, 2003**

COUNTY OF LOS ANGELES
FIRE DEPARTMENT
5823 Rickenbacker Road
Commerce, California 90040

SUBDIVISION, WATER AND ACCESS REQUIREMENTS

ADDITIONAL PAGE

SUBDIVISION NO. **53425** PAGE NO. **3**

REVISED CONDITIONS

ADDITIONAL ACCESS REQUIREMENTS FOR PUBLIC STREETS:

1. **Street widths for this project shall conform to the widths indicated on the cross-sections on this Tract Map. All street widths shall be measured from the curb flow line to curb flow line.**

2. **Temporary turn-arounds are required for the end of Newhall Ranch Road and end of Santa Clarita Parkway. The turn-arounds shall be either a cul-de-sac bulb with a 32-foot center line or a hammer-head design, which would be posted and red curbbed "NO PARKING - FIRE LANE". These temporary turnarounds are required to stay in place until the bridges have been completed and are opened to an existing street.**

3. **All streets with center medians shall have a minimum paved width of 20 feet on each side of the median, with street posted and red curbed "NO PARKING - FIRE LANE".**

4. **The traffic circle at the end of "N" Street is approved. The area surrounding the traffic circle shall posted and red curbed "NO PARKING -FIRE LANE".**

5. **If gates are installed, provide 4 sets of gate detail plans to the Department's Land Development Unit prior to any approvals for this Tract Map, and the construction of any dwelling unit. Gates shall conform to the Department's Regulation #5.**

6. **Due to "N" Street extending greater than 700 feet in length, "N" Street shall a minimum street width of 36 feet, curb-flow-line to curb-flow-line, not 34 feet as indicated on the map. Provide four (4) revised copies of this page only of the Tract Map indicating this correction. This is required to be submitted to the Land Development Unit prior to any approvals of this Tract Map.**

ADDITIONAL ACCESS REQUIREMENTS FOR ON-SITE ACCESS FOR AREA "C" & AREA "D":

1. **Provide a minimum unobstructed driveway width of 28 feet, clear-to-sky to posted and red curbed "NO PARKING - FIRE LANE". Each turning radius shall be 42 feet from the center-line.**

2. **If gates are installed, provide 4 sets of gate detail plans to the Department's Land Development Unit prior to any approvals for this Tract Map, and the construction of any dwelling unit. Gates shall conform to the Department's Regulation #5. Gates shall be the same width as the driveway (28 feet), with all gate acessory hardware out of the accessway when the gate is in the fully open position.**

ADDITIONAL WATER SYSTEM REQUIREMENTS:

1. **The required fire flow for nineteen (20) public fire hydrants located on Newhall Ranch Road, adjacent to Area "C" and Area "D", is 5000 gpm at 20 psi for 5 hours with 3 fire hydrants flowing.**

2. **Fifty-eight (59) public fire hydrants are required to be installed on all other streets, including Newhall Ranch Road, as indicated on the tract map. The required fire flow is 1250 gpm at 20 for 2 hours with one (1) fire hydrant flowing.**

3. **Twenty-two (24) on-site fire hydrants are required within Area "C" & Area "D". The required fire flow is 2500 gpm at 20 psi for 2 hours with two (2) fire hydrants flowing.**

y Inspector: **Wally Collins** Date: **September 3, 2003**

Subject: FW: Proposed Fire Station to serve River Park Project
Date: Monday, June 16, 2003 8:09 AM
From: Susan Tebo <stebo@impactsciences.com>
To: julie berger <julie@impactsciences.com>

FYI...we are meeting with the City of Santa Clarita tomorrow--be sure that something to the effect of what is written below is included in the revisions. Thanks.

Susan

From: Glenn Adamick <gadamick@newhall.com>
Date: Fri, 13 Jun 2003 09:51:43 -0700
To: "Susan Tebo (E-mail)" <stebo@impactsciences.com>
Cc: Keith Herren <kherren@newhall.com>, Kevin Farr <kfarr@newhall.com>, Ross Pistone <rpistone@newhall.com>
Subject: FW: Proposed Fire Station to serve River Park Project

FYI

Glenn

-----Original Message-----
From: Debbie Aguirre [mailto:DAguirre@lacofd.org]
Sent: Friday, June 13, 2003 9:45 AM
To: gadamick@newhall.com
Cc: Barbara Herrera; Larry Hambleton
Subject: Proposed Fire Station to serve River Park Project

Glenn,

We've reviewed both the River Park Project, and a possible fire station site located in PM 20838 offered by Newhall Land.

While we are concerned about the response times into the easterly side of the River Park Project, this project is not an ideal location for a fire station site. Likewise, the site offered in PM 20838 would be located too close to our new Fire Station 126. The Fire Dept has elected to wait until a site more easterly on Soledad becomes available. Until then, our Fire Stations 111, 126 and temp 104's (which we hope to have operational by the end of the year) will provide service to River Park.

I do want to express my appreciation to you and Newhall Land for being proactive in planning for fire station sites. If you have any questions or need anything further, please don't hesitate to call.

Debbie Aguirre
Planning Division
Los Angeles County Fire Department
(323) 881-2404

Subject: RIVER PARK EIR
Date: Tuesday, July 22, 2003 5:09 PM
From: Loretta Bagwell <LBagwell@lacofd.org>
To: <julie@impactsciences.com>
Cc: Debbie Aguirre <DAguirre@lacofd.org>
Category: Junk

Julie,

Hope this helps, if you have any more questions, please let me know.

1) Where is Los Angeles County Fire Station 104 temporarily located? (address/intersection) In what City/area?

In the City of Santa Clarita on Golden Valley Road (please see attached map)

2) How many miles is the temporary station from the intersection of Bouquet Canyon and Newhall Ranch Roads?

3.4 miles

3) Is the station currently under construction? When will it be completed?

No. Completion is expected within one year.

4) Where will the station be relocated? (address/intersection) In what City/area?

Currently there is no site for the permanent station. Temporary Fire Station 104 is the result of a land-lease agreement recently approved by the City of Santa Clarita. The Fire Department will continue to look for a site for the permanent fire station within the same vicinity as the temporary station.

5) How many miles is it from the intersection of Bouquet Canyon and Newhall Ranch Roads? What is the anticipated response time to the intersection of Bouquet Canyon and Newhall Ranch Roads?

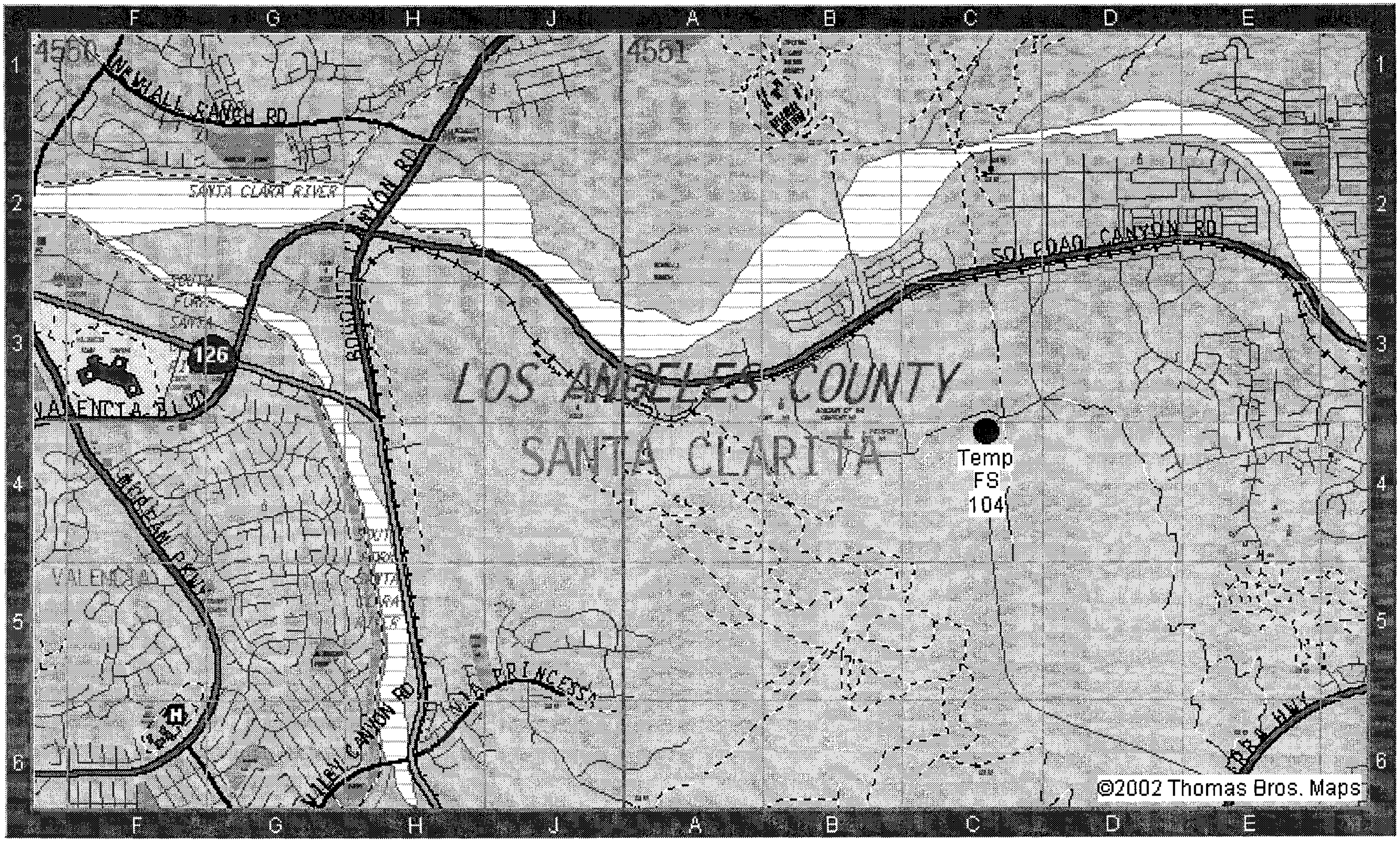
From temporary Fire Station 104 it is 3.4 miles and the response time is 11 minutes.

6) How many fire engines and firefighters will there be? Will there be

paramedics?

Minimum 3-person engine. Actual staffing will be determined when the fire station is under construction.

7) Is there anything else I should know about the station?



F G H J A B C D E
1 2 3 4 5 6
4550
4551
NEWHALL RANCH RD
SANTA CLARA RIVER
BOUQUET CANYON RD
SOLEDAD CANYON RD
126
VALENCIA BLVD
LOS ANGELES COUNTY
SANTA CLARITA
Temp
FS
104
VALENCIA
VALLEY CANYON RD
VIA PRINCESSA
©2002 Thomas Bros. Maps

Subject: Re: River Park EIR (one more thing)
Date: Tuesday, August 5, 2003 4:41 PM
From: Loretta Bagwell <LBagwell@lacofd.org>
To: <julie@impactsciences.com>
Category: Junk

Currently Fire Station 126 is staff with a 3-man engine and a 4-man truck/quint.

FYI, the Deputy Fire Chief and the Battalion Chief is also housed at Fire Station 126.

>>> Julie Berger <julie@impactsciences.com> 08/05/03 03:22PM >>>
Loretta,

One more thing.....

Will the permanent Station 126 maintain one fire engine and be supported by four firefighters, as the temporary station did? If not, what will the permanent station support?

Thanks again,

Julie

From: Julie Berger <julie@impactsciences.com>
Date: Tue, 05 Aug 2003 15:16:55 -0700
To: Loretta Bagwell <LBagwell@lacofd.org>
Subject: River Park EIR

Loretta,

I've another question I hope you can help me with.

I heard that Fire Station 126 is now permanently located and operational on Citrus Street near Magic Mountain Parkway and that the temporary Station 126 at 27400 Tourney Road is closed. Is this true? If so, what is the exact address on Citrus Street.

Thank you,

Julie

APPENDIX 4.14

Sheriff's Data and Correspondence

County of Los Angeles
Sheriff's Department Headquarters
4700 Ramona Boulevard
Monterey Park, California 91754-2169
(661) 255-1121

Leroy D. Baca, Sheriff

November 21, 2003

Mr. Jeff Hogan, Associate Planner
City of Santa Clarita
23920 Valencia Boulevard, Suite 300
Santa Clarita, California 91355

Dear Mr. Hogan:

RIVERPARK PROJECT
MASTER CASE # 02-175

The proposed Project consisting of 1,183 dwelling units located at the terminus of Newhall Ranch Road, east of Bouquet Canyon between the Castaic Lake Water Agency property and the Santa Clara River, north of Soledad Canyon Road, is within the jurisdiction of the Los Angeles County Sheriff's Department, Santa Clarita Valley Station, 23740 Magic Mountain Parkway, Valencia, California. The station is located approximately 3 to 4 miles from the project site.

It is anticipated that the non-emergent response time to a request for service would be approximately 40-50 minutes. The priority response time would be approximately 8-10 minutes and the response time under emergent circumstances would be approximately 5-8 minutes. All response times are approximations, only, and would be dependent on both the deployment of area radio cars and traffic conditions.

This station serves an area of 656 square miles, which is made up of the City of Santa Clarita and unincorporated County area between the Los Angeles City Limits to the South, the Kern County Line to the North and involving all area between the Ventura County Line to the West and the township of Agua Dulce to the East. The population served by our station is approximately 200,000 residents.

Our ideal officer to population ratio is one deputy per 1,000 residents and with our current staffing of 161 sworn deputies currently assigned, our ratio is less than ideal at one deputy per every 1,243 residents. According to the figures released by the Department of Finance as of January, 1998, residential density is 3.011 persons per dwelling unit. This proposed project will generate a population increase of 3,562. Based on the above, the project would require 3 additional deputies to the station complement.

Our primary concern is our ability to provide an adequate level of protection and service to all areas we police. Due to the rapidly expanding population of the Santa Clarita Valley and its record-setting home building, it is difficult to project the impact of this project on law enforcement.

Adding this project and other projects in progress, either proposed, approved or committed, it is certain they will all significantly strain our resources to the breaking point. Additionally, the increase in required field personnel for this project alone, will necessitate a concomitant increase in support resources such as detectives, complaint desk officers, vehicles and portable radios. While not directly a builder's matter, our ability to provide a sufficient level of law enforcement services must be considered when applications for new projects such as these are considered.

It is suggested, for the security and safety of the residents, that the builder apply defensible space concepts in its construction designs, and the following crime prevention measures be implemented during site and building layout design:

- Provide lighting in open areas and parking lots;
- Ensure the visibility of doors and windows from the street and between buildings;
- Provide adequate parking spaces in the parking lots to accommodate shoppers, employees and residents;
- Ensure that the required building address numbers are lighted and readily apparent from the street for emergency response agencies.

Should you have further questions, please feel free to call me at (661) 255-1121 extension 5102, or Deputy Patrick Rissler at extension 5159.

Sincerely,

LEROY D. BACA, SHERIFF

Patti A. Minutello, Captain
Santa Clarita Valley Station

PAM:par

DEPARTMENT OF CALIFORNIA HIGHWAY PATROL
28648 The Old Road
Valencia, CA 91355
(661) 294-5540
(800) 735-2929 (TT/TDD)
(800) 735-2922 (Voice)

November 15, 2002

File No.: 540.11583.9320

Ms. Julie Berger
Impact Sciences
30343 Canwood Street, Suite 210
Agoura Hills, CA 91301

Re: River Park Project - Environmental Impact Report

Dear Ms. Berger:

This letter is to address the Environmental Impact Report for the proposed River Park project in Santa Clarita. The 664 acre project will consist of a 29 acre park, apartments, townhouses and single family homes totaling 1,099 dwelling units. Even though the project will be developed within the city limits of Santa Clarita, the California Highway Patrol (CHP), Newhall Area, believes this project will have a significant impact on our operations.

In response to your request, the following are the answers to the questions addressed in your letter dated October 25, 2002:

1. What is the current staffing level at the Newhall CHP Area?

   The Newhall CHP Area is staffed by 73 uniform and 9 non uniform personnel.

2. Are there any planned upgrades to the Newhall CHP Station?

   None.

3. How many and what type of calls did the Newhall CHP Area respond to last year in the service area?

   None, the service area is within the city limits of Santa Clarita. Los Angeles Sheriff's Department has a contract with the city for law and traffic enforcement.

4. Is the station still served by a patrol helicopter from the Burbank CHP facility?

   The area is serviced on a limited basis by a helicopter and a fixed wing aircraft based at Fullerton Airport. In mid 2003, there are plans to centrally base two helicopters to service the Los Angeles County basin.

5. Is the following true?

   a. The primary funding source for CHP facilities and staffing is the State Motor Vehicle Registration Fees.

      Yes.

   b. The allocation of these fees to each service area is determined by CHP Headquarters in Sacramento, which bases its decision on an area's service needs (e.g., traffic levels, accident statistics, population, etc.), and not necessarily by the revenues that are generated in that area.

      The Newhall CHP Area's budget is determined by the headquarters' staff in Sacramento. The CHP does not receive or base its deployment on the revenues that may be generated within its service area.

   c. Under this present form of funding, are CHP facilities and staffing adequate to meet current and future demands in this service area?

      The service area for this project is within the city limits of Santa Clarita. This project, in conjunction with the numerous other projects slated to be developed in the Santa Clarita Valley, will place an increasing demand for service on existing CHP resources. There is an identified need for additional resources to address the ever-increasing demand for service.

   d. Will the CHP be able to serve the proposed project?

      The service area for this project is within the city limits of Santa Clarita, which is serviced by the Los Angeles County Sheriff's Department, Santa Clarita Station.

   e. How will the proposed project affect the CHP's ability to serve the community?

      The CHP will continue to provide service to the best of our ability, regardless of whether or not staffing levels are increased.

6. Is the following true?

   a. No long range planning document or uniform staffing requirements exist that the CHP uses to project future need within each service area. Rather, each station determines its own staffing needs based on the service area's unique requirements and budget constraints.

      The long range planning for the CHP is handled by the headquarters' staff in Sacramento and future staffing needs are based on the needs of the entire state and budget constraints.

   b. Does the Newhall CHP Area have projections for its future staffing needs?

      The Newhall CHP Area has submitted requests for future staffing, however, there are no immediate plans to increase its personnel.

7. Is there anything else I should know about the CHP or the CHP's ability to serve the project.

   This construction plan is just one of many planned developments which makes the Santa Clarita Valley one of the fastest growing communities in California. The CHP will continue to provide the best possible service to meet the needs of the public.

Sincerely,

For

B. M. KILMER, Captain
Commander

APPENDIX 4.15

Phase I Site Assessment

APPLIED ENVIRONMENTAL TECHNOLOGIES INC.
4561 Market St., Suite B • Ventura, CA 93003 • Phone: (805) 650-1400 Fax: (805) 650-1576

Phase I Environmental Site Assessment
664 Acre Riverpark Project, Tract No. 53425
Located East of Bouquet Canyon Road and North of Soledad Canyon Road
Santa Clarita, Los Angeles County, California

Prepared for:

Impact Sciences Inc.
30343 Canwood Street, Suite 210
Agoura Hills, California 91301

Prepared by:

Applied Environmental Technologies, Inc.
4840 Market Street, Suite B
Ventura California 93003
(805) 650-1400

Ref. No. 0161-19P

November 7, 2002

Phase I Environmental Site Assessment
664 Acre Riverpark Project, Tract No. 53425
Located East of Bouquet Canyon Road and North of Soledad Canyon Road
Santa Clarita, Los Angeles County, California

Prepared by:

Applied Environmental Technologies, Inc.
4840 Market Street, Suite B
Ventura California 93003
(805) 650-1400

Wallace A. Jensky, II, RG, REA
Principal Geologist

Ref. No. 0161-19P

November 7, 2002

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Plates

Appendices

1.0 INTRODUCTION

This report provides the results of a Phase I Environmental Site Assessment (ESA) performed by Applied Environmental Technologies, Inc., (AET) of an approximate 664 acre, irregular shaped, parcel of land (Tentative Tract No. 53425) extending eastward from Bouquet Canyon Road for approximately 2 miles along the north side of Soledad Canyon Road, Santa Clarita, Los Angeles County, California (Site, Plate 1). The ESA was performed for Impact Sciences of Agoura Hills, California.

The objective of the Phase I ESA is to identify recognized environmental conditions at the Site. As defined in the American Society for Testing and Materials (ASTM) Designation E 1527-00, recognized environmental conditions include "the presence or likely presence of any hazardous substances or petroleum products on a property under conditions that indicate an existing release, a past release, or a material threat of a release of any hazardous substances or petroleum products into structures on the property or into the ground, groundwater, or surface water of the property. The term includes hazardous substances or petroleum products even under conditions in compliance with laws. The term is not intended to include de minimis conditions that generally do not present a material risk of harm to public health or the environment and that generally would not be the subject of an enforcement action if brought to the attention of appropriate government agencies. Conditions determined to be de minimis are not recognized environmental conditions."

The ESA was performed in accordance with the scope of work provided in AET's proposal dated September 4, 2002, and with the scope of work for Phase I Environmental Site Assessments provided in the ASTM Designation E 1527-00. The Phase I ESA was performed under the direction of a California State Registered Environmental Assessor qualified to perform the work. In general, the investigation included: a review of current federal, state and county databases of known and potential environmentally impacted properties; a review of reasonably available county records; a review of available historical aerial photographs and historical maps; a review of Newhall Land & Farming (NL&F) documents and reports provided to Impact Sciences; interviews with persons familiar with the Site; and, a Site reconnaissance to observe current conditions at the Site. Details of the methods of investigation, findings, and conclusions are provided herein.

2.0 SITE DESCRIPTION

2.1 Property Description

The Site is an irregular shaped parcel of land consisting of approximately 664 acres. The southern portion of the Site extends from Bouquet Canyon Road on the west approximately 2 miles eastward on the north side of Soledad Canyon Road to a right-of-way for electric transmission towers on the east. The Site extends northward from Soledad Canyon Road approximately 0.5 mile on the east and west portions of the Site and approximately 0.75 mile in the central portion of the Site. The south half of the Site includes the Santa Clara River bed and flood plain. The northern half of the Site includes a south facing hillside, with generally steep topography on the east and west and with a sloping terrace divided by a small valley in the central portion.

The small valley between the terrace was historically developed as a Los Angeles County Fire Camp (Camp 4) since at least 1941. The camp buildings were last occupied by the Saugus Unified School District until the buildings were demolished in 1995. Two underground storage tanks (USTs) and asbestos containing building materials (ACBM) and lead based paint were removed during demolition of the buildings (further discussed in Sections 3.3.2 and 3.3.3, below). The address for the parcel where the camp and school buildings had been located is 22211 Newhall Ranch Road. The parcel is currently occupied by a construction company office, mobile storage buildings, a maintenance building, and a storage yard. Photographs showing the current development of the Site and vicinity are provided in Appendix A.

2.2 Physiographic Description

The Site is located on the northeast flank of the San Gabriel Mountains within the central Transverse Ranges physiographic province of southern California. The Site elevation ranges from approximately 1,150 feet above mean sea level (msl) in the southwest portion of the Site in the Santa Clara River to approximately 1,400 feet above msl in the northeast portion of the Site as measured from the United States Geological Survey, Newhall, California 7.5 Minute Topographic Quadrangle Map, 1952, (Photorevised, 1988). The topographic gradient is approximately 60 feet per mile (0.001-feet per foot) toward the west along the Santa Clara River. The topography rises approximately 200 feet above the river bed toward the north. The nearest surface water drainage is the Santa Clara River on the south portion of the Site. The Santa Clara River flows westerly to the Pacific Ocean.

2.3 Geology/Hydrogeology

The Site is located in the Santa Clara River Hydrologic Unit. The southern portion of the Site is underlain by Recent to Quaternary age river and alluvium deposits consisting of silts, sands and gravels. The alluvium overlies sedimentary rocks of the Pliocene age Saugus formation at depth. The Saugus formation crops out in hills in the northern portion of the Site. According to the Valencia Water Company, there are two groundwater wells (Well Nos. T2 and T4), located on the Site along the north bank of the Santa Clara River. The depth to static water level in Well T4, measured in October 2002, was 50.2 feet. The regional groundwater gradient is expected to be toward the west along the Santa Clara River valley.

3.0 INVESTIGATION METHODOLOGY AND FINDINGS

3.1 Federal and State Database Review

A government database report, prepared by Environmental Data Resources (EDR) of Southport, Connecticut of available federal, state and county agency databases was reviewed to identify government regulated properties having known recognized environmental conditions and potential environmental concerns within the vicinity of the Site. Because of the size of the Site, the radii of investigation for the Federal and State agency lists were extended up to 1.5 miles in accordance with the ASTM Standards for Environmental Site Assessments (E-1527-00). A description of the government databases reviewed are detailed in the EDR report. Also included in the EDR report are maps illustrating the location of listed properties relative to the location of the Site. A complete copy of the EDR report, dated September 25, 2002, is provided in Appendix B.

A summary of properties that could not be mapped by EDR but were identified as potentially within the Site vicinity (orphan properties) is also included in the EDR reports. Of the listed unmappable properties, a number are identifiable as being located south of Soledad Canyon Road in the Site vicinity; however, most are listed as generators of hazardous wastes and have a low probability to impact the Site. The pertinent findings of the government database review are summarized below.

- The Site is not identified in the EDR report:

- The Site is not located with 1.0 mile of a federal Superfund property.

- There are numerous properties within 0.25 mile of the southern Site boundary identified in the EDR Report. Most of the properties are located on Golden Triangle Road, southeast of the Site and parallel to Soledad Canyon Road, several properties are listed on Soledad Canyon Road. Most of the properties are listed on the HAZNET or Los Angeles Co. HMS Lists as waste generators. Being a generator of hazardous waste does not indicate that a release has occurred. One property is listed on the leaking underground storage tank list (LUST and Ca-SLIC List); however, the case was closed by the regulatory agency in 1995.

- There are numerous properties within 0.25 mile of the western and northwestern Site boundary identified in the EDR Report. These properties are located generally down gradient or flank gradient of the Site and have a low probability to impact the Site.

- There are two properties listed in the EDR Report located south of Soledad Canyon Road that are listed on a number of lists: American Cyanamid, 21444 Golden Triangle Road; and Bermite Division of Whittaker at 22116 West Soledad Canyon Road. The American Cyanamid property has been occupied by Simply Discount Furniture since 1995. The Bermite property is located in the hills south of Soledad Canyon Road. Based on their regulatory status, distance from the Site and their generally flank gradient locations, there is low probability that the properties have impacted the Site.

Based on the database review, there is a low probability that the listed off-site properties in the Site vicinity have impacted the Site.

3.2 Oil and Gas Development

The Munger Map Book of California-Alaska Oil and Gas Fields, 1990 Edition, was reviewed to assess the presence of known active or abandoned oil and gas wells within the Site vicinity. Based on the review, an oil field with one well (Bouquet Canyon Field, now abandoned) was located near the northern Site boundary in the western portion of the Site. Three dry holes were also drilled on the Site. According to the California Division of Oil and Gas Publication No. TR-12, California Oil and Gas Fields, Volume II, 1982) the Edward Lustgarten "Lucky Lusty" No. 1 Well was completed in 1958 in the Mint Canyon formation at a depth of approximately 2,340 feet below ground surface (bgs). The well initially produced 29 barrels of oil per day and produced a total of only 8,528 barrels of oil prior to being abandoned. The well location was in the vicinity of a water tank currently located on the top of a hill just beyond the Site boundary (Plate 1).

Two dry holes were drilled near the Lucky Lusty No. 1 well on the Site: the Union Oil Company Bonelli No. 1 located approximately 300 feet west-northwest of the Lucky Lusty No. 1 Well near the top of the hill; and the Lucky Lusty Well No. 3 located approximately 800 feet south of the Lucky Lusty No. 1 Well near the base of the hill (Plate 1). Neither well produced oil and were abandoned. A third oil well (Texaco Inc. NL&F No. H-1) was drilled in 1963 to a depth of 1,700 feet bgs at a location on the north side of the Santa Clara River in the south-central portion of the Site. Based on the lack of significant oil production from the Lucky Lusty Well No. 1 and the three dry holes (no oil production) on the Site, there is low probability that the Site has been impacted by oil and gas production.

3.3 Agency Records Review and Interview

3.3.1 County of Los Angeles Building Department

The County of Los Angeles Building Department maintains building permit records for structures located within the unincorporated portions of the County. Due to the lack of permanent structures on the Site (except for the buildings at the Fire Camp No 4, later Saugus Unified School District, which have all been removed), building records were not requested.

3.3.2 Newhall Land & Farming File Review at Impact Sciences Offices

September 7, 2002, AET reviewed reports and documents provided to Impact Sciences by NL&F. According to a report prepared by State Environmental Management, Inc. (SEM) of Ontario, California, two USTs (one 2,000 gallon capacity gasoline tank and one 2,000 gallon capacity diesel tank) were removed from 22211 Newhall Ranch Road (formerly occupied by Los Angeles County Camp 4 and the Saugus Unified School District) in June 1995. The file contained tank removal documents for the parcel. Groundwater was encountered in the tank pit at approximately 10 feet below ground surface (bgs) and a sheen of petroleum hydrocarbons was observed on the water in the pit. Soil samples collected from the sidewalls of the pit did not contain petroleum hydrocarbons. Following removal of the USTs, three 25-foot deep groundwater monitoring wells were installed and sampled. The groundwater did not contain detectable petroleum hydrocarbons.

A document contained disposal records prepared by Crawford Risk Control Service of Long Beach, California, for bins of roofing material and floor tile and other debris containing lead and asbestos. Also reviewed were an Inspection Report for the Saugus School District Buildings 1 through 6 and a Post Job Submittal for asbestos and lead based paint abatement prepared by The Environmental Group (TEG) dated October 3, 1995 for 22211 Newhall Ranch Road. Based on the documents reviewed, asbestos and lead based paint were identified and abated prior to demolition of the permanent buildings formerly occupied by Camp 4 and the Saugus School District.

3.3.3 County of Los Angeles Department of Public Works

The County of Los Angeles Department of Public Works (DPW) maintains records regarding industrial waste, UST permits and LUST cases. On September 24, 2002, AET reviewed the Site files at the DPW for information concerning the former USTs at 22211 Newhall Ranch Road. The former USTs were removed by the Saugus School District and were located northeast of a metal building and west of the creek in the southern portion of the small valley. The file contained the Tank Closure Report prepared by SEM and three quarterly groundwater monitoring reports (First Quarter through Third Quarter, 1996). No petroleum hydrocarbons were detected in the groundwater during the first and second quarterly events. The groundwater elevation had declined to below the bottom of the wells during the third quarter 1996 monitoring event. On July 12, 1997, SEM abandoned the three wells by pressure grouting in accordance with DPW and state requirements. The file contained a letter from SEM (and a record of a payment for agency time to review the file) requesting a closure letter for the Site; however, no letter was present in the file. AET requested additional information from one of the secretaries at the counter concerning the closure letter. The secretary checked the computer for information, and stated that, due a change in personnel, a closure letter was inadvertently not issued.

Based on the file review at the DPW, it appears that the Site was eligible for closure but a closure letter was not issued.

3.3.4 Valencia Water Company

The Valencia Water Company (VWC) has two groundwater production wells on the Site. AET contacted Mr. Keith Abacrombe of the VWC. The two wells are identified as Wells T4 and T2 and are located on the north side of the Santa Clara River in the central portion of the Site. The wells are accessed on the dirt road extension of Newhall Ranch Road. Well T2 is currently not pumping. The depth to groundwater in the wells in 2001 was approximately 34.8 feet bgs. The depth to water in Well T4 was measured in October 2002 at 50.2 feet bgs. Mr. Abacrombe indicated that the current wells would likely be abandoned and new wells drilled when the Site is developed in the future. He confirmed that the Castaic Lake Water Company had performed hillside grading and installed underground pipes on the northern portion of the

Site and constructed the Rio Vista Treatment Plant north of the Site (former Bouquet Canyon Boys Camp property).

3.4 Aerial Photograph Review

Copies of aerial photographs for the years 1928, 1947, 1952, 1968, 1976, 1989 and 1994 and Historical Topographic Maps for the years 1900 - 1903, and 1940 - 1941 available through EDR, were reviewed by AET for historical land use identification. Three individual photographs for each year were provided to cover the Site. Based on the review of available aerial photographs and maps, the historical development of the Site and vicinity was evaluated and is summarized below.

The 1900 San Fernando and 1903 Santa Susana 15-Minute Topographic Quadrangle Maps show the Site to be undeveloped land. The Southern Pacific Railroad track and a road that predated Soledad Canyon Road are present south of the Site. Bouquet Canyon Road is present west of the Site. A dirt road extends east from Bouquet Canyon Road part way onto the Site.

The 1928 aerial photographs (Fairchild, 1″ = 500′) show the Site to be undeveloped land. The generally flat area north of the Santa Clara River in the western portion of the Site appears to be cultivated, possibly with hay. The area southeast of the Site along the north side of Soledad Canyon Road is also cultivated. A dirt road is present on the north side of the River extending from Bouquet Canyon Road. The rest of the Site is brush covered hillsides and river bottom. Soledad Canyon Road has been realigned to it current location. The Saugus Motor Speedway, a dirt-oval cart race track, is present south of the Soledad Canyon Road. A large above ground pipe (Los Angeles Aqueduct) crosses the eastern portion of the Site from north to south. A dirt road runs parallel to the aqueduct across the Site.

The 1940 San Fernando and 1941 Santa Susana 15-Minute Topographic Quadrangle Maps show the Site to be little changed since the 1928 photograph, except for the presence of six buildings identified as Camp No. 4 in the small valley in the central portion of the Site. The southern portion of the Site appears to be part of the Bonelli Ranch. A line of electrical transmission towers is present at the east boundary of the Site.

The 1947 aerial photographs (Tubis, 1″ = 666′) show buildings of Camp 4 in the small canyon with a well graded road from Bouquet Canyon Road to the camp. The area south of the road and north of the Santa Clara River appears to be planted with row crops. Three areas of the terrace east of the small valley has been plowed, apparently for hay. Row crops are present of the flat land north of the Site. The eastern portion of the Site, from the aqueduct to the east boundary is little changed since the 1928 photograph.

The 1952 aerial photographs (Pacific Air, 1″ = 555′) show the Site and Site vicinity to be little changed since the 1947 photograph.

The 1968 aerial photographs (Teledyne, 1"=666') show the Site to be little changed since the 1952 photograph. The terrace area appears to be fallow. A drive-in movie theater is present southeast of the Site between Soledad Canyon Road and the Santa Clara River and between the aqueduct and the electrical transmission towers. A commercial building is present south of the Soledad Canyon Road, south of the drive-in theater. The Saugus Motor Speedway is configured with the oval track with a figure-8 track inside. The dirt road (Newhall Ranch Road) to Camp 4 appears to be paved. A residential neighborhood has been developed northwest of the Site, east of Bouquet Canyon Road. The area north of the central portion of the Site has been developed with a cluster of rectangular buildings identified on the topographic map as Bouquet Canyon Boys Camp (Plate 1). A dirt road and pad area are present just off-Site along the west portion of the northern Site boundary when the location of the "Lucky Lusty" No. 1 oil well may have been.

The 1976 aerial photographs (Teledyne, 1"=1,000') show the Site to be little changed since the 1968 photograph. The intersection of Soledad Canyon Road and Bouquet Canyon Road is developed with at least 3 gasoline stations and other small commercial buildings.

The 1989 aerial photographs (USGS, 1"= 666') show little change to the Site since the 1976 photograph except for the presence of an area of L shaped asphalt pavement located on the terrace in the central portion of the Site, east of the small valley. The east-west pavement section is approximately 400 feet long and the north-south pavement section is approximately 250 feet long. The pavement has the appearance of a landing strip, but due to its short length it may have been used for model aircraft. There are no structures visible near the pavement. There is continued development in the Site vicinity. A shopping center is present at the northwest corner of the Site along the east side of Bouquet Canyon Road. Newhall Ranch Road has been improved along the south side of the shopping center. A large water tank is present on the ridge north of the Site (where the oil well may have been located). The flat land southeast of the Site and north of Soledad Canyon Road (area of the former drive-in movie theater) has been developed as a mobile home park.

The 1994 aerial photographs (USGS, 1"=666') show significant grading of the hill side along the northern portion of the Site and in the west central portion of the Site south of Newhall Ranch Road and north of the Santa Clara River. The northern hill side has been benched and a wide, east to west trace of flat ground is present at the base of the cut (current location of the Castaic Lake Water Agency underground pipeline and future alignment of Newhall Ranch Road). The buildings in the small valley are still present. Dirt roads are present on the terraces east of the small valley near the L-shaped area of pavement. The area north of the Site (former Bouquet Canyon Boys Camp) is being graded and new construction is evident (Castaic Lake Water Agency treatment plant). Two dirt side roads are present off the main dirt road that access the two groundwater production wells on the north side of the Santa Clara River (Valencia Water Company Wells T2 and T4).

Based on the historic aerial photograph and topographic map review, a camp with at least 6 buildings and support equipment has been located in the small valley in the central portion of the Site since at least 1941. There are two groundwater production wells and possibly three abandon, dry oil wells on the Site. The Los Angeles Aqueduct and electrical transmission towers are present in the eastern portion of the Site. Except for major Site grading for water utilities between 1989 and 1994, the majority of the Site has been generally undeveloped land until today.

3.5 Site Reconnaissance

On October 11 and 23, 2002, an AET representative visited the Site to observe Site conditions. The Site was accessed from Newhall Ranch Road from Bouquet Canyon Road and from the aqueduct road from Soledad Canyon Road. All portions of the Site were observed from existing paved and dirt roads on the Site. The Santa Clara River bed, location along the southern portion of the Site north of Soledad Canyon Road, is environmentally unremarkable consisting of braided stream deposits of silt, sand, gravel and cobbles with scattered vegetation.

The middle portion of the Site consists of flat land along the north bank of the Santa Clara River and gently south sloping terraces with a small valley in the central portion of the Site (Photographs 1 and 2, Attachment A). A pile of asphalt was observed on the edge of the east terrace (Photograph 3). The asphalt is likely from the former L-shaped pavement observed on the terrace in the 1989 aerial photograph. At the time of the Site visit the terrace was plowed fallow land. Paddle signs marking several buried water pipelines were observed in the middle portion of the Site. Two groundwater production wells were observed on the north bank of the Santa Clara River (VWC Wells T2 and T4) in the central portion of the Site. In the eastern one-third of the Site, the terrace is narrow or non-existent and the hills slope to the Santa Clara River flood plain. A large above-ground pipe (approximately 12 feet in diameter) crosses the Santa Clara River on concrete piers. The pipe, which carries water, is a section of the Los Angeles Aqueduct. Electric transmission towers were observed along the east Site boundary.

The northern portion of the Site consists of south facing hills, steep in part. In the northwest corner of the Site, the hills from a ridge with a north facing slope down a residential neighborhood north of the Site boundary. Significant hillside grading was observed along the north Site boundary. Utility vaults and paddle signs for a buried water pipe were observed in the "road cut" through the hills (Photograph 4). The water pipe is owned by the Castaic Lake Water Company and runs west across the northern portion of the Site of the water treatment plant located north of the Site.

The small valley in the central portion of the Site (Photograph 5), the only developed portion of the Site, was the former location of Los Angeles County Fire Camp 4, later occupied by the Saugus School District. At least 6 permanent buildings and two USTs were removed from the valley in 1995 through 1996. Staats Construction Company is the current tenant on the parcel. The office is located in a trailer (Photograph 6) in the central portion of the valley. A metal shed (maintenance shop) and a red wooden building are the only permanent structures currently on the parcel. The red wooden building is used for storage of Mr. Staats personal items such as a camp trailer, dirt bikes and classic motor cycles. An air compressor is located at the rear of the building. No staining was observed around the compressor.

The metal shed (Photograph 7) is used for equipment maintenance. The mechanic provided access to the shed. The shed contained a bead-blaster, a parts' washer, approximately 20 cases of quart cans of new motor oil and various parts stored on shelves. A waste storage area was observed on the south side of the shed (Photograph 8). The storage area had a concrete secondary containment, a metal roof and contained 12 55-gallon drum for storage of used oil, used antifreeze and used oil filters. The wastes are recycled on an as need basis by licensed waste haulers. According to the mechanic, maintenance on the large equipment is generally performed in the field at various job sites.

The valley currently contains remnants of concrete building pads from the former buildings, concrete foundations for above ground propane and diesel tanks, and out-of-service utility posts with water and electric service connections. Construction materials such as clay and steel pipes and valves are stored on the ground or on the concrete pads at various location in the northern portion of the valley. Three empty 55-gallon trash drums were stored up-side-down in one of the areas. Two portable sheds, 3 truck-trailer containers, and a house trailer (vacant mobile home) were observed along the east side of the valley. The sheds were observed to contain construction supplies, such as pipe-flange gaskets, large bolts, fire plugs, PVC and black plastic pipes. No liquids were observed in the sheds.

Ms. Judy Forbes of Staats Construction provided access to the waste hauler records for the Site. On September 6, 2002, Safety-Kleen recycled 50-gallons of used antifreeze and 200-gallons of used motor oil. On November 20, 2001, Benny's Oil Filter Service recycled 2 drums of used oil filters and 2 drums of floor sweep absorbent. Based on the waste hauler records, Staats Construction is disposing of wastes properly.

At the time of the Site visit no underground storage tanks, pits, ponds, stressed vegetation, significant debris or significantly stained soil were observed on the Site. Except for the portion of the Site occupied by Staats Construction (former Camp 4), no buildings were observed on the Site.

3.6 Adjacent Property Reconnaissance

Adjacent properties around the Site were observed by AET for evidence of recognized environmental conditions. West of the Site, along Bouquet Canyon Road at Soledad Canyon Road on the south and at Newhall Ranch Road on the north, are commercial/retail centers. The Santa Clara River flows under the Bouquet Canyon Road bridge. Northwest of the Site, on the north side of a topographic ridge, is a residential neighborhood. Further east, along the north side of the Site are: a water tank; undeveloped land; the Castaic Lake Water Company Rio Vista Water Treatment Plant; and more undeveloped land. East of the Site is undeveloped hill side and the Santa Clara River. South of the Site is Soledad Canyon Road and scattered commercial properties including the Saugus Motor Speedway. Further east, between Soledad Canyon Road and the Santa Clara River is a large mobile home park. No recognized environmental conditions were observed on the adjacent properties.

4.0 SUMMARY AND CONCLUSIONS

The following is a summary of the findings presented in this report.

- Based on historical aerial photographs and maps, the Site has been generally undeveloped land since prior to 1900. A small valley in the central portion of the Site was developed with Los Angeles County Fire Camp 4 prior to 1941 and last occupied by the Saugus School District. The structures in the small valley were demolished in 1996.

- Two USTs were removed from the small valley by the Saugus School District in 1995. Three groundwater monitoring wells were installed and monitored for three quarters. The wells were properly in 1997. A closure letter for the Site was requested from the DPW; however, due a change in personnel, a closure letter was inadvertently not issued. Based on the data in the file at the DPW, the Site was eligible for closure.

- The Site is not within 1.0 mile of a state or federal Superfund property (NPL).

- Properties listed on agency databases with environmental conditions within the Site vicinity have a low probability of having impacted the Site.

- AET personnel observed the Site on October 11 and 23, 2002. The Santa Clara River bed, location along the southern portion of the Site north of Soledad Canyon Road, is environmentally unremarkable consisting of braided stream deposits of silt, sand, gravel and cobbles with scattered vegetation. The middle portion of the Site consists of flat land along the north bank of the Santa Clara River and gently south sloping terraces with a small valley in the central portion of the Site. A pile of asphalt was observed on the edge of the east terrace that is likely from the former L-shaped pavement observed on the terrace in the 1989 aerial photograph. Two groundwater production wells were observed on the north bank of the Santa Clara River (VWC Wells T2 and T4) in the central portion of the Site. In the eastern one-third of the Site, the terrace is narrow or non-existent and the hills slope to the Santa Clara River flood plain. A large above-ground pipe, a section of the Los Angeles Aqueduct, crosses the eastern portion of the Site. Electric transmission towers were observed along the east Site boundary. The northern portion of the Site consists of south facing hills, steep in part. Significant hillside grading was observed along the north Site boundary. Utility vaults and paddle signs for a buried water pipe were observed in a number of locations on the Site. The small valley in the central portion of the Site, the only developed portion of the Site, was the former location of Los Angeles County Fire Camp 4, later occupied by the Saugus School District. Staats Construction Company is the current tenant on the parcel. The office is located in a trailer in the central portion of the valley. A metal shed (maintenance shop) and a red wooden building are the only permanent structures currently on the parcel. The metal shed is used for equipment maintenance. A waste storage area was observed on the south side of the shed that had concrete secondary containment, a metal roof and contained 12 55-gallon drum for storage of used oil, used antifreeze and used oil filters. The wastes are recycled on an as need basis by licensed waste haulers. Construction materials such as clay and steel pipes and valves are stored on the ground or on the concrete pads at various location in the northern portion of the valley. Two portable sheds, 3 truck-trailer containers, and a house trailer (vacant mobile home) were observed to contain construction supplies, such as pipe-flange gaskets, large bolts, fire plugs, PVC and black plastic pipes. No liquids were observed in the sheds. Based on the waste hauler records, Staats Construction is disposing of wastes properly. At the time of the Site visit no underground storage tanks, pits, ponds, stressed vegetation, significant debris or significantly stained soil were observed on the Site. At the time of the Site visit, no significant environmental conditions were observed on adjacent properties.

Areas of potential concern (APCs) include the presence of three abandoned oil wells (dry holes) and a pile of asphalt fragments on the south edge of the central terrace. Because the oil wells were dry holes and did not produce oil, there is low probability that they impacted Site soil. However, the California Division of Oil, Gas and Geothermal Resources (DOGGR) regulates the development over abandoned oil wells. Prior to grading or construction, the well casings should be located and exposed for inspection by DOGGR personnel. If grading plans lower the ground elevation over the abandoned wells, the developer is responsible to reabandon the well to the appropriate elevation with DOGGR oversight. The pile of broken asphalt should remain segregated and be recycled for road base when construction begins, or be disposed off-Site.

It is AET's opinion that the identified APCs have not significantly impacted the Site. The asphalt is stockpile on the ground surface and can be easily recycled or disposed. Any soil impacted with petroleum hydrocarbons, if any, that may be encountered near the abandoned oil wells during grading operations can be properly handled at the time by following the procedures set out in a subsurface Workplan.

Based on the information presented above, it is AET's opinion that there are no recognized environmental conditions, as defined above, at the Site.

5.0 LIMITATIONS

This report has been prepared for Impact Sciences on behalf of Newhall Land and Farming, as a Phase I Environmental Site Assessment of a 664 acre property extending 0.3 mile to 0.9 mile north of Soledad Canyon Road between Bouquet Canyon Road on the west and electric transmission towers on the east, in the City of Santa Clarita, Los Angeles County, California. Parties not designated by Impact Sciences should not rely on the information in this report without the written consent of AET. In performing the professional services, AET applied present engineering and scientific judgement and used a level of effort consistent with the standard of practice measured on the date of this report and in the locale of the project Site for similar type studies. Applied Environmental Technologies, Inc., makes no warranty, expressed or implied, in fact or by law, whether of merchantability, fitness for any particular purpose, or otherwise, concerning any of the materials or "services" furnished by Applied Environmental Technologies, Inc., to the client.

Inferences with respect to potential subsurface contamination are based on a review of readily available government and historical records and Site reconnaissance. The findings and interpretations in this report have been developed based on the review of existing information pertaining to the subject Site. It should be recognized that subsurface contamination can vary laterally and with depth below a given Site.

References

The following resources and agencies were reviewed or contacted for information pertaining to the subject property:

Environmental Data Resources, Inc., Historical Aerial Photographs dated 1928, 1947, 1952, 1968, 1976, 1989 and 1994.

Environmental Data Resources, Inc., Historical Topographic Maps dated 1900 - 1901 and 1940 - 1941.

Environmental Data Resources, Inc., Radius Map Report, September 25, 2002.

Los Angeles County Department of Public Works, Underground Storage Tank File Review, September 2002.

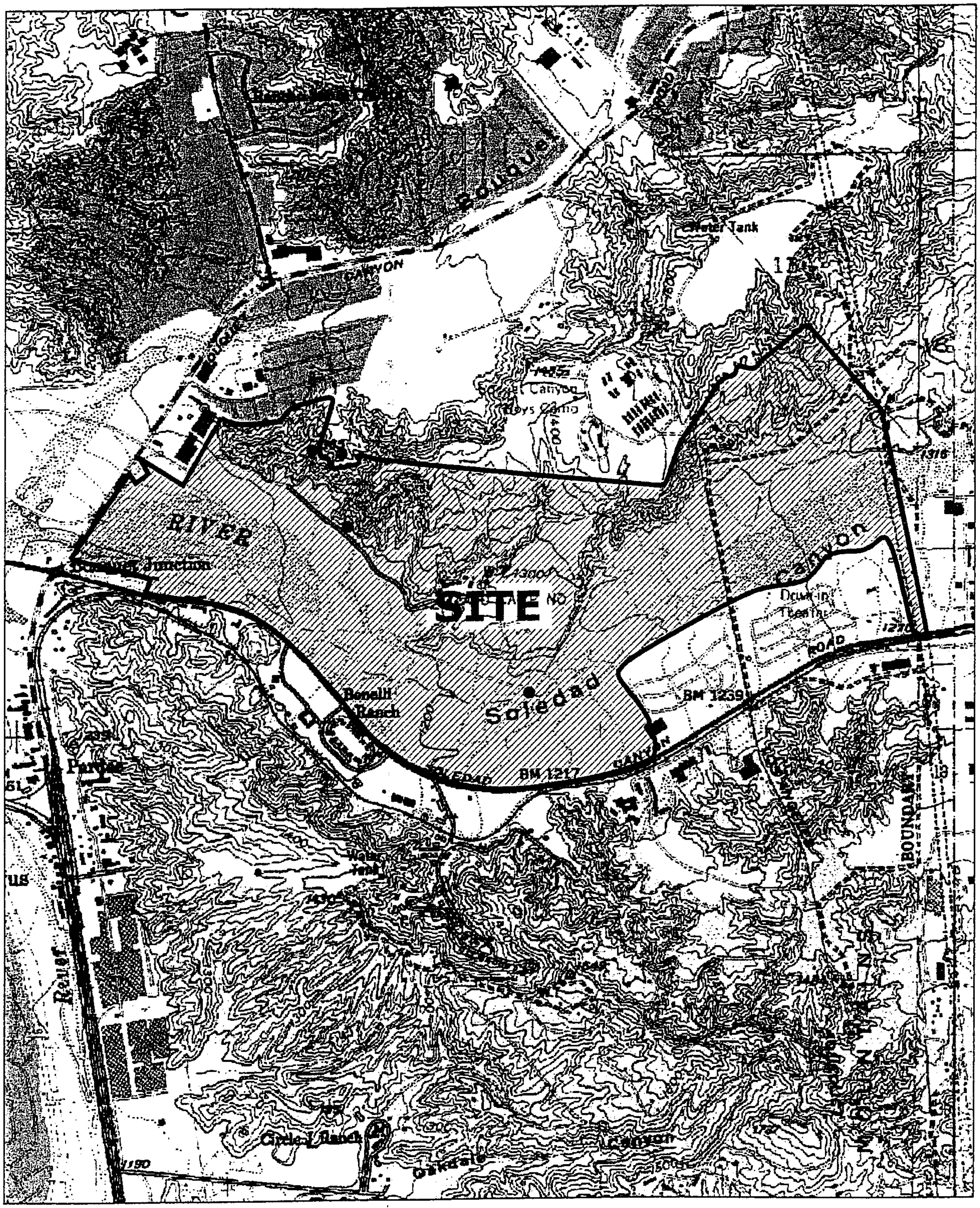
Newhall Land and Farming, File Review, September 2002.

Munger Map Book of California-Alaska Oil and Gas Fields, May 1990 Edition.

U. S. Geological Survey, 7.5-Minute Topographic Map Series, Newhall, California Quadrangle, 1952, revised 1988.

Valencia Water Company, personal communication, October 2002.

Plate



0' 2000' 1 MILE

SCALE - 1" = 2000' AT 8.5" x 11"

LEGEND

● ABANDONED OIL WELLS

Applied Environmental Technologies, Inc.

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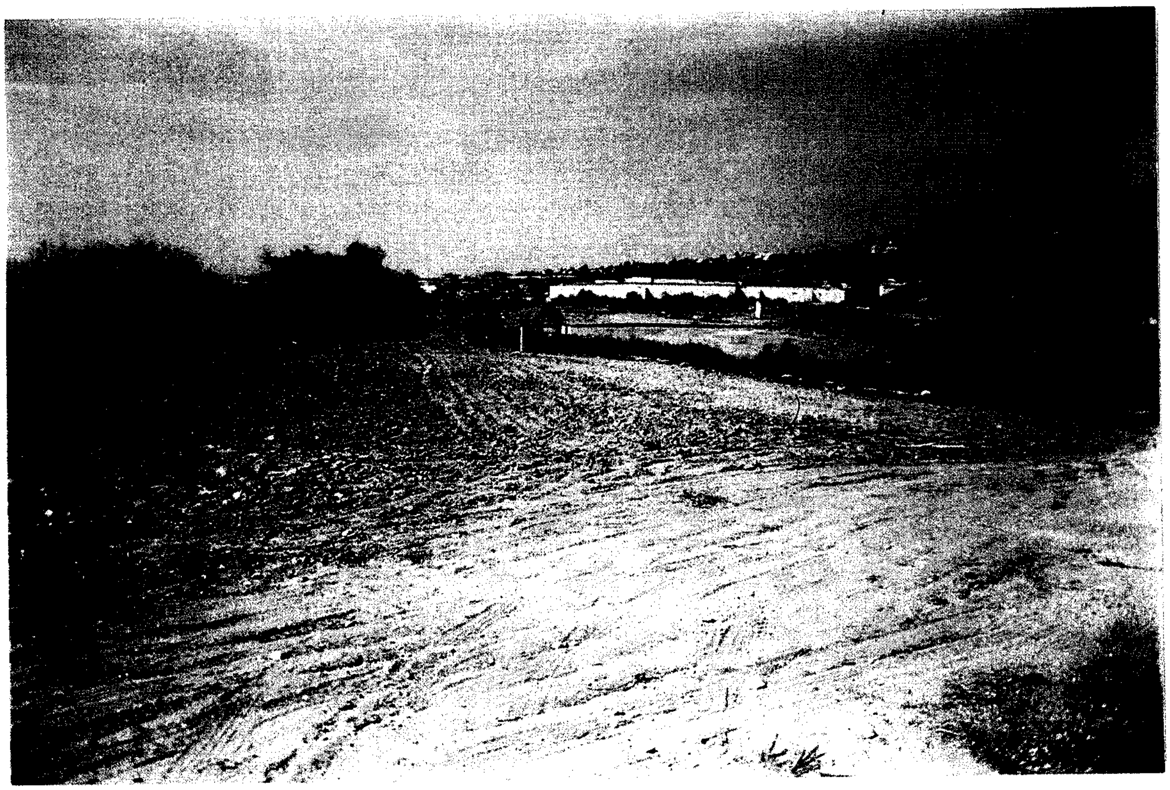
SITE LOCATION MAP
664 ACRE RIVERPARK PROJECT TRACT 53425
SANTA CLARITA, CALIFORNIA

PLATE 1

PLATE REFERENCE 016119P1A | NOVEMBER 7, 2002 | PROJECT NUMBER 0161-19

Appendix A

Representative Photographs

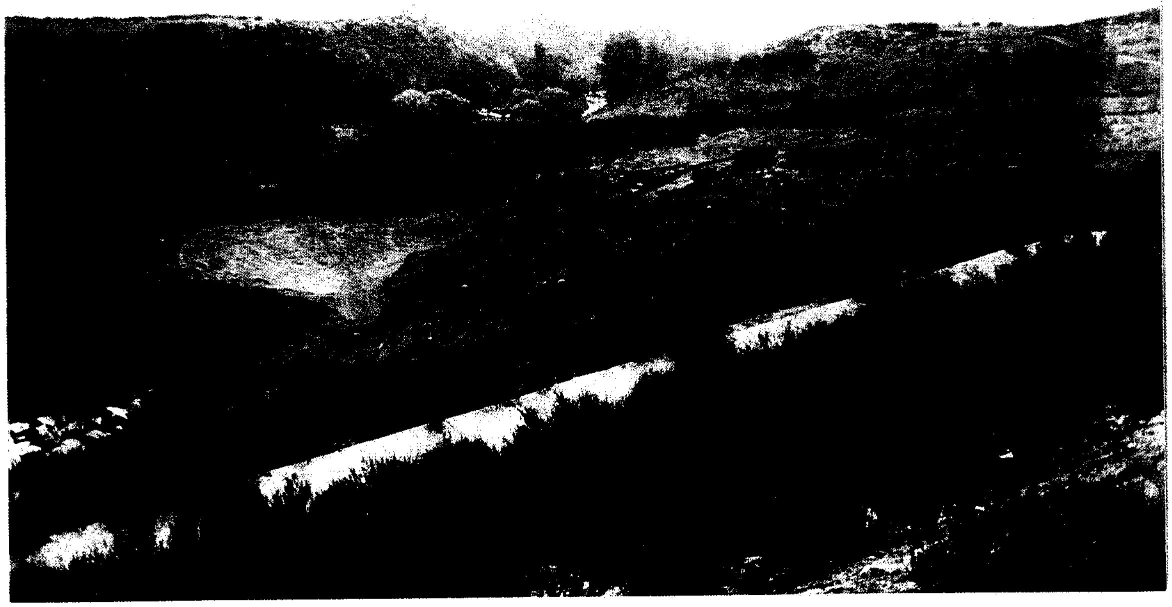


PHOTOGRAPH 1 - View looking west from the central portion of the Site. The rear of the shopping center on Bouquet Canyon Road is seen in the center of view (white buildings). Newhall Ranch Road is along the base of the hill on the right and the Santa Clara River is to the left of the view. The area in the foreground has been graded and a buried water pipeline is identified by warning posts as seen in the center of the view.

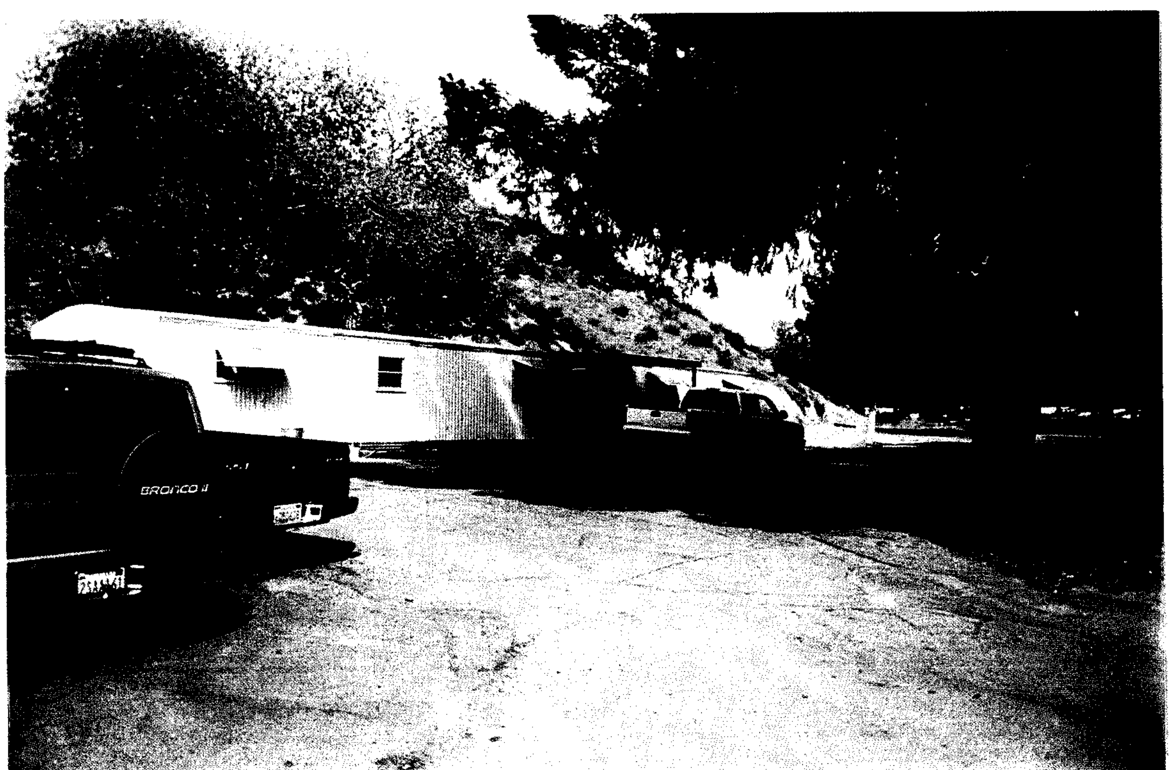
PHOTOGRAPH 2 - View to the west from the southeast corner of the terrace east of the small valley. The water tank in the foreground was formerly used by Camp 4 and is not in use Site. The large water tank on the skyline is just off-site near the location of former oil well. An L-shaped area of asphalt (small landing strip) was to the right of the view.

PHOTOGRAPH 3 - View looking northward from the top of a pile of asphalt located at the south edge of the terrace (likely the asphalt from the former landing strip).

PHOTOGRAPH 4 - View looking westward along the northern Site boundary. The large water tank is on the top of the hill. Castaic Lake Water Company utility vaults are in the foreground. The buried pipeline extends to the west beneath the road cut (future Newhall Ranch Road alignment).



PHOTOGRAPH 5 - View looking southward from the top of the road cut down the small valley in the central portion of the Site where the former Los Angeles County Camp 4 was located. The old water tank can be seen on the ridge line of the terrace (near tank in Photograph 2).



PHOTOGRAPH 6 - View of the office trailer for Staats Construction, the current tenant in the small valley (former Camp 4 and Saugus School District area). Staats uses the parcel for a storage yard for construction materials and equipment.

PHOTOGRAPH 7 - View looking southward from Staats office trailer. The metal building is used for equipment maintenance and storage. The former gasoline and diesel tanks removed in 1995 where located to the left of the building along the dirt berm of the creek where the trucks are currently parked.

PHOTOGRAPH 8 - View of the waste oil, antifreeze and used oil filter drum storage area south of the maintenacne building. The area has secondary containment and is covered. Wastes are manifested and recycled by a licensed contract waste-hauler on an as need basis. Most equipment maintenance is performed in the field at the various job sites.

Appendix B

EDR-Radius Map Report

The EDR Radius Map

Riverpark-Valencia
664 Acre Bonelli Ranch
Santa Clarita, CA 91350

Inquiry Number: 851417.3s

September 25, 2002

EDR® Environmental Data Resources, Inc.

The Source
For Environmental
Risk Management
Data

3530 Post Road
Southport, Connecticut 06890

Nationwide Customer Service

Telephone: 1-800-352-0050
Fax: 1-800-231-6802
Internet: www.edrnet.com

TABLE OF CONTENTS

Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

EXECUTIVE SUMMARY

A search of available environmental records was conducted by Environmental Data Resources, Inc. (EDR). The report meets the government records search requirements of ASTM Standard Practice for Environmental Site Assessments, E 1527-00. Search distances are per ASTM standard or custom distances requested by the user.

TARGET PROPERTY INFORMATION

ADDRESS

664 ACRE BONELLI RANCH
SANTA CLARITA, CA 91350

COORDINATES

Latitude (North):	34.421200 - 34° 25' 16.3"
Longitude (West):	118.518500 - 118° 31' 6.6"
Universal Tranverse Mercator:	Zone 11
UTM X (Meters):	360456.6
UTM Y (Meters):	3809709.0

USGS TOPOGRAPHIC MAP ASSOCIATED WITH TARGET PROPERTY

Target Property:	2434118-D5 NEWHALL, CA
Source:	USGS 7.5 min quad index

TARGET PROPERTY SEARCH RESULTS

The target property was not listed in any of the databases searched by EDR.

DATABASES WITH NO MAPPED SITES

No mapped sites were found in EDR's search of available ("reasonably ascertainable ") government records either on the target property or within the ASTM E 1527-00 search radius around the target property for the following databases:

FEDERAL ASTM STANDARD

NPL........................ National Priority List
Proposed NPL.............. Proposed National Priority List Sites
CERCLIS.................... Comprehensive Environmental Response, Compensation, and Liability Information System

STATE ASTM STANDARD

Notify 65.................. Proposition 65 Records
Toxic Pits.................. Toxic Pits Cleanup Act Sites
WMUDS/SWAT.............. Waste Management Unit Database
CA BOND EXP. PLAN....... Bond Expenditure Plan

FEDERAL ASTM SUPPLEMENTAL

CONSENT.................. Superfund (CERCLA) Consent Decrees
ROD........................ Records Of Decision
Delisted NPL............... National Priority List Deletions

HMIRS	Hazardous Materials Information Reporting System
MLTS	Material Licensing Tracking System
MINES	Mines Master Index File
NPL Liens	Federal Superfund Liens
PADS	PCB Activity Database System
FTTS	FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)

STATE OR LOCAL ASTM SUPPLEMENTAL

DEED	List of Deed Restrictions
AOCONCERN	San Gabriel Valley Areas of Concern

EDR PROPRIETARY HISTORICAL DATABASES

See the EDR Proprietary Historical Database Section for details

SURROUNDING SITES: SEARCH RESULTS

Surrounding sites were identified.

Elevations have been determined from the USGS 1 degree Digital Elevation Model and should be evaluated on a relative (not an absolute) basis. Relative elevation information between sites of close proximity should be field verified. EDR's definition of a site with an elevation equal to the target property includes a tolerance of +/- 10 feet. Sites with an elevation equal to or higher than the target property have been differentiated below from sites with an elevation lower than the target property (by more than 10 feet). Page numbers and map identification numbers refer to the EDR Radius Map report where detailed data on individual sites can be reviewed.

Sites listed in ***bold italics*** are in multiple databases.

Unmappable (orphan) sites are not considered in the foregoing analysis.

FEDERAL ASTM STANDARD

CERCLIS-NFRAP: As of February 1995. CERCLIS sites designated "No Further Remedial Action Planned" (NFRAP) have been removed from CERCLIS. NFRAP sites may be sites where, following an initial investigation, no contamination was found, contamination was removed quickly without the need for the site to be placed on the NPL, or the contamination was not serious enough to require Federal Superfund Action or NPL consideration. EPA has removed approximately 25,000 NFRAP sites to lift the unintended barriers to the redevelopment of these properties and has archived them as historical records so EPA does not needlessly repeat the investigations in the future. This policy change is part of the EPA's Brownfields Redevelopment Program to help cities, states, private investors and affected citizens to promote economic redevelopment of unproductive urban sites.

A review of the CERC-NFRAP list, as provided by EDR, and dated 05/15/2002 has revealed that there are 4 CERC-NFRAP sites within approximately 1.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir	Map ID	Page
GLASS SEAL CORPORATION	21516 WEST GOLDEN TRIAN	1/2 - 1 SE	C14	10
AMERICAN CYANAMID	***21444 GOLDEN TRIANGLE R***	***1/2 - 1 SE***	***D25***	***13***

Lower Elevation	Address	Dist / Dir	Map ID	Page
HASA CHEM INC	***23119 DRAYTON ST***	***1 - 2 WSW***	***AY324***	***187***

Lower Elevation	Address	Dist / Dir	Map ID	Page
KEYSOR-CENTURY CORP.	*26000 SPRINGBROOK AVE.*	*1 - 2 SW*	*BA342*	*200*

CORRACTS: CORRACTS is a list of handlers with RCRA Corrective Action Activity. This report shows which nationally-defined corrective action core events have occurred for every handler that has had corrective action activity.

A review of the CORRACTS list, as provided by EDR, and dated 05/02/2002 has revealed that there are 2 CORRACTS sites within approximately 1.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir	Map ID	Page
AMERICAN CYANAMID	*21444 GOLDEN TRIANGLE R*	*1/2 - 1 SE*	*D25*	*13*

Lower Elevation	Address	Dist / Dir	Map ID	Page
BERMITE DIVISION	*22116 WEST SOLEDAD CANY*	*1/2 - 1 SW*	*E34*	*21*

RCRIS: The Resource Conservation and Recovery Act database includes selected information on sites that generate, store, treat, or dispose of hazardous waste as defined by the Act. The source of this database is the U.S. EPA.

A review of the RCRIS-TSD list, as provided by EDR, and dated 07/10/2002 has revealed that there are 2 RCRIS-TSD sites within approximately 1.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir	Map ID	Page
AMERICAN CYANAMID	*21444 GOLDEN TRIANGLE R*	*1/2 - 1 SE*	*D25*	*13*

Lower Elevation	Address	Dist / Dir	Map ID	Page
BERMITE DIVISION	*22116 WEST SOLEDAD CANY*	*1/2 - 1 SW*	*E34*	*21*

RCRIS: The Resource Conservation and Recovery Act database includes selected information on sites that generate, store, treat, or dispose of hazardous waste as defined by the Act. The source of this database is the U.S. EPA.

A review of the RCRIS-LQG list, as provided by EDR, and dated 07/10/2002 has revealed that there is 1 RCRIS-LQG site within approximately 1.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir	Map ID	Page
AMERICAN CYANAMID	*21444 GOLDEN TRIANGLE R*	*1/2 - 1 SE*	*D25*	*13*

RCRIS: The Resource Conservation and Recovery Act database includes selected information on sites that generate, store, treat, or dispose of hazardous waste as defined by the Act. The source of this database is the U.S. EPA.

A review of the RCRIS-SQG list, as provided by EDR, and dated 07/10/2002 has revealed that there are 46 RCRIS-SQG sites within approximately 1.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir	Map ID	Page
CASTAIC LAKE WATER AGNCY	*27234 BOUQUET CANYON RD*	*1 - 2 N*	*L68*	*46*

EXECUTIVE SUMMARY

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
MARANATHA CHEVROLET	*26770 OAK AVE*	*1 - 2*	*E*	*M78*	*49*
PACIFIC EXPO	*26776 OAK AVE*	*1 - 2*	*E*	*M79*	*50*
VON CO TOOL	*26778 OAK AVE*	*1 - 2*	*E*	*M81*	*51*
NATIONAL METAL STAMPINGS INC	*26796 OAK AVENUE*	*1 - 2*	*E*	*M86*	*53*
HONDA OUTPOST	*26724 OAK AVE UNIT C*	*1 - 2*	*E*	*K91*	*56*
WM S HART UNIFIED SCHOOL DIST	*21429 REDVIEW DR*	*1 - 2*	*SE*	*P95*	*58*
STUDIO CITY SPORTS CARS	*26846 OAK AVE BLDG 5*	*1 - 2*	*E*	*O100*	*60*
G W FRANZ GRINDING	*26818 OAK AVE UNIT L*	*1 - 2*	*E*	*O102*	*61*
D K TRUCKING	*20811 SANTA CLARA ST*	*1 - 2*	*ENE*	*Q107*	*64*
ADROS CUSTOM WOOD FINISHING	*26524 GOLDEN VALLEY*	*1 - 2*	*ESE*	*AA158*	*91*
INLAND PACIFIC MTR	*26502 GOLDEN VALLEY RD*	*1 - 2*	*ESE*	*AA159*	*91*
BENS TEK	*26536 GOLDEN VALLEY RD*	*1 - 2*	*ESE*	*AA160*	*91*
RUSSELL DUNN AUTOMOTIVE	*26821 RUETHER UNIT G*	*1 - 2*	*E*	*AD184*	*106*
POINTS WEST	*20727 SANTA CLARA ST*	*1 - 2*	*ENE*	*AE195*	*112*
SOUTHWEST INDUSTRIES	*26911 RUETHER AVE STE S*	*1 - 2*	*E*	*AC197*	*114*
NATIONAL READY MIX	27050 RUETHER AVE	1 - 2	ENE	AE206	119
DISCOUNT TIRE CENTERS	*20737 SOLEDAD CANYON RD*	*1 - 2*	*E*	*AD210*	*120*
IMPORT AUTO CARE	*20723 SOLEDAD CANYON RD*	*1 - 2*	*E*	*AI215*	*124*
R C ACRYLICS	*20665 SANTA CLARA*	*1 - 2*	*ENE*	*AL239*	*140*
HI-SHEAR TECHNOLOGY CORP	*26413 N GOLDEN VALLEY R*	*1 - 2*	*SE*	*AM251*	*145*
BLUE CROSS LABORATORIES	*26411 N GOLDEN VALLEY R*	*1 - 2*	*SE*	*AM253*	*146*
EDS CLEANERS	*20655 SOLEDAD CANYON RD*	*1 - 2*	*E*	*AO259*	*150*
BROWN AUTO BODY	*26935 FURNIVALL*	*1 - 2*	*E*	*AO268*	*155*
EUROPEAN AUTO CENTER	*27134 FURNIVALL AVE*	*1 - 2*	*ENE*	*AR289*	*169*
MIKES TIREMAN	*20529 SOLEDAD CANYON RD*	*1 - 2*	*E*	*AZ338*	*197*
JERRY AUTOMATIC TRANSMISSIONS	*20501 SOLEDAD CYN ROAD*	*1 - 2*	*E*	*AZ356*	*210*
JIM DANDY	*27600 BOUGUET CYN RD*	*1 - 2*	*NNE*	*BD362*	*215*
WM S HART USD SAUGUS HS	*21900 W CENTURION WY*	*1 - 2*	*N*	*364*	*216*

Lower Elevation	Address	Dist / Dir		Map ID	Page
BERMITE DIVISION	*22116 WEST SOLEDAD CANY*	*1/2 - 1*	*SW*	*E34*	*21*
RITE AID NO 5555	*26825 BOUQUET CYN RD*	*1 - 2*	*NW*	*U117*	*68*
SHELL SERVICE STATION	26801 BOQUET CANYON ROA	1 - 2	NW	U121	71
CLARKS DRUGS 21	*26550 BOUQET CANYON RD*	*1 - 2*	*WNW*	*W129*	*76*
FLAMINGO CLEANERS	*26512 BOQUET CYN RD*	*1 - 2*	*WNW*	*Z144*	*85*
CHEVRON STN 9 2437	*26753 BOUQUET CANYON RD*	*1 - 2*	*NW*	*X147*	*86*
SECO ONE HOUR MARTINIZING	*26830 SECO CYN RD*	*1 - 2*	*NW*	*AF190*	*109*
TEAM ENTERPRISES INC	26830 SECO CYN RD	1 - 2	NW	AF192	111
CHEVRON STATION 97436	*23055 SOLEDAD CYN RD*	*1 - 2*	*W*	*AK236*	*137*
GLORY CLEANERS	*23142 VALENCIA*	*1 - 2*	*W*	*AT301*	*173*
VALENCIA DODGE	*26011 BOQUET CANYON RD*	*1 - 2*	*WSW*	*AX318*	*184*
HASA CHEM INC	*23119 DRAYTON ST*	*1 - 2*	*WSW*	*AY324*	*187*
KEYSOR-CENTURY CORP.	*26000 SPRINGBROOK AVE.*	*1 - 2*	*SW*	*BA342*	*200*
HI TECH TRANSMISSION	*25845 SAN FERNANDO RD*	*1 - 2*	*WSW*	*BB346*	*204*
VALENCIA AUTOMOTIVE CENTER MD	*25835 SAN FERNANDO RD*	*1 - 2*	*WSW*	*BC351*	*206*
A & K BODY & FENDER	*25834 SPRINGBROOK AVE*	*1 - 2*	*SW*	*BE375*	*221*
MIDAS MUFFLER	*25745 SAN FERNANDO RD*	*1 - 2*	*SW*	*BG381*	*225*

ERNS: The Emergency Response Notification System records and stores information on reported releases of oil and hazardous substances. The source of this database is the U.S. EPA.

A review of the ERNS list, as provided by EDR, and dated 12/31/2001 has revealed that there are 12 ERNS sites within approximately 1.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
21444 GOLDEN TRIANGLE RD	21444 GOLDEN TRIANGLE R	1/2 - 1	SE	D17	12

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
21444 GOLDEN TRIANGLE	21444 GOLDEN TRIANGLE	1/2 - 1	SE	D18	12
21444 GOLDEN TRIANGLE	21444 GOLDEN TRIANGLE	1/2 - 1	SE	D20	12
21444 GOLDEN TRIANGLE RD	21444 GOLDEN TRIANGLE R	1/2 - 1	SE	D21	12
21444 GOLDEN TRIANGLE RD	21444 GOLDEN TRIANGLE R	1/2 - 1	SE	D23	12
21444 GOLDEN TRIANGLE RD	21444 GOLDEN TRIANGLE R	1/2 - 1	SE	D24	13
21361 SOLEDAD CANYON RD.	21361 SOLEDAD CANYON RD	1/2 - 1	ESE	41	29
26417 GOLDEN VALLEY RD	26417 GOLDEN VALLEY RD	1 - 2	SE	AM250	145
22520 BARBACOA DR.	22520 BARBACOA DR.	1 - 2	NNW	345	204

Lower Elevation	Address	Dist / Dir		Map ID	Page
22211 W. NEWHALL RANCH RD	22211 W. NEWHALL RANCH	1 - 2	WNW	N73	47
23119 DRAYTON ST.	23119 DRAYTON ST.	1 - 2	WSW	AY326	190
CORNER SAN FERNANDO RD. AND DR	CORNER SAN FERNANDO RD.	1 - 2	WSW	BC365	218

STATE ASTM STANDARD

AWP: California DTSC's Annual Workplan, formerly known as BEP, identifies known hazardous substance sites targeted for cleanup. The source is the California Environmental Protection Agency.

A review of the AWP list, as provided by EDR, and dated 07/05/2002 has revealed that there is 1 AWP site within approximately 1.5 miles of the target property.

Lower Elevation	Address	Dist / Dir		Map ID	Page
WHITTAKER/BERMITE FACILITY	***22116 WEST SOLEDAD CANY***	***1/2 - 1***	***SW***	***E28***	***18***

CAL-SITES: Formerly known as ASPIS, this database contains both known and potential hazardous substance sites. The source is the California Department of Toxic Substance Control.

A review of the Cal-Sites list, as provided by EDR, has revealed that there are 5 Cal-Sites sites within approximately 1.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
WILLIAM S. HART UNION SCHOOL D	21469 REDVIEW DRIVE	1/2 - 1	SE	53	35
MERLE NORMAN COSMETICS, INC.	26407 N. GOLDEN VALLEY	1 - 2	SE	AM278	161

Lower Elevation	Address	Dist / Dir		Map ID	Page
WHITTAKER BERMITE/RAIL STATION	22116 WEST SOLEDAD CANY	1/2 - 1	SW	E27	17
WHITTAKER/BERMITE FACILITY	***22116 WEST SOLEDAD CANY***	***1/2 - 1***	***SW***	***E28***	***18***
KEYSOR-CENTURY CORPORATION	26000 SPRINGBROOK ROAD	1 - 2	SW	BA339	197

CHMIRS: The California Hazardous Material Incident Report System contains information on reported hazardous material incidents, i.e., accidental releases or spills. The source is the California Office of Emergency Services.

A review of the CHMIRS list, as provided by EDR, and dated 12/31/1994 has revealed that there are 9 CHMIRS sites within approximately 1.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
Not reported	26477 GOLDEN TRIANGLE R	1/2 - 1	SE	C38	27

EXECUTIVE SUMMARY

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
Not reported	21361 SOLEDAD CNY RD	1/2 - 1	ESE	F39	27
Not reported	SOLEDAD CANYON/REUTHER	1 - 2	E	116	67
Not reported	***26477 GOLDEN VALLEY RD***	***1 - 2***	***SE***	***AB164***	***94***
Not reported	20988 GOLDEN TRIANGLE	1 - 2	E	AG217	125
Not reported	26411 GOLDEN VALLEY RD	1 - 2	SE	AM254	148

Lower Elevation	Address	Dist / Dir		Map ID	Page
Not reported	***23119 DRAYTON***	***1 - 2***	***WSW***	***AY325***	***189***
Not reported	23119 DRAYTON ST	1 - 2	WSW	AY329	192
Not reported	25848 SPRINGBROOK RD	1 - 2	SW	BE369	218

CORTESE: This database identifies public drinking water wells with detectable levels of contamination, hazardous substance sites selected for remedial action, sites with known toxic material identified through the abandoned site assessment program, sites with USTs having a reportable release and all solid waste disposal facilities from which there is known migration. The source is the California Environmental Protection Agency/Office of Emergency Information.

A review of the Cortese list, as provided by EDR, has revealed that there are 15 Cortese sites within approximately 1.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
GLASS SEAL CORPORATION	***21516 GOLDEN TRIANGLE R***	***1/2 - 1***	***SE***	***C8***	***8***
AMERICAN CYANAMID	***21444 GOLDEN TRIANGLE R***	***1/2 - 1***	***SE***	***D25***	***13***
NATIONAL READY MIXED CONCRETE	***27050 RUETHER AVE***	***1 - 2***	***ENE***	***AE204***	***116***
PACIFIC BELL	***26971 FURNIVALL AVE***	***1 - 2***	***E***	***AP275***	***158***

Lower Elevation	Address	Dist / Dir		Map ID	Page
BERMITE, DIVISION OF WHIT	22116 SOLEDAD CNYN	1/2 - 1	SW	E29	19
WHITTAKER BERMITE/RAIL ST	22116 SOLEDAD CNYN	1/2 - 1	SW	E30	19
WHITTAKER/BERMITE FACILIT	22116 SOLEDAD CNYN	1/2 - 1	SW	E32	20
SHELL	26801 BOUQUET CANYON RD	1 - 2	NW	U120	71
LA CO FIRE STATION #111	26829 SECO CANYON RD	1 - 2	NW	AF186	106
UNOCAL #5518	26279 BOUQUET CANYON RD	1 - 2	W	AJ221	129
CHEVRON #9-7436 (FORMER)	23055 SOLEDAD CANYON RD	1 - 2	W	AK234	136
SANTA CLARITA CAR WASH INC	***23105 VALENCIA BLVD***	***1 - 2***	***W***	***AQ281***	***164***
WORTMANN OIL CO	26954 SECO CANYON RD	1 - 2	NW	AU302	175
Not reported	***23119 DRAYTON***	***1 - 2***	***WSW***	***AY325***	***189***
KEYSOR-CENTURY CORPORATIO	***26000 SPRINGBROOK***	***1 - 2***	***SW***	***BA340***	***198***

SWF/LF: The Solid Waste Facilities/Landfill Sites records typically contain an inventory of solid waste disposal facilities or landfills in a particular state. The data come from the Integrated Waste Management Board's Solid Waste Information System (SWIS) database.

A review of the SWF/LF list, as provided by EDR, has revealed that there is 1 SWF/LF site within approximately 1.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
MIKE'S TIREMAN INC	***20529 SOLEDAD CANYON RD***	***1 - 2***	***E***	***AZ336***	***196***

EXECUTIVE SUMMARY

LUST: The Leaking Underground Storage Tank Incident Reports contain an inventory of reported leaking underground storage tank incidents. The data come from the State Water Resources Control Board Leaking Underground Storage Tank Information System.

A review of the LUST list, as provided by EDR, and dated 07/11/2002 has revealed that there are 15 LUST sites within approximately 1.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
GLASS SEAL CORPORATION	***21516 GOLDEN TRIANGLE R***	***1/2 - 1***	***SE***	***C8***	***8***
NATIONAL READY MIXED CONCRETE	***27050 RUETHER AVE***	***1 - 2***	***ENE***	***AE204***	***116***
PACIFIC BELL	***26971 FURNIVALL AVE***	***1 - 2***	***E***	***AP275***	***158***

Lower Elevation	Address	Dist / Dir		Map ID	Page
BERMITE DIVISION	***22116 WEST SOLEDAD CANY***	***1/2 - 1***	***SW***	***E34***	***21***
SHELL	***26801 BOUQUET CANYON RD***	***1 - 2***	***NW***	***U122***	***72***
LA CO FIRE STATION #111	26829 SECO CANYON RD	1 - 2	NW	AF187	107
LA CO FIRE STATION #111	26829 SECO CANYON RD	1 - 2	NW	AF188	108
UNOCAL	***502 BEAUMONT AVE***	***1 - 2***	***W***	***200***	***115***
UNOCAL #5518	26279 BOUQUET CANYON RD	1 - 2	W	AJ223	129
CHEVRON STATION 97436	***23055 SOLEDAD CYN RD***	***1 - 2***	***W***	***AK236***	***137***
EXXON #7-3550 (FORMER)	23060 SOLEDAD CANYON RD	1 - 2	W	AK245	143
ARCO #1974	23105 VALENCIA BLVD	1 - 2	W	AQ283	165
WORTMANN OIL CO	26954 SECO CANYON RD	1 - 2	NW	AU304	175
P & M #987/TEXACO (FORMER)	26015 BOUQUET CANYON RD	1 - 2	WSW	AX315	181
HASA CHEM INC	***23119 DRAYTON ST***	***1 - 2***	***WSW***	***AY324***	***187***

UST: The Underground Storage Tank database contains registered USTs. USTs are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA). The data come from the State Water Resources Control Board's Hazardous Substance Storage Container Database.

A review of the UST list, as provided by EDR, and dated 01/17/2002 has revealed that there are 16 UST sites within approximately 1.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
RIO VISTA WTP PUMPING STA	27234 BOUQUET CANYON RD	1 - 2	N	L67	45
RIO VISTA WATER TREATMENT PLT	27236 BOUQUET CANYON RD	1 - 2	N	L71	46
WM HART UHSD - TRANSPORT DEPT	21429 REDVIEW DR	1 - 2	SE	P94	58
SANTA CLARITA WATER CO	21110 GOLDEN TRIANGLE R	1 - 2	E	S106	64
SAUGUS UNION SD TRANSPORTATION	***26501 GOLDEN VALLEY RD***	***1 - 2***	***ESE***	***V139***	***81***
POINTS WEST TRUCKING,INC.	20727 SANTA CLARA ST	1 - 2	ENE	AE194	112
PACIFIC BELL CNCYCAPB/KC652	26971 FURNIVALL AVE	1 - 2	E	AP273	157

Lower Elevation	Address	Dist / Dir		Map ID	Page
BOUQUET CANYON SHELL	26801 BOUQUET CANYON RD	1 - 2	NW	U123	73
CHEVRON USA SS 092437	26753 BOUQUET CANYON RD	1 - 2	NW	X145	85
DAKOTA VENTURES,LLC	26485 BOUQUET CANYON RD	1 - 2	WNW	Z162	94
TOSCO/UNOCAL #31309	23055 SOLEDAD CANYON RD	1 - 2	W	AK233	136
SAM'S MOBIL	***23060 SOLEDAD CANYON RD***	***1 - 2***	***W***	***AK244***	***143***
CROSS ROADS AUTO WASH	***23105 VALENCIA BLVD***	***1 - 2***	***W***	***AQ284***	***166***
LA CO SAN DIS-SAUGUS WRP	26200 SPRINGBROOK AVE	1 - 2	WSW	AS296	171
WORTMANN OIL CO	26954 SECO CANYON RD	1 - 2	NW	AU303	175
UNITED OIL #69	***26015 BOUQUET CANYON RD***	***1 - 2***	***WSW***	***AX313***	***180***

EXECUTIVE SUMMARY

CA FID: The Facility Inventory Database contains active and inactive underground storage tank locations. The source is the State Water Resource Control Board.

A review of the CA FID UST list, as provided by EDR, has revealed that there are 7 CA FID UST sites within approximately 1.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
POINTS WEST	***20727 SANTA CLARA ST***	***1 - 2***	***ENE***	***AE195***	***112***
NATIONAL READY MIXED CONCRETE	27050 RUETHER AVE	1 - 2	ENE	AE201	115
MERLE NORMAN COSMETICS	26407 N GOLDEN VALLEY R	1 - 2	SE	AM277	160

Lower Elevation	Address	Dist / Dir		Map ID	Page
CAR WASH USA INC	26225 BOUQUET CANYON R	1 - 2	W	AN252	146
P&M SERVICE STATIONS #987	***26015 N BOUQUET CANYON***	***1 - 2***	***WSW***	***AX316***	***183***
DANA MOTORS	26011 BOUQUET CANYON R	1 - 2	WSW	AX319	184
KEYSOR-CENTURY CORP.	***26000 SPRINGBROOK AVE.***	***1 - 2***	***SW***	***BA342***	***200***

HIST UST: Historical UST Registered Database.

A review of the HIST UST list, as provided by EDR, and dated 10/15/1990 has revealed that there are 26 HIST UST sites within approximately 1.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
AMERICAN CYANAMID, ENGINEERED	21444 GOLDEN TRIANGLE R	1/2 - 1	SE	D15	11
SANTA CLARA YARD	21014 SOLEDAD CANYON RD	1/2 - 1	E	I50	33
POINTS WEST TRUCKING, INC.	20727 SANTA CLARA ST	1 - 2	ENE	AE196	113
WAREHOUSE	21030 GOLDEN TRIANGLE R	1 - 2	E	AG198	114
NATIONAL READY MIXED CONCRETE	27050 RUETHER AVE	1 - 2	ENE	AE202	116
NATIONAL READY MIX CONCRETE CO	27050 RUETHER AVE	1 - 2	ENE	AE205	119
PACIFIC BELL (KC-652)	26971 FURNIVALL AVE	1 - 2	E	AP274	158
SAUGUS FACILITY	26407 GOLDEN VALLEY RD	1 - 2	SE	AM279	161
NEW HALL AMBULANCE	20607 SOLEDAD CANYON RD	1 - 2	E	AO294	170
FOLVEN BUILDING MATERIALS	26957 HONBY AVE	1 - 2	E	335	195
JERRY AUTOMATIC TRANSMISSIONS	***20501 SOLEDAD CYN ROAD***	***1 - 2***	***E***	***AZ356***	***210***

Lower Elevation	Address	Dist / Dir		Map ID	Page
BERMITE DIVISION OF WHITTAKER	22116 SOLEDAD CANYON RD	1/2 - 1	SW	E33	20
SAUGUS SWAP MEET/SAUGUS SPEEDW	22500 SOLEDAD CANYON RD	1/2 - 1	W	G43	29
LEON A. THOMPSON	26801 BOUQUET CANYON RD	1 - 2	NW	U118	70
DISTRICT OFFICE	26590 BOUQUET CANYON RD	1 - 2	WNW	Y138	81
92437	26753 BOUQUET CANYON RD	1 - 2	NW	X146	86
SERVICE STATION 5518	26279 BOUQUET CANYON RD	1 - 2	W	AJ219	127
WOLF'S BOUQUET UNION & TOW. IN	26279 BOUQUET CANYON RD	1 - 2	W	AJ220	128
UNION OIL SERVICE STATION 5518	26279 BOUQUET CANYON RD	1 - 2	W	AJ222	129
97436	23055 SOLEDAD CANYON RD	1 - 2	W	AK232	135
EXXON SERVICE STATION	23060 SOLEDAD CANYON RD	1 - 2	W	AK243	142
MICHAEL J SCANLON	23105 VALENCIA BLVD	1 - 2	W	AQ282	164
MOHAWK SERVICE STATION #04061	26015 BOUQUET CANYON RD	1 - 2	WSW	AX314	181
KIRCHNER & SON, INC.	26011 BOUQUET CANYON RD	1 - 2	WSW	AX320	185
HASA CHEMICALS, INC.	23119 DRAYTON ST	1 - 2	WSW	AY327	190
KEYSOR CENTURY CORPORATION	26000 SPRINGBROOK AVE	1 - 2	SW	BA341	199

EXECUTIVE SUMMARY

FEDERAL ASTM SUPPLEMENTAL

FINDS: The Facility Index System contains both facility information and "pointers" to other sources of information that contain more detail. These include: RCRIS; Permit Compliance System (PCS); Aerometric Information Retrieval System (AIRS); FATES (FIFRA [Federal Insecticide Fungicide Rodenticide Act] and TSCA Enforcement System, FTTS [FIFRA/TSCA Tracking System]; CERCLIS; DOCKET (Enforcement Docket used to manage and track information on civil judicial enforcement cases for all environmental statutes); Federal Underground Injection Control (FURS); Federal Reporting Data System (FRDS); Surface Impoundments (SIA); TSCA Chemicals in Commerce Information System (CICS); PADS; RCRA-J (medical waste transporters/disposers); TRIS; and TSCA. The source of this database is the U.S. EPA/NTIS.

A review of the FINDS list, as provided by EDR, and dated 03/21/2002 has revealed that there are 48 FINDS sites within approximately 1.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
AMERICAN CYANAMID	*21444 GOLDEN TRIANGLE R*	*1/2 - 1*	*SE*	*D25*	*13*
VAL-PAK PRODUCTS	*26751 OAK AVE.*	*1 - 2*	*E*	*K64*	*42*
CASTAIC LAKE WATER AGNCY	*27234 BOUQUET CANYON RD*	*1 - 2*	*N*	*L68*	*46*
MARANATHA CHEVROLET	*26770 OAK AVE*	*1 - 2*	*E*	*M78*	*49*
PACIFIC EXPO	*26776 OAK AVE*	*1 - 2*	*E*	*M79*	*50*
VON CO TOOL	*26778 OAK AVE*	*1 - 2*	*E*	*M81*	*51*
NATIONAL METAL STAMPINGS INC	*26796 OAK AVENUE*	*1 - 2*	*E*	*M86*	*53*
HONDA OUTPOST	*26724 OAK AVE UNIT C*	*1 - 2*	*E*	*K91*	*56*
WM S HART UNIFIED SCHOOL DIST	*21429 REDVIEW DR*	*1 - 2*	*SE*	*P95*	*58*
STUDIO CITY SPORTS CARS	*26846 OAK AVE BLDG 5*	*1 - 2*	*E*	*O100*	*60*
G W FRANZ GRINDING	*26818 OAK AVE UNIT L*	*1 - 2*	*E*	*O102*	*61*
D K TRUCKING	*20811 SANTA CLARA ST*	*1 - 2*	*ENE*	*Q107*	*64*
ADROS CUSTOM WOOD FINISHING	*26524 GOLDEN VALLEY*	*1 - 2*	*ESE*	*AA158*	*91*
INLAND PACIFIC MTR	*26502 GOLDEN VALLEY RD*	*1 - 2*	*ESE*	*AA159*	*91*
BENS TEK	*26536 GOLDEN VALLEY RD*	*1 - 2*	*ESE*	*AA160*	*91*
RUSSELL DUNN AUTOMOTIVE	*26821 RUETHER UNIT G*	*1 - 2*	*E*	*AD184*	*106*
POINTS WEST	*20727 SANTA CLARA ST*	*1 - 2*	*ENE*	*AE195*	*112*
SOUTHWEST INDUSTRIES	*26911 RUETHER AVE STE S*	*1 - 2*	*E*	*AC197*	*114*
NATIONAL READY MIX	27050 RUETHER AVE	1 - 2	ENE	AE203	116
DISCOUNT TIRE CENTERS	*20737 SOLEDAD CANYON RD*	*1 - 2*	*E*	*AD210*	*120*
IMPORT AUTO CARE	*20723 SOLEDAD CANYON RD*	*1 - 2*	*E*	*AI215*	*124*
R C ACRYLICS	*20665 SANTA CLARA*	*1 - 2*	*ENE*	*AL239*	*140*
HI-SHEAR TECHNOLOGY CORP	*26413 N GOLDEN VALLEY R*	*1 - 2*	*SE*	*AM251*	*145*
BLUE CROSS LABORATORIES	*26411 N GOLDEN VALLEY R*	*1 - 2*	*SE*	*AM253*	*146*
EDS CLEANERS	*20655 SOLEDAD CANYON RD*	*1 - 2*	*E*	*AO259*	*150*
BROWN AUTO BODY	*26935 FURNIVALL*	*1 - 2*	*E*	*AO268*	*155*
EUROPEAN AUTO CENTER	*27134 FURNIVALL AVE*	*1 - 2*	*ENE*	*AR289*	*169*
MIKES TIREMAN	*20529 SOLEDAD CANYON RD*	*1 - 2*	*E*	*AZ338*	*197*
JERRY AUTOMATIC TRANSMISSIONS	*20501 SOLEDAD CYN ROAD*	*1 - 2*	*E*	*AZ356*	*210*
JIM DANDY	*27600 BOUGUET CYN RD*	*1 - 2*	*NNE*	*BD362*	*215*
WM S HART USD SAUGUS HS	*21900 W CENTURION WY*	*1 - 2*	*N*	*364*	*216*

Lower Elevation	Address	Dist / Dir		Map ID	Page
BERMITE DIVISION	*22116 WEST SOLEDAD CANY*	*1/2 - 1*	*SW*	*E34*	*21*
SAUGUS UNION SD	22211 W NEWHALL RANCH R	1 - 2	WNW	N72	47
RITE AID NO 5555	*26825 BOUQUET CYN RD*	*1 - 2*	*NW*	*U117*	*68*
CLARKS DRUGS 21	*26550 BOUQET CANYON RD*	*1 - 2*	*WNW*	*W129*	*76*
FLAMINGO CLEANERS	*26512 BOQUET CYN RD*	*1 - 2*	*WNW*	*Z144*	*85*
CHEVRON STN 9 2437	*26753 BOUQUET CANYON RD*	*1 - 2*	*NW*	*X147*	*86*

EXECUTIVE SUMMARY

Lower Elevation	Address	Dist / Dir		Map ID	Page
SECO ONE HOUR MARTINIZING	*26830 SECO CYN RD*	*1 - 2*	*NW*	*AF190*	*109*
CHEVRON STATION 97436	*23055 SOLEDAD CYN RD*	*1 - 2*	*W*	*AK236*	*137*
LA CO., SANITATION DIST	26200 SPRINGBROOK AVE	1 - 2	WSW	AS297	171
GLORY CLEANERS	*23142 VALENCIA*	*1 - 2*	*W*	*AT301*	*173*
VALENCIA DODGE	*26011 BOQUET CANYON RD*	*1 - 2*	*WSW*	*AX318*	*184*
HASA CHEM INC	*23119 DRAYTON ST*	*1 - 2*	*WSW*	*AY324*	*187*
KEYSOR-CENTURY CORP.	*26000 SPRINGBROOK AVE.*	*1 - 2*	*SW*	*BA342*	*200*
HI TECH TRANSMISSION	*25845 SAN FERNANDO RD*	*1 - 2*	*WSW*	*BB346*	*204*
VALENCIA AUTOMOTIVE CENTER MD	*25835 SAN FERNANDO RD*	*1 - 2*	*WSW*	*BC351*	*206*
A & K BODY & FENDER	*25834 SPRINGBROOK AVE*	*1 - 2*	*SW*	*BE375*	*221*
MIDAS MUFFLER	*25745 SAN FERNANDO RD*	*1 - 2*	*SW*	*BG381*	*225*

RAATS: The RCRA Administration Action Tracking System contains records based on enforcement actions issued under RCRA and pertaining to major violators. It includes administrative and civil actions brought by the United States Environmental Protection Agency. The source of this database is the U.S. EPA.

A review of the RAATS list, as provided by EDR, and dated 04/17/1995 has revealed that there is 1 RAATS site within approximately 1.5 miles of the target property.

Lower Elevation	Address	Dist / Dir		Map ID	Page
BERMITE DIVISION	*22116 WEST SOLEDAD CANY*	*1/2 - 1*	*SW*	*E34*	*21*

TRIS: The Toxic Chemical Release Inventory System identifies facilities that release toxic chemicals to the air, water, and land in reportable quantities under SARA Title III, Section 313. The source of this database is the U.S. EPA.

A review of the TRIS list, as provided by EDR, and dated 12/31/2000 has revealed that there are 3 TRIS sites within approximately 1.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
AMERICAN CYANAMID	*21444 GOLDEN TRIANGLE R*	*1/2 - 1*	*SE*	*D25*	*13*

Lower Elevation	Address	Dist / Dir		Map ID	Page
HASA INC.	23119 DRAYTON ST.	1 - 2	WSW	AY328	191
KEYSOR-CENTURY CORP.	*26000 SPRINGBROOK AVE.*	*1 - 2*	*SW*	*BA342*	*200*

TSCA: The Toxic Substances Control Act identifies manufacturers and importers of chemical substances included on the TSCA Chemical Substance Inventory list. It includes data on the production volume of these substances by plant site. The United States Environmental Protection Agency has no current plan to update and/or re-issue this database.

A review of the TSCA list, as provided by EDR, and dated 12/31/1998 has revealed that there are 2 TSCA sites within approximately 1.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
E. I. DU PONT DE NEMOURS & CO	21444 GOLDEN TRIANGLE R	1/2 - 1	SE	D19	12

Lower Elevation	Address	Dist / Dir		Map ID	Page
KEYSOR-CENTURY CORP.	*26000 SPRINGBROOK AVE.*	*1 - 2*	*SW*	*BA342*	*200*

EXECUTIVE SUMMARY

SSTS: Section 7 of the Federal Insecticide, Fungicide and Rodenticide Act, as amended (92 Stat. 829) requires all registered pesticide-producing establishments to submit a report to the Environmental Protection Agency by March 1st each year. Each establishment must report the types and amounts of pesticides, active ingredients and devices being produced, and those having been produced and sold or distributed in the past year.

A review of the SSTS list, as provided by EDR, and dated 12/31/2000 has revealed that there is 1 SSTS site within approximately 1.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
VAL-PAK PRODUCTS	*26751 OAK AVE.*	*1 - 2*	*E*	*K64*	*42*

STATE OR LOCAL ASTM SUPPLEMENTAL

AST: The Aboveground Storage Tank database contains registered ASTs. The data come from the State Water Resources Control Board's Hazardous Substance Storage Container Database.

A review of the AST list, as provided by EDR, and dated 05/21/2002 has revealed that there is 1 AST site within approximately 1.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
JIFFY LUBE #680	*20703 SOLEDAD CANYON RD*	*1 - 2*	*E*	*AI226*	*132*

DRYCLEANERS:A list of drycleaner related facilities that have EPA ID numbers. These are facilities with certain SIC codes: power laundries, family and commercial; garment pressing and cleaners' agents; linen supply; coin-operated laundries and cleaning; drycleaning plants except rugs; carpet and upholster cleaning; industrial launderers; laundry and garment services.

A review of the CLEANERS list, as provided by EDR, and dated 03/18/2002 has revealed that there are 7 CLEANERS sites within approximately 1.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
ED'S CLEANERS	20655 SOLEDAD CANYON RD	1 - 2	E	AO256	149
ED'S CLEANERS	20655 SOLEDAD CANYON RD	1 - 2	E	AO260	152
BONGIOVANNI CHIROPRACTIC	*27600 BOUQUET CANYON RD*	*1 - 2*	*NNE*	*BD359*	*212*
JIM DANDY CLEANERS	*27600 BOUGUET CYN RD*	*1 - 2*	*NNE*	*BD361*	*214*

Lower Elevation	Address	Dist / Dir		Map ID	Page
CARRIAGE TRADE CLEANERS	*26512 BOUQUET CANYON*	*1 - 2*	*WNW*	*Z143*	*84*
ONE HOUR MARTINIZING	*26830 SECO CYN RD*	*1 - 2*	*NW*	*AF191*	*110*
GLORY CLEANERS	*23142 VALENCIA*	*1 - 2*	*W*	*AT301*	*173*

WDS: California Water Resources Control Board - Waste Discharge System.

A review of the CA WDS list, as provided by EDR, and dated 06/17/2002 has revealed that there are 2 CA WDS sites within approximately 1.5 miles of the target property.

Lower Elevation	Address	Dist / Dir		Map ID	Page
SAUGUS WWRP, NPDES	26200 SPRINGBROOK AVE	1 - 2	WSW	AS298	171
KEYSOR-CENTURY CORPORATIO	*26000 SPRINGBROOK*	*1 - 2*	*SW*	*BA340*	*198*

EXECUTIVE SUMMARY

CA SLIC: SLIC Region comes from the California Regional Water Quality Control Board.

A review of the CA SLIC list, as provided by EDR, has revealed that there are 2 CA SLIC sites within approximately 1.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
GLASS SEAL CORP.	21516 GOLDEN TRIANGLE R	1/2 - 1	SE	C13	10

Lower Elevation	Address	Dist / Dir		Map ID	Page
MJW INVESTMENT	26830 SECO CANYON ROAD	1 - 2	NW	AF179	103

HAZNET: The data is extracted from the copies of hazardous waste manifests received each year by the DTSC. The annual volume of manifests is typically 700,000-1,000,000 annually, representing approximately 350,000-500,000 shipments. Data from non-California manifests & continuation sheets are not included at the present time. Data are from the manifests submitted without correction, and therefore many contain some invalid values for data elements such as generator ID, TSD ID, waste category, & disposal method. The source is the Department of Toxic Substance Control is the agency

A review of the HAZNET list, as provided by EDR, has revealed that there are 112 HAZNET sites within approximately 1.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
OLIVER WILLIAMS ELEVATOR COMPA	21700 W GOLDEN TRIANGLE	1/4 - 1/2	SSE	A1	6
SANTA CLARITA MEDICAL GROUP	21700 W GOLDEN TRIANGLE	1/4 - 1/2	SSE	A2	6
SANTA CLARITA VALLEY HEALTH CA	21704 W GOLDEN TRIANGLE	1/4 - 1/2	SSE	A3	6
PUBLIC STORAGE	21648 W GOLDEN TRIANGLE	1/4 - 1/2	SSE	A4	7
PACIFIC COAST ROOFING INC	21616 GOLDEN TRIANGLE R	1/4 - 1/2	SE	B6	7
MFG SANTA CLARITA LP	21516 W GOLDEN TRIANGLE	1/2 - 1	SE	C9	9
AMERICAN CYANAMID	***21444 GOLDEN TRIANGLE R***	***1/2 - 1***	***SE***	***D25***	***13***
LAKESIDE BOAT SERVICE	21452 GOLDEN TRIANGLE R	1/2 - 1	SE	D26	17
BOWMAN HIGH SCHOOL/WM S HART U	21508 REDVIEW DR	1/2 - 1	SE	45	30
WHITTAKER CORP/BERMITE DIV	22116 W SOLEDAD CYN RD	1/2 - 1	S	52	34
PREMIER AUTO BODY & FRAME	26723 OAK AVENUE	1 - 2	E	K58	38
MORRIS PRECISION PRODUCTS, INC	26732 OAK AVE	1 - 2	E	K61	40
BOHANS AUTOMOTOVIE	26741 OAK ST	1 - 2	E	K63	41
CASTAIC LAKE WATER AGENCY	27234 BOUQUET CANYON RD	1 - 2	N	L65	44
MARANATHA CHEVROLET	***26770 OAK AVE***	***1 - 2***	***E***	***M78***	***49***
CANYON COUNTRY INDUSTRIAL PARK	26776 OAK AVE	1 - 2	E	M80	51
VON CO TOOL	***26778 OAK AVE***	***1 - 2***	***E***	***M81***	***51***
VIP AUTO REPAIR	26794 OAK AVE	1 - 2	E	M85	53
VP MANUFACTURING INC	20732 SOLEDAD ST	1 - 2	E	O87	54
SENSORTECH SYSTEMS INC	26810-I OAK AVE	1 - 2	E	O89	55
AMERICAN UNITED INC	20730 SOLEDAD ST	1 - 2	E	O90	56
HART UNION HIGH SCHOOL DISTRIC	21429 REDVIEW DR	1 - 2	SE	P93	57
METAL WORKS	26846 OAK AVENUE #K	1 - 2	E	O99	60
RESTORATIONS PLUS	26846 OAK AVENUE UNIT "	1 - 2	E	O101	61
G W FRANZ GRINDING	***26818 OAK AVE UNIT L***	***1 - 2***	***E***	***O102***	***61***
SANTA CLARITA WATER CO	***21110 GOLDEN TRIANGLE***	***1 - 2***	***E***	***S105***	***62***
D K TRUCKING	***20811 SANTA CLARA ST***	***1 - 2***	***ENE***	***Q107***	***64***
D & K TRUCKING INC	20811 SANTA CLARA ST	1 - 2	ENE	Q108	65
INSPECTOR'S PAINT & BODY	26516 GOLDEN VALLEY RD	1 - 2	ESE	V125	74
1X ANESCO MANUFACTURING PARTNE	26502 GOLDEN VALLEY ROA	1 - 2	ESE	V134	79
JPS INC	26502 GOLDEN VALLEY RD	1 - 2	ESE	V135	79
KAR BODY & PAINT INC	26502 GOLDEN VALLEY	1 - 2	ESE	V136	80
SAUGUS USD/TRANSPORTATION	26501 GOLDEN VALLEY ROA	1 - 2	ESE	V140	82

EXECUTIVE SUMMARY

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
UNIVERSAL ENGINE	26536 GOLDEN VALLEY RD,	1 - 2	ESE	V151	88
MATO PLASTICS	***26541 GOLDEN VALLEY***	***1 - 2***	***ESE***	***V152***	***89***
BENS TEK	***26536 GOLDEN VALLEY RD***	***1 - 2***	***ESE***	***AA160***	***91***
Not reported	***26477 GOLDEN VALLEY RD***	***1 - 2***	***SE***	***AB164***	***94***
SCV AUTO SPECIALIST	26921 RUETHER UNIT A	1 - 2	E	AC166	95
VELS AUTOMOTIVE/ADVANCED AUTOM	26831 RUETHER #K	1 - 2	E	AD167	97
SANTA CLARITA COLLISION CENTER	26867 RUETHER AVE	1 - 2	E	AC169	98
PETE'S AUTO REPAIR	***26911 RUETHER AVE. #D***	***1 - 2***	***E***	***AC173***	***100***
VAL-AERO INDUSTRIES INC	***26559 GOLDEN VALLEY RD***	***1 - 2***	***ESE***	***V176***	***101***
SANTA CLARITA VALLEY TOYOTA SP	26911 RUETHER AVE	1 - 2	E	AC178	102
POINT AUTO SERVICE	26921 RUETHER AVE #A	1 - 2	E	AC181	103
JERRYS TOWING SERVICE INC	26921-B RUETHER AVE	1 - 2	E	AC182	104
PREMIER PRINTING COMPANY	26951 RUETHER AVE STE G	1 - 2	E	AC183	104
ANDY GUMP INC	***26954 RUETHER AVENUE***	***1 - 2***	***E***	***AC189***	***108***
POINTS WEST	***20727 SANTA CLARA ST***	***1 - 2***	***ENE***	***AE195***	***112***
NATIONAL READY MIXED CONCRETE	***27050 RUETHER AVE***	***1 - 2***	***ENE***	***AE204***	***116***
SCV AUTO SPECIALIST	20733 SOLEDAD CANYON RD	1 - 2	E	AD211	121
NATIONAL TECHNICAL SYSTEMS	***20988 W GOLDEN TRIANGLE***	***1 - 2***	***E***	***AG218***	***126***
CANYON COUNTRY LUBRICATION	20703 SOLEDAD CANYON RO	1 - 2	E	AI224	130
JIFFY LUBE #680	***20703 SOLEDAD CANYON RD***	***1 - 2***	***E***	***AI226***	***132***
ACRYLLIC CUSTOMS COLLISION & B	20665 SANTA CLARA	1 - 2	ENE	AL238	139
BLUE CROSS LABORATORIES	***26411 N GOLDEN VALLEY R***	***1 - 2***	***SE***	***AM253***	***146***
EDS CLEANERS	***20655 SOLEDAD CANYON RD***	***1 - 2***	***E***	***AO259***	***150***
CANYON COUNTRY VETERINARY	20655 SOLEDAD CANYON RO	1 - 2	E	AO261	152
KWIK INK CREEEN PRINTING DESIG	26915 FURNIVALL	1 - 2	E	AO262	153
LOLA OLSEN PROPERTIES	26917 FURNIVALL	1 - 2	E	AO263	154
PRECISION CNC PRODUCTS	26921 1/2 FURNIVALL ST	1 - 2	E	AO266	154
BROWN AUTO BODY	***26935 FURNIVALL***	***1 - 2***	***E***	***AO268***	***155***
WILLIAM ETTER & PATRICK BETZ	26949 FURNIBAL AVE	1 - 2	E	AO270	156
STAATS CONSTRUCTION	***26951 FURNIVAL***	***1 - 2***	***E***	***AP271***	***156***
CITY OF SANTA CLARITA	***26407 GOLDEN VALLEY RD***	***1 - 2***	***SE***	***AM276***	***160***
PACIFIC BELL	26971 N FUNIVALL AVE	1 - 2	E	AP280	162
DESIGN MASONRY INC	27121 FURNIVAL	1 - 2	E	AR286	167
CALIFORNIA COLLECTIBLE COACH W	27134 FURNIVALL AVE	1 - 2	ENE	AR288	168
LIL'JOHN AUTO PARTS (USED OIL	20541 SOLEDAD CANYON RD	1 - 2	E	AZ333	194
MIKE'S TIREMAN INC	***20529 SOLEDAD CANYON RD***	***1 - 2***	***E***	***AZ336***	***196***
JERRY HIDDER	20501 SOLEDA CANYON ROA	1 - 2	E	AZ354	209
JERRY'S TRANSMISSIONS	20501 SOLEDAD CANYON RD	1 - 2	E	AZ355	209
JERRY AUTOMATIC TRANSMISSIONS	***20501 SOLEDAD CYN ROAD***	***1 - 2***	***E***	***AZ356***	***210***
BONGIOVANNI CHIROPRACTIC	***27600 BOUQUET CANYON RD***	***1 - 2***	***NNE***	***BD359***	***212***
JIM DANDY CLEANERS	***27600 BOUGUET CYN RD***	***1 - 2***	***NNE***	***BD361***	***214***
WM S HART USD SAUGUS HS	***21900 W CENTURION WY***	***1 - 2***	***N***	***364***	***216***
MAIN STREET VIDIO	27611 BOUQUET CYN RD	1 - 2	NNE	BD366	218
RIO VISTA ELEMENTARY SCHOOL	20417 CEDARCREEK ST	1 - 2	E	373	220

Lower Elevation	Address	Dist / Dir		Map ID	Page
SANTA CLARITA VALLEY DENTAL	22770 WEST SOLEDAD CYN	1/2 - 1	W	H46	31
SAUGUS UNION SCHOOL DIST	22635 ESPUELLA DR	1/2 - 1	NW	51	34
FIRST CARE WALK IN MEDICAL GR	22840 SOLDEDAD CANYON R	1/2 - 1	W	J57	37
SAUGUS SCH DIST	22211 NEWHALL RANCH RD	1 - 2	WNW	N75	47
SAUGUS	22211 W NEWHALL RANCH R	1 - 2	WNW	N76	48
RITE AID NO 5555	***26825 BOUQUET CYN RD***	***1 - 2***	***NW***	***U117***	***68***
SHELL	***26801 BOUQUET CANYON RD***	***1 - 2***	***NW***	***U122***	***72***
SAV ON 9722	26550 BOUQUET CANYON RD	1 - 2	WNW	W128	75
CLARKS DRUGS 21	***26550 BOUQET CANYON RD***	***1 - 2***	***WNW***	***W129***	***76***

EXECUTIVE SUMMARY

Lower Elevation	Address	Dist / Dir		Map ID	Page
CARRIAGE TRADE CLEANERS	***26512 BOUQUET CANYON***	***1 - 2***	***WNW***	***Z143***	***84***
CHEVRON USA PRODUCTS COMPANY	26753 BOQUET CANYON	1 - 2	NW	X150	87
SECO ONE HOUR MARTINIZING	***26830 SECO CYN RD***	***1 - 2***	***NW***	***AF190***	***109***
ONE HOUR MARTINIZING	***26830 SECO CYN RD***	***1 - 2***	***NW***	***AF191***	***110***
CROSSROADS DENTAL CENTER	26246 BOUQUET CANYON RD	1 - 2	WNW	AH212	121
PIP PRINTING #675	26240 BOUQUET CANYON RD	1 - 2	WNW	AH213	123
TOSCO CORPORATION STATION #313	23055 SOLEDAD CANYON RD	1 - 2	W	AK230	134
UNOCAL SERVICE STATION #7344	23055 SOLEDAD CANYON RO	1 - 2	W	AK235	136
SAMS EXXON	***23060 SOLEDAD CYN RD***	***1 - 2***	***W***	***AK241***	***141***
SANTA CLARITA CAR WASH INC	***23105 VALENCIA BLVD***	***1 - 2***	***W***	***AQ281***	***164***
GERMAN AUTO CENTER	23051 DRAYTON ST	1 - 2	WSW	AS291	169
CNTY LA SANITATION DIST/SAUGUS	26200 SPRINGBOOK AVE	1 - 2	WSW	AS295	171
GLORY CLEANERS	***23142 VALENCIA***	***1 - 2***	***W***	***AT301***	***173***
ANIMAL CLINIC OF SANTA CLARITA	26062 BOUQUET CANYON RD	1 - 2	WSW	AV305	177
RODNEY L CUMMINGS DC CHIROPRAC	26045 BOQUET CANYON RD.	1 - 2	WSW	AV312	179
ALERT MOBILE REPAIR SERVICE, I	26011 BOUQUET CYN RD	1 - 2	WSW	AX317	183
AUTO BODY SPECIALIST	23108 DRAYTON ST	1 - 2	WSW	AS321	185
HASA CHEMICALS INC	***23119 DRAYTON STREET***	***1 - 2***	***WSW***	***AY330***	***192***
KEYSOR-CENTURY CORP.	***26000 SPRINGBROOK AVE.***	***1 - 2***	***SW***	***BA342***	***200***
PURRFECT AUTO SERVICE #69	***25843 SAN FERNANDO RD***	***1 - 2***	***WSW***	***BC348***	***204***
VALENCIA AUTOMOTIVE CENTER MD	***25835 SAN FERNANDO RD***	***1 - 2***	***WSW***	***BC351***	***206***
LIONS TOWING AND MOTORS	25835 SAN FERNANDO ROAD	1 - 2	WSW	BC352	208
AAMCO TRANSMISSION	25825 SAN FERNANDO RD	1 - 2	WSW	BC357	211
WESTERN BAGEL TOO	23170 W VALENCIA BLVD	1 - 2	W	358	212
A & K BODY & FENDER	***25834 SPRINGBROOK AVE***	***1 - 2***	***SW***	***BE375***	***221***
MYFRAN INC DBA MIDAS MUFFLER	25745 SAN FERNANDO RD	1 - 2	SW	BG379	223

HMS: Los Angeles County Industrial Waste and Underground Storage Tank Sites.

A review of the LOS ANGELES CO. HMS list, as provided by EDR, has revealed that there are 162 LOS ANGELES CO. HMS sites within approximately 1.5 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
SANTA CLARITA AUTO TRCK	21618 GOLDEN TRIANGLE R	1/4 - 1/2	SE	B5	7
SANTA CLARITA CONCESSIONS, INC	21554 GOLDEN TRIANGLE R	1/4 - 1/2	SE	C7	7
MOUNTASIA OF SANTA CLARITA LP	21516 GOLDEN TRIANGLE R	1/2 - 1	SE	C10	9
MCDONALDS RESTAURANT	21516 GOLDEN TRIANGLE R	1/2 - 1	SE	C11	10
GLASS SEAL CORPORATION	21516 GOLDEN TRIANGLE R	1/2 - 1	SE	C12	10
CYTEC INDUSTRIES	21444 W GOLDEN TRIANGLE	1/2 - 1	SE	D16	11
AMERICAN CYANAMID CO	21444 W GOLDEN TRIANGLE	1/2 - 1	SE	D22	12
FOSTERS FREEZE	21525 W SOLEDAD CANYON	1/2 - 1	ESE	F35	26
FOSTER FREEZE	21525 W SOLEDAD CANYON	1/2 - 1	ESE	F36	26
FOSTERS FREEZE	21515 SOLEDAD CANYON RD	1/2 - 1	ESE	F37	26
CAMEL WORKS	21020 W SOLEDAD CANYON	1/2 - 1	E	I47	32
LA CO DPW FLOOD SANTA CLARITA	21014 W SOLEDAD CANYON	1/2 - 1	E	I48	33
PROWLERS SPEED & CUSTOMS INC.	21021 SOLEDAD CANYON RD	1/2 - 1	E	I49	33
AUTO CENTER	26723 OAK AVE	1 - 2	E	K59	39
PREMIER AUTO BODY	26723 OAK AVE	1 - 2	E	K60	40
BOHAN'S AUTOMOTIVE	26741 OAK AVE	1 - 2	E	K62	41
RIO VISTA WATER TREATMENT	27234 BOUQUET CANYON RD	1 - 2	N	L66	45
RIO VISTA WATER TREATMENT PLT	27234 BOUQUET CANYON RD	1 - 2	N	L69	46
PACIFIC AIR LOGISTICS	26763 OAK AVE	1 - 2	E	M70	46
MARANATHA CHEVROLET SERVICE	26770 OAK AVE	1 - 2	E	M77	49
WINNERS CIRCLE AUTO PATRS	26786 OAK AVE	1 - 2	E	M82	52

EXECUTIVE SUMMARY

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
HOBBY SHOP	26790 OAK AVE	1 - 2	E	M83	52
HONEST JOHN'S EVO'S ETC	26792 OAK AVE	1 - 2	E	M84	53
VP MFG, INC.	20732 SOLEDAD ST A	1 - 2	E	O88	55
AV BREAK SUPPLY	26818 OAK AVE E	1 - 2	E	O92	57
WS HART UNION HIGH SCH DT	21429 REDVIEW DR	1 - 2	SE	P96	59
QUALITY PAPER FIBERS, INC	20833 SANTA CLARA ST	1 - 2	ENE	Q97	59
RENT A BIN	20830 SANTA CLARA ST	1 - 2	ENE	Q98	59
SANTA CLARITA WATER CO	***21110 GOLDEN TRIANGLE***	***1 - 2***	***E***	***S105***	***62***
INSPECTORS PAINT & BODY	26516 GOLDEN VALLEY RD	1 - 2	ESE	114	67
CLASSIC UPHOLSTERY	26524 GOLDEN VALLEY RD	1 - 2	ESE	V126	75
BABY YOUR CAR	26529 GOLDEN VALLEY RD	1 - 2	ESE	V130	78
SAUGUS UNION SD TRANSPORTATION	***26501 GOLDEN VALLEY RD***	***1 - 2***	***ESE***	***V139***	***81***
SAUGUS UNION SD TRANSPORTATION	26501 GOLDEN VALLEY RD	1 - 2	ESE	V141	83
MATO PLASTICS	***26541 GOLDEN VALLEY***	***1 - 2***	***ESE***	***V152***	***89***
BENS TEK	***26536 GOLDEN VALLEY RD***	***1 - 2***	***ESE***	***AA160***	***91***
ELEC-TROL INC	26477 N GOLDEN VALLEY R	1 - 2	SE	AB163	94
FORBES METAL STAMPING CO.	26555 GOLDEN VALLEY RD	1 - 2	ESE	V165	95
SCORE INDUSTRIES	26841 RUETHER AVE E	1 - 2	E	AD168	98
PRIDE COLLISION CENTER	26867 RUETHER AVE	1 - 2	E	AC170	99
SANTA CLARITA COLLISION CENTER	26867 RUETHER AVE	1 - 2	E	AC171	100
VIDAC	26883 RUETHER AVE	1 - 2	E	AC172	100
PETE'S AUTO REPAIR	***26911 RUETHER AVE. #D***	***1 - 2***	***E***	***AC173***	***100***
INDUSTRIAL ASPHALT CO	20735 W SANTA CLARA ST	1 - 2	ENE	AE174	100
SO PACIFIC MILLING CO	20735 W SANTA CLARA ST	1 - 2	ENE	AE175	101
VAL-AERO INDUSTRIES INC	***26559 GOLDEN VALLEY RD***	***1 - 2***	***ESE***	***V176***	***101***
MOFIELD PRODUCTIONS	26911 RUETHER AVE E	1 - 2	E	AC177	101
ANDY GUMP INC	***26954 RUETHER AVENUE***	***1 - 2***	***E***	***AC189***	***108***
POINTS WEST TRUCKING,INC.	20727 SANTA CLARA ST	1 - 2	ENE	AE193	112
JOHN PAUL MICHAEL SYSTEMS	26455 GOLDEN VALLEY RD	1 - 2	SE	199	115
NATIONAL READY MIXED CONCRETE	***27050 RUETHER AVE***	***1 - 2***	***ENE***	***AE204***	***116***
LA CO DPW FLOOD DIST	21014 GOLDEN TRIANGLE R	1 - 2	E	AG208	120
DPW FMD SANTA CLARITA REFERRAL	21014 GOLDEN TRIANGLE R	1 - 2	E	AG209	120
FRONTIER AUTO SERVICE	20723 SOLEDAD CANYON RD	1 - 2	E	AI214	124
NATIONAL TECHNICAL SYSTEMS	20988 GOLDEN TRIANGLE R	1 - 2	E	AG216	125
NATIONAL TECHNICAL SYSTEMS	***20988 W GOLDEN TRIANGLE***	***1 - 2***	***E***	***AG218***	***126***
JIFFY LUBE	20703 SOLEDAD CANYON RD	1 - 2	E	AI225	131
ROBERT SAUMERS	20665 W SANTA CLARA ST	1 - 2	ENE	AL240	141
BOCCHI LABORATORIES INC	26421 GOLDEN VALLEY RD	1 - 2	SE	AM246	144
VALENCIA LABORATORY	26421 GOLDEN VALLEY RD	1 - 2	SE	AM247	144
STAR LABORATORIES INC	26421 N GOLDEN VALLEY R	1 - 2	SE	AM248	145
BLUE CROSS LABORATORIES	***26411 N GOLDEN VALLEY R***	***1 - 2***	***SE***	***AM253***	***146***
IVAN COHEN	20655 W SOLEDAD CANYON	1 - 2	E	AO257	150
SANTA CLARITA BREWING CO	20655 W SOLEDAD CANYON	1 - 2	E	AO258	150
KOCH'S	26917 FURNIVALL AVE	1 - 2	E	AO264	154
B & D GLASS	26919 FURNIVALL AVE	1 - 2	E	AO265	154
DICK SANCHEZ AUTO BODY	26935 FURNIVALL AVE	1 - 2	E	AO267	155
STORAGE LOT	26949 N FURNIVALL AVE	1 - 2	E	AO269	156
STAATS CONSTRUCTION	***26951 FURNIVAL***	***1 - 2***	***E***	***AP271***	***156***
PACIFIC BELL CNCYCAPB/KC652	26971 N FURNIVALL AVE	1 - 2	E	AP272	157
PACIFIC BELL	***26971 FURNIVALL AVE***	***1 - 2***	***E***	***AP275***	***158***
CITY OF SANTA CLARITA	***26407 GOLDEN VALLEY RD***	***1 - 2***	***SE***	***AM276***	***160***
SANTA CLARITA CAR WASH	20625 SOLEDAD CANYON RD	1 - 2	E	AO287	168
JERRYS AUTOMATIC TRANS RP	20601 W SANTA CLARA ST	1 - 2	ENE	AR290	169
MED TRANS CORP.	20607 W SOLEDAD CANYON	1 - 2	E	AO293	170
NAPA AUTO PARTS	20541 SOLEDAD CANYON RD	1 - 2	E	AZ331	193
LIL JOHN AUTO PARTS	20541 SOLEDAD CANYON RD	1 - 2	E	AZ332	194

EXECUTIVE SUMMARY

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
CANYON AUTO SUPPLY	20541 SOLEDAD CANYON RD	1 - 2	E	AZ334	195
MIKE'S TIRE MAN	20529 SOLEDAD CANYON RD	1 - 2	E	AZ337	197
LA RUMBA	27600 N BOUQUET CANYON	1 - 2	NNE	BD360	213
JIM DANDY	***27600 BOUGUET CYN RD***	***1 - 2***	***NNE***	***BD362***	***215***
CAFE BOUQUET	27600 N BOUQUET CANYON	1 - 2	NNE	BD363	216
DRIVE-IN DAIRY	26954 N SECO CANYON RD	1 - 2	NW	BF370	219
WORTMANN OIL CO	26954 N SECO CANYON RD	1 - 2	NW	BF371	220

Lower Elevation	Address	Dist / Dir		Map ID	Page
BERMITE DIV-WHITTAKER	22116 SOLEDAD CANYON RD	1/2 - 1	SW	E31	19
BONELLI PHAR PROD	22500 W SOLEDAD CANYON	1/2 - 1	WSW	G40	28
SAUGUS SPEED WAY - SWAPMEET	22500 SOLEDAD CANYON RD	1/2 - 1	W	G42	29
SANTA CLARITA WATER CO.	22722 SOLEDAD CANYON RD	1/2 - 1	W	H44	30
AMERICAN MOTOR CYCLE	22820 SOLEDAD CANYON RD	1/2 - 1	W	J54	36
PIZZA HUT RESTAURANT #758132	22830 W SOLEDAD CANYON	1/2 - 1	W	J55	36
L A POLICE MISDEMEANANT F	27000 N BOUQUET CANYON	1/2 - 1	NNW	56	37
SAUGUS UNION SCHOOL DISTRICT	22211 NEWHALL RANCH RD	1 - 2	WNW	N74	47
POPPIS	22903 W SOLEDAD CANYON	1 - 2	W	R103	62
SPORTS BAR & GRILL	22903 W SOLEDAD CANYON	1 - 2	W	R104	62
SAFEWAY STORES INC #1024	26877 BOUQUET CANYON RD	1 - 2	NW	T109	65
MANDARIN EXPRESS	22911 W SOLEDAD CANYON	1 - 2	W	R110	66
MADARIN EXPRESS	22911 W SOLEDAD CANYON	1 - 2	W	R111	66
PEARSON AND CO	22911 W SOLEDAD CANYON	1 - 2	W	R112	66
NUMERO UNO #52	22917 W SOLEDAD CANYON	1 - 2	W	R113	66
COUSINS BURGERS	26851 N BOUQUET CANYON	1 - 2	NW	T115	67
BOUQUET CANYON SHELL	26801 N BOUQUET CANYON	1 - 2	NW	U119	71
SHELL OIL #204-7050/CAR WASH	26801 N BOUQUET CANYON	1 - 2	NW	U124	73
HUGHES MARKETS INC	26550 N BOUQUET CANYON	1 - 2	WNW	W127	75
BOUQUET AUTO PARTS	26769 BOUQET CANYON RD	1 - 2	NW	X131	78
SWENSENS BOUQUET CENTER	26586 N BOUQUET CANYON	1 - 2	WNW	W132	78
WENDYS HAMBURGERS	26538 N BOUQUET CANYON	1 - 2	WNW	W133	79
CAMP BOUQUET CANYON	26590 N BOUQUET CANYON	1 - 2	WNW	Y137	81
VONS #1669	26518 N BOUQUET CANYON	1 - 2	WNW	W142	83
CHEVRON USA SS 092437	26753 N BOUQUET CANYON	1 - 2	NW	X148	87
CHEVRON USA CO / CARWASH	26753 N BOUQUET CANYON	1 - 2	NW	X149	87
ORCHARD SUPPLY HARDWARE	26565 N BOUQUET CANYON	1 - 2	WNW	W153	89
BURGER KING RESTAURANT	26480 N BOUQUET CANYON	1 - 2	WNW	Z154	90
JACK-IN-THE-BOX	26547 N BOUQUET CANYON	1 - 2	WNW	W155	90
PRESIDENTE RESTAURANT	26625 N BOUQUET CANYON	1 - 2	NW	Y156	90
BOSTON MARKET RESTAURANT	26543 N BOUQUET CANYON	1 - 2	WNW	W157	90
CRISTA ENTERPRISES DEVELOPMENT	26485 N BOUQUET CANYON	1 - 2	WNW	Z161	93
LA CO FD FIRE STA #111	26829 N SECO CANYON RD	1 - 2	NW	AF185	106
UNOCAL	***502 BEAUMONT AVE***	***1 - 2***	***W***	***200***	***115***
DR BORIS ZAK'S DENTAL OFFICE	26324 N BOUQUET CANYON	1 - 2	WNW	AH207	120
UNOCAL CORP SS 7344	23055 W SOLEDAD CANYON	1 - 2	W	AK227	133
TOSCO/UNOCAL #31309	23055 W SOLEDAD CANYON	1 - 2	W	AK228	133
ACWA ASSOC - SEE FILE I09575	23055 W SOLEDAD CANYON	1 - 2	W	AK229	133
TOSCO/UNOCAL #31309	23055 W SOLEDAD CANYON	1 - 2	W	AK231	134
ACWA ASSOCIATES INC	23055 W SOLEDAD CANYON	1 - 2	W	AK237	139
SAMS EXXON	***23060 SOLEDAD CYN RD***	***1 - 2***	***W***	***AK241***	***141***
EXXON USA #7-3550	23060 SOLEDAD CANYON RD	1 - 2	W	AK242	142
SAM'S MOBIL	***23060 SOLEDAD CANYON RD***	***1 - 2***	***W***	***AK244***	***143***
U-HAUL CO.	26230 BOUQUET CANYON RD	1 - 2	W	AN249	145
UNOCAL CORP SS	26279 N BOUQUET CANYON	1 - 2	W	AK255	149
CROSS ROADS AUTO WASH	***23105 VALENCIA BLVD***	***1 - 2***	***W***	***AQ284***	***166***

EXECUTIVE SUMMARY

Lower Elevation	Address	Dist / Dir		Map ID	Page
MCDONALDS RESTAURANT	23111 W VALENCIA BLVD	1 - 2	W	AQ285	167
GERMAN AUTO CENTERS INC.	23051 DRAYTON AVE	1 - 2	WSW	AS292	170
LA CO SAN DIS-SAUGUS WRP	26200 SPRINGBROOK AVE	1 - 2	WSW	AS299	173
BOOK NIPPAN	1123 E DOMINGUEZ ST K	1 - 2	W	AQ300	173
VACANT	26111 N BOUQUET CANYON	1 - 2	W	AW306	178
FRED SANDS	26111 N BOUQUET CANYON	1 - 2	W	AW307	178
GERALD H. HEIDT CO.	23300 W CINEMA DR #112	1 - 2	W	AW308	178
M&M HARRIGAN	23300 W CINEMA DR #112	1 - 2	W	AW309	178
JUGGLES RESTAURANT	23300 W CINEMA DR #112	1 - 2	W	AW310	179
PAULI'S ITALIAN RESTAURANT	23300 CINEMA DR #109	1 - 2	W	AW311	179
UNITED OIL #69	***26015 BOUQUET CANYON RD***	***1 - 2***	***WSW***	***AX313***	***180***
P&M SERVICE STATIONS #987	***26015 N BOUQUET CANYON***	***1 - 2***	***WSW***	***AX316***	***183***
BACKYARD INVESTMENT GROUP	23154 W VALENCIA BLVD	1 - 2	W	AT322	187
DIRSHNER DODGE	26011 BOUQUET CANYON RD	1 - 2	WSW	323	187
HASA CHEMICALS INC	***23119 DRAYTON STREET***	***1 - 2***	***WSW***	***AY330***	***192***
KEYSOR-CENTURY CORP.	***26000 SPRINGBROOK AVE.***	***1 - 2***	***SW***	***BA342***	***200***
J I GANDARA TRUCKING REPAIR	25885 SAN FERNANDO RD	1 - 2	WSW	BB343	203
LUNA'S TIRE SERVICE	25885 SAN FERNANDO RD	1 - 2	WSW	BB344	203
PLAZA CLARITA	25845 SAN FERNANDO RD	1 - 2	WSW	BB347	204
PURRFECT AUTO SERVICE #69	***25843 SAN FERNANDO RD***	***1 - 2***	***WSW***	***BC348***	***204***
INTERSTATE BATTERIES	25835 SAN FERNANDO RD #	1 - 2	WSW	BC349	206
ACE AUTOMOTIVE	25835 SAN FERNANDO RD #	1 - 2	WSW	BC350	206
HASA PRODUCTS CO INC	25950 SPRINGBROOK AVE	1 - 2	SW	BA353	208
BEE & BEE MACHINE SHOP	25852 SPRINGBROOK AVE	1 - 2	SW	BE367	218
FOOTHILL ELECTRIC MOTORS	25852 SPRINGBROOK AVE	1 - 2	SW	BE368	218
LEONARD'S MOLDED PRODUCTS	25847 SPRINGBROOK AVE	1 - 2	SW	BE372	220
FOOTHILL ELECTRIC MOTORS	25838 SPRINGBROOK AVE	1 - 2	SW	BE374	221
A & K FRAME ALIGNMENT	25834 SPRINGBROOK AVE	1 - 2	SW	BE376	223
MYERS PUMPING CO.	25824 SPRINGBROOK AVE	1 - 2	SW	BE377	223
AUTO BODY SPECIALISTS	25823 SPRINGBROOK AVE	1 - 2	SW	BE378	223
MIDAS MUFFLER & BRAKE SHOP	25745 SAN FERNANDO RD	1 - 2	SW	BG380	225
VIKING AUTO UPHOLSTERY	25819 SPRINGBROOK AVE	1 - 2	SW	BE382	225

Site Mitigation Complaint Control Log: The Los Angeles County Site Mitigation Log comes from Community Health Services.

A review of the LA Co. Site Mitigation list, as provided by EDR, has revealed that there is 1 LA Co. Site Mitigation site within approximately 1.5 miles of the target property.

Lower Elevation	Address	Dist / Dir		Map ID	Page
SANTA CLARITA PLACE/1 HR. CLNR	26830 SECO CANYON RD	1 - 2	NW	AF180	103

EDR PROPRIETARY HISTORICAL DATABASES

See the EDR Proprietary Historical Database Section for details

EXECUTIVE SUMMARY

Due to poor or inadequate address information, the following sites were not mapped:

Site Name	Database(s)
MINNIE MAX CLEANERS	CLEANERS
ACE CLEANERS	CLEANERS
COUNTRY CLEANERS	HAZNET, CLEANERS
J. MICHAEL MCGRATH NEW ELEM. SCH.	Cal-Sites
BILL SMALL'S MUD SUMP	SWF/LF
BILL SMALL'S MUD SUMP	SWF/LF
USA PETROLEUM COMPANY #82	HIST UST
LOS ANGELES COUNTY FIRE DEPT	HAZNET
SAUGUS UNION SCHOOL DISTRICT	HAZNET
OAK COLOR	HAZNET
JEMCO ELECTRICAL	HAZNET
AMERICAN GRAFFITII	HAZNET
A & S EXCHANGE	HAZNET
SHARON KENNEALLY	HAZNET
LOS ANGELES COUNTY FIRE DEPT	HAZNET
CITY OF LA - ENVIRO SVCS DEPT	HAZNET
WELLS FARGO BANK	HAZNET
MERLE NORMAN COSMETICS SAUGUS	HAZNET
EXECUTIVE AUTOMOTIVE	HAZNET
THE CROISDALE GROUP	HAZNET
ROTO-JET OF AMERICA CO INC	HAZNET
AUTOMOTIVE FITNESS CENTER INC.	HAZNET
VP MANUFACTURING INC	HAZNET
CARDINAL RESTAURANT SUPPLY	HAZNET
S C RADIATOR & BODY PARTS	HAZNET
USDA FOREST SERVICE	HAZNET
LOS ANGELES COUNTY FIRE DEPT	HAZNET
SHELL	HAZNET
V P MANUFACTURING INC	RCRIS-SQG
HI TECH TRANSMISSION	RCRIS-SQG
SHELL SERVICE STATION	RCRIS-SQG
CANYON SQUARE SHOP. CTR/MOBIL	LA Co. Site Mitigation
GOLDEN VALLEY RD. SANTA CLARITA	CA SLIC
WM HART UHSD - TRANSPORT DEPT	LOS ANGELES CO. HMS, CA SLIC
SOUTHERN CALIFORNIA GAS CO.	CA WDS
DEL LAGO DEWATERING PROJ.	CA WDS
WOK EXPRESS	LOS ANGELES CO. HMS
GOOD GUYS AUTO REPAIR	LOS ANGELES CO. HMS
AQUA-FLO SUPPLY	LOS ANGELES CO. HMS
SAUGUS SUZUKI	LOS ANGELES CO. HMS
UNITED OIL CO.	LOS ANGELES CO. HMS
ALERT MOBILE REPAIR	LOS ANGELES CO. HMS
ALERT MOBILE REPAIR	LOS ANGELES CO. HMS
IN-N-OUT BURGER	LOS ANGELES CO. HMS
PANDA EXPRESS	LOS ANGELES CO. HMS
LOWE'S HOME IMPROVMNT WRHOUSE	LOS ANGELES CO. HMS
CAR WASH USA INC	LOS ANGELES CO. HMS
LUSTGARTEN OIL CO	LOS ANGELES CO. HMS
RIO VISTA WTP PUMPING STA	LOS ANGELES CO. HMS
BOUQUET CYN OILFIELD	LOS ANGELES CO. HMS
BONELLI & SONS PRCSN	LOS ANGELES CO. HMS
LON'S DIESEL REPAIR	LOS ANGELES CO. HMS
ARB ENTERPRISES	LOS ANGELES CO. HMS
PROJEX	LOS ANGELES CO. HMS
KARS BODY & PAINT	LOS ANGELES CO. HMS
STARR AUTO DETAIL	LOS ANGELES CO. HMS
GOLDEN VALLEY INDUSTRIAL	LOS ANGELES CO. HMS
AUTO DISCOUNT CENTER	LOS ANGELES CO. HMS
THE AUTOLINE	LOS ANGELES CO. HMS

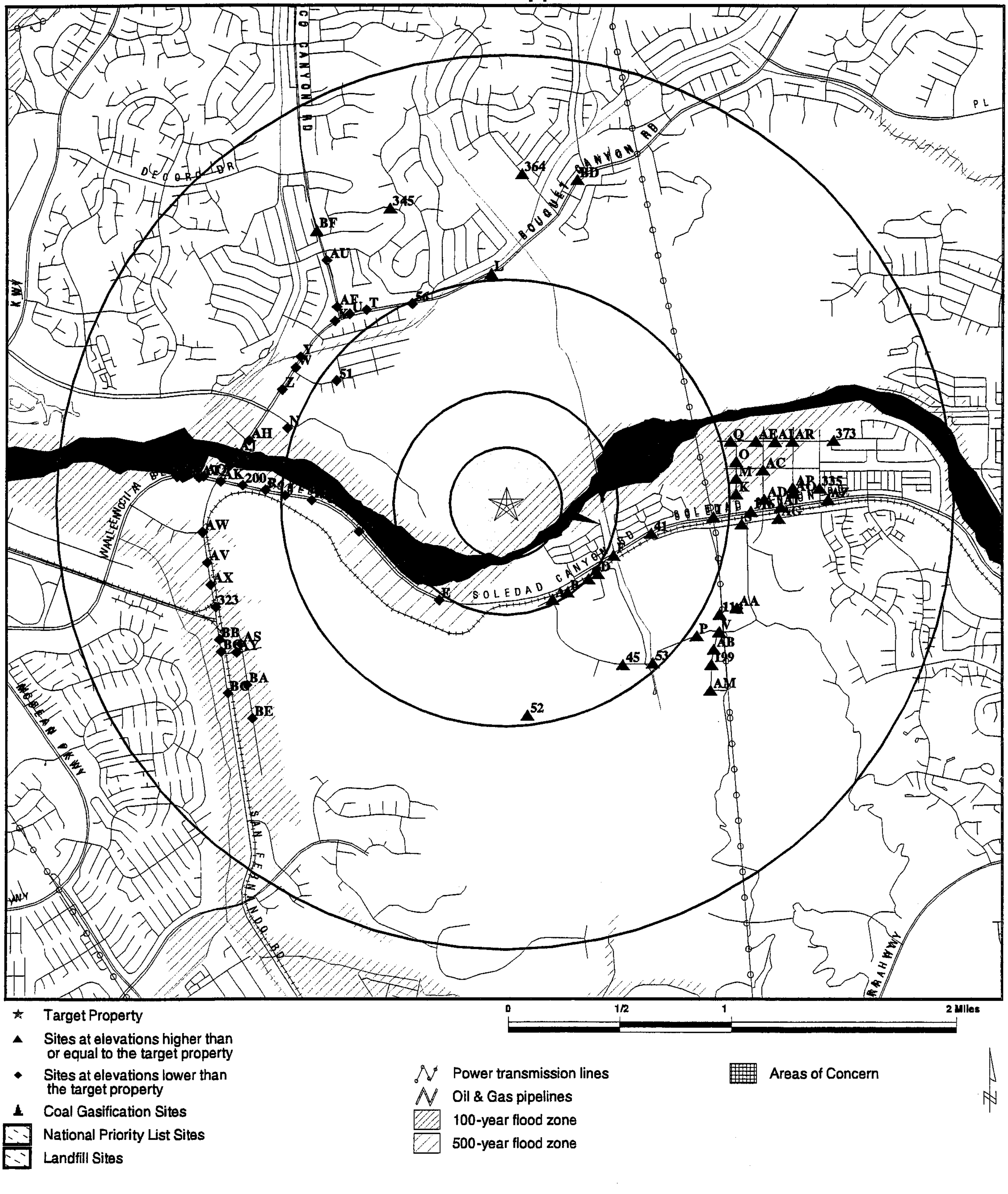
EXECUTIVE SUMMARY

R & R ENGINEERING COMPANY	LOS ANGELES CO. HMS
GALAXY DIE & ENGINEERING INC.	LOS ANGELES CO. HMS
ALL AROUND SHEET METAL	LOS ANGELES CO. HMS
HMV MOLDES & TOOLS	LOS ANGELES CO. HMS
PACIFIC AUTOMOTIVE	LOS ANGELES CO. HMS
C & N AUTOMOTIVE	LOS ANGELES CO. HMS
A SUPERIOR WOODWORKS	LOS ANGELES CO. HMS
ACCURATE TRAILER HITCH & WELD	LOS ANGELES CO. HMS
C & F SHEET METAL	LOS ANGELES CO. HMS
CALIF COLLECTABLE COACHCRAFT	LOS ANGELES CO. HMS
MERLE NORMAN COSMETICS	LOS ANGELES CO. HMS
MERLE NORMAN COSMETICS	LOS ANGELES CO. HMS
CITY OF SANTA CLARITA	LOS ANGELES CO. HMS
GOLDEN TRIANGLE INDL PARK	LOS ANGELES CO. HMS
NEWHALL OIL FIELD	LOS ANGELES CO. HMS
KERNVIEW OIL CO	LOS ANGELES CO. HMS
WILLIAM S HART REGIONAL PARK	LOS ANGELES CO. HMS
HOME DEPOT, INC	LOS ANGELES CO. HMS
GATE KING PROPERTIES INC	LOS ANGELES CO. HMS
ATLANTIC OIL CO	LOS ANGELES CO. HMS
PREMIER AUTOBODY FRAME	LOS ANGELES CO. HMS
BODEN'S CYLINDER HEADS	LOS ANGELES CO. HMS
CANYON AUTO ELECTRIC	LOS ANGELES CO. HMS
ARNECKES AUTOMOTIVE MACH. SHOP	LOS ANGELES CO. HMS
FINE CABINETS	LOS ANGELES CO. HMS
STRAIGHT LINE PERFORMANCE	LOS ANGELES CO. HMS
MICHAEL'S SHUTTER MFG.	LOS ANGELES CO. HMS
CHEMEX EXTERMINATORS	LOS ANGELES CO. HMS
PATROL SECURITY	LOS ANGELES CO. HMS
CYCLE ENGINEERING	LOS ANGELES CO. HMS
AMT SYSTEMS INC	LOS ANGELES CO. HMS
ACTION WOODWORKS	LOS ANGELES CO. HMS
C B C	LOS ANGELES CO. HMS
EXCLUSIVELY BRITISH & IMPORTS	LOS ANGELES CO. HMS
SKIN TIGHT	LOS ANGELES CO. HMS
TLC WOODWORKS	LOS ANGELES CO. HMS
THE BLOWERS SHOP	LOS ANGELES CO. HMS
TLC WOODWORK	LOS ANGELES CO. HMS
SANTA CLARITA AUTO AIR & RADTR	LOS ANGELES CO. HMS
ALL VALLEY CARBURETORS	LOS ANGELES CO. HMS
ADVANCED HONDA-ACURA	LOS ANGELES CO. HMS
ARENS INDUSTRIES INC.	LOS ANGELES CO. HMS
BARBS QUALITY REPAIR SERVICE	LOS ANGELES CO. HMS
CYCLE CONCEPTS INC.	LOS ANGELES CO. HMS
HERMANN MW CO.	LOS ANGELES CO. HMS
SCV TOYOTA	LOS ANGELES CO. HMS
BRITISH CUSTOMS	LOS ANGELES CO. HMS
CLASSIC MANTELS	LOS ANGELES CO. HMS
A & S EXCHANGE	LOS ANGELES CO. HMS
PACIFIC WOOD PRODUCTS	LOS ANGELES CO. HMS
SERVICE MASTER	LOS ANGELES CO. HMS
BLACKSTOCK WOODWORKS	LOS ANGELES CO. HMS
JOHN TOMMY WOODWORKS	LOS ANGELES CO. HMS
STANDARD FASTENERS MFG.	LOS ANGELES CO. HMS
TOM'S AUTOMOTIVE SERVICE	LOS ANGELES CO. HMS
VALENCIA VOLVO INDEPENDENT	LOS ANGELES CO. HMS
SOLAR DESIGN WINDOW TINTING	LOS ANGELES CO. HMS
SC CUSTOM CYCLES	LOS ANGELES CO. HMS
AJ AUTO DETAIL & ACCESSORIES	LOS ANGELES CO. HMS
CALIFORNIA TINT	LOS ANGELES CO. HMS
SANTA CLARITA VALLEY HUBCAPS	LOS ANGELES CO. HMS
WINDSHIELDS WHOLESALE AUTO GLS	LOS ANGELES CO. HMS

EXECUTIVE SUMMARY

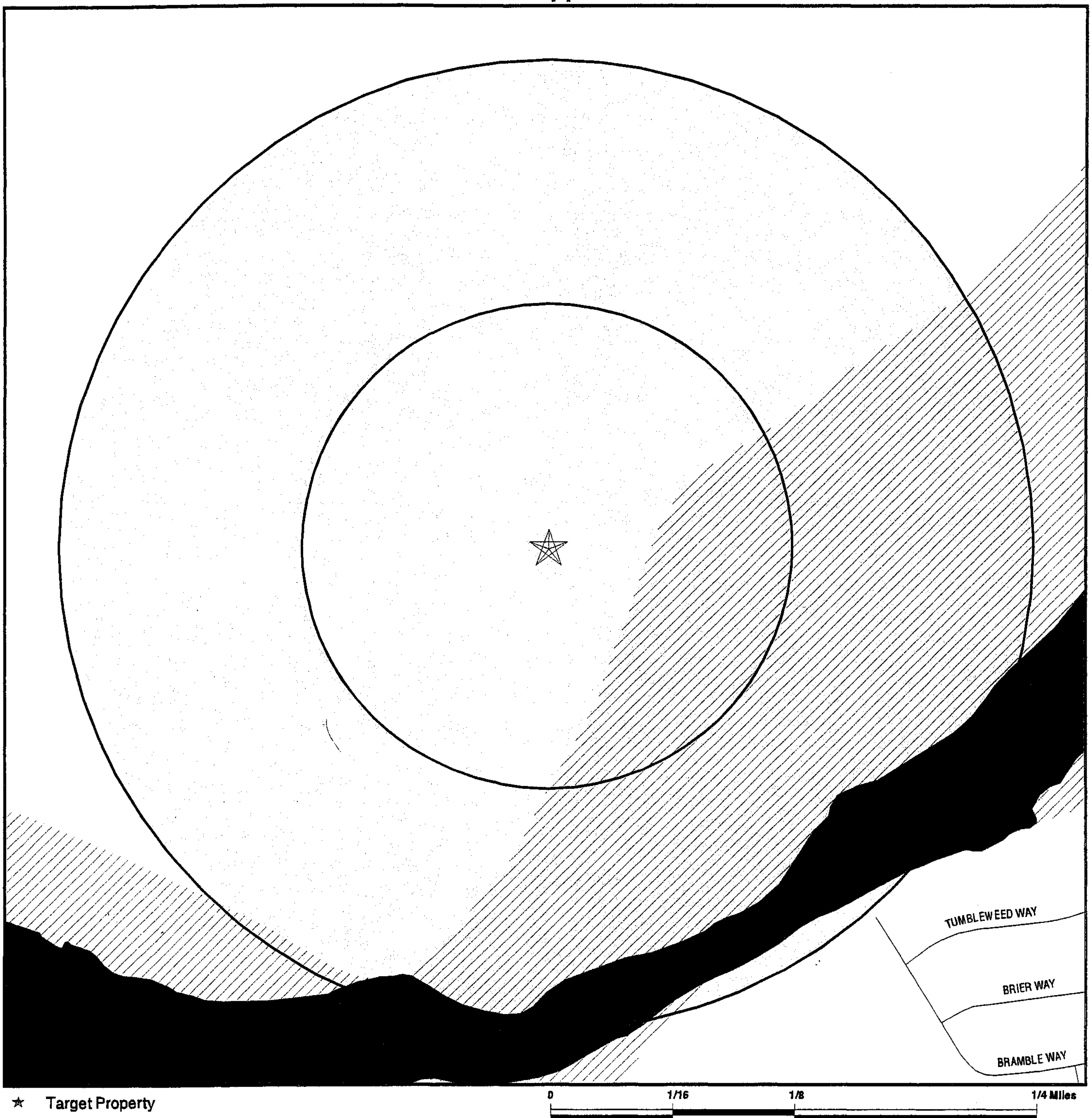
AAMCO TRANSMISSIONS	LOS ANGELES CO. HMS
NICK'S AUTO REPAIR	LOS ANGELES CO. HMS
GASOLINE ALLEY	LOS ANGELES CO. HMS
MANJON AUTO BODY & PAINT	LOS ANGELES CO. HMS
CUSTOM SPECIALTIES	LOS ANGELES CO. HMS
HAVE YOU SEEN MY TRUCK	LOS ANGELES CO. HMS
KWIK RIG INC.	LOS ANGELES CO. HMS
J & S AUTOBODY & PAINT SUPPLY	LOS ANGELES CO. HMS
CANYON MOTORS INC.	LOS ANGELES CO. HMS
AUTOMOTIVE TECHNOLOGY	LOS ANGELES CO. HMS
ACRYLIC CUSTOM CLLSN & BODY	LOS ANGELES CO. HMS
SAUMERS WELDING	LOS ANGELES CO. HMS
SANTA CLARA RIVER BRIDGE CONST	LOS ANGELES CO. HMS
NORTH OAKS SHELL	LOS ANGELES CO. HMS
SHELL OIL CO	LOS ANGELES CO. HMS
CANYON CLEANERS	LOS ANGELES CO. HMS

OVERVIEW MAP - 851417.3s - Applied Environmental Tech.



TARGET PROPERTY:	Riverpark-Valencia	CUSTOMER:	Applied Environmental Tech.
ADDRESS:	664 Acre Bonelli Ranch	CONTACT:	Wally Jensky
CITY/STATE/ZIP:	Santa Clarita CA 91350	INQUIRY #:	851417.3s
LAT/LONG:	34.4212 / 118.5185	DATE:	September 25, 2002 7:07 am

DETAIL MAP - 851417.3s - Applied Environmental Tech.



- Target Property
- Sites at elevations higher than or equal to the target property
- Sites at elevations lower than the target property
- Coal Gasification Sites
- Historical Gas Stations / Historical Dry Cleaners See the EDR Proprietary Historical Map Findings
- Sensitive Receptors
- National Priority List Sites
- Landfill Sites
- Power transmission lines
- Oil & Gas pipelines
- 100-year flood zone
- 500-year flood zone
- Areas of Concern

TARGET PROPERTY:	Riverpark-Valencia	CUSTOMER:	Applied Environmental Tech.
ADDRESS:	664 Acre Bonelli Ranch	CONTACT:	Wally Jensky
CITY/STATE/ZIP:	Santa Clarita CA 91350	INQUIRY #:	851417.3s
LAT/LONG:	34.4212 / 118.5185	DATE:	September 25, 2002 7:09 am

MAP FINDINGS SUMMARY

Database	Target Property	Search Distance (Miles)	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
FEDERAL ASTM STANDARD								
NPL		1.500	0	0	0	0	0	0
Proposed NPL		1.500	0	0	0	0	0	0
CERCLIS		1.500	0	0	0	0	0	0
CERC-NFRAP		1.500	0	0	0	2	2	4
CORRACTS		1.500	0	0	0	2	0	2
RCRIS-TSD		1.500	0	0	0	2	0	2
RCRIS Lg. Quan. Gen.		1.500	0	0	0	1	0	1
RCRIS Sm. Quan. Gen.		1.500	0	0	0	1	45	46
ERNS		1.500	0	0	0	7	5	12
STATE ASTM STANDARD								
AWP		1.500	0	0	0	1	0	1
Cal-Sites		1.500	0	0	0	3	2	5
CHMIRS		1.500	0	0	0	2	7	9
Cortese		1.500	0	0	0	5	10	15
Notify 65		1.500	0	0	0	0	0	0
Toxic Pits		1.500	0	0	0	0	0	0
State Landfill		1.500	0	0	0	0	1	1
WMUDS/SWAT		1.500	0	0	0	0	0	0
LUST		1.500	0	0	0	2	13	15
CA Bond Exp. Plan		1.500	0	0	0	0	0	0
UST		1.500	0	0	0	0	16	16
CA FID UST		1.500	0	0	0	0	7	7
HIST UST		1.500	0	0	0	4	22	26
FEDERAL ASTM SUPPLEMENTAL								
CONSENT		1.500	0	0	0	0	0	0
ROD		1.500	0	0	0	0	0	0
Delisted NPL		1.500	0	0	0	0	0	0
FINDS		1.500	0	0	0	2	46	48
HMIRS		1.500	0	0	0	0	0	0
MLTS		1.500	0	0	0	0	0	0
MINES		1.500	0	0	0	0	0	0
NPL Liens		1.500	0	0	0	0	0	0
PADS		1.500	0	0	0	0	0	0
RAATS		1.500	0	0	0	1	0	1
TRIS		1.500	0	0	0	1	2	3
TSCA		1.500	0	0	0	1	1	2
SSTS		1.500	0	0	0	0	1	1
FTTS		1.500	0	0	0	0	0	0
STATE OR LOCAL ASTM SUPPLEMENTAL								
AST		1.500	0	0	0	0	1	1

MAP FINDINGS SUMMARY

Database	Target Property	Search Distance (Miles)	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
CLEANERS		1.500	0	0	0	0	7	7
CA WDS		1.500	0	0	0	0	2	2
DEED		TP	NR	NR	NR	NR	NR	0
CA SLIC		1.500	0	0	0	1	1	2
HAZNET		1.500	0	0	5	8	99	112
Los Angeles Co. HMS		1.500	0	0	2	18	142	162
LA Co. Site Mitigation		1.500	0	0	0	0	1	1
AOCONCERN		1.000	0	0	0	0	NR	0

EDR PROPRIETARY HISTORICAL DATABASES

Database	Target Property	Search Distance (Miles)	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
Gas Stations/Dry Cleaners		0.250	0	0	NR	NR	NR	0
Coal Gas		1.500	0	0	0	0	0	0

See the EDR Proprietary Historical Database Section for details

TP = Target Property

NR = Not Requested at this Search Distance

* Sites may be listed in more than one database

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number
A1 SSE 1/4-1/2 2517 ft. Higher	**OLIVER WILLIAMS ELEVATOR COMPANY 21700 W GOLDEN TRIANGLE RD SAUGUS, CA 93555** **Site 1 of 4 in cluster A**	**HAZNET**	**S103979971 N/A**

HAZNET:
Gepaid: CAC001505560
Tepaid: CAD099452708
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2293
Category: Oil/water separation sludge
Disposal Method: Transfer Station
Contact: OLIVER WILLIAMS ELEVATOR CO
Telephone: (213) 478-2104
Mailing Address: 3039 ROSWELL ST
LOS ANGELES, CA 90065
County Los Angeles

A2 SSE 1/4-1/2 2517 ft. Higher	**SANTA CLARITA MEDICAL GROUP 21700 W GOLDEN TRIANGLE ROAD SAUGUS, CA 91350** **Site 2 of 4 in cluster A**	**HAZNET**	**S103986696 N/A**

HAZNET:
Gepaid: CAL000127661
Tepaid: CAL000121946
Gen County: Los Angeles
Tsd County: Marin
Tons: .0200
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: JOHN B JUNG
Telephone: (805) 259-9800
Mailing Address: 21700 GOLDEN TRIANGLE RD STE 104
SANTA CLARITA, CA 91350 - 2934
County Los Angeles

A3 SSE 1/4-1/2 2519 ft. Higher	**SANTA CLARITA VALLEY HEALTH CARE MNG GRP 21704 W GOLDEN TRIANGLE SAUGUS, CA 91350** **Site 3 of 4 in cluster A**	**HAZNET**	**S103986699 N/A**

HAZNET:
Gepaid: CAC000881800
Tepaid: CAT080010101
Gen County: Los Angeles
Tsd County: San Diego
Tons: .3044
Category: Oxygenated solvents (acetone, butanol, ethyl acetate, etc.)
Disposal Method: Transfer Station
Contact: SANTA CLARITA VALLEY ETC
Telephone: (000) 000-0000
Mailing Address: 21704 W GOLDEN TRIANGLE
SAUGUS, CA 91350
County Los Angeles

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

A4
SSE
1/4-1/2
2525 ft.
Higher

PUBLIC STORAGE
21648 W GOLDEN TRIANGLE
SAUGUS, CA 91350

HAZNET — **S103982923** / **N/A**

Site 4 of 4 in cluster A

HAZNET:
- Gepaid: CAC001129936
- Tepaid: CAD000088252
- Gen County: Los Angeles
- Tsd County: Los Angeles
- Tons: .3127
- Category: Waste oil and mixed oil
- Disposal Method: Transfer Station
- Contact: PUBLIC STORAGE
- Telephone: (000) 000-0000
- Mailing Address: 21648 W GOLDEN TRIANGLE, SAUGUS, CA 91350
- County: Los Angeles

B5
SE
1/4-1/2
2559 ft.
Higher

SANTA CLARITA AUTO TRCK
21618 GOLDEN TRIANGLE RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS — **S103945077** / **N/A**

Site 1 of 2 in cluster B

HMS:
- Facility Id: 019967-028486
- Facility Type: Not reported
- Permit Number: Not reported — Permit Status: Not reported
- Facility Status: OPEN — Area: 7A
- Region: Los Angeles County:

B6
SE
1/4-1/2
2561 ft.
Higher

PACIFIC COAST ROOFING INC
21616 GOLDEN TRIANGLE RD
SANTA CLARITA, CA 91350

HAZNET — **S104579764** / **N/A**

Site 2 of 2 in cluster B

HAZNET:
- Gepaid: CAL000157138
- Tepaid: CAT000613893
- Gen County: Los Angeles
- Tsd County: Los Angeles
- Tons: 0.0834
- Category: Aqueous solution with less than 10% total organic residues
- Disposal Method: Transfer Station
- Contact: PJ OWENS PRESIDENT
- Telephone: (000) 000-0000
- Mailing Address: 21616 GOLDEN TRIANGLE RD, SANTA CLARITA, CA 91350 - 2618
- County: Los Angeles

C7
SE
1/4-1/2
2620 ft.
Higher

SANTA CLARITA CONCESSIONS, INC
21554 GOLDEN TRIANGLE RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS — **S104733642** / **N/A**

Site 1 of 9 in cluster C

SANTA CLARITA CONCESSIONS, INC (Continued) **S104733642**

HMS:

Facility Id:	006483-I06703		
Facility Type:	I01		
Permit Number:	000006583	Permit Status:	Closed
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

C8
SE
1/2-1
2648 ft.
Higher

GLASS SEAL CORPORATION
21516 GOLDEN TRIANGLE RD
SAUGUS, CA 91351

LUST **Cortese** **S101298092** **N/A**

Site 2 of 9 in cluster C

State LUST:

Cross Street:	HOPE		
Qty Leaked:	Not reported		
Case Number	913510034		
Reg Board:	4		
Chemical:	1		
Lead Agency:	Regional Board		
Local Agency :	19000		
Case Type:	Other ground water affected		
Status:	Not reported		
County:	Los Angeles		
Review Date:	Not reported	Confirm Leak:	Not reported
Workplan:	Not reported	Prelim Assess:	Not reported
Pollution Char:	Not reported	Remed Plan:	Not reported
Remed Action:	Not reported	Monitoring:	Not reported
Close Date:	2/1/95		
Release Date:	Not reported		
Cleanup Fund Id :	Not reported		
Discover Date :	Not reported		
Enforcement Dt :	Not reported		
Enf Type:	Not reported		
Enter Date :	6/14/88		
Funding:	Not reported		
Staff Initials:	Not reported		
How Discovered:	Not reported		
How Stopped:	Not reported		
Interim :	Not reported		
Leak Cause:	Not reported		
Leak Source:	Not reported		
MTBE Date :	Not reported		
Max MTBE GW :	Not reported		
MTBE Tested:	Not Required to be Tested.		
Priority:	Not reported		
Local Case # :	Not reported		
Beneficial:	Not reported		
Staff :	SLC		
GW Qualifies :	Not reported		
Max MTBE Soil :	Not reported		
Soil Qualifies :	Not reported		
Hydr Basin #:	Not reported		
Operator :	Not reported		
Oversight Prgm:	Spills, Leaks, Investigations and Cleanup UST		
Oversight Prgm :	SLIC		
Review Date :	6/14/88		
Stop Date :	Not reported		

GLASS SEAL CORPORATION (Continued) **S101298092**

Work Suspended :Not reported
Responsible PartyBLANK RP
RP Address: Not reported
Global Id: T0603702308
Org Name: Not reported
Contact Person: Not reported
MTBE Conc: 0
Mtbe Fuel: Not reported
Water System Name: VALENCIA WATER CO
Well Name: WELL U-4
Distance To Lust: 2262.92162
Waste Discharge Global ID: Not reported
Waste Disch Assigned Name: Not reported

LUST Region 4:
Report Date: 2/8/1988
Lead Agency: Regional Board
Local Agency: 19000
Case Number: 913510034
Substance: 1
Case Type: Groundwater
Status: Case Closed
Region: 4
Staff: SLC

CORTESE:
Reg Id: 913510034
Region: CORTESE
Reg By: Leaking Underground Storage Tanks

C9 **MFG SANTA CLARITA LP** **HAZNET** **S103642096**
SE **21516 W GOLDEN TRIANGLE RD** **N/A**
1/2-1 **SANTA CLARITA, CA 91350**
2648 ft.
Higher **Site 3 of 9 in cluster C**

HAZNET:
Gepaid: CAC000961264
Tepaid: CAD009007626
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 1.6856
Category: Asbestos-containing waste
Disposal Method: Disposal, Land Fill
Contact: MFG SANTA CLARITA LP
Telephone: (000) 000-0000
Mailing Address: 18140 PARTHENIA ST
NORTHRIDGE, CA 91325
County Los Angeles

C10 **MOUNTASIA OF SANTA CLARITA LP** **LOS ANGELES CO. HMS** **S102064074**
SE **21516 GOLDEN TRIANGLE RD** **N/A**
1/2-1 **SANTA CLARITA, CA**
2648 ft.
Higher **Site 4 of 9 in cluster C**

HMS:
Facility Id: 001936-022613
Facility Type: I01

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number

MOUNTASIA OF SANTA CLARITA LP (Continued) — S102064074

Permit Number: 000284883 — Permit Status: Permit
Facility Status: Permit — Area: 7A
Region: Los Angeles County:

C11
SE
1/2-1
2648 ft.
Higher

MCDONALDS RESTAURANT
21516 GOLDEN TRIANGLE RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS — **S102064073** / **N/A**

Site 5 of 9 in cluster C

HMS:
Facility Id: 001936-022296
Facility Type: I01
Permit Number: 000140578 — Permit Status: Closed
Facility Status: Closed — Area: 7A
Region: Los Angeles County:

C12
SE
1/2-1
2648 ft.
Higher

GLASS SEAL CORPORATION
21516 GOLDEN TRIANGLE RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS — **U003058320** / **N/A**

Site 6 of 9 in cluster C

HMS:
Facility Id: 001936-I02011
Facility Type: I00
Permit Number: 000008008 — Permit Status: Closed
Facility Status: Closed — Area: 7A
Region: Los Angeles County:

C13
SE
1/2-1
2648 ft.
Higher

GLASS SEAL CORP.
21516 GOLDEN TRIANGLE ROAD
SANTA CLARITA, CA 91350

CA SLIC — **1000483606** / **N/A**

Site 7 of 9 in cluster C

SLIC Region 4:
Facility Status: Unassigned
Region: 4
SLIC: 0063
Staff: Manjulika Chakarbarti
Substance: Not reported
Cross Street: Not reported

C14
SE
1/2-1
2648 ft.
Higher

GLASS SEAL CORPORATION
21516 WEST GOLDEN TRIANGLE RD.
SAUGUS, CA 91350

CERC-NFRAP — **1003879618** / **CAD983610148**

Site 8 of 9 in cluster C

CERCLIS-NFRAP Classification Data:
Site Incident Category: Not reported — Federal Facility: Not a Federal Facility
Non NPL Code: NFRAP
Ownership Status: Private — NPL Status: Not on the NPL
CERCLIS-NFRAP Assessment History:
Assessment: DISCOVERY — Completed: 10/25/1991

Map ID / Direction / Distance / Distance (ft.) / Elevation | Site | Database(s) | EDR ID Number / EPA ID Number

GLASS SEAL CORPORATION (Continued) **1003879618**

Assessment:	PRELIMINARY ASSESSMENT	Completed:	10/22/1992
Assessment:	SITE INSPECTION	Completed:	06/18/1993
Assessment:	EXPANDED SITE INSPECTION	Completed:	04/08/1996
Assessment:	ARCHIVE SITE	Completed:	02/07/1997

D15
SE
1/2-1
2741 ft.
Higher

AMERICAN CYANAMID, ENGINEERED
21444 GOLDEN TRIANGLE RD
SAUGUS, CA 91350

HIST UST **U001567686**
N/A

Site 1 of 12 in cluster D

UST HIST:

Facility ID:	6429		
Tank Num:	1	Container Num:	ACS-0001
Tank Capacity:	500	Year Installed:	Not reported
Tank Used for:	WASTE		
Type of Fuel:	Not Reported	Tank Construction:	Not reported
Leak Detection:			
Contact Name:	STUART C. BLAIR	Telephone:	(805) 259-1415
Total Tanks:	3	Region:	STATE
Facility Type:	2	Other Type:	MANUFACTURING

Facility ID:	6429		
Tank Num:	2	Container Num:	ACS-0002
Tank Capacity:	5000	Year Installed:	1970
Tank Used for:	PRODUCT		
Type of Fuel:	Not Reported	Tank Construction:	1/4IN inches
Leak Detection:	Stock Inventor, Pressure Test		
Contact Name:	STUART C. BLAIR	Telephone:	(805) 259-1415
Total Tanks:	3	Region:	STATE
Facility Type:	2	Other Type:	MANUFACTURING

Facility ID:	6429		
Tank Num:	3	Container Num:	ACS-0003
Tank Capacity:	8000	Year Installed:	1970
Tank Used for:	PRODUCT		
Type of Fuel:	Not Reported	Tank Construction:	1/4 INC unknown
Leak Detection:	Stock Inventor, Pressure Test		
Contact Name:	STUART C. BLAIR	Telephone:	(805) 259-1415
Total Tanks:	3	Region:	STATE
Facility Type:	2	Other Type:	MANUFACTURING

D16
SE
1/2-1
2741 ft.
Higher

CYTEC INDUSTRIES
21444 W GOLDEN TRIANGLE RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S102064071**
N/A

Site 2 of 12 in cluster D

HMS:

Facility Id:	001972-021306		
Facility Type:	T0		
Permit Number:	000077740	Permit Status:	Removed
Facility Status:	Removed	Area:	7A
Region:	Los Angeles County:		

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number
D17 SE 1/2-1 2741 ft. Higher	**21444 GOLDEN TRIANGLE RD** **21444 GOLDEN TRIANGLE RD** **SAUGUS, CA 91350** **Site 3 of 12 in cluster D**	ERNS	91467142 N/A
D18 SE 1/2-1 2741 ft. Higher	**21444 GOLDEN TRIANGLE** **21444 GOLDEN TRIANGLE** **SAUGUS, CA 91350** **Site 4 of 12 in cluster D**	ERNS	92263926 N/A
D19 SE 1/2-1 2741 ft. Higher	**E. I. DU PONT DE NEMOURS & CO** **21444 GOLDEN TRIANGLE ROAD** **SAUGUS, CA 91350** **Site 5 of 12 in cluster D**	TSCA	1000245205 N/A
D20 SE 1/2-1 2741 ft. Higher	**21444 GOLDEN TRIANGLE** **21444 GOLDEN TRIANGLE** **SAUGUS, CA 91350** **Site 6 of 12 in cluster D**	ERNS	92263925 N/A
D21 SE 1/2-1 2741 ft. Higher	**21444 GOLDEN TRIANGLE RD** **21444 GOLDEN TRIANGLE RD** **SAUGUS, CA** **Site 7 of 12 in cluster D**	ERNS	91233147 N/A
D22 SE 1/2-1 2741 ft. Higher	**AMERICAN CYANAMID CO** **21444 W GOLDEN TRIANGLE RD** **SANTA CLARITA, CA** **Site 8 of 12 in cluster D**	LOS ANGELES CO. HMS	S104537092 N/A

HMS:

Facility Id:	001972-I02049		
Facility Type:	I09		
Permit Number:	000009478	Permit Status:	Removed
Facility Status:	Removed	Area:	7A
Region:	Los Angeles County:		
Facility Id:	001972-002049		
Facility Type:	T0		
Permit Number:	00000270T	Permit Status:	Closed
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number
D23 SE 1/2-1 2741 ft. Higher	**21444 GOLDEN TRIANGLE RD** **21444 GOLDEN TRIANGLE RD** **SAUGUS, CA 91350** **Site 9 of 12 in cluster D**	ERNS	91234870 N/A

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number
D24 **SE** **1/2-1** **2741 ft.** **Higher**	**21444 GOLDEN TRIANGLE RD** **21444 GOLDEN TRIANGLE RD** **SAUGUS, CA 91350** **Site 10 of 12 in cluster D**	**ERNS**	**92261459** **N/A**
D25 **SE** **1/2-1** **2741 ft.** **Higher**	**AMERICAN CYANAMID** **21444 GOLDEN TRIANGLE RD** **SAUGUS, CA 91350** **Site 11 of 12 in cluster D**	**RCRIS-LQG** **RCRIS-TSD** **FINDS** **TRIS** **CORRACTS** **CERC-NFRAP** **HAZNET** **Cortese**	**1000360638** **91311MRCNN20**

CERCLIS-NFRAP Classification Data:
Site Incident Category: Not reported — Federal Facility: Not a Federal Facility
Non NPL Code: DR
Ownership Status: Private — NPL Status: Not on the NPL

CERCLIS-NFRAP Assessment History:

Assessment:	DISCOVERY	Completed:	04/01/1991
Assessment:	PRELIMINARY ASSESSMENT	Completed:	09/24/1991
Assessment:	ARCHIVE SITE	Completed:	01/23/1996

CORRACTS Data:

EPA Id: CAT080010929
Region: 9
State: CA
Area Name: ENTIRE FACILITY
Original Scheduled Date: Not reported
New Scheduled Date: Not reported
Actual Date: 09/15/1991
Corrective Action: CA075LO - CA Prioritization, Facility or area was assigned a low corrective action priority

RCRIS Corrective Action Summary:
Event: CA Prioritization, Facility or area was assigned a low corrective action priority.
Event Date: 09/15/1991

RCRIS:
Owner: AMERICAN CYANAMID COMPANY
(201) 831-2000
EPA ID: CAT080010929

Contact: JEAN TOBIN
(805) 259-1415

Rank Status: 3
Rank Date: 08/27/1992
Classification: Large Quantity Generator, TSDF
Used Oil Recyc: No
TSDF Activities: Not reported

AMERICAN CYANAMID (Continued) **1000360638**

Violation Status: Violations exist

Regulation Violated: Not reported
Area of Violation: TSD-FINANCIAL RESPONSIBILITY REQUIREMENTS
Date Violation Determined: 04/29/1994
Actual Date Achieved Compliance: 06/08/1994

Enforcement Action: WRITTEN INFORMAL
Enforcement Action Date: 03/08/1994
Penalty Type: Not reported

Regulation Violated: Not reported
Area of Violation: GENERATOR-GENERAL REQUIREMENTS
Date Violation Determined: 04/29/1994
Actual Date Achieved Compliance: 06/08/1994

Enforcement Action: WRITTEN INFORMAL
Enforcement Action Date: 03/08/1994
Penalty Type: Not reported

Regulation Violated: Not reported
Area of Violation: TSD-GENERAL STANDARDS
Date Violation Determined: 04/29/1994
Actual Date Achieved Compliance: 06/08/1994

Enforcement Action: WRITTEN INFORMAL
Enforcement Action Date: 03/08/1994
Penalty Type: Not reported

Regulation Violated: Not reported
Area of Violation: TSD-CONTINGENCY PLAN REQUREMENTS
Date Violation Determined: 04/29/1994
Actual Date Achieved Compliance: 06/08/1994

Enforcement Action: WRITTEN INFORMAL
Enforcement Action Date: 03/08/1994
Penalty Type: Not reported

Regulation Violated: Not reported
Area of Violation: TSD-LAND BAN REQUIREMENTS
Date Violation Determined: 05/23/1990
Actual Date Achieved Compliance: 06/08/1990

Enforcement Action: WRITTEN INFORMAL
Enforcement Action Date: 06/08/1990
Penalty Type: Not reported

Regulation Violated: Not reported
Area of Violation: GENERATOR-LAND BAN REQUIREMENTS
Date Violation Determined: 05/23/1990
Actual Date Achieved Compliance: 06/08/1990

Enforcement Action: WRITTEN INFORMAL
Enforcement Action Date: 06/08/1990
Penalty Type: Not reported

Regulation Violated: Not reported
Area of Violation: TSD-OTHER REQUIREMENTS
Date Violation Determined: 05/23/1990
Actual Date Achieved Compliance: 06/08/1990

Enforcement Action: WRITTEN INFORMAL
Enforcement Action Date: 06/08/1990
Penalty Type: Not reported

AMERICAN CYANAMID (Continued) **1000360638**

Regulation Violated: Not reported
Area of Violation: TSD-MANIFEST REQUIREMENTS
Date Violation Determined: 05/23/1990
Actual Date Achieved Compliance: 06/08/1990

Enforcement Action: WRITTEN INFORMAL
Enforcement Action Date: 06/08/1990
Penalty Type: Not reported

Regulation Violated: Not reported
Area of Violation: TSD-LAND BAN REQUIREMENTS
Date Violation Determined: 07/20/1988
Actual Date Achieved Compliance: 06/08/1990

Regulation Violated: Not reported
Area of Violation: GENERATOR-LAND BAN REQUIREMENTS
Date Violation Determined: 07/20/1988
Actual Date Achieved Compliance: 06/08/1990

Regulation Violated: Not reported
Area of Violation: TSD-OTHER REQUIREMENTS
Date Violation Determined: 07/20/1988
Actual Date Achieved Compliance: 12/06/1988

Enforcement Action: WRITTEN INFORMAL
Enforcement Action Date: 08/09/1988
Penalty Type: Not reported

Regulation Violated: Not reported
Area of Violation: TSD-FINANCIAL RESPONSIBILITY REQUIREMENTS
Date Violation Determined: 07/14/1988
Actual Date Achieved Compliance: 11/02/1988

Enforcement Action: WRITTEN INFORMAL
Enforcement Action Date: 08/22/1988
Penalty Type: Not reported

There are 12 violation record(s) reported at this site:

Evaluation	Area of Violation	Date of Compliance
Compliance Evaluation Inspection	TSD-FINANCIAL RESPONSIBILITY REQUIREMENTS	19940608
	GENERATOR-GENERAL REQUIREMENTS	19940608
	TSD-GENERAL STANDARDS	19940608
	TSD-CONTINGENCY PLAN REQUREMENTS	19940608
Compliance Evaluation Inspection	TSD-LAND BAN REQUIREMENTS	19900608
	GENERATOR-LAND BAN REQUIREMENTS	19900608
	TSD-OTHER REQUIREMENTS	19900608
	TSD-MANIFEST REQUIREMENTS	19900608
Compliance Evaluation Inspection	TSD-OTHER REQUIREMENTS	19881206
Other Evaluation	TSD-LAND BAN REQUIREMENTS	19900608
	GENERATOR-LAND BAN REQUIREMENTS	19900608
Financial Record Review	TSD-FINANCIAL RESPONSIBILITY REQUIREMENTS	19881102

AMERICAN CYANAMID (Continued) **1000360638**

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)
Toxic Chemical Release Inventory System (TRIS)

HAZNET:
Gepaid: CAT080010929
Tepaid: CAD008302903
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .1876
Category: Unspecified organic liquid mixture
Disposal Method: Not reported
Contact: AMERICAN CYANAMID COMPANY
Telephone: (000) 000-0000
Mailing Address: 21444 GOLDEN TRIANGLE RD
SAUGUS, CA 91350
County Los Angeles

Gepaid: CAT080010929
Tepaid: CAD008302903
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 1.1467
Category: Oxygenated solvents (acetone, butanol, ethyl acetate, etc.)
Disposal Method: Recycler
Contact: AMERICAN CYANAMID COMPANY
Telephone: (000) 000-0000
Mailing Address: 21444 GOLDEN TRIANGLE RD
SAUGUS, CA 91350
County Los Angeles

Gepaid: CAT080010929
Tepaid: CAL000027741
Gen County: Los Angeles
Tsd County: 5
Tons: 8.4280
Category: Asbestos-containing waste
Disposal Method: Disposal, Land Fill
Contact: AMERICAN CYANAMID COMPANY
Telephone: (000) 000-0000
Mailing Address: 21444 GOLDEN TRIANGLE RD
SAUGUS, CA 91350
County Los Angeles

Gepaid: CAT080010929
Tepaid: CAD982484933
Gen County: Los Angeles
Tsd County: 7
Tons: 7.0000
Category: Other empty containers 30 gallons or more
Disposal Method: Recycler
Contact: AMERICAN CYANAMID COMPANY
Telephone: (000) 000-0000
Mailing Address: 21444 GOLDEN TRIANGLE RD
SAUGUS, CA 91350
County Los Angeles

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number

AMERICAN CYANAMID (Continued) **1000360638**

Gepaid: CAT080010929
Tepaid: CAT000646117
Gen County: Los Angeles
Tsd County: Kings
Tons: 2.2517
Category: Unspecified aqueous solution
Disposal Method: Not reported
Contact: AMERICAN CYANAMID COMPANY
Telephone: (000) 000-0000
Mailing Address: 21444 GOLDEN TRIANGLE RD
SAUGUS, CA 91350
County Los Angeles

The CA HAZNET database contains 11 additional records for this site.
Please contact your EDR Account Executive for more information.

CORTESE:
Reg Id: 3134
Region: CORTESE
Reg By: Leaking Underground Storage Tanks

D26 **LAKESIDE BOAT SERVICE** **HAZNET** **S105093538**
SE **21452 GOLDEN TRIANGLE RD** **N/A**
1/2-1 **SANTA CLARITA, CA 91350**
2742 ft.
Higher **Site 12 of 12 in cluster D**

HAZNET:
Gepaid: CAL000221254
Tepaid: CAD099452708
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2293
Category: Waste oil and mixed oil
Disposal Method: Recycler
Contact: AMIR IBRAHIM
Telephone: (661) 254-0644
Mailing Address: 21452 GOLDEN TRIANGLE RD
SANTA CLARITA, CA 91350
County Los Angeles

Gepaid: CAL000221254
Tepaid: CAD008302903
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2293
Category: Unspecified solvent mixture Waste
Disposal Method: Not reported
Contact: AMIR IBRAHIM
Telephone: (661) 254-0644
Mailing Address: 21452 GOLDEN TRIANGLE RD
SANTA CLARITA, CA 91350
County Los Angeles

E27 **WHITTAKER BERMITE/RAIL STATION - SITE A** **Cal-Sites** **S101480673**
SW **22116 WEST SOLEDAD CANYON ROAD** **N/A**
1/2-1 **SANTA CLARITA, CA 91350**
2778 ft.
Lower **Site 1 of 8 in cluster E**

WHITTAKER BERMITE/RAIL STATION - SITE A (Continued) **S101480673**

CAL-SITES:

Facility ID	19281203	
Status:	NFA - NO FURTHER ACTION FOR DTSC	
Status Date:	10/25/1994	
Lead:	DTSC	
Region:	3 - BURBANK	
Branch:	SA - SOUTHERN CA. - A	
File Name:	Not reported	
Status Name:	NO FURTHER ACTION FOR DTSC	
Lead Agency:	DEPT OF TOXIC SUBSTANCES CONTROL	Not reported
NPL:	Not Listed	
SIC:	28 MANU - CHEMICALS & ALLIED PRODUCTS	
Facility Type:	RESPONSIBLE PARTY	
Type Name:	RP	
Staff Member Responsible for Site:	TCOTA	
Supervisor Responsible for Site:	SAMIREBR	
Region Water Control Board:	LA - LOS ANGELES	
Access:	Not reported	
Cortese:	Not reported	
Hazardous Ranking Score:	Not reported	
Date Site Hazard Ranked:	Not reported	
Groundwater Contamination:	Not reported	
No. of Contamination Sources:	0	
Lat/Long:	0° 0′ 0.00″ / 0° 0′ 0.00″	
Lat/long Method:	Not reported	
State Assembly District Code:	36	
State Senate District:	17	

The CAL-SITES database may contain additional details for this site.
Please contact your EDR Account Executive for more information.

E28 **SW** **1/2-1** **2778 ft.** **Lower**	**WHITTAKER/BERMITE FACILITY** **22116 WEST SOLEDAD CANYON ROAD** **SAUGUS, CA 91350** **Site 2 of 8 in cluster E**	**Cal-Sites** **AWP**	**S101272742** **N/A**

CAL-SITES:

Facility ID	19281087	
Status:	AWP - ANNUAL WORKPLAN (AWP) - ACTIVE SITE	
Status Date:	04/14/1995	
Lead:	DTSC	
Region:	3 - BURBANK	
Branch:	SA - SOUTHERN CA. - A	
File Name:	Not reported	
Status Name:	ANNUAL WORKPLAN - ACTIVE SITE	
Lead Agency:	DEPT OF TOXIC SUBSTANCES CONTROL	Not reported
NPL:	Not Listed	
SIC:	28 MANU - CHEMICALS & ALLIED PRODUCTS	
Facility Type:	RESPONSIBLE PARTY	
Type Name:	RP	
Staff Member Responsible for Site:	NCARDER	
Supervisor Responsible for Site:	SAMIREBR	
Region Water Control Board:	LA - LOS ANGELES	
Access:	Not reported	
Cortese:	Not reported	
Hazardous Ranking Score:	Not reported	
Date Site Hazard Ranked:	Not reported	

WHITTAKER/BERMITE FACILITY (Continued) **S101272742**

Groundwater Contamination: Not reported
No. of Contamination Sources: 0
Lat/Long: 0° 0′ 0.00″ / 0° 0′ 0.00″
Lat/long Method: Not reported
State Assembly District Code: 36
State Senate District: 17

The CAL-SITES database may contain additional details for this site.
Please contact your EDR Account Executive for more information.

AWP Facility ID: 19281087
Facility Type: AWP

E29
SW
1/2-1
2778 ft.
Lower

BERMITE, DIVISION OF WHIT
22116 SOLEDAD CNYN
SAUGUS, CA 91350

Site 3 of 8 in cluster E

Database(s): **Cortese** — EDR ID: **S105026557** — EPA ID: **N/A**

CORTESE:
Reg Id: R-00975
Region: CORTESE
Reg By: Leaking Underground Storage Tanks

E30
SW
1/2-1
2778 ft.
Lower

WHITTAKER BERMITE/RAIL ST
22116 SOLEDAD CNYN
SAUGUS, CA 91350

Site 4 of 8 in cluster E

Database(s): **Cortese** — EDR ID: **S105026559** — EPA ID: **N/A**

CORTESE:
Reg Id: 19281203
Region: CORTESE
Reg By: CALSI

E31
SW
1/2-1
2778 ft.
Lower

BERMITE DIV-WHITTAKER
22116 SOLEDAD CANYON RD
SANTA CLARITA, CA

Site 5 of 8 in cluster E

Database(s): **LOS ANGELES CO. HMS** — EDR ID: **S105032927** — EPA ID: **N/A**

HMS:
Facility Id: 000930-I00975
Facility Type: I09
Permit Number: 000008494 — Permit Status: Closed
Facility Status: Permit — Area: 7A
Region: Los Angeles County:

Facility Id: 000930-000975
Facility Type: T0
Permit Number: 00001581T — Permit Status: Removed
Facility Status: Removed — Area: 7A
Region: Los Angeles County:

Facility Id: 000930-028916
Facility Type: Not reported
Permit Number: Not reported — Permit Status: Not reported
Facility Status: OPEN — Area: 7A

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number

BERMITE DIV-WHITTAKER (Continued) — S105032927

Region: Los Angeles County:

E32 / SW / 1/2-1 / 2778 ft. / Lower

WHITTAKER/BERMITE FACILIT
22116 SOLEDAD CNYN
SAUGUS, CA 91350

Database(s): **Cortese** — **S105026558** / **N/A**

Site 6 of 8 in cluster E

CORTESE:
Reg Id: 19281087
Region: CORTESE
Reg By: CALSI

E33 / SW / 1/2-1 / 2778 ft. / Lower

BERMITE DIVISION OF WHITTAKER
22116 SOLEDAD CANYON RD
SAUGUS, CA 91350

Database(s): **HIST UST** — **U001567688** / **N/A**

Site 7 of 8 in cluster E

UST HIST:

Facility ID:	6423		
Tank Num:	1	Container Num:	004
Tank Capacity:	1000	Year Installed:	1982
Tank Used for:	WASTE		
Type of Fuel:	Not Reported	Tank Construction:	6" inches
Leak Detection:	Visual, None		
Contact Name:	Not reported	Telephone:	(805) 259-2241
Total Tanks:	4	Region:	STATE
Facility Type:	2	Other Type:	MFG.

Facility ID:	6423		
Tank Num:	2	Container Num:	001
Tank Capacity:	2000	Year Installed:	Not reported
Tank Used for:	PRODUCT		
Type of Fuel:	REGULAR	Tank Construction:	Not reported
Leak Detection:	Stock Inventor, None		
Contact Name:	Not reported	Telephone:	(805) 259-2241
Total Tanks:	4	Region:	STATE
Facility Type:	2	Other Type:	MFG.

Facility ID:	6423		
Tank Num:	3	Container Num:	003
Tank Capacity:	1000	Year Installed:	Not reported
Tank Used for:	PRODUCT		
Type of Fuel:	DIESEL	Tank Construction:	Not reported
Leak Detection:	Stock Inventor, None		
Contact Name:	Not reported	Telephone:	(805) 259-2241
Total Tanks:	4	Region:	STATE
Facility Type:	2	Other Type:	MFG.

Facility ID:	6423		
Tank Num:	4	Container Num:	002
Tank Capacity:	2000	Year Installed:	1975
Tank Used for:	PRODUCT		
Type of Fuel:	UNLEADED	Tank Construction:	Not reported
Leak Detection:	Stock Inventor, None		
Contact Name:	Not reported	Telephone:	(805) 259-2241
Total Tanks:	4	Region:	STATE

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

BERMITE DIVISION OF WHITTAKER (Continued) **U001567688**

Facility Type: 2 Other Type: MFG.

E34 **SW** **1/2-1** **2778 ft.** **Lower**	**BERMITE DIVISION** **22116 WEST SOLEDAD CANYON ROAD** **SAUGUS, CA 91350** **Site 8 of 8 in cluster E**	**RCRIS-SQG** **RCRIS-TSD** **FINDS** **RAATS** **CORRACTS** **LUST**	**1000421644** **CAD064573108**

CORRACTS Data:

EPA Id: CAD064573108
Region: 9
State: CA
Area Name: ENTIRE FACILITY
Original Scheduled Date: Not reported
New Scheduled Date: Not reported
Actual Date: 08/06/1992
Corrective Action: CA075ME - CA Prioritization, Facility or area was assigned a medium corrective action priority

EPA Id: CAD064573108
Region: 9
State: CA
Area Name: ENTIRE FACILITY
Original Scheduled Date: Not reported
New Scheduled Date: Not reported
Actual Date: 06/09/1998
Corrective Action: CA075HI - CA Prioritization, Facility or areawas assigned a high corrective action priority

EPA Id: CAD064573108
Region: 9
State: CA
Area Name: ENTIRE FACILITY
Original Scheduled Date: Not reported
New Scheduled Date: Not reported
Actual Date: 11/21/1994
Corrective Action: CA100 - RFI Imposition

EPA Id: CAD064573108
Region: 9
State: CA
Area Name: AREA 34
Original Scheduled Date: Not reported
New Scheduled Date: Not reported
Actual Date: 11/21/1994
Corrective Action: CA600SR - Stabilization Measures Implemented , Primary measure is source removal and/or treatment

EPA Id: CAD064573108
Region: 9
State: CA
Area Name: AREA 34
Original Scheduled Date: Not reported
New Scheduled Date: Not reported
Actual Date: 06/01/1996
Corrective Action: CA650 - Stabilization Construction Completed

BERMITE DIVISION (Continued) **1000421644**

The CORRACTS database contains 2 additional records for this site.
Please contact your EDR Account Executive for more information.

RCRIS Corrective Action Summary:

Event: CA Prioritization, Facility or area was assigned a high corrective action priority.
Event Date: 06/09/1998

Event: Current Human Exposures under Control, Current human exposures are NOT under control.
Event Date: 06/09/1998

Event: Igration of Contaminated Groundwater under Control, Unacceptable migration of contaminated groundwater is observed or expected.
Event Date: 06/09/1998

Event: Stabilization Construction Completed
Event Date: 06/01/1996

Event: RFI Imposition
Event Date: 11/21/1994

Event: Stabilization Measures Implemented, Primary measure is source removal and/or treatment (e.g., soil or waste excavation, in-situ soil treatment, off-site treatment).
Event Date: 11/21/1994

Event: Stabilization Measures Evaluation,This facility is not amenable to stabilization activity because of a lack of technical data. An evaluation has been completed, but further data is necessary to determine stabilization measures, feasibility or appropriateness. This status should be changed when data becomes available.
Event Date: 03/08/1993

Event: CA Prioritization, Facility or area was assigned a medium corrective action priority.
Event Date: 08/06/1992

RCRIS:

Owner: SANTA CLARITA L LC
(602) 238-9007
EPA ID: CAD064573108

Contact: ALAN BERG
(602) 238-9007

Rank Status: 1
Rank Date: 08/27/1992
Classification: Handler transports wastes, but commercial status is unknown, TSDF
Used Oil Recyc: No
TSDF Activities: Not reported

Violation Status: Violations exist

Regulation Violated: 264.90-94.F
Area of Violation: TSD-GOUNDWATER MONITORING REQUIREMENTS
Date Violation Determined: 03/26/2001
Actual Date Achieved Compliance: Not reported

Enforcement Action: WRITTEN INFORMAL
Enforcement Action Date: 03/28/2001
Penalty Type: Not reported

Regulation Violated: 264.140-150.H

BERMITE DIVISION (Continued) **1000421644**

Area of Violation:	TSD-FINANCIAL RESPONSIBILITY REQUIREMENTS
Date Violation Determined:	11/21/1991
Actual Date Achieved Compliance:	11/21/1996
Regulation Violated:	270
Area of Violation:	TSD-OTHER REQUIREMENTS (OVERSIGHT)
Date Violation Determined:	04/26/1991
Actual Date Achieved Compliance:	Not reported
Enforcement Action:	WRITTEN INFORMAL
Enforcement Action Date:	06/28/1991
Penalty Type:	Not reported
Regulation Violated:	264.90-94.F
Area of Violation:	TSD-GOUNDWATER MONITORING REQUIREMENTS
Date Violation Determined:	06/25/1990
Actual Date Achieved Compliance:	Not reported
Enforcement Action:	WRITTEN INFORMAL
Enforcement Action Date:	07/30/1990
Penalty Type:	Not reported
Enforcement Action:	FINAL 3008(A) COMPLIANCE ORDER
Enforcement Action Date:	01/16/1991
Penalty Type:	Not reported
Regulation Violated:	270
Area of Violation:	TSD-OTHER REQUIREMENTS (OVERSIGHT)
Date Violation Determined:	04/27/1989
Actual Date Achieved Compliance:	Not reported
Enforcement Action:	WRITTEN INFORMAL
Enforcement Action Date:	06/08/1989
Penalty Type:	Not reported
Regulation Violated:	264.140-150.H
Area of Violation:	TSD-FINANCIAL RESPONSIBILITY REQUIREMENTS
Date Violation Determined:	06/07/1988
Actual Date Achieved Compliance:	05/02/1989
Enforcement Action:	WRITTEN INFORMAL
Enforcement Action Date:	11/28/1988
Penalty Type:	Not reported
Regulation Violated:	264.90-94.F
Area of Violation:	TSD-GOUNDWATER MONITORING REQUIREMENTS
Date Violation Determined:	06/25/1985
Actual Date Achieved Compliance:	12/31/1989
Enforcement Action:	INITIAL 3008(A) COMPLIANCE ORDER
Enforcement Action Date:	06/03/1986
Penalty Type:	Proposed Monetary Penalty
Enforcement Action:	INITIAL 3008(A) COMPLIANCE ORDER
Enforcement Action Date:	06/04/1986
Penalty Type:	Proposed Monetary Penalty
Regulation Violated:	264.140-150.H
Area of Violation:	TSD-FINANCIAL RESPONSIBILITY REQUIREMENTS
Date Violation Determined:	06/25/1985
Actual Date Achieved Compliance:	07/02/1986
Enforcement Action:	INITIAL 3008(A) COMPLIANCE ORDER
Enforcement Action Date:	06/03/1986

BERMITE DIVISION (Continued) 1000421644

Penalty Type:	Proposed Monetary Penalty
Enforcement Action:	INITIAL 3008(A) COMPLIANCE ORDER
Enforcement Action Date:	06/04/1986
Penalty Type:	Proposed Monetary Penalty
Regulation Violated:	264.110-120.G
Area of Violation:	TSD-CLOSURE/POST-CLOSURE REQUIREMENTS
Date Violation Determined:	06/25/1985
Actual Date Achieved Compliance:	08/16/1986
Enforcement Action:	INITIAL 3008(A) COMPLIANCE ORDER
Enforcement Action Date:	06/03/1986
Penalty Type:	Proposed Monetary Penalty
Enforcement Action:	INITIAL 3008(A) COMPLIANCE ORDER
Enforcement Action Date:	06/04/1986
Penalty Type:	Proposed Monetary Penalty
Enforcement Action:	FINAL 3008(A) COMPLIANCE ORDER
Enforcement Action Date:	08/26/1986
Penalty Type:	Proposed Monetary Penalty
Regulation Violated:	264.110-120.G
Area of Violation:	TSD-CLOSURE/POST-CLOSURE REQUIREMENTS
Date Violation Determined:	06/25/1985
Actual Date Achieved Compliance:	08/16/1986
Enforcement Action:	INITIAL 3008(A) COMPLIANCE ORDER
Enforcement Action Date:	06/03/1986
Penalty Type:	Proposed Monetary Penalty
Enforcement Action:	INITIAL 3008(A) COMPLIANCE ORDER
Enforcement Action Date:	06/04/1986
Penalty Type:	Proposed Monetary Penalty
Enforcement Action:	FINAL 3008(A) COMPLIANCE ORDER
Enforcement Action Date:	08/26/1986
Penalty Type:	Proposed Monetary Penalty

There are 10 violation record(s) reported at this site:

Evaluation	Area of Violation	Date of Compliance
Compliance GW Monitoring Evaluation	TSD-GOUNDWATER MONITORING REQUIREMENTS	.
Financial Record Review	TSD-FINANCIAL RESPONSIBILITY REQUIREMENTS	19961121
Compliance Evaluation Inspection	TSD-OTHER REQUIREMENTS (OVERSIGHT)	
Compliance GW Monitoring Evaluation	TSD-GOUNDWATER MONITORING REQUIREMENTS	
Compliance Evaluation Inspection	TSD-OTHER REQUIREMENTS (OVERSIGHT)	
Financial Record Review	TSD-FINANCIAL RESPONSIBILITY REQUIREMENTS	19890502
Compliance Evaluation Inspection	TSD-GOUNDWATER MONITORING REQUIREMENTS	19891231
	TSD-CLOSURE/POST-CLOSURE REQUIREMENTS	19860816
Financial Record Review	TSD-FINANCIAL RESPONSIBILITY REQUIREMENTS	19860702
	TSD-CLOSURE/POST-CLOSURE REQUIREMENTS	19860816

NY MANIFEST
Additional detail is available in NY MANIFEST. Please contact your EDR Account Executive for more information.

BERMITE DIVISION (Continued) **1000421644**

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

State LUST:
Cross Street: SIERRA HWY
Qty Leaked: Not reported
Case Number R-00975
Reg Board: 4
Chemical: Diesel
Lead Agency: Local Agency
Local Agency : 19000
Case Type: Soil only
Status: Not reported
County: Los Angeles
Review Date: 1/2/86 Confirm Leak: 1/2/86
Workplan: Not reported Prelim Assess: Not reported
Pollution Char: Not reported Remed Plan: Not reported
Remed Action: Not reported Monitoring: Not reported
Close Date: Not reported
Release Date: Not reported
Cleanup Fund Id : Not reported
Discover Date : 1/2/86
Enforcement Dt : Not reported
Enf Type: Not reported
Enter Date : 12/31/86
Funding: Not reported
Staff Initials: Not reported
How Discovered: Tank Closure
How Stopped: Close Tank
Interim : Not reported
Leak Cause: Corrosion
Leak Source: Tank
MTBE Date : Not reported
Max MTBE GW : Not reported
MTBE Tested: Not Required to be Tested.
Priority: Not reported
Local Case # : Not reported
Beneficial: Not reported
Staff : JLC
GW Qualifies : Not reported
Max MTBE Soil : Not reported
Soil Qualifies : Not reported
Hydr Basin #: Not reported
Operator : Not reported
Oversight Prgm: Local Implementing Agency UST (includes non-LOP cases within LOP jurisdiction)
Oversight Prgm : LIA
Review Date : 8/25/87
Stop Date : 1/2/86
Work Suspended :Not reported
Responsible PartyBERMITE, DIVISION OF WHITTIKER
RP Address: 22116 SOLEDAD CANYON, SAUGUS, CA 91350
Global Id: T0603704547
Org Name: Not reported
Contact Person: Not reported

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

BERMITE DIVISION (Continued) **1000421644**

MTBE Conc: 0
Mtbe Fuel: Not reported
Water System Name: VALENCIA WATER CO
Well Name: T-2
Distance To Lust: 1222.732762
Waste Discharge Global ID: Not reported
Waste Disch Assigned Name: Not reported

LUST Region 4:
Report Date: 1/2/1986
Lead Agency: Local Agency
Local Agency: 19000
Case Number: R-00975
Substance: Diesel
Case Type: Soil
Status: Leak being confirmed
Region: 4
Staff: Not reported

F35
ESE
1/2-1
2802 ft.
Higher

FOSTERS FREEZE
21525 W SOLEDAD CANYON RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S105422130** **N/A**

Site 1 of 4 in cluster F

HMS:
Facility Id: 008239-022268
Facility Type: I02
Permit Number: 000220926 Permit Status: Permit
Facility Status: Permit Area: 7A
Region: Los Angeles County:

F36
ESE
1/2-1
2802 ft.
Higher

FOSTER FREEZE
21525 W SOLEDAD CANYON RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S105422129** **N/A**

Site 2 of 4 in cluster F

HMS:
Facility Id: 008239-I08780
Facility Type: I02
Permit Number: 00009944A Permit Status: Closed
Facility Status: Closed Area: 7A
Region: Los Angeles County:

F37
ESE
1/2-1
2827 ft.
Higher

FOSTERS FREEZE
21515 SOLEDAD CANYON RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S102064072** **N/A**

Site 3 of 4 in cluster F

HMS:
Facility Id: 009179-008780
Facility Type: Not reported
Permit Number: Not reported Permit Status: Not reported
Facility Status: OPEN Area: 7A
Region: Los Angeles County:

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number
C38 **SE** **1/2-1** **2848 ft.** **Higher**	**26477 GOLDEN TRIANGLE RD.** **SANTA CLARITA, CA 91355** **Site 9 of 9 in cluster C**	**CHMIRS**	**S100217867** **N/A**

CHMIRS:

OES Control Number:	8908461	DOT ID:	Not reported
DOT Hazard Class:	Not Reported		
Chemical Name:	RHODIUM & RUTHENIUM		
Extent of Release:	Not reported		
CAS Number:	7440-16-6	Quantity Released:	5
Environmental Contamination:	None Reported	Property Use:	Manufacturing
Incident Date:	18-OCT-89	Date Completed:	18-OCT-89

Time Completed :	800
Physical State Stored :	Liquid
Physical State Released :	Liquid
Release Unit :	Gallons
Container Description :	Not reported
Container Type :	Not reported
Container Material :	Not reported
Level Of Container :	Not reported
Container Capacity :	Not reported
Container Capacity Units (code) :	Not reported
Extent Of Release (code) :	3
Agency Id Number :	19110
Agency Incident Number :	9
OES Incident Number :	8908461
Time Notified :	619
Surrounding Area :	500
Estimated Temperature :	60
Property Management :	K
More Than Two Substances Involved? :	Not reported
Special Studies 1 :	Not reported
Special Studies 2 :	Not reported
Special Studies 3 :	Not reported
Special Studies 4 :	Not reported
Special Studies 5 :	Not reported
Special Studies 6 :	Not reported
Responding Agency Personel # Of Injuries :	0
Responding Agency Personel # Of Fatalities :	0
Resp Agncy Personel # Of Decontaminated :	0
Others Number Of Decontaminated :	0
Others Number Of Injuries :	0
Others Number Of Fatalities :	0
Vehicle Make/year :	Not reported
Vehicle License Number :	Not reported
Vehicle State :	Not reported
Vehicle Id Number :	Not reported
CA/DOT/PUC/ICC Number :	Not reported
Company Name :	Not reported
Reporting Officer Name/ID :	ROBERT J SHEETS CAPT 185
Report Date :	18-OCT-89
Comments :	Not reported
Facility Telephone Number :	213 267-2485

F39 **ESE** **1/2-1** **2861 ft.** **Higher**	**21361 SOLEDAD CNY RD** **SANTA CLARITA, CA** **Site 4 of 4 in cluster F**	**CHMIRS**	**S100216378** **N/A**

(Continued) **S100216378**

CHMIRS:

OES Control Number:	8803256	DOT ID:	1789
DOT Hazard Class:	Corrosives		
Chemical Name:	ACID, MURIATIC		
Extent of Release:	Not reported		
CAS Number:	Not reported	Quantity Released:	.5
Environmental Contamination:	Ground	Property Use:	099
Incident Date:	12-OCT-88	Date Completed:	12-OCT-88

Time Completed :	1245
Physical State Stored :	Liquid
Physical State Released :	Liquid
Release Unit :	Gallons
Container Description :	2
Container Type :	04
Container Material :	Plastic Fiberglass , Rigid
Level Of Container :	Ground Level
Container Capacity :	2
Container Capacity Units (code) :	2
Extent Of Release (code) :	9
Agency Id Number :	19110
Agency Incident Number :	0
OES Incident Number :	8803256
Time Notified :	1208
Surrounding Area :	400
Estimated Temperature :	70
Property Management :	K
More Than Two Substances Involved? :	Not reported
Special Studies 1 :	Not reported
Special Studies 2 :	Not reported
Special Studies 3 :	Not reported
Special Studies 4 :	Not reported
Special Studies 5 :	Not reported
Special Studies 6 :	Not reported
Responding Agency Personel # Of Injuries :	Not reported
Responding Agency Personel # Of Fatalities :	Not reported
Resp Agncy Personel # Of Decontaminated :	Not reported
Others Number Of Decontaminated :	Not reported
Others Number Of Injuries :	Not reported
Others Number Of Fatalities :	Not reported
Vehicle Make/year :	Not reported
Vehicle License Number :	Not reported
Vehicle State :	Not reported
Vehicle Id Number :	Not reported
CA/DOT/PUC/ICC Number :	Not reported
Company Name :	Not reported
Reporting Officer Name/ID :	CAPT JOHN W EVERETT
Report Date :	12-OCT-88
Comments :	Yes
Facility Telephone Number :	213 267-2485

G40 **BONELLI PHAR PROD** **LOS ANGELES CO. HMS** **U003060423**
WSW **22500 W SOLEDAD CANYON RD** **N/A**
1/2-1 **UNINCORPORATED, CA**
3491 ft.
Lower **Site 1 of 3 in cluster G**

HMS:
Facility Id: 004213-I04366

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

BONELLI PHAR PROD (Continued) **U003060423**

Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7
Region:	Los Angeles County:		

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41 **ESE** **1/2-1** **3495 ft.** **Higher**	**21361 SOLEDAD CANYON RD.** **21361 SOLEDAD CANYON RD.** **SANTA CLARITA, CA**	**ERNS**	**8874052** **N/A**

G42 **West** **1/2-1** **3505 ft.** **Lower**	**SAUGUS SPEED WAY - SWAPMEET** **22500 SOLEDAD CANYON RD** **SANTA CLARITA, CA** **Site 2 of 3 in cluster G**	**LOS ANGELES CO. HMS**	**S102064137** **N/A**

HMS:

Facility Id:	009029-004366		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	Removed	Area:	7A
Region:	Los Angeles County:		

G43 **West** **1/2-1** **3505 ft.** **Lower**	**SAUGUS SWAP MEET/SAUGUS SPEEDW** **22500 SOLEDAD CANYON RD** **SAUGUS, CA 91350** **Site 3 of 3 in cluster G**	**HIST UST**	**U001567721** **N/A**

UST HIST:

Facility ID:	66476		
Tank Num:	1	Container Num:	#1
Tank Capacity:	3000	Year Installed:	Not reported
Tank Used for:	WASTE		
Type of Fuel:	Not Reported	Tank Construction:	X inches
Leak Detection:	None		
Contact Name:	RAYMOND J. WILKINGS, MGR.	Telephone:	(805) 259-3886
Total Tanks:	3	Region:	STATE
Facility Type:	2	Other Type:	SPEEDWAY

Facility ID:	66476		
Tank Num:	2	Container Num:	#2
Tank Capacity:	3000	Year Installed:	Not reported
Tank Used for:	PRODUCT		
Type of Fuel:	UNLEADED	Tank Construction:	Not reported
Leak Detection:	None		
Contact Name:	RAYMOND J. WILKINGS, MGR.	Telephone:	(805) 259-3886
Total Tanks:	3	Region:	STATE
Facility Type:	2	Other Type:	SPEEDWAY

Facility ID:	66476		
Tank Num:	3	Container Num:	#3
Tank Capacity:	4000	Year Installed:	Not reported
Tank Used for:	PRODUCT		
Type of Fuel:	DIESEL	Tank Construction:	Not reported
Leak Detection:	None		

SAUGUS SWAP MEET/SAUGUS SPEEDW (Continued) **U001567721**

Contact Name:	RAYMOND J. WILKINGS, MGR.	Telephone:	(805) 259-3886
Total Tanks:	3	Region:	STATE
Facility Type:	2	Other Type:	SPEEDWAY

H44
West
1/2-1
4560 ft.
Lower

SANTA CLARITA WATER CO.
22722 SOLEDAD CANYON RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S103945137** **N/A**

Site 1 of 2 in cluster H

HMS:

Facility Id:	020322-028917		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

45
SE
1/2-1
4713 ft.
Higher

BOWMAN HIGH SCHOOL/WM S HART UNION HSD
21508 REDVIEW DR
SANTA CLARITA, CA 91350

HAZNET **S102816201** **N/A**

HAZNET:

Gepaid:	CAL000083996
Tepaid:	CAD981402522
Gen County:	Los Angeles
Tsd County:	Kern
Tons:	.0083
Category:	Photochemicals/photoprocessing waste
Disposal Method:	Recycler
Contact:	WM S HART UNION HS DISTRICT
Telephone:	(805) 259-0033
Mailing Address:	21515 REDVIEW DR SANTA CLARITA, CA 91350 - 2947
County	Los Angeles

Gepaid:	CAL000083996
Tepaid:	CAD981402522
Gen County:	Los Angeles
Tsd County:	Kern
Tons:	.0250
Category:	Photochemicals/photoprocessing waste
Disposal Method:	Recycler
Contact:	WM S HART UNION HS DISTRICT
Telephone:	(805) 259-0033
Mailing Address:	21515 REDVIEW DR SANTA CLARITA, CA 91350 - 2947
County	Los Angeles

Gepaid:	CAL000083996
Tepaid:	CAD008364432
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.0000
Category:	Laboratory waste chemicals
Disposal Method:	Not reported
Contact:	WM S HART UNION HS DISTRICT
Telephone:	(805) 259-0033

BOWMAN HIGH SCHOOL/WM S HART UNION HSD (Continued) **S102816201**

Mailing Address: 21515 REDVIEW DR
SANTA CLARITA, CA 91350 - 2947
County Los Angeles

Gepaid: CAL000083996
Tepaid: CAD008364432
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .0400
Category: Laboratory waste chemicals
Disposal Method: Recycler
Contact: WM S HART UNION HS DISTRICT
Telephone: (805) 259-0033
Mailing Address: 21515 REDVIEW DR
SANTA CLARITA, CA 91350 - 2947
County Los Angeles

Gepaid: CAL000083996
Tepaid: CAD008364432
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .0050
Category: Laboratory waste chemicals
Disposal Method: Treatment, Tank
Contact: WM S HART UNION HS DISTRICT
Telephone: (805) 259-0033
Mailing Address: 21515 REDVIEW DR
SANTA CLARITA, CA 91350 - 2947
County Los Angeles

The CA HAZNET database contains 3 additional records for this site.
Please contact your EDR Account Executive for more information.

H46 **SANTA CLARITA VALLEY DENTAL** **HAZNET** **S103986698**
West **22770 WEST SOLEDAD CYN RD** **N/A**
1/2-1 **SAUGUS, CA 91350**
4816 ft.
Lower **Site 2 of 2 in cluster H**

HAZNET:
Gepaid: CAL000099024
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .0625
Category: Photochemicals/photoprocessing waste
Disposal Method: Not reported
Contact: R MEEKER/A MINDEL/M ORRO
Telephone: (805) 259-9674
Mailing Address: 22770 SOLEDAD CANYON RD
SANTA CLARITA, CA 91350 - 2629
County Los Angeles

SANTA CLARITA VALLEY DENTAL (Continued) **S103986698**

Gepaid: CAL000099024
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .0625
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: R MEEKER/A MINDEL/M ORRO
Telephone: (805) 259-9674
Mailing Address: 22770 SOLEDAD CANYON RD
SANTA CLARITA, CA 91350 - 2629
County Los Angeles

Gepaid: CAL000099024
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .0625
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: R MEEKER/A MINDEL/M ORRO
Telephone: (805) 259-9674
Mailing Address: 22770 SOLEDAD CANYON RD
SANTA CLARITA, CA 91350 - 2629
County Los Angeles

Gepaid: CAL000099024
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .0625
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: R MEEKER/A MINDEL/M ORRO
Telephone: (805) 259-9674
Mailing Address: 22770 SOLEDAD CANYON RD
SANTA CLARITA, CA 91350 - 2629
County Los Angeles

Gepaid: CAL000099024
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .0625
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: R MEEKER/A MINDEL/M ORRO
Telephone: (805) 259-9674
Mailing Address: 22770 SOLEDAD CANYON RD
SANTA CLARITA, CA 91350 - 2629
County Los Angeles

I47 **CAMEL WORKS** **LOS ANGELES CO. HMS** **U003061634**
East **21020 W SOLEDAD CANYON RD** **N/A**
1/2-1 **SANTA CLARITA, CA**
4840 ft.
Higher **Site 1 of 4 in cluster I**

HMS:
Facility Id: 005600-I05804

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number

CAMEL WORKS (Continued) **U003061634**

Facility Type: I00
Permit Number: 000003368 Permit Status: Closed
Facility Status: Closed Area: 7A
Region: Los Angeles County:

I48
East
1/2-1
4861 ft.
Higher

LA CO DPW FLOOD SANTA CLARITA — **LOS ANGELES CO. HMS** — **S102064043** **N/A**
21014 W SOLEDAD CANYON RD
SANTA CLARITA, CA

Site 2 of 4 in cluster I

HMS:
Facility Id: 010790-010750
Facility Type: T0
Permit Number: 00005232T Permit Status: Removed
Facility Status: Removed Area: 7A
Region: Los Angeles County:

I49
East
1/2-1
4904 ft.
Higher

PROWLERS SPEED & CUSTOMS INC. — **LOS ANGELES CO. HMS** — **S103945054** **N/A**
21021 SOLEDAD CANYON RD
SANTA CLARITA, CA

Site 3 of 4 in cluster I

HMS:
Facility Id: 020321-028915
Facility Type: Not reported
Permit Number: Not reported Permit Status: Not reported
Facility Status: OPEN Area: 7A
Region: Los Angeles County:

I50
East
1/2-1
4928 ft.
Higher

SANTA CLARA YARD — **HIST UST** — **U001567720** **N/A**
21014 SOLEDAD CANYON RD
CANYON COUNTRY, CA 91350

Site 4 of 4 in cluster I

UST HIST:
Facility ID: 32673
Tank Num: 1 Container Num: 1
Tank Capacity: 1000 Year Installed: 1972
Tank Used for: PRODUCT
Type of Fuel: DIESEL Tank Construction: Not reported
Leak Detection: None
Contact Name: Not reported Telephone: (818) 896-0594
Total Tanks: 2 Region: STATE
Facility Type: 2 Other Type: MAINTENANCE SUB YARD

Facility ID: 32673
Tank Num: 2 Container Num: 2
Tank Capacity: 1000 Year Installed: 1972
Tank Used for: PRODUCT
Type of Fuel: REGULAR Tank Construction: Not reported
Leak Detection: None
Contact Name: Not reported Telephone: (818) 896-0594
Total Tanks: 2 Region: STATE
Facility Type: 2 Other Type: MAINTENANCE SUB YARD

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number
51 **NW** **1/2-1** **4929 ft.** **Lower**	**SAUGUS UNION SCHOOL DIST** **22635 ESPUELLA DR** **SAUGUS, CA 91350**	**HAZNET**	**S102815982** **N/A**

HAZNET:

Gepaid: CAL000082553
Tepaid: CAD067786749
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 4.2140
Category: Asbestos-containing waste
Disposal Method: Not reported
Contact: PUBLIC AGENCY
Telephone: (805) 297-8800
Mailing Address: 22211 WEST NEWHALL RANCH RD
SAUGUS, CA 91350
County Los Angeles

Gepaid: CAL000082553
Tepaid: CAD067786749
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 67.4240
Category: Asbestos-containing waste
Disposal Method: Disposal, Land Fill
Contact: PUBLIC AGENCY
Telephone: (805) 297-8800
Mailing Address: 22211 WEST NEWHALL RANCH RD
SAUGUS, CA 91350
County Los Angeles

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number
52 **South** **1/2-1** **5039 ft.** **Higher**	**WHITTAKER CORP/BERMITE DIV** **22116 W SOLEDAD CYN RD** **SAUGUS, CA 91350**	**HAZNET**	**S103642834** **N/A**

HAZNET:

Gepaid: CAD064573108
Tepaid: CAT080010101
Gen County: Los Angeles
Tsd County: San Diego
Tons: .0250
Category: Other inorganic solid waste
Disposal Method: Treatment, Tank
Contact: WHITTAKER PORTA BELLA DEV INC
Telephone: (805) 526-5700
Mailing Address: 22116 SOLEDAD CANYON RD #W
SANTA CLARITA, CA 91350 - 2627
County Los Angeles

WHITTAKER CORP/BERMITE DIV (Continued) **S103642834**

Gepaid: CAD064573108
Tepaid: CAT000646117
Gen County: Los Angeles
Tsd County: Kings
Tons: .0000
Category: Other organic solids
Disposal Method: Not reported
Contact: WHITTAKER PORTA BELLA DEV INC
Telephone: (805) 526-5700
Mailing Address: 22116 SOLEDAD CANYON RD #W
SANTA CLARITA, CA 91350 - 2627
County Los Angeles

Gepaid: CAD064573108
Tepaid: CAT000646117
Gen County: Los Angeles
Tsd County: Kings
Tons: 8.4280
Category: Other organic solids
Disposal Method: Disposal, Land Fill
Contact: WHITTAKER PORTA BELLA DEV INC
Telephone: (805) 526-5700
Mailing Address: 22116 SOLEDAD CANYON RD #W
SANTA CLARITA, CA 91350 - 2627
County Los Angeles

Gepaid: CAD064573108
Tepaid: CAT080022148
Gen County: Los Angeles
Tsd County: San Bernardino
Tons: .0005
Category: Off-specification, aged, or surplus organics
Disposal Method: Disposal, Other
Contact: WHITTAKER PORTA BELLA DEV INC
Telephone: (805) 526-5700
Mailing Address: 22116 SOLEDAD CANYON RD #W
SANTA CLARITA, CA 91350 - 2627
County Los Angeles

Gepaid: CAD064573108
Tepaid: CAT000646117
Gen County: Los Angeles
Tsd County: Kings
Tons: 39.6116
Category: Contaminated soil from site clean-ups
Disposal Method: Disposal, Land Fill
Contact: WHITTAKER PORTA BELLA DEV INC
Telephone: (805) 526-5700
Mailing Address: 22116 SOLEDAD CANYON RD #W
SANTA CLARITA, CA 91350 - 2627
County Los Angeles

The CA HAZNET database contains 3 additional records for this site.
Please contact your EDR Account Executive for more information.

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53 **WILLIAM S. HART UNION SCHOOL DISTRICT** **Cal-Sites** **S100848272**
SE **21469 REDVIEW DRIVE** **N/A**
1/2-1 **SANTA CLARITA, CA 91350**
5126 ft.
Higher

WILLIAM S. HART UNION SCHOOL DISTRICT (Continued) **S100848272**

CAL-SITES:

Facility ID	19470010	
Status:	NFA - NO FURTHER ACTION FOR DTSC	
Status Date:	11/07/1994	
Lead:	Not reported	
Region:	3 - BURBANK	
Branch:	SA - SOUTHERN CA. - A	
File Name:	WILLIAM S. HART UNION SCHOOL DISTRICT	
Status Name:	NO FURTHER ACTION FOR DTSC	
Lead Agency:	N/A	Not reported
NPL:	Not reported	
SIC:	47 TRANSPORTATION SERVICES	

Facility Type:	N/A
Type Name:	Not reported
Staff Member Responsible for Site:	JABRAHAM
Supervisor Responsible for Site:	MMONROY
Region Water Control Board:	LA - LOS ANGELES
Access:	Not reported
Cortese:	Not reported
Hazardous Ranking Score:	Not reported
Date Site Hazard Ranked:	Not reported
Groundwater Contamination:	Not reported
No. of Contamination Sources:	0
Lat/Long:	0° 0′ 0.00″ / 0° 0′ 0.00″
Lat/long Method:	Not reported
State Assembly District Code:	Not reported
State Senate District:	Not reported

The CAL-SITES database may contain additional details for this site.
Please contact your EDR Account Executive for more information.

J54
West
1/2-1
5133 ft.
Lower

AMERICAN MOTOR CYCLE — **LOS ANGELES CO. HMS** — **S103945138** / **N/A**
22820 SOLEDAD CANYON RD
SANTA CLARITA, CA

Site 1 of 3 in cluster J

HMS:

Facility Id:	020323-028918		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

J55
West
1/2-1
5195 ft.
Lower

PIZZA HUT RESTAURANT #758132 — **LOS ANGELES CO. HMS** — **S103317719** / **N/A**
22830 W SOLEDAD CANYON RD
SANTA CLARITA, CA

Site 2 of 3 in cluster J

HMS:

Facility Id:	008919-I16652		
Facility Type:	I01		
Permit Number:	000012437	Permit Status:	Permit
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

MAP FINDINGS

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number
56 NNW 1/2-1 5216 ft. Lower	**L A POLICE MISDEMEANANT F 27000 N BOUQUET CANYON RD SANTA CLARITA, CA**	**LOS ANGELES CO. HMS**	**U003057660 N/A**

HMS:

Facility Id:	001208-I01268		
Facility Type:	I00		
Permit Number:	000000727	Permit Status:	Closed
Facility Status:	Closed	Area:	7A
Region:	Los Angeles County:		

J57 West 1/2-1 5238 ft. Lower	**FIRST CARE WALK IN MEDICAL GR 22840 SOLDEDAD CANYON RD SANTA CLARITA, CA 91350**	**HAZNET**	**S103964431 N/A**

Site 3 of 3 in cluster J

HAZNET:

Gepaid: CAL000080691
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .5294
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: RALPH FARINELLA/LARRY BARNHART
Telephone: (000) 000-0000
Mailing Address: 22840 SOLEDAD CANYON RD
SANTA CLARITA, CA 91350
County Los Angeles

Gepaid: CAL000080691
Tepaid: CAD982041980
Gen County: Los Angeles
Tsd County: Fresno
Tons: .0200
Category: Metal sludge - Alkaline solution (pH <UN-> 12.5) with metals (antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc)
Disposal Method: Treatment, Incineration
Contact: RALPH FARINELLA/LARRY BARNHART
Telephone: (000) 000-0000
Mailing Address: 22840 SOLEDAD CANYON RD
SANTA CLARITA, CA 91350
County Los Angeles

Gepaid: CAL000080691
Tepaid: CAD982041980
Gen County: Los Angeles
Tsd County: Fresno
Tons: .0000
Category:
Disposal Method: Treatment, Incineration
Contact: RALPH FARINELLA/LARRY BARNHART
Telephone: (000) 000-0000
Mailing Address: 22840 SOLEDAD CANYON RD
SANTA CLARITA, CA 91350
County Los Angeles

FIRST CARE WALK IN MEDICAL GR (Continued) **S103964431**

Gepaid: CAL000080691
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .3710
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: RALPH FARINELLA/LARRY BARNHART
Telephone: (000) 000-0000
Mailing Address: 22840 SOLEDAD CANYON RD
SANTA CLARITA, CA 91350
County Los Angeles

Gepaid: CAL000080691
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .1000
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: RALPH FARINELLA/LARRY BARNHART
Telephone: (000) 000-0000
Mailing Address: 22840 SOLEDAD CANYON RD
SANTA CLARITA, CA 91350
County Los Angeles

K58 **PREMIER AUTO BODY & FRAME** **HAZNET** **S100942731**
East **26723 OAK AVENUE** **N/A**
> 1 **CANYON COUNTRY, CA 91351**
5431 ft.
Higher **Site 1 of 8 in cluster K**

HAZNET:
Gepaid: CAL000005147
Tepaid: CAD008252405
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2293
Category: Unspecified solvent mixture Waste
Disposal Method: Recycler
Contact: FRANK PINTO
Telephone: (805) 298-0198
Mailing Address: 26723 OAK AVE
CANYON COUNTRY, CA 91351
County Los Angeles

Gepaid: CAL000005147
Tepaid: CAD008252405
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2293
Category: Oxygenated solvents (acetone, butanol, ethyl acetate, etc.)
Disposal Method: Recycler
Contact: FRANK PINTO
Telephone: (805) 298-0198
Mailing Address: 26723 OAK AVE
CANYON COUNTRY, CA 91351
County Los Angeles

PREMIER AUTO BODY & FRAME (Continued) **S100942731**

Gepaid: CAL000005147
Tepaid: CAD008252405
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 0.2293
Category: Unspecified solvent mixture Waste
Disposal Method: Recycler
Contact: FRANK PINTO
Telephone: (805) 298-0198
Mailing Address: 26723 OAK AVE
CANYON COUNTRY, CA 91351
County Los Angeles

Gepaid: CAL000005147
Tepaid: CAD982444481
Gen County: Los Angeles
Tsd County: San Bernardino
Tons: 0.2085
Category: Unspecified organic liquid mixture
Disposal Method: Recycler
Contact: FRANK PINTO
Telephone: (805) 298-0198
Mailing Address: 26723 OAK AVE
CANYON COUNTRY, CA 91351
County Los Angeles

Gepaid: CAL000005147
Tepaid: CAD097030993
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .1000
Category: Other organic solids
Disposal Method: Disposal, Other
Contact: FRANK PINTO
Telephone: (805) 298-0198
Mailing Address: 26723 OAK AVE
CANYON COUNTRY, CA 91351
County Los Angeles

The CA HAZNET database contains 12 additional records for this site.
Please contact your EDR Account Executive for more information.

K59 **East** **> 1** **5431 ft.** **Higher**	**AUTO CENTER** **26723 OAK AVE** **SANTA CLARITA, CA** **Site 2 of 8 in cluster K**	**LOS ANGELES CO. HMS**	**S104537772** **N/A**

HMS:

Facility Id:	007868-008329		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number
K60 **East** **> 1** **5431 ft.** **Higher**	**PREMIER AUTO BODY** **26723 OAK AVE** **SANTA CLARITA, CA** **Site 3 of 8 in cluster K**	**LOS ANGELES CO. HMS**	**U003063603** **N/A**

HMS:
Facility Id: 007868-I08329
Facility Type: I01
Permit Number: 000009001 Permit Status: Permit
Facility Status: Permit Area: 7A
Region: Los Angeles County:

K61 **East** **> 1** **5432 ft.** **Higher**	**MORRIS PRECISION PRODUCTS, INC.** **26732 OAK AVE** **CANYON COUNTRY, CA 91351** **Site 4 of 8 in cluster K**	**HAZNET**	**S102814076** **N/A**

HAZNET:
Gepaid: CAL000059926
Tepaid: CAD980883177
Gen County: Los Angeles
Tsd County: Kern
Tons: 1.5429
Category: Unspecified oil-containing waste
Disposal Method: Recycler
Contact: MORRIS NORMAN
Telephone: (000) 000-0000
Mailing Address: 26732 OAK AVE
CANYON COUNTRY, CA 91351
County Los Angeles

Gepaid: CAL000059926
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .6880
Category: Unspecified oil-containing waste
Disposal Method: Recycler
Contact: MORRIS NORMAN
Telephone: (000) 000-0000
Mailing Address: 26732 OAK AVE
CANYON COUNTRY, CA 91351
County Los Angeles

Gepaid: CAL000059926
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .7506
Category: Waste oil and mixed oil
Disposal Method: Recycler
Contact: MORRIS NORMAN
Telephone: (000) 000-0000
Mailing Address: 26732 OAK AVE
CANYON COUNTRY, CA 91351
County Los Angeles

MORRIS PRECISION PRODUCTS, INC. (Continued) **S102814076**

Gepaid: CAL000059926
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .8131
Category: Unspecified oil-containing waste
Disposal Method: Recycler
Contact: MORRIS NORMAN
Telephone: (000) 000-0000
Mailing Address: 26732 OAK AVE
CANYON COUNTRY, CA 91351
County Los Angeles

Gepaid: CAL000059926
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .7923
Category: Unspecified oil-containing waste
Disposal Method: Recycler
Contact: MORRIS NORMAN
Telephone: (000) 000-0000
Mailing Address: 26732 OAK AVE
CANYON COUNTRY, CA 91351
County Los Angeles

The CA HAZNET database contains 2 additional records for this site.
Please contact your EDR Account Executive for more information.

K62
East
> 1
5434 ft.
Higher

BOHAN'S AUTOMOTIVE
26741 OAK AVE
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S103945455**
N/A

Site 5 of 8 in cluster K

HMS:
Facility Id: 020054-028585
Facility Type: Not reported
Permit Number: Not reported
Permit Status: Not reported
Facility Status: OPEN
Area: 7A
Region: Los Angeles County:

K63
East
> 1
5434 ft.
Higher

BOHANS AUTOMOTOVIE
26741 OAK ST
SANTA CLARITA, CA 91351

HAZNET **S104583059**
N/A

Site 6 of 8 in cluster K

HAZNET:
Gepaid: CAL000208720
Tepaid: CAD099452708
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 1.5636
Category: Unspecified aqueous solution
Disposal Method: Recycler
Contact: KENNETH MC KERNAN
Telephone: (662) 251-4288

BOHANS AUTOMOTOVIE (Continued) **S104583059**

Mailing Address:	26741 OAK ST SANTA CLARITA, CA 91351
County	Los Angeles
Gepaid:	CAL000208720
Tepaid:	CAD099452708
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	0.6255
Category:	Unspecified aqueous solution
Disposal Method:	Recycler
Contact:	KENNETH MC KERNAN
Telephone:	(662) 251-4288
Mailing Address:	26741 OAK ST SANTA CLARITA, CA 91351
County	Los Angeles

K64
East
> 1
5436 ft.
Higher

VAL-PAK PRODUCTS
26751 OAK AVE.
CANYON COUNTRY, CA 91351

FINDS 1004439683
SSTS 058291CA 001

Site 7 of 8 in cluster K

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Section Seven Tracking System (SSTS)

SSTS:

Product:	ALGI - CONTROL
Status:	Active
Registration #:	058291CA 001
Report Year:	1996
Permit:	Registered
Product #:	00683600047010897
Product Type:	End-use blend, formulation, or concentrate
Product Class:	20
Product Use:	5
Market:	Marketed in the United States
Product:	ALGI-CONTROL
Status:	Active
Registration #:	058291CA 001
Report Year:	1997
Permit:	Registered
Product #:	00683600047010897
Product Type:	End-use blend, formulation, or concentrate
Product Class:	20
Product Use:	5
Market:	Marketed in the United States
Product:	ALGI-CONTROL
Status:	Active
Registration #:	058291CA 001
Report Year:	Not reported
Permit:	Registered
Product #:	00683600047010897
Product Type:	End-use blend, formulation, or concentrate
Product Class:	Algicide
Product Use:	All other products
Market:	Marketed in the United States

VAL-PAK PRODUCTS (Continued) **1004439683**

Product:	HASACIDE
Status:	Active
Registration #:	058291CA 001
Report Year:	1991
Permit:	Registered
Product #:	01089700013
Product Type:	End-use blend, formulation, or concentrate
Product Class:	Algicide
Product Use:	All other products
Market:	Marketed in the United States
Product:	ALGI CONTROL
Status:	Active
Registration #:	058291CA 001
Report Year:	1991
Permit:	Registered
Product #:	00683600047
Product Type:	End-use blend, formulation, or concentrate
Product Class:	Algicide
Product Use:	All other products
Market:	Marketed in the United States
Product:	HASACIDE
Status:	Active
Registration #:	058291CA 001
Report Year:	1990
Permit:	Registered
Product #:	01089700013
Product Type:	End-use blend, formulation, or concentrate
Product Class:	Algicide
Product Use:	All other products
Market:	Marketed in the United States
Product:	ALGI-CONTROL
Status:	Active
Registration #:	058291CA 001
Report Year:	1990
Permit:	Registered
Product #:	00683600047
Product Type:	End-use blend, formulation, or concentrate
Product Class:	Algicide
Product Use:	All other products
Market:	Marketed in the United States
Product:	ALGI-CONTROL
Status:	Not reported
Registration #:	058291CA 001
Report Year:	1999
Permit:	Registered
Product #:	00683600047010897
Product Type:	End-use blend, formulation, or concentrate
Product Class:	Algicide
Product Use:	All other products
Market:	Marketed in the United States

VAL-PAK PRODUCTS (Continued) **1004439683**

Product:	ALGI-CONTROL
Status:	Not reported
Registration #:	058291CA 001
Report Year:	2000
Permit:	Registered
Product #:	00683600047
Product Type:	End-use blend, formulation, or concentrate
Product Class:	Algicide
Product Use:	All other products
Market:	Marketed in the United States

L65 **CASTAIC LAKE WATER AGENCY** **HAZNET** **S103955090**
North **27234 BOUQUET CANYON RD** **N/A**
> 1 **SAUGUS, CA 91350**
5437 ft.
Higher **Site 1 of 6 in cluster L**

HAZNET:

Gepaid:	CAR000006544
Tepaid:	CAD050806850
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.1876
Category:	Liquids with pH <UN-> 2
Disposal Method:	Transfer Station
Contact:	CASTAIC LAKE WATER AGENCY
Telephone:	(805) 297-1600
Mailing Address:	27234 BOUQUET CYN RD SANTA CLARITA, CA 91350
County	Los Angeles

Gepaid:	CAR000006544
Tepaid:	CAT080033681
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.9174
Category:	Liquids with pH <UN-> 2 with metals
Disposal Method:	Recycler
Contact:	CASTAIC LAKE WATER AGENCY
Telephone:	(805) 297-1600
Mailing Address:	27234 BOUQUET CYN RD SANTA CLARITA, CA 91350
County	Los Angeles

Gepaid:	CAR000006544
Tepaid:	CAT080033681
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	3.0024
Category:	Alkaline solution without metals (pH > 12.5)
Disposal Method:	Recycler
Contact:	CASTAIC LAKE WATER AGENCY
Telephone:	(805) 297-1600
Mailing Address:	27234 BOUQUET CYN RD SANTA CLARITA, CA 91350
County	Los Angeles

CASTAIC LAKE WATER AGENCY (Continued) **S103955090**

Gepaid:	CAR000006544
Tepaid:	CAT080013352
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.4170
Category:	Waste oil and mixed oil
Disposal Method:	Recycler
Contact:	CASTAIC LAKE WATER AGENCY
Telephone:	(805) 297-1600
Mailing Address:	27234 BOUQUET CYN RD SANTA CLARITA, CA 91350
County	Los Angeles

Gepaid:	CAR000006544
Tepaid:	CAT080013352
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.2293
Category:	Unspecified organic liquid mixture
Disposal Method:	Recycler
Contact:	CASTAIC LAKE WATER AGENCY
Telephone:	(805) 297-1600
Mailing Address:	27234 BOUQUET CYN RD SANTA CLARITA, CA 91350
County	Los Angeles

The CA HAZNET database contains 20 additional records for this site.
Please contact your EDR Account Executive for more information.

L66 **RIO VISTA WATER TREATMENT** **LOS ANGELES CO. HMS** **S104536199**
North **27234 BOUQUET CANYON RD** **N/A**
> 1 **SANTA CLARITA, CA**
5437 ft.
Higher **Site 2 of 6 in cluster L**

HMS:

Facility Id:	019947-028465		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

L67 **RIO VISTA WTP PUMPING STA** **UST** **U003777367**
North **27234 BOUQUET CANYON RD** **N/A**
> 1 **SANTA CLARITA, CA 91350**
5437 ft.
Higher **Site 3 of 6 in cluster L**

State UST:

Facility ID:	20673
Total Tanks:	1
Region:	STATE
Local Agency:	19000

Map ID / Direction / Distance / Distance (ft.) / Elevation | Site | Database(s) | EDR ID Number / EPA ID Number

L68
North
> 1
5437 ft.
Higher

CASTAIC LAKE WATER AGNCY
27234 BOUQUET CANYON RD
SAUGUS, CA 91350

RCRIS-SQG **1001075566**
FINDS **CAR000006544**

Site 4 of 6 in cluster L

RCRIS:
Owner: CASTAIC LAKE WATER AGNCY
(805) 297-1600
EPA ID: CAR000006544
Contact: GEORGE CORE
(805) 297-1600
Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported
Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

L69
North
> 1
5437 ft.
Higher

RIO VISTA WATER TREATMENT PLT
27234 BOUQUET CANYON RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S105512334**
N/A

Site 5 of 6 in cluster L

HMS:
Facility Id: 008984-001268
Facility Type: T0
Permit Number: 0000T6392 | Permit Status: Permit
Facility Status: Permit | Area: 7A
Region: Los Angeles County:

M70
East
> 1
5441 ft.
Higher

PACIFIC AIR LOGISTICS
26763 OAK AVE
SANTA CLARITA, CA

LOS ANGELES CO. HMS **U003063469**
N/A

Site 1 of 11 in cluster M

HMS:
Facility Id: 007714-I08146
Facility Type: I02
Permit Number: 000010275 | Permit Status: Permit
Facility Status: Permit | Area: 7A
Region: Los Angeles County:

L71
North
> 1
5443 ft.
Higher

RIO VISTA WATER TREATMENT PLT
27236 BOUQUET CANYON RD
SANTA CLARITA, CA 91350

UST **U003775875**
N/A

Site 6 of 6 in cluster L

State UST:
Facility ID: 1268
Total Tanks: 1
Region: STATE

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

RIO VISTA WATER TREATMENT PLT (Continued) — **U003775875**

Local Agency: 19000

N72 **WNW** **> 1** **5443 ft.** **Lower**	**SAUGUS UNION SD** **22211 W NEWHALL RANCH RD** **SAUGUS, CA 91350** **Site 1 of 5 in cluster N**	**FINDS**	**1004442941** **C09#09-88185**

FINDS:
Other Pertinent Environmental Activity Identified at Site:
National Compliance Database (NCDB)

N73 **WNW** **> 1** **5443 ft.** **Lower**	**22211 W. NEWHALL RANCH RD** **22211 W. NEWHALL RANCH RD** **FAUGUS, CA 91350** **Site 2 of 5 in cluster N**	**ERNS**	**92284936** **N/A**

N74 **WNW** **> 1** **5443 ft.** **Lower**	**SAUGUS UNION SCHOOL DISTRICT** **22211 NEWHALL RANCH RD** **SANTA CLARITA, CA** **Site 3 of 5 in cluster N**	**LOS ANGELES CO. HMS**	**S102064119** **N/A**

HMS:

Facility Id:	012851-013065		
Facility Type:	T1		
Permit Number:	000109219	Permit Status:	Removed
Facility Status:	Removed	Area:	7A
Region:	Los Angeles County:		

N75 **WNW** **> 1** **5443 ft.** **Lower**	**SAUGUS SCH DIST** **22211 NEWHALL RANCH RD** **SAUGUS, CA 91350** **Site 4 of 5 in cluster N**	**HAZNET**	**S103986849** **N/A**

HAZNET:

Gepaid:	CAC001036560
Tepaid:	CAD067786749
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	57.3104
Category:	Asbestos-containing waste
Disposal Method:	Disposal, Land Fill
Contact:	THE NEWHALL LAND
Telephone:	(000) 000-0000
Mailing Address:	23823 VALENCIA BLVD VALENCIA, CA 91355
County	Los Angeles

SAUGUS SCH DIST (Continued) **S103986849**

Gepaid: CAL000206728
Tepaid: CAD982444481
Gen County: Los Angeles
Tsd County: San Bernardino
Tons: 1.2000
Category: Other inorganic solid waste
Disposal Method: Transfer Station
Contact: BILL STAATS
Telephone: (000) 000-0000
Mailing Address: 22211 NEWHALL RANCH RD
SAUGUS, CA 91350
County Los Angeles

N76 **SAUGUS** **HAZNET** **1001614077**
WNW **22211 W NEWHALL RANCH RD** **N/A**
> 1 **SAUGUS, CA 91350**
5443 ft.
Lower **Site 5 of 5 in cluster N**

HAZNET:
Gepaid: CAD981429087
Tepaid: AZD983478322
Gen County: Los Angeles
Tsd County: 99
Tons: 8.2154
Category: Polychlorinated biphenyls and material containing PCB's
Disposal Method: Not reported
Contact: Not reported
Telephone: (000) 000-0000
Mailing Address: 24930 AVENUE STANFORD
VALENCIA, CA 91355
County Los Angeles

Gepaid: CAD981429087
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .1251
Category: Unspecified oil-containing waste
Disposal Method: Recycler
Contact: Not reported
Telephone: (000) 000-0000
Mailing Address: 24930 AVENUE STANFORD
VALENCIA, CA 91355
County Los Angeles

Gepaid: CAD981429087
Tepaid: CAD093459485
Gen County: Los Angeles
Tsd County: Fresno
Tons: .0208
Category: Unspecified solvent mixture Waste
Disposal Method: Transfer Station
Contact: Not reported
Telephone: (000) 000-0000
Mailing Address: 24930 AVENUE STANFORD
VALENCIA, CA 91355
County Los Angeles

SAUGUS (Continued) **1001614077**

Gepaid:	CAD981429087
Tepaid:	CAD099452708
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	1.0008
Category:	Waste oil and mixed oil
Disposal Method:	Transfer Station
Contact:	Not reported
Telephone:	(000) 000-0000
Mailing Address:	24930 AVENUE STANFORD VALENCIA, CA 91355
County	Los Angeles

Gepaid:	CAD981429087
Tepaid:	CAD099452708
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	1.0008
Category:	Waste oil and mixed oil
Disposal Method:	Recycler
Contact:	Not reported
Telephone:	(000) 000-0000
Mailing Address:	24930 AVENUE STANFORD VALENCIA, CA 91355
County	Los Angeles

The CA HAZNET database contains 15 additional records for this site.
Please contact your EDR Account Executive for more information.

M77
East
> 1
5445 ft.
Higher

MARANATHA CHEVROLET SERVICE
26770 OAK AVE
SANTA CLARITA, CA

Site 2 of 11 in cluster M

LOS ANGELES CO. HMS **S103945460**
N/A

HMS:

Facility Id:	020068-028605		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

M78
East
> 1
5445 ft.
Higher

MARANATHA CHEVROLET
26770 OAK AVE
CANYON COUNTRY, CA 91351

Site 3 of 11 in cluster M

RCRIS-SQG **1000596099**
FINDS **CAD983600628**
HAZNET

MARANATHA CHEVROLET (Continued) **1000596099**

RCRIS:
Owner: JERRY SHUMARD
(415) 555-1212
EPA ID: CAD983600628

Contact: SHUMAD JERRY
(805) 251-5600

Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

HAZNET:
Gepaid: CAD983600628
Tepaid: CAT000613893
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .7545
Category: Aqueous solution with less than 10% total organic residues
Disposal Method: Transfer Station
Contact: JERRY SHUMARD
Telephone: (000) 000-0000
Mailing Address: 26776 OAK AVE
CANYON COUNTRY, CA 91351
County Los Angeles

Gepaid: CAD983600628
Tepaid: CAD099452708
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2293
Category: Unspecified aqueous solution
Disposal Method: Recycler
Contact: JERRY SHUMARD
Telephone: (000) 000-0000
Mailing Address: 26776 OAK AVE
CANYON COUNTRY, CA 91351
County Los Angeles

M79 **PACIFIC EXPO** **RCRIS-SQG** **1000598101**
East **26776 OAK AVE** **FINDS** **CAD983621434**
> 1 **CANYON COUNTRY, CA 91351**
5449 ft.
Higher **Site 4 of 11 in cluster M**

PACIFIC EXPO (Continued) **1000598101**

RCRIS:
Owner: PACIFIC EXPORT CORP
(805) 250-1226
EPA ID: CAD983621434

Contact: GEORGE BAKER
(805) 250-1226

Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

M80
East
> 1
5449 ft.
Higher

CANYON COUNTRY INDUSTRIAL PARK
26776 OAK AVE
CANYON COUNTRY, CA 91351

HAZNET **S104571518**
N/A

Site 5 of 11 in cluster M

HAZNET:
Gepaid: CAC002180625
Tepaid: CAD099452708
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 1.5637
Category: Unspecified oil-containing waste
Disposal Method: Recycler
Contact: JOE WANG
Telephone: (000) 000-0000
Mailing Address: PO BOX 7016
THOUSAND OAKS, CA 91359
County Los Angeles

M81
East
> 1
5450 ft.
Higher

VON CO TOOL
26778 OAK AVE
CANYON COUNTRY, CA 91351

RCRIS-SQG **1000685940**
FINDS **CAD983629056**
HAZNET

Site 6 of 11 in cluster M

RCRIS:
Owner: JON PATTERSON
(805) 251-5300
EPA ID: CAD983629056

Contact: JON PATTERSON
(805) 251-5300

Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

VON CO TOOL (Continued) **1000685940**

Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

HAZNET:

Gepaid:	CAD983629056
Tepaid:	CAD099452708
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	0.2293
Category:	Oil/water separation sludge
Disposal Method:	Transfer Station
Contact:	JON PATTERSON
Telephone:	(805) 251-5300
Mailing Address:	26778 OAK AVE CANYON COUNTRY, CA 91351 - 2409
County	Los Angeles

Gepaid:	CAD983629056
Tepaid:	CAT000613976
Gen County:	Los Angeles
Tsd County:	Orange
Tons:	.0458
Category:	Hydrocarbon solvents (benzene, hexane, Stoddard, etc.)
Disposal Method:	Transfer Station
Contact:	JON PATTERSON
Telephone:	(805) 251-5300
Mailing Address:	26778 OAK AVE CANYON COUNTRY, CA 91351 - 2409
County	Los Angeles

M82
East
> 1
5456 ft.
Higher

WINNERS CIRCLE AUTO PATRS
26786 OAK AVE
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S103945461**
N/A

Site 7 of 11 in cluster M

HMS:

Facility Id:	020069-028610		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

M83
East
> 1
5459 ft.
Higher

HOBBY SHOP
26790 OAK AVE
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S103945462**
N/A

Site 8 of 11 in cluster M

HMS:

Facility Id:	020070-028611		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number
M84 **East** **> 1** **5460 ft.** **Higher**	**HONEST JOHN'S EVO'S ETC** **26792 OAK AVE** **SANTA CLARITA, CA** **Site 9 of 11 in cluster M**	**LOS ANGELES CO. HMS**	**S102064465** **N/A**

HMS:

Facility Id:	016641-022157		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number
M85 **East** **> 1** **5462 ft.** **Higher**	**VIP AUTO REPAIR** **26794 OAK AVE** **SANTA CLARITA, CA 91351** **Site 10 of 11 in cluster M**	**HAZNET**	**S104581660** **N/A**

HAZNET:

Gepaid: CAL000189794
Tepaid: CAD981696420
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2293
Category: Aqueous solution with less than 10% total organic residues
Disposal Method: Transfer Station
Contact: FRED GARZA
Telephone: (000) 000-0000
Mailing Address: 26794 OAK AVE
SANTA CLARITA, CA 91351
County Los Angeles

Gepaid: CAL000189794
Tepaid: CAD981696420
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 0.4586
Category: Aqueous solution with less than 10% total organic residues
Disposal Method: Transfer Station
Contact: FRED GARZA
Telephone: (000) 000-0000
Mailing Address: 26794 OAK AVE
SANTA CLARITA, CA 91351
County Los Angeles

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number
M86 **East** **> 1** **5464 ft.** **Higher**	**NATIONAL METAL STAMPINGS INC** **26796 OAK AVENUE** **CANYON COUNTRY, CA 91351** **Site 11 of 11 in cluster M**	**RCRIS-SQG** **FINDS**	**1000260515** **CAD981652225**

NATIONAL METAL STAMPINGS INC (Continued) **1000260515**

RCRIS:
Owner: BILL & JEAN BLOOMER
(415) 555-1212
EPA ID: CAD981652225
Contact: ENVIRONMENTAL MANAGER
(805) 251-5141
Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported
Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

O87 **East** **> 1** **5470 ft.** **Higher**	**VP MANUFACTURING INC** **20732 SOLEDAD ST** **SANTA CLARITA, CA 91351** **Site 1 of 9 in cluster O**	**HAZNET**	**S103640949** **N/A**

HAZNET:
Gepaid: CAL000179066
Tepaid: CAD000088252
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .1000
Category: Unspecified oil-containing waste
Disposal Method: Transfer Station
Contact: VP MANUFACTURING INC
Telephone: (805) 298-2632
Mailing Address: 20732 SOLEDAD ST
CANYON COUNTRY, CA 91351 - 2420
County Los Angeles

Gepaid: CAL000179066
Tepaid: CAT080033681
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .0050
Category: Liquids with pH <UN-> 2
Disposal Method: Recycler
Contact: VP MANUFACTURING INC
Telephone: (805) 298-2632
Mailing Address: 20732 SOLEDAD ST
CANYON COUNTRY, CA 91351 - 2420
County Los Angeles

VP MANUFACTURING INC (Continued) **S103640949**

Gepaid:	CAL000179066
Tepaid:	CAD008252405
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.0750
Category:	Unspecified organic liquid mixture
Disposal Method:	Recycler
Contact:	VP MANUFACTURING INC
Telephone:	(805) 298-2632
Mailing Address:	20732 SOLEDAD ST CANYON COUNTRY, CA 91351 - 2420
County	Los Angeles

Gepaid:	CAL000179066
Tepaid:	CAT080033681
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.0065
Category:	Other organic solids
Disposal Method:	Disposal, Land Fill
Contact:	VP MANUFACTURING INC
Telephone:	(805) 298-2632
Mailing Address:	20732 SOLEDAD ST CANYON COUNTRY, CA 91351 - 2420
County	Los Angeles

Gepaid:	CAL000179066
Tepaid:	CAD008252405
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.0500
Category:	Liquids with halogenated organic compounds > 1000 mg/l
Disposal Method:	Recycler
Contact:	VP MANUFACTURING INC
Telephone:	(805) 298-2632
Mailing Address:	20732 SOLEDAD ST CANYON COUNTRY, CA 91351 - 2420
County	Los Angeles

O88
East
> 1
5474 ft.
Higher

VP MFG, INC.
20732 SOLEDAD ST A
SANTA CLARITA, CA

Site 2 of 9 in cluster O

LOS ANGELES CO. HMS **S103945036**
N/A

HMS:

Facility Id:	020305-028893		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

O89
East
> 1
5477 ft.
Higher

SENSORTECH SYSTEMS INC
26810-I OAK AVE
SANTA CLARITA, CA 91351

Site 3 of 9 in cluster O

HAZNET **S103987389**
N/A

SENSORTECH SYSTEMS INC (Continued) **S103987389**

HAZNET:
Gepaid: CAC001361840
Tepaid: CAD008252405
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .1876
Category: Oxygenated solvents (acetone, butanol, ethyl acetate, etc.)
Disposal Method: Recycler
Contact: SENSORTECH SYSTEMS INC
Telephone: (805) 252-1103
Mailing Address: 26810-I OAK AVE
SANTA CLARITA, CA 91351
County Los Angeles

O90 **AMERICAN UNITED INC** **HAZNET** **S104572896**
East **20730 SOLEDAD ST** **N/A**
> 1 **SANTA CLARITA, CA 91351**
5478 ft.
Higher **Site 4 of 9 in cluster O**

HAZNET:
Gepaid: CAC002228521
Tepaid: CAT080022148
Gen County: Los Angeles
Tsd County: San Bernardino
Tons: 0.1668
Category: Hydrocarbon solvents (benzene, hexane, Stoddard, etc.)
Disposal Method: Transfer Station
Contact: AMERICAN UNITED INC
Telephone: (805) 297-2979
Mailing Address: 20730 SOLEDAD ST
SANTA CLARITA, CA 91351
County Los Angeles

K91 **HONDA OUTPOST** **RCRIS-SQG** **1000596599**
East **26724 OAK AVE UNIT C** **FINDS** **CAD983605734**
> 1 **CANYON COUNTRY, CA 91351**
5482 ft.
Higher **Site 8 of 8 in cluster K**

RCRIS:
Owner: JEFFREY D MILLER
(805) 252-5553
EPA ID: CAD983605734

Contact: JEFF MILLER
(805) 298-8874

Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

HONDA OUTPOST (Continued) **1000596599**

Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

O92
East
> 1
5485 ft.
Higher

AV BREAK SUPPLY
26818 OAK AVE E
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S103945465** **N/A**

Site 5 of 9 in cluster O

HMS:

Facility Id:	020073-028614		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

P93
SE
> 1
5488 ft.
Higher

HART UNION HIGH SCHOOL DISTRICT
21429 REDVIEW DR
SANTA CLARITA, CA 91350

HAZNET **S100863745** **N/A**

Site 1 of 4 in cluster P

HAZNET:

Gepaid:	CAL000072887
Tepaid:	CAT080013352
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	19.1820
Category:	Unspecified oil-containing waste
Disposal Method:	Not reported
Contact:	Not reported
Telephone:	(000) 000-0000
Mailing Address:	21429 REDVIEW DR SANTA CLARITA, CA 91350
County	Los Angeles

Gepaid:	CAL000072887
Tepaid:	CAT080013352
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	42.1170
Category:	Unspecified oil-containing waste
Disposal Method:	Recycler
Contact:	Not reported
Telephone:	(000) 000-0000
Mailing Address:	21429 REDVIEW DR SANTA CLARITA, CA 91350
County	Los Angeles

HART UNION HIGH SCHOOL DISTRICT (Continued) **S100863745**

Gepaid: CAL000072887
Tepaid: CAD050806850
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2376
Category: Detergent and soap
Disposal Method: Transfer Station
Contact: Not reported
Telephone: (000) 000-0000
Mailing Address: 21429 REDVIEW DR
SANTA CLARITA, CA 91350
County Los Angeles

Gepaid: CAL000072887
Tepaid: CAD099452708
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 32.4759
Category: Oil/water separation sludge
Disposal Method: Transfer Station
Contact: Not reported
Telephone: (000) 000-0000
Mailing Address: 21429 REDVIEW DR
SANTA CLARITA, CA 91350
County Los Angeles

Gepaid: CAL000072887
Tepaid: CAD050806850
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .0965
Category: Laboratory waste chemicals
Disposal Method: Transfer Station
Contact: Not reported
Telephone: (000) 000-0000
Mailing Address: 21429 REDVIEW DR
SANTA CLARITA, CA 91350
County Los Angeles

The CA HAZNET database contains 22 additional records for this site.
Please contact your EDR Account Executive for more information.

P94 **WM HART UHSD - TRANSPORT DEPT** **UST** **U003776224**
SE **21429 REDVIEW DR** **N/A**
> 1 **SANTA CLARITA, CA 91350**
5488 ft.
Higher **Site 2 of 4 in cluster P**

State UST:
Facility ID: 8705
Total Tanks: 1
Region: STATE
Local Agency: 19000

P95 **WM S HART UNIFIED SCHOOL DIST** **RCRIS-SQG** **1000820110**
SE **21429 REDVIEW DR** **FINDS** **CAD983661349**
> 1 **SANTA CLARITA, CA 91350**
5488 ft.
Higher **Site 3 of 4 in cluster P**

WM S HART UNIFIED SCHOOL DIST (Continued) **1000820110**

RCRIS:
Owner: WM S HART UNIFIED HIGH SCHOOL DIST
(805) 259-0096
EPA ID: CAD983661349
Contact: GARY SMITH
(805) 259-0096
Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported
Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

P96
SE
> 1
5488 ft.
Higher

WS HART UNION HIGH SCH DT
21429 REDVIEW DR
SANTA CLARITA, CA

LOS ANGELES CO. HMS **U003063880**
N/A

Site 4 of 4 in cluster P

HMS:
Facility Id: 008184-I08705
Facility Type: I01
Permit Number: 000009868 Permit Status: Permit
Facility Status: Permit Area: 7A
Region: Los Angeles County:

Q97
ENE
> 1
5502 ft.
Higher

QUALITY PAPER FIBERS, INC
20833 SANTA CLARA ST
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S103945041**
N/A

Site 1 of 4 in cluster Q

HMS:
Facility Id: 020255-028837
Facility Type: Not reported
Permit Number: Not reported Permit Status: Not reported
Facility Status: OPEN Area: 7A
Region: Los Angeles County:

Q98
ENE
> 1
5510 ft.
Higher

RENT A BIN
20830 SANTA CLARA ST
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S103945040**
N/A

Site 2 of 4 in cluster Q

HMS:
Facility Id: 020254-028835
Facility Type: Not reported
Permit Number: Not reported Permit Status: Not reported
Facility Status: OPEN Area: 7A
Region: Los Angeles County:

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number
O99 **East** **> 1** **5522 ft.** **Higher**	**METAL WORKS** **26846 OAK AVENUE #K** **CANYON COUNTRY, CA 91351** **Site 6 of 9 in cluster O**	**HAZNET**	**S103648105** **N/A**

HAZNET:

Gepaid: CAL000055158
Tepaid: CAD008302903
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2085
Category: Paint sludge
Disposal Method: Recycler
Contact: BOB DALE
Telephone: (805) 251-8975
Mailing Address: 26846 OAK AVE #K
CANYON COUNTRY, CA 91351
County Los Angeles

Gepaid: CAL000055158
Tepaid: CAD008302903
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2168
Category: Paint sludge
Disposal Method: Recycler
Contact: BOB DALE
Telephone: (805) 251-8975
Mailing Address: 26846 OAK AVE #K
CANYON COUNTRY, CA 91351
County Los Angeles

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number
O100 **East** **> 1** **5530 ft.** **Higher**	**STUDIO CITY SPORTS CARS** **26846 OAK AVE BLDG 5** **CANYON COUNTRY, CA 91351** **Site 7 of 9 in cluster O**	**RCRIS-SQG** **FINDS**	**1000595472** **CAD983594094**

RCRIS:

Owner: JOHN MATTINGLY
(415) 555-1212
EPA ID: CAD983594094

Contact: DARIN SHAUER
(805) 298-3887

Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

Violation Status: No violations found

FINDS:

Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number

O101 **East** **> 1** **5530 ft.** **Higher**

RESTORATIONS PLUS
26846 OAK AVENUE UNIT "R"
CANYON COUNTRY, CA 91351

HAZNET — **S103984166** **N/A**

Site 8 of 9 in cluster O

HAZNET:
- Gepaid: CAL000045245
- Tepaid: CAD980887418
- Gen County: Los Angeles
- Tsd County: 1
- Tons: 10.8420
- Category: Waste oil and mixed oil
- Disposal Method: Recycler
- Contact: NEWARK ANTHONY C
- Telephone: (000) 000-0000
- Mailing Address: 26846 OAK AVE STE R
  CANYON COUNTRY, CA 91351 - 2401
- County: Los Angeles

O102 **East** **> 1** **5541 ft.** **Higher**

G W FRANZ GRINDING
26818 OAK AVE UNIT L
CANYON COUNTRY, CA 91351

RCRIS-SQG **FINDS** **HAZNET** — **1000819973** **CAD983659921**

Site 9 of 9 in cluster O

RCRIS:
- Owner: GEORGE FRANZ
  (805) 252-0836
- EPA ID: CAD983659921
- Contact: GEORGE FRANZ
  (805) 252-0836
- Classification: Small Quantity Generator
- Used Oil Recyc: No
- TSDF Activities: Not reported
- Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

HAZNET:
- Gepaid: CAD983659921
- Tepaid: CAD099452708
- Gen County: Los Angeles
- Tsd County: Los Angeles
- Tons: 2.0433
- Category: Oil/water separation sludge
- Disposal Method: Recycler
- Contact: GEORGE FRANZ
- Telephone: (000) 000-0000
- Mailing Address: 26818 OAK AVE UNIT L
  CANYON COUNTRY, CA 91351
- County: Los Angeles

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

G W FRANZ GRINDING (Continued) **1000819973**

Gepaid: CAD983659921
Tepaid: CAD982444481
Gen County: Los Angeles
Tsd County: San Bernardino
Tons: 0.2293
Category: Unspecified oil-containing waste
Disposal Method: Recycler
Contact: GEORGE FRANZ
Telephone: (000) 000-0000
Mailing Address: 26818 OAK AVE UNIT L
CANYON COUNTRY, CA 91351
County Los Angeles

Gepaid: CAD983659921
Tepaid: CAT000613976
Gen County: Los Angeles
Tsd County: Orange
Tons: .2502
Category: Liquids with halogenated organic compounds > 1000 mg/l
Disposal Method: Transfer Station
Contact: GEORGE FRANZ
Telephone: (000) 000-0000
Mailing Address: 26818 OAK AVE UNIT L
CANYON COUNTRY, CA 91351
County Los Angeles

R103 West > 1 5584 ft. Lower

POPPIS
22903 W SOLEDAD CANYON RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **U003062543** **N/A**

Site 1 of 6 in cluster R

HMS:
Facility Id: 006675-106899
Facility Type: Not reported
Permit Number: Not reported — Permit Status: Not reported
Facility Status: OPEN — Area: 7A
Region: Los Angeles County:

R104 West > 1 5584 ft. Lower

SPORTS BAR & GRILL
22903 W SOLEDAD CANYON RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S102064159** **N/A**

Site 2 of 6 in cluster R

HMS:
Facility Id: 006675-020528
Facility Type: Not reported
Permit Number: Not reported — Permit Status: Not reported
Facility Status: OPEN — Area: 7A
Region: Los Angeles County:

S105 East > 1 5584 ft. Higher

SANTA CLARITA WATER CO
21110 GOLDEN TRIANGLE
SANTA CLARITA, CA 91350

HAZNET **LOS ANGELES CO. HMS** **S102064053** **N/A**

Site 1 of 2 in cluster S

SANTA CLARITA WATER CO (Continued) **S102064053**

HAZNET:

Gepaid: CAL000180921
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .7297
Category: Unspecified oil-containing waste
Disposal Method: Recycler
Contact: SANTA CLARITA WATER CO
Telephone: (805) 255-8223
Mailing Address: PO BOX 903
SANTA CLARITA, CA 91380
County Los Angeles

Gepaid: CAL000180921
Tepaid: CAD008252405
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2875
Category: Paint sludge
Disposal Method: Recycler
Contact: SANTA CLARITA WATER CO
Telephone: (805) 255-8223
Mailing Address: PO BOX 903
SANTA CLARITA, CA 91380
County Los Angeles

Gepaid: CAL000180921
Tepaid: CAD982444481
Gen County: Los Angeles
Tsd County: San Bernardino
Tons: .1500
Category: Other organic solids
Disposal Method: Transfer Station
Contact: SANTA CLARITA WATER CO
Telephone: (805) 255-8223
Mailing Address: PO BOX 903
SANTA CLARITA, CA 91380
County Los Angeles

Gepaid: CAL000180921
Tepaid: CAD099452708
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2085
Category: Waste oil and mixed oil
Disposal Method: Recycler
Contact: SANTA CLARITA WATER CO
Telephone: (805) 255-8223
Mailing Address: PO BOX 903
SANTA CLARITA, CA 91380
County Los Angeles

SANTA CLARITA WATER CO (Continued) **S102064053**

Gepaid: CAC000766536
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .1459
Category: Tank bottom waste
Disposal Method: Recycler
Contact: SANTA CLARITA WATER CO
Telephone: (805) 255-8223
Mailing Address: PO BOX 903
SANTA CLARITA, CA 91380
County Los Angeles

HMS:
Facility Id: 012852-013067
Facility Type: T0
Permit Number: 00005251T Permit Status: Permit
Facility Status: Permit Area: 7A
Region: Los Angeles County:

Facility Id: 015539-017013
Facility Type: T0
Permit Number: 0000T6381 Permit Status: Removed
Facility Status: Removed Area: 7A
Region: Los Angeles County:

S106
East
> 1
5584 ft.
Higher

SANTA CLARITA WATER CO
21110 GOLDEN TRIANGLE RD
SANTA CLARITA, CA 91350

UST **U003777086** **N/A**

Site 2 of 2 in cluster S

State UST:
Facility ID: 13067
Total Tanks: 1
Region: STATE
Local Agency: 19000

Q107
ENE
> 1
5601 ft.
Higher

D K TRUCKING
20811 SANTA CLARA ST
CANYON COUNTRY, CA 91351

RCRIS-SQG **FINDS** **HAZNET** **1000595471** **CAD983594086**

Site 3 of 4 in cluster Q

RCRIS:
Owner: C JILL NIXON
(415) 555-1212
EPA ID: CAD983594086

Contact: C NIXON
(805) 252-3700

Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

D K TRUCKING (Continued) **1000595471**

Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

HAZNET:

Gepaid:	CAD983594086
Tepaid:	CAD099452708
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	1.6680
Category:	Waste oil and mixed oil
Disposal Method:	Recycler
Contact:	C JILL NIXON
Telephone:	(415) 555-1212
Mailing Address:	20811 SANTA CLARA CANYON COUNTRY, CA 91351
County	Los Angeles

Q108
ENE
> 1
5601 ft.
Higher

D & K TRUCKING INC **HAZNET** **S104577396**
20811 SANTA CLARA ST **N/A**
CANYON COUNTRY, CA 91351

Site 4 of 4 in cluster Q

HAZNET:

Gepaid:	CAL000081456
Tepaid:	CAT000613893
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.0625
Category:	Organic liquids with metals Alkaline solution (pH <UN-> 12.5) with metals (antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc)
Disposal Method:	Transfer Station
Contact:	D & K TRUCKING INC
Telephone:	(000) 000-0000
Mailing Address:	20811 SANTA CLARA ST CANYON COUNTRY, CA 91351
County	Los Angeles

T109
NW
> 1
5630 ft.
Lower

SAFEWAY STORES INC #1024 **LOS ANGELES CO. HMS** **U003062140**
26877 BOUQUET CANYON RD **N/A**
SANTA CLARITA, CA

Site 1 of 2 in cluster T

HMS:

Facility Id:	006195-I06411		
Facility Type:	I00		
Permit Number:	000010785	Permit Status:	Closed
Facility Status:	Closed	Area:	7A
Region:	Los Angeles County:		

Map ID
Direction
Distance
Distance (ft.)
Elevation | Site | Database(s) | EDR ID Number / EPA ID Number

R110 **MANDARIN EXPRESS** **LOS ANGELES CO. HMS** **S104538368**
West **22911 W SOLEDAD CANYON RD** **N/A**
> 1 **SANTA CLARITA, CA**
5634 ft.
Lower **Site 3 of 6 in cluster R**

HMS:

Facility Id:	007913-I08382		
Facility Type:	I02		
Permit Number:	000010793	Permit Status:	Closed
Facility Status:	Closed	Area:	7A
Region:	Los Angeles County:		
Facility Id:	007913-022127		
Facility Type:	I01		
Permit Number:	000133192	Permit Status:	Closed
Facility Status:	Closed	Area:	7A
Region:	Los Angeles County:		
Facility Id:	007913-025306		
Facility Type:	I01		
Permit Number:	000220727	Permit Status:	Suspended
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

R111 **MADARIN EXPRESS** **LOS ANGELES CO. HMS** **U002281550**
West **22911 W SOLEDAD CANYON RD** **N/A**
> 1 **SANTA CLARITA, CA**
5634 ft.
Lower **Site 4 of 6 in cluster R**

HMS:

Facility Id:	007913-008382		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

R112 **PEARSON AND CO** **LOS ANGELES CO. HMS** **S105193895**
West **22911 W SOLEDAD CANYON RD** **N/A**
> 1 **SANTA CLARITA, CA**
5634 ft.
Lower **Site 5 of 6 in cluster R**

HMS:

Facility Id:	007913-036549		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

R113 **NUMERO UNO #52** **LOS ANGELES CO. HMS** **U003063511**
West **22917 W SOLEDAD CANYON RD** **N/A**
> 1 **SANTA CLARITA, CA**
5667 ft.
Lower **Site 6 of 6 in cluster R**

HMS:

Facility Id:	007762-I08203
Facility Type:	I02

NUMERO UNO #52 (Continued) **U003063511**

Permit Number:	000009253	Permit Status:	Closed
Facility Status:	Closed	Area:	7A
Region:	Los Angeles County:		

114
ESE
> 1
5686 ft.
Higher

INSPECTORS PAINT & BODY
26516 GOLDEN VALLEY RD 310
SANTA CLARITA, CA

LOS ANGELES CO. HMS **U003064484** **N/A**

HMS:

Facility Id:	008871-I16496		
Facility Type:	I01		
Permit Number:	000012388	Permit Status:	Closed
Facility Status:	Closed	Area:	7A
Region:	Los Angeles County:		

T115
NW
> 1
5714 ft.
Lower

COUSINS BURGERS
26851 N BOUQUET CANYON RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S104913316** **N/A**

Site 2 of 2 in cluster T

HMS:

Facility Id:	026468-036131		
Facility Type:	I01		
Permit Number:	000327349	Permit Status:	Permit
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

116
East
> 1
5785 ft.
Higher

SOLEDAD CANYON/REUTHER
SANTA CLARITA, CA

CHMIRS **S100278980** **N/A**

CHMIRS:

OES Control Number:	8802950	DOT ID:	Not reported
DOT Hazard Class:	Not Reported		
Chemical Name:	ACID		
Extent of Release:	Not reported		
CAS Number:	Not reported	Quantity Released:	Not reported
Environmental Contamination:	None Reported	Property Use:	County/City Road
Incident Date:	19-SEP-88	Date Completed:	19-SEP-88

Time Completed :	1258
Physical State Stored :	Liquid
Physical State Released :	Not reported
Release Unit :	Not reported
Container Description :	2
Container Type :	04
Container Material :	Plastic , Flexible
Level Of Container :	0
Container Capacity :	1
Container Capacity Units (code) :	2
Extent Of Release (code) :	8
Agency Id Number :	19110
Agency Incident Number :	0A-27
OES Incident Number :	8802950

(Continued) **S100278980**

Time Notified :	1058
Surrounding Area :	500
Estimated Temperature :	80
Property Management :	K
More Than Two Substances Involved? :	Not reported
Special Studies 1 :	Not reported
Special Studies 2 :	Not reported
Special Studies 3 :	Not reported
Special Studies 4 :	Not reported
Special Studies 5 :	Not reported
Special Studies 6 :	Not reported
Responding Agency Personel # Of Injuries :	Not reported
Responding Agency Personel # Of Fatalities :	Not reported
Resp Agncy Personel # Of Decontaminated :	Not reported
Others Number Of Decontaminated :	Not reported
Others Number Of Injuries :	Not reported
Others Number Of Fatalities :	Not reported
Vehicle Make/year :	Not reported
Vehicle License Number :	Not reported
Vehicle State :	Not reported
Vehicle Id Number :	Not reported
CA/DOT/PUC/ICC Number :	Not reported
Company Name :	Not reported
Reporting Officer Name/ID :	CAPT. LYNN MOHR HM-76)
Report Date :	19-SEP-88
Comments :	Yes
Facility Telephone Number :	213 267-2485

U117 **RITE AID NO 5555** **RCRIS-SQG** **1000857175**
NW **26825 BOUQUET CYN RD** **FINDS** **CA0000068890**
> 1 **SAUGUS, CA 91350** **HAZNET**
5791 ft.
Lower **Site 1 of 8 in cluster U**

RCRIS:

Owner:	RITE AID (717) 761-2633
EPA ID:	CA0000068890
Contact:	GAIL RATAJCZAK (800) 769-5845
Classification:	Small Quantity Generator
Used Oil Recyc:	No
TSDF Activities:	Not reported
Violation Status:	No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

RITE AID NO 5555 (Continued) **1000857175**

HAZNET:

Gepaid:	CA0000068890
Tepaid:	CAT000613976
Gen County:	Los Angeles
Tsd County:	Orange
Tons:	.0427
Category:	Photochemicals/photoprocessing waste
Disposal Method:	Transfer Station
Contact:	RITE AID CORP
Telephone:	(717) 761-2633
Mailing Address:	4020 STIRRUP CREEK DRIVE SUITE 211 DURHAM, NC 27703 - 3165
County	Los Angeles

Gepaid:	CA0000068890
Tepaid:	CAD981402522
Gen County:	Los Angeles
Tsd County:	Kern
Tons:	.0300
Category:	Photochemicals/photoprocessing waste
Disposal Method:	Recycler
Contact:	RITE AID CORP
Telephone:	(717) 761-2633
Mailing Address:	4020 STIRRUP CREEK DRIVE SUITE 211 DURHAM, NC 27703 - 3165
County	Los Angeles

Gepaid:	CA0000068890
Tepaid:	CAD981402522
Gen County:	Los Angeles
Tsd County:	Kern
Tons:	3.0355
Category:	Photochemicals/photoprocessing waste
Disposal Method:	Recycler
Contact:	RITE AID CORP
Telephone:	(717) 761-2633
Mailing Address:	4020 STIRRUP CREEK DRIVE SUITE 211 DURHAM, NC 27703 - 3165
County	Los Angeles

Gepaid:	CA0000068890
Tepaid:	CAT000613976
Gen County:	Los Angeles
Tsd County:	Orange
Tons:	.1678
Category:	Photochemicals/photoprocessing waste
Disposal Method:	Transfer Station
Contact:	RITE AID CORP
Telephone:	(717) 761-2633
Mailing Address:	4020 STIRRUP CREEK DRIVE SUITE 211 DURHAM, NC 27703 - 3165
County	Los Angeles

RITE AID NO 5555 (Continued) **1000857175**

Gepaid:	CA0000068890
Tepaid:	CAT000613976
Gen County:	Los Angeles
Tsd County:	Orange
Tons:	.0035
Category:	
Disposal Method:	Transfer Station
Contact:	RITE AID CORP
Telephone:	(717) 761-2633
Mailing Address:	4020 STIRRUP CREEK DRIVE SUITE 211 DURHAM, NC 27703 - 3165
County	Los Angeles

The CA HAZNET database contains 4 additional records for this site.
Please contact your EDR Account Executive for more information.

U118
NW
> 1
5838 ft.
Lower

LEON A. THOMPSON
26801 BOUQUET CANYON RD
SAUGUS, CA 91350

Site 2 of 8 in cluster U

HIST UST **U001567706** **N/A**

UST HIST:

Facility ID:	55591		
Tank Num:	1	Container Num:	1
Tank Capacity:	12000	Year Installed:	1982
Tank Used for:	PRODUCT		
Type of Fuel:	DIESEL	Tank Construction:	1/4 inches
Leak Detection:	Stock Inventor, GW Monitoring Well		
Contact Name:	Not reported	Telephone:	(805) 259-9797
Total Tanks:	4	Region:	STATE
Facility Type:	1	Other Type:	Not reported

Facility ID:	55591		
Tank Num:	2	Container Num:	2
Tank Capacity:	10000	Year Installed:	1982
Tank Used for:	PRODUCT		
Type of Fuel:	UNLEADED	Tank Construction:	1/4 inches
Leak Detection:	Stock Inventor, GW Monitoring Well		
Contact Name:	Not reported	Telephone:	(805) 259-9797
Total Tanks:	4	Region:	STATE
Facility Type:	1	Other Type:	Not reported

Facility ID:	55591		
Tank Num:	3	Container Num:	3
Tank Capacity:	10000	Year Installed:	1982
Tank Used for:	PRODUCT		
Type of Fuel:	REGULAR	Tank Construction:	1/4 inches
Leak Detection:	Stock Inventor, GW Monitoring Well		
Contact Name:	Not reported	Telephone:	(805) 259-9797
Total Tanks:	4	Region:	STATE
Facility Type:	1	Other Type:	Not reported

Facility ID:	55591		
Tank Num:	4	Container Num:	4
Tank Capacity:	10000	Year Installed:	1982
Tank Used for:	PRODUCT		
Type of Fuel:	PREMIUM	Tank Construction:	1/4 inches

LEON A. THOMPSON (Continued) **U001567706**

Leak Detection:	Stock Inventor, GW Monitoring Well		
Contact Name:	Not reported	Telephone:	(805) 259-9797
Total Tanks:	4	Region:	STATE
Facility Type:	1	Other Type:	Not reported

U119
NW
> 1
5838 ft.
Lower

BOUQUET CANYON SHELL — **LOS ANGELES CO. HMS** — **S103392973** / **N/A**
26801 N BOUQUET CANYON RD
SANTA CLARITA, CA

Site 3 of 8 in cluster U

HMS:

Facility Id:	006245-026426		
Facility Type:	T0		
Permit Number:	000228928	Permit Status:	Permit
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		
Facility Id:	019946-028464		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

U120
NW
> 1
5838 ft.
Lower

SHELL — **Cortese** — **S105026546** / **N/A**
26801 BOUQUET CANYON RD
SAUGUS, CA 91350

Site 4 of 8 in cluster U

CORTESE:

Reg Id: I-06462
Region: CORTESE
Reg By: Leaking Underground Storage Tanks

U121
NW
> 1
5838 ft.
Lower

SHELL SERVICE STATION — **RCRIS-SQG** — **1005441238** / **CAR000117010**
26801 BOQUET CANYON ROAD
SAUGUS, CA 91350

Site 5 of 8 in cluster U

RCRIS:

Owner: EQUILON ENT LLC DBA S O P US
(713) 241-5036
EPA ID: CAR000117010
Contact: SONDRA BIENVENU
(713) 241-5036
Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

SHELL SERVICE STATION (Continued) **1005441238**

Violation Status: No violations found

U122 **SHELL** **LUST** **S102436873**
NW **26801 BOUQUET CANYON RD** **HAZNET** **N/A**
> 1 **SAUGUS, CA 91350**
5838 ft.
Lower **Site 6 of 8 in cluster U**

State LUST:

Cross Street:	SECO		
Qty Leaked:	Not reported		
Case Number	I-06462A		
Reg Board:	4		
Chemical:	Gasoline		
Lead Agency:	Regional Board		
Local Agency :	19000		
Case Type:	Soil only		
Status:	Not reported		
County:	Los Angeles		
Review Date:	Not reported	Confirm Leak:	Not reported
Workplan:	10/29/01	Prelim Assess:	10/29/01
Pollution Char:	1/20/92	Remed Plan:	1/20/92
Remed Action:	Not reported	Monitoring:	Not reported
Close Date:	7/30/96		
Release Date:	Not reported		
Cleanup Fund Id :	Not reported		
Discover Date :	10/24/01		
Enforcement Dt :	Not reported		
Enf Type:	Not reported		
Enter Date :	Not reported		
Funding:	Not reported		
Staff Initials:	Not reported		
How Discovered:	Other Means		
How Stopped:	Other Means		
Interim :	Not reported		
Leak Cause:	Unknown		
Leak Source:	Unknown		
MTBE Date :	Not reported		
Max MTBE GW :	Not reported		
MTBE Tested:	Site NOT Tested for MTBE.Includes Unknown and Not Analyzed.		
Priority:	Not reported		
Local Case # :	Not reported		
Beneficial:	Not reported		
Staff :	JLC		
GW Qualifies :	Not reported		
Max MTBE Soil :	Not reported		
Soil Qualifies :	Not reported		
Hydr Basin #:	Not reported		
Operator :	Not reported		
Oversight Prgm:	RB Lead Underground Storage Tank		
Oversight Prgm :	UST		
Review Date :	10/16/96		
Stop Date :	11/30/88		
Work Suspended :	Not reported		
Responsible Party	SHELL OIL CO.		
RP Address:	P.O. BOX 4848, ANAHEIM, CA 92803	D	
Global Id:	T0603703215		
Org Name:	Not reported		

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

SHELL (Continued) **S102436873**

Contact Person: Not reported
MTBE Conc: 0
Mtbe Fuel: Not reported
Water System Name: SANTA CLARITA WATER CO
Well Name: METHODIST
Distance To Lust: 850.8236944
Waste Discharge Global ID: Not reported
Waste Disch Assigned Name: Not reported

LUST Region 4:
Report Date: 5/1/1989
Lead Agency: Regional Board
Local Agency: 19000
Case Number: I-06462
Substance: Gasoline
Case Type: Soil
Status: Case Closed
Region: 4
Staff: Not reported

HAZNET:
Gepaid: CAL000162212
Tepaid: CAD982484933
Gen County: Los Angeles
Tsd County: 7
Tons: .6500
Category: Empty containers less than 30 gallons
Disposal Method: Disposal, Other
Contact: EQUILON ENTERPRISES LLC
Telephone: (713) 241-2258
Mailing Address: PO BOX 4453
HOUSTON, TX 77210 - 4453
County Los Angeles

U123
NW
> 1
5838 ft.
Lower

BOUQUET CANYON SHELL — **UST** — **U003778043** / **N/A**
26801 BOUQUET CANYON RD
SANTA CLARITA, CA 91350

Site 7 of 8 in cluster U

State UST:
Facility ID: 26426
Total Tanks: 1
Region: STATE
Local Agency: 19000

U124
NW
> 1
5838 ft.
Lower

SHELL OIL #204-7050/CAR WASH — **LOS ANGELES CO. HMS** — **S102064466** / **N/A**
26801 N BOUQUET CANYON RD
SANTA CLARITA, CA

Site 8 of 8 in cluster U

HMS:
Facility Id: 006245-I06462
Facility Type: I01
Permit Number: 00009816A — Permit Status: Permit
Facility Status: Permit — Area: 7A
Region: Los Angeles County:

SHELL OIL #204-7050/CAR WASH (Continued) **S102064466**

Facility Id:	006245-006462		
Facility Type:	T0		
Permit Number:	00000583T	Permit Status:	Closed
Facility Status:	Closed	Area:	7A
Region:	Los Angeles County:		

V125
ESE
> 1
5870 ft.
Higher

INSPECTOR'S PAINT & BODY
26516 GOLDEN VALLEY RD #209
CANYON COUNTRY, CA 91350

HAZNET **S103647889**
N/A

Site 1 of 13 in cluster V

HAZNET:

Gepaid:	CAL000044888
Tepaid:	CAD008252405
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	0.4503
Category:	Unspecified solvent mixture Waste
Disposal Method:	Recycler
Contact:	INDERBITZIN TONY
Telephone:	(000) 000-0000
Mailing Address:	26516 GOLDEN VALLEY RD #310 SANTA-CLARITA, CA 91350
County	Los Angeles

Gepaid:	CAL000044888
Tepaid:	CAD008252405
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.5086
Category:	Unspecified solvent mixture Waste
Disposal Method:	Recycler
Contact:	INDERBITZIN TONY
Telephone:	(000) 000-0000
Mailing Address:	26516 GOLDEN VALLEY RD #310 SANTA-CLARITA, CA 91350
County	Los Angeles

Gepaid:	CAL000044888
Tepaid:	CAD008252405
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.3127
Category:	Unspecified solvent mixture Waste
Disposal Method:	Recycler
Contact:	INDERBITZIN TONY
Telephone:	(000) 000-0000
Mailing Address:	26516 GOLDEN VALLEY RD #310 SANTA-CLARITA, CA 91350
County	Los Angeles

INSPECTOR'S PAINT & BODY (Continued) **S103647889**

Gepaid: CAL000044888
Tepaid: CAD008252405
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .5003
Category: Unspecified solvent mixture Waste
Disposal Method: Recycler
Contact: INDERBITZIN TONY
Telephone: (000) 000-0000
Mailing Address: 26516 GOLDEN VALLEY RD #310
SANTA-CLARITA, CA 91350
County Los Angeles

Gepaid: CAL000044888
Tepaid: CAD008252405
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .0667
Category: Unspecified solvent mixture Waste
Disposal Method: Recycler
Contact: INDERBITZIN TONY
Telephone: (000) 000-0000
Mailing Address: 26516 GOLDEN VALLEY RD #310
SANTA-CLARITA, CA 91350
County Los Angeles

V126 **CLASSIC UPHOLSTERY** **LOS ANGELES CO. HMS** **S103945437**
ESE **26524 GOLDEN VALLEY RD** **N/A**
> 1 **SANTA CLARITA, CA**
5882 ft.
Higher **Site 2 of 13 in cluster V**

HMS:
Facility Id: 019978-028500
Facility Type: Not reported
Permit Number: Not reported Permit Status: Not reported
Facility Status: OPEN Area: 7A
Region: Los Angeles County:

W127 **HUGHES MARKETS INC** **LOS ANGELES CO. HMS** **S104536197**
WNW **26550 N BOUQUET CANYON RD** **N/A**
> 1 **SANTA CLARITA, CA**
5893 ft.
Lower **Site 1 of 9 in cluster W**

HMS:
Facility Id: 007676-I08100
Facility Type: I01
Permit Number: 000009146 Permit Status: Closed
Facility Status: Closed Area: 7A
Region: Los Angeles County:

W128 **SAV ON 9722** **HAZNET** **S105092268**
WNW **26550 BOUQUET CANYON RD** **N/A**
> 1 **SAUGUS, CA 91350**
5893 ft.
Lower **Site 2 of 9 in cluster W**

SAV ON 9722 (Continued) **S105092268**

HAZNET:
Gepaid: CAL000208013
Tepaid: CAD008364432
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .3252
Category: Alkaline solution without metals (pH > 12.5)
Disposal Method: Treatment, Tank
Contact: AMERICAN DRUG STORES INC
Telephone: (208) 395-5245
Mailing Address: PO BOX 20 DEPT 74100
BOISE, ID 83726
County Los Angeles

Gepaid: CAL000208013
Tepaid: COD991300484
Gen County: Los Angeles
Tsd County: 99
Tons: .0250
Category: Photochemicals/photoprocessing waste
Disposal Method: Transfer Station
Contact: AMERICAN DRUG STORES INC
Telephone: (208) 395-5245
Mailing Address: PO BOX 20 DEPT 74100
BOISE, ID 83726
County Los Angeles

W129
WNW
> 1
5893 ft.
Lower

CLARKS DRUGS 21
26550 BOUQET CANYON RD
SAUGUS, CA 91350

RCRIS-SQG **1000818980**
FINDS **CAD983649211**
HAZNET

Site 3 of 9 in cluster W

RCRIS:
Owner: CLARKS DRUGS
(310) 306-4435
EPA ID: CAD983649211
Contact: DAVID CLYMER
(310) 494-9474
Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported
Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

CLARKS DRUGS 21 (Continued) **1000818980**

HAZNET:

Gepaid: CAD983649211
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: 2.4311
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: CLARKS DRUGS
Telephone: (310) 306-4435
Mailing Address: 26550 BOUQUET CANYON RD
SANTA CLARITA, CA 91350 - 2353
County Los Angeles

Gepaid: CAD983649211
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .0475
Category: Metal sludge - Alkaline solution (pH <UN-> 12.5) with metals (antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc)
Disposal Method: Recycler
Contact: CLARKS DRUGS
Telephone: (310) 306-4435
Mailing Address: 26550 BOUQUET CANYON RD
SANTA CLARITA, CA 91350 - 2353
County Los Angeles

Gepaid: CAD983649211
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: 1.2093
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: CLARKS DRUGS
Telephone: (310) 306-4435
Mailing Address: 26550 BOUQUET CANYON RD
SANTA CLARITA, CA 91350 - 2353
County Los Angeles

Gepaid: CAD983649211
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .3753
Category: Photochemicals/photoprocessing waste
Disposal Method: Not reported
Contact: CLARKS DRUGS
Telephone: (310) 306-4435
Mailing Address: 26550 BOUQUET CANYON RD
SANTA CLARITA, CA 91350 - 2353
County Los Angeles

CLARKS DRUGS 21 (Continued) **1000818980**

Gepaid:	CAD983649211
Tepaid:	CAD981402522
Gen County:	Los Angeles
Tsd County:	Kern
Tons:	3.4777
Category:	Photochemicals/photoprocessing waste
Disposal Method:	Recycler
Contact:	CLARKS DRUGS
Telephone:	(310) 306-4435
Mailing Address:	26550 BOUQUET CANYON RD SANTA CLARITA, CA 91350 - 2353
County	Los Angeles

The CA HAZNET database contains 4 additional records for this site.
Please contact your EDR Account Executive for more information.

V130
ESE
> 1
5894 ft.
Higher

BABY YOUR CAR
26529 GOLDEN VALLEY RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S103945438** **N/A**

Site 3 of 13 in cluster V

HMS:

Facility Id:	019979-028501		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

X131
NW
> 1
5898 ft.
Lower

BOUQUET AUTO PARTS
26769 BOUQET CANYON RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S103945459** **N/A**

Site 1 of 7 in cluster X

HMS:

Facility Id:	019823-028294		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

W132
WNW
> 1
5898 ft.
Lower

SWENSENS BOUQUET CENTER
26586 N BOUQUET CANYON RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **U003063560** **N/A**

Site 4 of 9 in cluster W

HMS:

Facility Id:	007820-I08278		
Facility Type:	I02		
Permit Number:	000009359	Permit Status:	Closed
Facility Status:	Closed	Area:	7A
Region:	Los Angeles County:		

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number

W133 **WNW** **> 1** **5898 ft.** **Lower**

WENDYS HAMBURGERS
26538 N BOUQUET CANYON RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS — **U003063775** — **N/A**

Site 5 of 9 in cluster W

HMS:
Facility Id: 008061-I08566
Facility Type: I01
Permit Number: 000009451 — Permit Status: Permit
Facility Status: Permit — Area: 7A
Region: Los Angeles County:

V134 **ESE** **> 1** **5899 ft.** **Higher**

1X ANESCO MANUFACTURING PARTNERSHIP
26502 GOLDEN VALLEY ROAD,#107
SANTA CLARITA, CA 91350

HAZNET — **S103647875** — **N/A**

Site 4 of 13 in cluster V

HAZNET:
Gepaid: CAC000557696
Tepaid: CAD980883177
Gen County: Los Angeles
Tsd County: Kern
Tons: .4378
Category: Unspecified oil-containing waste
Disposal Method: Recycler
Contact: ANESCO MFG PARTNERSHIP
Telephone: (000) 000-0000
Mailing Address: 26502 GOLDEN VALLEY ROAD, STE
SANTA CLARITA, CA 91350
County Los Angeles

V135 **ESE** **> 1** **5899 ft.** **Higher**

JPS INC
26502 GOLDEN VALLEY RD #105
SAUGUS, CA 91350

HAZNET — **S103972794** — **N/A**

Site 5 of 13 in cluster V

HAZNET:
Gepaid: CAC001356056
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2293
Category: Waste oil and mixed oil
Disposal Method: Not reported
Contact: PAUL SHAPIRO PRESIDENT
Telephone: (805) 251-4241
Mailing Address: 26502 GOLDEN VALLEY RD #105
SAUGUS, CA 91350
County Los Angeles

JPS INC (Continued) **S103972794**

Gepaid: CAC001356056
Tepaid: CAD008302903
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2293
Category: Waste oil and mixed oil
Disposal Method: Recycler
Contact: PAUL SHAPIRO PRESIDENT
Telephone: (805) 251-4241
Mailing Address: 26502 GOLDEN VALLEY RD #105
SAUGUS, CA 91350
County Los Angeles

V136 **KAR BODY & PAINT INC** **HAZNET** **S103973038**
ESE **26502 GOLDEN VALLEY** **N/A**
> 1 **CANYON COUNTRY, CA 91351**
5899 ft.
Higher **Site 6 of 13 in cluster V**

HAZNET:
Gepaid: CAL000178646
Tepaid: CAD008302903
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2919
Category: Paint sludge
Disposal Method: Recycler
Contact: KAR BODY & PAINT INC
Telephone: (805) 298-1046
Mailing Address: 26502 GOLDEN VALLEY RD
SANTA CLARITA, CA 91350 - 2943
County Los Angeles

Gepaid: CAL000178646
Tepaid: CAT000613893
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .0180
Category: Oxygenated solvents (acetone, butanol, ethyl acetate, etc.)
Disposal Method: Transfer Station
Contact: KAR BODY & PAINT INC
Telephone: (805) 298-1046
Mailing Address: 26502 GOLDEN VALLEY RD
SANTA CLARITA, CA 91350 - 2943
County Los Angeles

Gepaid: CAL000178646
Tepaid: CAT000613893
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .0540
Category: Oxygenated solvents (acetone, butanol, ethyl acetate, etc.)
Disposal Method: Transfer Station
Contact: KAR BODY & PAINT INC
Telephone: (805) 298-1046
Mailing Address: 26502 GOLDEN VALLEY RD
SANTA CLARITA, CA 91350 - 2943
County Los Angeles

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number
Y137 WNW > 1 5905 ft. Lower	**CAMP BOUQUET CANYON 26590 N BOUQUET CANYON RD SANTA CLARITA, CA** **Site 1 of 3 in cluster Y**	**LOS ANGELES CO. HMS**	**U003060795 N/A**

HMS:

Facility Id:	004644-I04822		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

Y138 WNW > 1 5905 ft. Lower	**DISTRICT OFFICE 26590 BOUQUET CANYON RD SAUGUS, CA 91350** **Site 2 of 3 in cluster Y**	**HIST UST**	**U001567692 N/A**

UST HIST:

Facility ID:	29386		
Tank Num:	1	Container Num:	2
Tank Capacity:	2000	Year Installed:	1974
Tank Used for:	PRODUCT		
Type of Fuel:	REGULAR	Tank Construction:	Not reported
Leak Detection:	None		
Contact Name:	DR. JAMES M. FOSTER	Telephone:	(805) 259-1886
Total Tanks:	3	Region:	STATE
Facility Type:	2	Other Type:	OFFICE

Facility ID:	29386		
Tank Num:	2	Container Num:	1
Tank Capacity:	2000	Year Installed:	1974
Tank Used for:	PRODUCT		
Type of Fuel:	DIESEL	Tank Construction:	Not reported
Leak Detection:	None		
Contact Name:	DR. JAMES M. FOSTER	Telephone:	(805) 259-1886
Total Tanks:	3	Region:	STATE
Facility Type:	2	Other Type:	OFFICE

Facility ID:	29386		
Tank Num:	3	Container Num:	3
Tank Capacity:	500	Year Installed:	Not reported
Tank Used for:	PRODUCT		
Type of Fuel:	Not Reported	Tank Construction:	Not reported
Leak Detection:	None		
Contact Name:	DR. JAMES M. FOSTER	Telephone:	(805) 259-1886
Total Tanks:	3	Region:	STATE
Facility Type:	2	Other Type:	OFFICE

V139 ESE > 1 5906 ft. Higher	**SAUGUS UNION SD TRANSPORTATION 26501 GOLDEN VALLEY RD SANTA CLARITA, CA 91350** **Site 7 of 13 in cluster V**	**UST LOS ANGELES CO. HMS**	**U003777448 N/A**

HMS:

Facility Id:	016620-036312		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported

SAUGUS UNION SD TRANSPORTATION (Continued) **U003777448**

Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

State UST:

Facility ID:	22108
Total Tanks:	1
Region:	STATE
Local Agency:	19000

V140 **SAUGUS USD/TRANSPORTATION** **HAZNET** **S105090153**
ESE **26501 GOLDEN VALLEY ROAD** **N/A**
> 1 **CANYON COUNTRY, CA 91351**
5906 ft.
Higher **Site 8 of 13 in cluster V**

HAZNET:

Gepaid:	CAL000125215
Tepaid:	CAT080013352
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.9174
Category:	Waste oil and mixed oil
Disposal Method:	Recycler
Contact:	SAUGUS USD
Telephone:	(805) 297-8827
Mailing Address:	24930 AVENUE STANFORD
	VALENCIA, CA 91355 - 1272
County	Los Angeles

Gepaid:	CAL000125215
Tepaid:	CAD008252405
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.0375
Category:	Off-specification, aged, or surplus organics
Disposal Method:	Recycler
Contact:	SAUGUS USD
Telephone:	(805) 297-8827
Mailing Address:	24930 AVENUE STANFORD
	VALENCIA, CA 91355 - 1272
County	Los Angeles

Gepaid:	CAL000125215
Tepaid:	CAD008252405
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.0625
Category:	Unspecified solvent mixture Waste
Disposal Method:	Recycler
Contact:	SAUGUS USD
Telephone:	(805) 297-8827
Mailing Address:	24930 AVENUE STANFORD
	VALENCIA, CA 91355 - 1272
County	Los Angeles

SAUGUS USD/TRANSPORTATION (Continued) **S105090153**

Gepaid: CAL000125215
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 10.0080
Category: Unspecified oil-containing waste
Disposal Method: Recycler
Contact: SAUGUS USD
Telephone: (805) 297-8827
Mailing Address: 24930 AVENUE STANFORD
VALENCIA, CA 91355 - 1272
County Los Angeles

Gepaid: CAL000125215
Tepaid: CAD097030993
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .0875
Category: Liquids with pH <UN-> 2
Disposal Method: Recycler
Contact: SAUGUS USD
Telephone: (805) 297-8827
Mailing Address: 24930 AVENUE STANFORD
VALENCIA, CA 91355 - 1272
County Los Angeles

The CA HAZNET database contains 10 additional records for this site.
Please contact your EDR Account Executive for more information.

V141 **SAUGUS UNION SD TRANSPORTATION** **LOS ANGELES CO. HMS** **S102685272**
ESE **26501 GOLDEN VALLEY RD** **N/A**
> 1 **SANTA CLARITA, CA**
5906 ft.
Higher **Site 9 of 13 in cluster V**

HMS:
Facility Id: 016620-022108
Facility Type: T0
Permit Number: 000114557 Permit Status: Permit
Facility Status: Permit Area: 7A
Region: Los Angeles County:

W142 **VONS #1669** **LOS ANGELES CO. HMS** **S103945436**
WNW **26518 N BOUQUET CANYON RD** **N/A**
> 1 **SANTA CLARITA, CA**
5912 ft.
Lower **Site 6 of 9 in cluster W**

HMS:
Facility Id: 019051-027320
Facility Type: I01
Permit Number: 000262706 Permit Status: Removed
Facility Status: Permit Area: 7A
Region: Los Angeles County:

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number
Z143 **WNW** **> 1** **5913 ft.** **Lower**	**CARRIAGE TRADE CLEANERS** **26512 BOUQUET CANYON** **SAUGUS, CA 91350** **Site 1 of 5 in cluster Z**	**HAZNET** **CLEANERS**	**S103647886** **N/A**

CA Cleaners:
Create Date: 07/03/1987
Inactive Date: 06/30/1998
EPA Id: CAD981636384
County : Los Angeles

HAZNET:
Gepaid: CAD981636384
Tepaid: CAT000613992
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .1950
Category: Liquids with halogenated organic compounds > 1000 mg/l
Disposal Method: Transfer Station
Contact: G1& M SHERPO, D KLINE
Telephone: (805) 296-0606
Mailing Address: 26512 BOUQUET CANYON RD
SANTA CLARITA, CA 91350
County Los Angeles

Gepaid: CAD981636384
Tepaid: CAT000613893
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .1950
Category: Liquids with halogenated organic compounds > 1000 mg/l
Disposal Method: Transfer Station
Contact: G1& M SHERPO, D KLINE
Telephone: (805) 296-0606
Mailing Address: 26512 BOUQUET CANYON RD
SANTA CLARITA, CA 91350
County Los Angeles

Gepaid: CAD981636384
Tepaid: CAT000613893
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .7800
Category: Liquids with halogenated organic compounds > 1000 mg/l
Disposal Method: Transfer Station
Contact: G1& M SHERPO, D KLINE
Telephone: (805) 296-0606
Mailing Address: 26512 BOUQUET CANYON RD
SANTA CLARITA, CA 91350
County Los Angeles

Gepaid: CAD981636384
Tepaid: CAT000613893
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 0
Category:
Disposal Method: Transfer Station
Contact: G1& M SHERPO, D KLINE
Telephone: (805) 296-0606

CARRIAGE TRADE CLEANERS (Continued) **S103647886**

Mailing Address: 26512 BOUQUET CANYON RD
SANTA CLARITA, CA 91350
County Los Angeles

Gepaid: CAD981636384
Tepaid: CAT000613893
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 0.0975
Category: Liquids with halogenated organic compounds > 1000 mg/l
Disposal Method: Not reported
Contact: G1& M SHERPO, D KLINE
Telephone: (805) 296-0606
Mailing Address: 26512 BOUQUET CANYON RD
SANTA CLARITA, CA 91350
County Los Angeles

The CA HAZNET database contains 7 additional records for this site.
Please contact your EDR Account Executive for more information.

Z144
WNW
> 1
5913 ft.
Lower

FLAMINGO CLEANERS
26512 BOQUET CYN RD
SAUGUS, CA 91350

RCRIS-SQG **1000358291**
FINDS **CAD981636384**

Site 2 of 5 in cluster Z

RCRIS:
Owner: ERTUN SEKEROGU
(805) 296-0606
EPA ID: CAD981636384

Contact: ERTUN SEKEROGU
(661) 296-0606

Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

X145
NW
> 1
5916 ft.
Lower

CHEVRON USA SS 092437
26753 BOUQUET CANYON RD
SANTA CLARITA, CA 91350

UST **U003776335**
N/A

Site 2 of 7 in cluster X

State UST:
Facility ID: 9574
Total Tanks: 1
Region: STATE
Local Agency: 19000

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number
X146 / **NW** / **> 1** / **5916 ft.** / **Lower**	**92437** / **26753 BOUQUET CANYON RD** / **SAUGUS, CA 91350** / **Site 3 of 7 in cluster X**	**HIST UST**	**U001567683** / **N/A**

UST HIST:

Facility ID:	62259		
Tank Num:	1	Container Num:	1
Tank Capacity:	10000	Year Installed:	1970
Tank Used for:	PRODUCT		
Type of Fuel:	Not Reported	Tank Construction:	0000250 unknown
Leak Detection:	Stock Inventor		
Contact Name:	NEIDIGH,KENNETH	Telephone:	(805) 259-2325
Total Tanks:	4	Region:	STATE
Facility Type:	1	Other Type:	Not reported

Facility ID:	62259		
Tank Num:	2	Container Num:	2
Tank Capacity:	10000	Year Installed:	1970
Tank Used for:	PRODUCT		
Type of Fuel:	Not Reported	Tank Construction:	0000250 unknown
Leak Detection:	Stock Inventor		
Contact Name:	NEIDIGH,KENNETH	Telephone:	(805) 259-2325
Total Tanks:	4	Region:	STATE
Facility Type:	1	Other Type:	Not reported

Facility ID:	62259		
Tank Num:	3	Container Num:	3
Tank Capacity:	5000	Year Installed:	1970
Tank Used for:	PRODUCT		
Type of Fuel:	Not Reported	Tank Construction:	0000250 unknown
Leak Detection:	Stock Inventor		
Contact Name:	NEIDIGH,KENNETH	Telephone:	(805) 259-2325
Total Tanks:	4	Region:	STATE
Facility Type:	1	Other Type:	Not reported

Facility ID:	62259		
Tank Num:	4	Container Num:	4
Tank Capacity:	1000	Year Installed:	1970
Tank Used for:	WASTE		
Type of Fuel:	Not Reported	Tank Construction:	0000130 unknown
Leak Detection:	Stock Inventor		
Contact Name:	NEIDIGH,KENNETH	Telephone:	(805) 259-2325
Total Tanks:	4	Region:	STATE
Facility Type:	1	Other Type:	Not reported

X147 / **NW** / **> 1** / **5916 ft.** / **Lower**	**CHEVRON STN 9 2437** / **26753 BOUQUET CANYON RD** / **SAUGUS, CA 91350** / **Site 4 of 7 in cluster X**	**RCRIS-SQG** / **FINDS**	**1000857051** / **CA0000031807**

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

CHEVRON STN 9 2437 (Continued) **1000857051**

RCRIS:
Owner: CHEVRON PRODUCTS COMPANY
(925) 842-5931
EPA ID: CA0000031807
Contact: KATHY NORRIS
(925) 842-5931
Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported
Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

X148 **CHEVRON USA SS 092437** **LOS ANGELES CO. HMS** **S102064464**
NW **26753 N BOUQUET CANYON RD** **N/A**
> 1 **SANTA CLARITA, CA**
5916 ft.
Lower **Site 5 of 7 in cluster X**

HMS:
Facility Id: 008429-009574
Facility Type: T0
Permit Number: 00000794T Permit Status: Permit
Facility Status: Permit Area: 7A
Region: Los Angeles County:

X149 **CHEVRON USA CO / CARWASH** **LOS ANGELES CO. HMS** **S104827211**
NW **26753 N BOUQUET CANYON RD** **N/A**
> 1 **SANTA CLARITA, CA**
5916 ft.
Lower **Site 6 of 7 in cluster X**

HMS:
Facility Id: 008429-I09574
Facility Type: I01
Permit Number: 000009040 Permit Status: Permit
Facility Status: Permit Area: 7A
Region: Los Angeles County:

X150 **CHEVRON USA PRODUCTS COMPANY** **HAZNET** **S103648043**
NW **26753 BOQUET CANYON** **N/A**
> 1 **SAUGUS, CA 91350**
5916 ft.
Lower **Site 7 of 7 in cluster X**

CHEVRON USA PRODUCTS COMPANY (Continued) **S103648043**

HAZNET:
Gepaid: CAC000713304
Tepaid: CAT080010101
Gen County: Los Angeles
Tsd County: San Diego
Tons: .0208
Category: Aqueous solution with 10% or more total organic residues
Disposal Method: Transfer Station
Contact: CHEVRON USA PRODUCTS COMPANY
Telephone: (310) 694-7452
Mailing Address: PO BOX 2833
LA HABRA, CA 90632
County Los Angeles

V151 **UNIVERSAL ENGINE** **HAZNET** **S103647896**
ESE **26536 GOLDEN VALLEY RD, #616** **N/A**
> 1 **SANTA CLARITA, CA 91351**
5921 ft.
Higher **Site 10 of 13 in cluster V**

HAZNET:
Gepaid: CAL000110336
Tepaid: CAD099452708
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .4586
Category: Unspecified aqueous solution
Disposal Method: Recycler
Contact: ARMOND ASLANIAN
Telephone: (000) 000-0000
Mailing Address: 26536 GOLDEN VALLEY RD, #616
SANTA CLARITA, CA 91351
County Los Angeles

Gepaid: CAL000110336
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2293
Category: Unspecified aqueous solution
Disposal Method: Recycler
Contact: ARMOND ASLANIAN
Telephone: (000) 000-0000
Mailing Address: 26536 GOLDEN VALLEY RD, #616
SANTA CLARITA, CA 91351
County Los Angeles

Gepaid: CAL000110336
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .5837
Category: Unspecified aqueous solution
Disposal Method: Recycler
Contact: ARMOND ASLANIAN
Telephone: (000) 000-0000
Mailing Address: 26536 GOLDEN VALLEY RD, #616
SANTA CLARITA, CA 91351
County Los Angeles

UNIVERSAL ENGINE (Continued) **S103647896**

Gepaid:	CAL000110336
Tepaid:	CAD099452708
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.4587
Category:	Unspecified oil-containing waste
Disposal Method:	Recycler
Contact:	ARMOND ASLANIAN
Telephone:	(000) 000-0000
Mailing Address:	26536 GOLDEN VALLEY RD, #616 SANTA CLARITA, CA 91351
County	Los Angeles

Gepaid:	CAL000110336
Tepaid:	CAD099452708
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.2085
Category:	Unspecified aqueous solution
Disposal Method:	Recycler
Contact:	ARMOND ASLANIAN
Telephone:	(000) 000-0000
Mailing Address:	26536 GOLDEN VALLEY RD, #616 SANTA CLARITA, CA 91351
County	Los Angeles

V152
ESE
> 1
5935 ft.
Higher

MATO PLASTICS
26541 GOLDEN VALLEY
SAUGUS, CA 91350

HAZNET **S102825380**
LOS ANGELES CO. HMS **N/A**

Site 11 of 13 in cluster V

HAZNET:

Gepaid:	CAL000177650
Tepaid:	CAT080013352
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.9174
Category:	Unspecified oil-containing waste
Disposal Method:	Recycler
Contact:	MANFRED TOLL
Telephone:	(000) 000-0000
Mailing Address:	26541 GOLDEN VALLEY RD UNIT A SANTA CLARITA, CA 91350
County	Los Angeles

HMS:

Facility Id:	019983-028505		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

W153
WNW
> 1
5945 ft.
Lower

ORCHARD SUPPLY HARDWARE
26565 N BOUQUET CANYON RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S104536198**
N/A

Site 7 of 9 in cluster W

ORCHARD SUPPLY HARDWARE (Continued) **S104536198**

HMS:

Facility Id:	017246-023319		
Facility Type:	I04		
Permit Number:	000158319	Permit Status:	Permit
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

Z154
WNW
> 1
5948 ft.
Lower

BURGER KING RESTAURANT **LOS ANGELES CO. HMS** **S104536194**
26480 N BOUQUET CANYON RD **N/A**
SANTA CLARITA, CA

Site 3 of 5 in cluster Z

HMS:

Facility Id:	017165-023081		
Facility Type:	I02		
Permit Number:	000148729	Permit Status:	Permit
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

W155
WNW
> 1
5949 ft.
Lower

JACK-IN-THE-BOX **LOS ANGELES CO. HMS** **S104536196**
26547 N BOUQUET CANYON RD **N/A**
SANTA CLARITA, CA

Site 8 of 9 in cluster W

HMS:

Facility Id:	017100-022947		
Facility Type:	I01		
Permit Number:	000144585	Permit Status:	Permit
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

Y156
NW
> 1
5951 ft.
Lower

PRESIDENTE RESTAURANT **LOS ANGELES CO. HMS** **S102229787**
26625 N BOUQUET CANYON RD **N/A**
SANTA CLARITA, CA

Site 3 of 3 in cluster Y

HMS:

Facility Id:	017343-023505		
Facility Type:	I01		
Permit Number:	000165205	Permit Status:	Permit
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

W157
WNW
> 1
5952 ft.
Lower

BOSTON MARKET RESTAURANT **LOS ANGELES CO. HMS** **S104536195**
26543 N BOUQUET CANYON RD **N/A**
SANTA CLARITA, CA

Site 9 of 9 in cluster W

HMS:

Facility Id:	016925-022697		
Facility Type:	I01		
Permit Number:	000140929	Permit Status:	Permit
Facility Status:	Permit	Area:	7A

Map ID
Direction
Distance
Distance (ft.)
Elevation | Site | Database(s) | EDR ID Number / EPA ID Number

BOSTON MARKET RESTAURANT (Continued) **S104536195**

Region: Los Angeles County:

AA158
ESE
> 1
5987 ft.
Higher

ADROS CUSTOM WOOD FINISHING
26524 GOLDEN VALLEY
CANYON COUNTRY, CA 91351

RCRIS-SQG 1000472923
FINDS CAD982435539

Site 1 of 3 in cluster AA

RCRIS:
Owner: A R B ENTERPRISES
(415) 555-1212
EPA ID: CAD982435539
Contact: ENVIRONMENTAL MANAGER
(805) 252-1870
Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported
Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

AA159
ESE
> 1
5987 ft.
Higher

INLAND PACIFIC MTR
26502 GOLDEN VALLEY RD 104
SAUGUS, CA 91350

RCRIS-SQG 1000596273
FINDS CAD983602384

Site 2 of 3 in cluster AA

RCRIS:
Owner: ARB ENTERPRISES
(805) 298-1046
EPA ID: CAD983602384
Contact: CARMELO HENSON
(805) 298-8633
Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported
Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

AA160
ESE
> 1
5987 ft.
Higher

BENS TEK
26536 GOLDEN VALLEY RD 606
SANTA CLARITA, CA 91350

RCRIS-SQG 1000376046
FINDS CAD982507139
HAZNET
LOS ANGELES CO. HMS

Site 3 of 3 in cluster AA

BENS TEK (Continued) **1000376046**

RCRIS:
Owner: GOULDMANS PAUL M
(415) 555-1212
EPA ID: CAD982507139

Contact: ENVIRONMENTAL MANAGER
(805) 255-9521

Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

HAZNET:
Gepaid: CAD982507139
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2293
Category: Unspecified aqueous solution
Disposal Method: Recycler
Contact: PAUL GLOUDEMANS
Telephone: (000) 000-0000
Mailing Address: 26536 GOLDEN VALLEY RD STE 606
SANTA CLARITA, CA 91350 - 2661
County Los Angeles

Gepaid: CAD982507139
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 0.2293
Category: Aqueous solution with 10% or more total organic residues
Disposal Method: Recycler
Contact: PAUL GLOUDEMANS
Telephone: (000) 000-0000
Mailing Address: 26536 GOLDEN VALLEY RD STE 606
SANTA CLARITA, CA 91350 - 2661
County Los Angeles

Gepaid: CAD982507139
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2293
Category: Aqueous solution with 10% or more total organic residues
Disposal Method: Recycler
Contact: PAUL GLOUDEMANS
Telephone: (000) 000-0000
Mailing Address: 26536 GOLDEN VALLEY RD STE 606
SANTA CLARITA, CA 91350 - 2661
County Los Angeles

BENS TEK (Continued) **1000376046**

Gepaid: CAD982507139
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2293
Category: Unspecified aqueous solution
Disposal Method: Treatment, Incineration
Contact: PAUL GLOUDEMANS
Telephone: (000) 000-0000
Mailing Address: 26536 GOLDEN VALLEY RD STE 606
SANTA CLARITA, CA 91350 - 2661
County Los Angeles

Gepaid: CAD982507139
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .4586
Category: Aqueous solution with 10% or more total organic residues
Disposal Method: Recycler
Contact: PAUL GLOUDEMANS
Telephone: (000) 000-0000
Mailing Address: 26536 GOLDEN VALLEY RD STE 606
SANTA CLARITA, CA 91350 - 2661
County Los Angeles

The CA HAZNET database contains 3 additional records for this site.
Please contact your EDR Account Executive for more information.

HMS:

Facility Id:	019981-028503		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

Z161 **CRISTA ENTERPRISES DEVELOPMENT** **LOS ANGELES CO. HMS** **S103945429**
WNW **26485 N BOUQUET CANYON RD** **N/A**
> 1 **SANTA CLARITA, CA**
5998 ft.
Lower **Site 4 of 5 in cluster Z**

HMS:

Facility Id:	018997-037607		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

Facility Id:	018997-027259		
Facility Type:	T1		
Permit Number:	000263000	Permit Status:	Permit
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

Facility Id:	018997-027815		
Facility Type:	I01		
Permit Number:	000272593	Permit Status:	Permit
Facility Status:	Permit	Area:	7A

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

CRISTA ENTERPRISES DEVELOPMENT (Continued) — **S103945429**

Region: Los Angeles County:

Z162 **WNW** **> 1** **5998 ft.** **Lower**	**DAKOTA VENTURES,LLC** **26485 BOUQUET CANYON RD** **SANTA CLARITA, CA 91350** **Site 5 of 5 in cluster Z**	**UST**	**U003778157** **N/A**

State UST:

Facility ID: 27259
Total Tanks: 1
Region: STATE
Local Agency: 19000

AB163 **SE** **> 1** **5999 ft.** **Higher**	**ELEC-TROL INC** **26477 N GOLDEN VALLEY RD** **SANTA CLARITA, CA** **Site 1 of 2 in cluster AB**	**LOS ANGELES CO. HMS**	**1000165981** **N/A**

HMS:

Facility Id:	007711-I08142		
Facility Type:	I01		
Permit Number:	00010962B	Permit Status:	Closed
Facility Status:	Closed	Area:	7A
Region:	Los Angeles County:		

AB164 **SE** **> 1** **5999 ft.** **Higher**	 **26477 GOLDEN VALLEY RD** **SANTA CLARITA, CA 91350** **Site 2 of 2 in cluster AB**	**CHMIRS** **HAZNET**	**S100281071** **N/A**

HAZNET:

Gepaid: CAC001090240
Tepaid: CAD099452708
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 2.5228
Category: Waste oil and mixed oil
Disposal Method: Recycler
Contact: J.L. SAINI
Telephone: (661) 250-9090
Mailing Address: 26477 GOLDEN VALLEY RD
SANTA CLARITA, CA 91350
County Los Angeles

CHMIRS:

OES Control Number:	9991811	DOT ID:	Not reported
DOT Hazard Class:	Not Reported		
Chemical Name:	HAIR GEL ALCOHOL		
Extent of Release:	Not reported		
CAS Number:	Not reported	Quantity Released:	50
Environmental Contamination:	Ground	Property Use:	Vacant Lot
Incident Date:	13-JUL-88	Date Completed:	13-JUL-88

Time Completed : Not reported
Physical State Stored : Not reported
Physical State Released : Not reported

(Continued) **S100281071**

Release Unit :	Gallons
Container Description :	Not reported
Container Type :	Not reported
Container Material :	Not reported
Level Of Container :	Not reported
Container Capacity :	50
Container Capacity Units (code) :	2
Extent Of Release (code) :	9
Agency Id Number :	Not reported
Agency Incident Number :	Not reported
OES Incident Number :	9991811
Time Notified :	Not reported
Surrounding Area :	Not reported
Estimated Temperature :	Not reported
Property Management :	Not reported
More Than Two Substances Involved? :	Not reported
Special Studies 1 :	Not reported
Special Studies 2 :	Not reported
Special Studies 3 :	Not reported
Special Studies 4 :	Not reported
Special Studies 5 :	Not reported
Special Studies 6 :	Not reported
Responding Agency Personel # Of Injuries :	Not reported
Responding Agency Personel # Of Fatalities :	Not reported
Resp Agncy Personel # Of Decontaminated :	Not reported
Others Number Of Decontaminated :	Not reported
Others Number Of Injuries :	Not reported
Others Number Of Fatalities :	Not reported
Vehicle Make/year :	Not reported
Vehicle License Number :	Not reported
Vehicle State :	Not reported
Vehicle Id Number :	Not reported
CA/DOT/PUC/ICC Number :	Not reported
Company Name :	Not reported
Reporting Officer Name/ID :	Not reported
Report Date :	Not reported
Comments :	Not reported
Facility Telephone Number :	Not reported

V165 **FORBES METAL STAMPING CO.** **LOS ANGELES CO. HMS** **S103945442**
ESE **26555 GOLDEN VALLEY RD** **N/A**
> 1 **SANTA CLARITA, CA**
6014 ft.
Higher **Site 12 of 13 in cluster V**

HMS:

Facility Id:	019984-028506		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

AC166 **SCV AUTO SPECIALIST** **HAZNET** **S103648154**
East **26921 RUETHER UNIT A** **N/A**
> 1 **SANTA CLARITA, CA 91351**
6048 ft.
Higher **Site 1 of 13 in cluster AC**

SCV AUTO SPECIALIST (Continued) **S103648154**

HAZNET:

Gepaid:	CAL000077272
Tepaid:	CAT080013352
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.2919
Category:	Unspecified aqueous solution
Disposal Method:	Not reported
Contact:	MOORSE JERRY
Telephone:	(000) 000-0000
Mailing Address:	20733 SOLEDAD CYN RD CANYON COUNTRY, CA 91357 - 6508
County	Los Angeles

Gepaid:	CAL000077272
Tepaid:	CAT080013352
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	1.4384
Category:	Unspecified aqueous solution
Disposal Method:	Recycler
Contact:	MOORSE JERRY
Telephone:	(000) 000-0000
Mailing Address:	20733 SOLEDAD CYN RD CANYON COUNTRY, CA 91357 - 6508
County	Los Angeles

Gepaid:	CAL000077272
Tepaid:	CAD099452708
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.3753
Category:	Unspecified aqueous solution
Disposal Method:	Recycler
Contact:	MOORSE JERRY
Telephone:	(000) 000-0000
Mailing Address:	20733 SOLEDAD CYN RD CANYON COUNTRY, CA 91357 - 6508
County	Los Angeles

Gepaid:	CAL000077272
Tepaid:	CAT080013352
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	1.4177
Category:	Aqueous solution with 10% or more total organic residues
Disposal Method:	Recycler
Contact:	MOORSE JERRY
Telephone:	(000) 000-0000
Mailing Address:	20733 SOLEDAD CYN RD CANYON COUNTRY, CA 91357 - 6508
County	Los Angeles

SCV AUTO SPECIALIST (Continued) **S103648154**

Gepaid: CAL000077272
Tepaid: CAD099452708
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 1.2510
Category: Unspecified aqueous solution
Disposal Method: Recycler
Contact: MOORSE JERRY
Telephone: (000) 000-0000
Mailing Address: 20733 SOLEDAD CYN RD
CANYON COUNTRY, CA 91357 - 6508
County Los Angeles

The CA HAZNET database contains 6 additional records for this site.
Please contact your EDR Account Executive for more information.

AD167 **VELS AUTOMOTIVE/ADVANCED AUTOMOTIVE** **HAZNET** **S104579344**
East **26831 RUETHER #K** **N/A**
> 1 **SANTA CLARITA, CA 91351**
6051 ft.
Higher **Site 1 of 5 in cluster AD**

HAZNET:
Gepaid: CAL000146206
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .4586
Category: Aqueous solution with 10% or more total organic residues
Disposal Method: Not reported
Contact: DAN VELS
Telephone: (000) 000-0000
Mailing Address: 26831 RUETHER #K
SANTA CLARITA, CA 91351
County Los Angeles

Gepaid: CAL000146206
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .6879
Category: Aqueous solution with 10% or more total organic residues
Disposal Method: Recycler
Contact: DAN VELS
Telephone: (000) 000-0000
Mailing Address: 26831 RUETHER #K
SANTA CLARITA, CA 91351
County Los Angeles

Gepaid: CAL000146206
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2293
Category: Aqueous solution with 10% or more total organic residues
Disposal Method: Recycler
Contact: DAN VELS
Telephone: (000) 000-0000
Mailing Address: 26831 RUETHER #K

VELS AUTOMOTIVE/ADVANCED AUTOMOTIVE (Continued) **S104579344**

	SANTA CLARITA, CA 91351
County	Los Angeles
Gepaid:	CAL000146206
Tepaid:	CAT080013352
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	0.9172
Category:	Aqueous solution with 10% or more total organic residues
Disposal Method:	Recycler
Contact:	DAN VELS
Telephone:	(000) 000-0000
Mailing Address:	26831 RUETHER #K
	SANTA CLARITA, CA 91351
County	Los Angeles

AD168 **SCORE INDUSTRIES** **LOS ANGELES CO. HMS** **S103945479**
East **26841 RUETHER AVE E** **N/A**
> 1 **SANTA CLARITA, CA**
6052 ft.
Higher **Site 2 of 5 in cluster AD**

HMS:

Facility Id:	020147-028708		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

AC169 **SANTA CLARITA COLLISION CENTER** **HAZNET** **S100930816**
East **26867 RUETHER AVE** **N/A**
> 1 **CANYON COUNTRY, CA 91351**
6057 ft.
Higher **Site 2 of 13 in cluster AC**

HAZNET:

Gepaid:	CAD981403462
Tepaid:	CAD008302903
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.7714
Category:	Paint sludge
Disposal Method:	Recycler
Contact:	ALANE DUFRENE-PRES
Telephone:	(805) 252-2277
Mailing Address:	26867 RUETHER AVE
	CANYON COUNTRY, CA 91351 - 2414
County	Los Angeles
Gepaid:	CAD981403462
Tepaid:	CAD008302903
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.4587
Category:	Paint sludge
Disposal Method:	Recycler
Contact:	ALANE DUFRENE-PRES
Telephone:	(805) 252-2277
Mailing Address:	26867 RUETHER AVE

SANTA CLARITA COLLISION CENTER (Continued) **S100930816**

	CANYON COUNTRY, CA 91351 - 2414
County	Los Angeles
Gepaid:	CAD981403462
Tepaid:	CAD089446710
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.2293
Category:	Aqueous solution with 10% or more total organic residues
Disposal Method:	Transfer Station
Contact:	ALANE DUFRENE-PRES
Telephone:	(805) 252-2277
Mailing Address:	26867 RUETHER AVE
	CANYON COUNTRY, CA 91351 - 2414
County	Los Angeles
Gepaid:	CAD981403462
Tepaid:	CAD008252405
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.3044
Category:	Unspecified solvent mixture Waste
Disposal Method:	Recycler
Contact:	ALANE DUFRENE-PRES
Telephone:	(805) 252-2277
Mailing Address:	26867 RUETHER AVE
	CANYON COUNTRY, CA 91351 - 2414
County	Los Angeles
Gepaid:	CAD981403462
Tepaid:	CAD050806850
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.1042
Category:	Paint sludge
Disposal Method:	Recycler
Contact:	ALANE DUFRENE-PRES
Telephone:	(805) 252-2277
Mailing Address:	26867 RUETHER AVE
	CANYON COUNTRY, CA 91351 - 2414
County	Los Angeles

The CA HAZNET database contains 5 additional records for this site.
Please contact your EDR Account Executive for more information.

AC170 **PRIDE COLLISION CENTER** **LOS ANGELES CO. HMS** **S104827906**
East **26867 RUETHER AVE** **N/A**
> 1 **SANTA CLARITA, CA**
6057 ft.
Higher **Site 3 of 13 in cluster AC**

HMS:

Facility Id:	003354-035533		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

AC171 **East** **> 1** **6057 ft.** **Higher**

SANTA CLARITA COLLISION CENTER
26867 RUETHER AVE
SANTA CLARITA, CA

LOS ANGELES CO. HMS — **S105053534** **N/A**

Site 4 of 13 in cluster AC

HMS:

Facility Id:	003354-I03470		
Facility Type:	I05		
Permit Number:	000008019	Permit Status:	Suspended
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

AC172 **East** **> 1** **6062 ft.** **Higher**

VIDAC
26883 RUETHER AVE
SANTA CLARITA, CA

LOS ANGELES CO. HMS — **S103945487** **N/A**

Site 5 of 13 in cluster AC

HMS:

Facility Id:	020155-028710		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

AC173 **East** **> 1** **6070 ft.** **Higher**

PETE'S AUTO REPAIR
26911 RUETHER AVE. #D
SANTA CLARITA, CA 91351

HAZNET **LOS ANGELES CO. HMS** — **S103945494** **N/A**

Site 6 of 13 in cluster AC

HAZNET:

Gepaid:	CAL000142996
Tepaid:	CAD982321879
Gen County:	Los Angeles
Tsd County:	Stanislaus
Tons:	0.0125
Category:	Photochemicals/photoprocessing waste
Disposal Method:	Not reported
Contact:	PETE GARCIA
Telephone:	(000) 000-0000
Mailing Address:	27385 CROSSGLADE AVE CANYON COUNTRY, CA 91351
County	Los Angeles

HMS:

Facility Id:	020167-028726		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

AE174 **ENE** **> 1** **6072 ft.** **Higher**

INDUSTRIAL ASPHALT CO
20735 W SANTA CLARA ST
SANTA CLARITA, CA

LOS ANGELES CO. HMS — **U003059733** **N/A**

Site 1 of 12 in cluster AE

HMS:

INDUSTRIAL ASPHALT CO (Continued) **U003059733**

Facility Id: 003454-I04283
Facility Type: I00
Permit Number: 000001926 Permit Status: Closed
Facility Status: Closed Area: 7A
Region: Los Angeles County:

AE175 **SO PACIFIC MILLING CO** **LOS ANGELES CO. HMS** **U003059732**
ENE **20735 W SANTA CLARA ST** **N/A**
> 1 **SANTA CLARITA, CA**
6072 ft.
Higher **Site 2 of 12 in cluster AE**

HMS:
Facility Id: 003454-I03573
Facility Type: I00
Permit Number: 000001664 Permit Status: Closed
Facility Status: Closed Area: 7A
Region: Los Angeles County:

V176 **VAL-AERO INDUSTRIES INC** **HAZNET** **S103945443**
ESE **26559 GOLDEN VALLEY RD** **LOS ANGELES CO. HMS** **N/A**
> 1 **SANTA CLARITA, CA 91350**
6072 ft.
Higher **Site 13 of 13 in cluster V**

HAZNET:
Gepaid: CAL000213068
Tepaid: CAT000613976
Gen County: Los Angeles
Tsd County: Orange
Tons: .0667
Category: Liquids with halogenated organic compounds > 1000 mg/l
Disposal Method: Transfer Station
Contact: VAL-AERO INDUSTRIES INC
Telephone: (000) 000-0000
Mailing Address: 26559 GOLDEN VALLEY RD
SANTA CLARITA, CA 91350
County Los Angeles

HMS:
Facility Id: 019985-028507
Facility Type: Not reported
Permit Number: Not reported Permit Status: Not reported
Facility Status: OPEN Area: 7A
Region: Los Angeles County:

AC177 **MOFIELD PRODUCTIONS** **LOS ANGELES CO. HMS** **S103945492**
East **26911 RUETHER AVE E** **N/A**
> 1 **SANTA CLARITA, CA**
6074 ft.
Higher **Site 7 of 13 in cluster AC**

HMS:
Facility Id: 020160-028724
Facility Type: Not reported
Permit Number: Not reported Permit Status: Not reported
Facility Status: OPEN Area: 7A
Region: Los Angeles County:

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number
AC178 **East** **> 1** **6074 ft.** **Higher**	**SANTA CLARITA VALLEY TOYOTA SPECALISTS** **26911 RUETHER AVE** **CANYON COUNTRY, CA 91351** **Site 8 of 13 in cluster AC**	**HAZNET**	**S102817022** **N/A**

HAZNET:

Gepaid: CAL000092195
Tepaid: CAL000113451
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 1.4386
Category: Unspecified organic liquid mixture
Disposal Method: Transfer Station
Contact: KEVIN FERGUSON
Telephone: (805) 251-2091
Mailing Address: 26911 RUETHER AVE STE A
CANYON COUNTRY, CA 91351 - 6520
County Los Angeles

Gepaid: CAL000092195
Tepaid: CAD099452708
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 1.6680
Category: Unspecified aqueous solution
Disposal Method: Recycler
Contact: KEVIN FERGUSON
Telephone: (805) 251-2091
Mailing Address: 26911 RUETHER AVE STE A
CANYON COUNTRY, CA 91351 - 6520
County Los Angeles

Gepaid: CAL000092195
Tepaid: CAL000113451
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 1.6680
Category: Unspecified organic liquid mixture
Disposal Method: Transfer Station
Contact: KEVIN FERGUSON
Telephone: (805) 251-2091
Mailing Address: 26911 RUETHER AVE STE A
CANYON COUNTRY, CA 91351 - 6520
County Los Angeles

Gepaid: CAL000092195
Tepaid: CAD099452708
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 1.0425
Category: Unspecified aqueous solution
Disposal Method: Recycler
Contact: KEVIN FERGUSON
Telephone: (805) 251-2091
Mailing Address: 26911 RUETHER AVE STE A
CANYON COUNTRY, CA 91351 - 6520
County Los Angeles

SANTA CLARITA VALLEY TOYOTA SPECALISTS (Continued) **S102817022**

Gepaid: CAL000092195
Tepaid: CAL000113451
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .7713
Category: Unspecified organic liquid mixture
Disposal Method: Transfer Station
Contact: KEVIN FERGUSON
Telephone: (805) 251-2091
Mailing Address: 26911 RUETHER AVE STE A
CANYON COUNTRY, CA 91351 - 6520
County Los Angeles

AF179
NW
> 1
6077 ft.
Lower

MJW INVESTMENT
26830 SECO CANYON ROAD
SANTA CLARITA, CA 91354

CA SLIC **S104404953**
N/A

Site 1 of 9 in cluster AF

SLIC Region 4:
Facility Status: Closure
Region: 4
SLIC 0849
Staff: PR
Substance: VOCs
Cross Street: Not reported

AF180
NW
> 1
6077 ft.
Lower

SANTA CLARITA PLACE/1 HR. CLNR
26830 SECO CANYON RD
SCV, CA 91350

LA Co. Site Mitigation **S103697106**
N/A

Site 2 of 9 in cluster AF

Site Mitigation Log:
Case Number: 98S447
Abatement Date: 03/31/99
Thomas Guide Page Numbers: 4550J1

AC181
East
> 1
6080 ft.
Higher

POINT AUTO SERVICE
26921 RUETHER AVE #A
CANYON COUNTRY, CA 91351

HAZNET **S103982144**
N/A

Site 9 of 13 in cluster AC

HAZNET:
Gepaid: CAL000147770
Tepaid: CAD099452708
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2710
Category: Unspecified aqueous solution
Disposal Method: Recycler
Contact: SEHMI SAMMY
Telephone: (000) 000-0000
Mailing Address: 26921 RUETHER AVE #A
CANYON COUNTRY, CA 91351
County Los Angeles

POINT AUTO SERVICE (Continued) S103982144

Gepaid: CAL000147770
Tepaid: CAD099452708
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2293
Category: Unspecified aqueous solution
Disposal Method: Recycler
Contact: SEHMI SAMMY
Telephone: (000) 000-0000
Mailing Address: 26921 RUETHER AVE #A
CANYON COUNTRY, CA 91351
County Los Angeles

Gepaid: CAL000147770
Tepaid: CAD099452708
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 0.2293
Category: Unspecified aqueous solution
Disposal Method: Recycler
Contact: SEHMI SAMMY
Telephone: (000) 000-0000
Mailing Address: 26921 RUETHER AVE #A
CANYON COUNTRY, CA 91351
County Los Angeles

AC182 **JERRYS TOWING SERVICE INC** **HAZNET** **S105090167**
East **26921-B RUETHER AVE** **N/A**
> 1 **SANTA CLARITA, CA 91351**
6080 ft.
Higher **Site 10 of 13 in cluster AC**

HAZNET:
Gepaid: CAL000125880
Tepaid: CAD028409019
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2000
Category: Other organic solids
Disposal Method: Transfer Station
Contact: JERRY MORSE
Telephone: (805) 252-8869
Mailing Address: 26921 RUETHER AVE STE B
CANYON COUNTRY, CA 91351 - 6509
County Los Angeles

AC183 **PREMIER PRINTING COMPANY** **HAZNET** **S104583456**
East **26951 RUETHER AVE STE G** **N/A**
> 1 **SANTA CLARITA, CA 91351**
6087 ft.
Higher **Site 11 of 13 in cluster AC**

PREMIER PRINTING COMPANY (Continued) **S104583456**

HAZNET:

Gepaid:	CAL912343463
Tepaid:	CAD108040858
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.0750
Category:	Photochemicals/photoprocessing waste
Disposal Method:	Not reported
Contact:	KIRK PEELER
Telephone:	(661) 251-7913
Mailing Address:	26951 RUETHER AVE STE G SANTA CLARITA, CA 91351
County	Los Angeles

Gepaid:	CAL912343463
Tepaid:	CAD108040858
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.1876
Category:	Photochemicals/photoprocessing waste
Disposal Method:	Recycler
Contact:	KIRK PEELER
Telephone:	(661) 251-7913
Mailing Address:	26951 RUETHER AVE STE G SANTA CLARITA, CA 91351
County	Los Angeles

Gepaid:	CAL912343463
Tepaid:	CAD000088252
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.0825
Category:	Unspecified solvent mixture Waste
Disposal Method:	Transfer Station
Contact:	KIRK PEELER
Telephone:	(661) 251-7913
Mailing Address:	26951 RUETHER AVE STE G SANTA CLARITA, CA 91351
County	Los Angeles

Gepaid:	CAL912343463
Tepaid:	CAD108040858
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.0792
Category:	Photochemicals/photoprocessing waste
Disposal Method:	Recycler
Contact:	KIRK PEELER
Telephone:	(661) 251-7913
Mailing Address:	26951 RUETHER AVE STE G SANTA CLARITA, CA 91351
County	Los Angeles

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

PREMIER PRINTING COMPANY (Continued) **S104583456**

Gepaid: CAL912343463
Tepaid: CAD108040858
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .1751
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: KIRK PEELER
Telephone: (661) 251-7913
Mailing Address: 26951 RUETHER AVE STE G
SANTA CLARITA, CA 91351
County Los Angeles

The CA HAZNET database contains 1 additional record for this site.
Please contact your EDR Account Executive for more information.

AD184 **East** **> 1** **6089 ft.** **Higher**	**RUSSELL DUNN AUTOMOTIVE** **26821 RUETHER UNIT G** **CANYON COUNTRY, CA 91351** **Site 3 of 5 in cluster AD**	**RCRIS-SQG** **FINDS**	**1000596839** **CAD983608225**

RCRIS:
Owner: P AND E PROPERTIES
EPA ID: CAD983608225

Contact: RUSSELL DUNN
(805) 252-8646

Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

AF185 **NW** **> 1** **6101 ft.** **Lower**	**LA CO FD FIRE STA #111** **26829 N SECO CANYON RD** **SANTA CLARITA, CA** **Site 3 of 9 in cluster AF**	**LOS ANGELES CO. HMS**	**S102064468** **N/A**

HMS:

Facility Id:	012424-012555		
Facility Type:	T0		
Permit Number:	00004311T	Permit Status:	Removed
Facility Status:	Removed	Area:	7A
Region:	Los Angeles County:		

AF186 **NW** **> 1** **6101 ft.** **Lower**	**LA CO FIRE STATION #111** **26829 SECO CANYON RD** **SANTA CLARITA, CA 91350** **Site 4 of 9 in cluster AF**	**Cortese**	**S105027183** **N/A**

LA CO FIRE STATION #111 (Continued) **S105027183**

CORTESE:
Reg Id: R-12555
Region: CORTESE
Reg By: Leaking Underground Storage Tanks

AF187
NW
> 1
6101 ft.
Lower

LA CO FIRE STATION #111
26829 SECO CANYON RD
VALENCIA, CA 91350

LUST **S103065926**
N/A

Site 5 of 9 in cluster AF

State LUST:
Cross Street: BOUQUET CANYON RD
Qty Leaked: Not reported
Case Number R-12555
Reg Board: 4
Chemical: Gasoline
Lead Agency: Regional Board
Local Agency : 19000
Case Type: Soil only
Status: Not reported
County: Los Angeles
Abate Method: Other Means
Review Date: 1/23/97 Confirm Leak: 1/23/97
Workplan: 8/8/01 Prelim Assess: 8/8/01
Pollution Char: Not reported Remed Plan: Not reported
Remed Action: Not reported Monitoring: Not reported
Close Date: Not reported
Release Date: Not reported
Cleanup Fund Id : Not reported
Discover Date : 12/3/96
Enforcement Dt : Not reported
Enf Type: Not reported
Enter Date : 3/31/97
Funding: Not reported
Staff Initials: Not reported
How Discovered: Tank Closure
How Stopped: Close Tank
Interim : Not reported
Leak Cause: Not reported
Leak Source: Piping
MTBE Date : 4/2/01
Max MTBE GW : Not reported
MTBE Tested: MTBE Detected. Site tested for MTBE & MTBE detected
Priority: Not reported
Local Case # : Not reported
Beneficial: Not reported
Staff : JLC
GW Qualifies : Not reported
Max MTBE Soil : Not reported
Soil Qualifies : =
Hydr Basin #: Not reported
Operator : Not reported
Oversight Prgm: RB Lead Underground Storage Tank
Oversight Prgm : UST
Review Date : 9/7/01
Stop Date : Not reported
Work Suspended :Not reported

LA CO FIRE STATION #111 (Continued) **S103065926**

Responsible PartyDOUG MEYERS
RP Address: 1320 N. EASTERN AVE.
Global Id: T0603705147
Org Name: Not reported
Contact Person: Not reported
MTBE Conc: 1
Mtbe Fuel: Not reported
Water System Name: SANTA CLARITA WATER CO
Well Name: METHODIST
Distance To Lust: 764.2367395
Waste Discharge Global ID: Not reported
Waste Disch Assigned Name: Not reported

AF188 **LA CO FIRE STATION #111** **LUST** **S104916234**
NW **26829 SECO CANYON RD** **N/A**
> 1 **SANTA CLARITA, CA 91350**
6101 ft.
Lower **Site 6 of 9 in cluster AF**

LUST Region 4:
Report Date: 1/23/1997
Lead Agency: Regional Board
Local Agency: 19000
Case Number: R-12555
Substance: Gasoline
Case Type: Soil
Status: Leak being confirmed
Region: 4
Staff: Not reported

AC189 **ANDY GUMP INC** **HAZNET** **S103648174**
East **26954 RUETHER AVENUE** **LOS ANGELES CO. HMS** **N/A**
> 1 **CANYON COUNTRY, CA 91351**
6103 ft.
Higher **Site 12 of 13 in cluster AC**

HAZNET:
Gepaid: CAL000026603
Tepaid: CAL000113451
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2085
Category: Unspecified organic liquid mixture
Disposal Method: Transfer Station
Contact: ANDY GUMP INC
Telephone: (000) 000-0000
Mailing Address: 26954 RUETHER AVE
CANYON COUNTRY, CA 91351
County Los Angeles

ANDY GUMP INC (Continued) **S103648174**

Gepaid: CAL000026603
Tepaid: CAL000113451
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2085
Category: Unspecified organic liquid mixture
Disposal Method: Transfer Station
Contact: ANDY GUMP INC
Telephone: (000) 000-0000
Mailing Address: 26954 RUETHER AVE
CANYON COUNTRY, CA 91351
County Los Angeles

Gepaid: CAL000026603
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2293
Category: Aqueous solution with 10% or more total organic residues
Disposal Method: Recycler
Contact: ANDY GUMP INC
Telephone: (000) 000-0000
Mailing Address: 26954 RUETHER AVE
CANYON COUNTRY, CA 91351
County Los Angeles

HMS:
Facility Id: 008047-I08549
Facility Type: I05
Permit Number: 00010528C — Permit Status: Permit
Facility Status: Permit — Area: 7A
Region: Los Angeles County:

AF190 **SECO ONE HOUR MARTINIZING** — RCRIS-SQG — 1000326388
NW **26830 SECO CYN RD** — FINDS — CAD981638729
> 1 **SAUGUS, CA 91350** — HAZNET
6113 ft.
Lower **Site 7 of 9 in cluster AF**

RCRIS:
Owner: TEAM ENTERPRISES
(415) 555-1212
EPA ID: CAD981638729

Contact: NANCY HINDENBURG
(209) 224-7705

Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

Violation Status: No violations found

SECO ONE HOUR MARTINIZING (Continued) **1000326388**

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

HAZNET:
Gepaid: CAD981638729
Tepaid: CAT000613893
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .1400
Category: Liquids with halogenated organic compounds > 1000 mg/l
Disposal Method: Transfer Station
Contact: Not reported
Telephone: (000) 000-0000
Mailing Address: 750 N VALINETINE
FRESNO, CA 93706
County Los Angeles

AF191 **NW** **> 1** **6113 ft.** **Lower**	**ONE HOUR MARTINIZING** **26830 SECO CYN RD** **SAUGUS, CA 93150** **Site 8 of 9 in cluster AF**	**HAZNET** **CLEANERS**	**S103648098** **N/A**

CA Cleaners:
Create Date: 07/03/1987
Inactive Date: 0
EPA Id: CAD981637499
County : Los Angeles

HAZNET:
Gepaid: CAD981637499
Tepaid: CAT000613893
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2100
Category: Liquids with halogenated organic compounds > 1000 mg/l
Disposal Method: Transfer Station
Contact: HEUNG KYU JANG OWNER
Telephone: (000) 000-0000
Mailing Address: 26830 SECO CANYON RD
SANTA CLARITA, CA 91350 - 2216
County Los Angeles

Gepaid: CAD981637499
Tepaid: CAT000613992
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2100
Category: Liquids with halogenated organic compounds > 1000 mg/l
Disposal Method: Transfer Station
Contact: HEUNG KYU JANG OWNER
Telephone: (000) 000-0000
Mailing Address: 26830 SECO CANYON RD
SANTA CLARITA, CA 91350 - 2216
County Los Angeles

ONE HOUR MARTINIZING (Continued) **S103648098**

Gepaid: CAD981637499
Tepaid: CAT000613992
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .0700
Category: Liquids with halogenated organic compounds > 1000 mg/l
Disposal Method: Not reported
Contact: HEUNG KYU JANG OWNER
Telephone: (000) 000-0000
Mailing Address: 26830 SECO CANYON RD
SANTA CLARITA, CA 91350 - 2216
County Los Angeles

Gepaid: CAD981637499
Tepaid: CAT000613893
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .4500
Category: Liquids with halogenated organic compounds > 1000 mg/l
Disposal Method: Transfer Station
Contact: HEUNG KYU JANG OWNER
Telephone: (000) 000-0000
Mailing Address: 26830 SECO CANYON RD
SANTA CLARITA, CA 91350 - 2216
County Los Angeles

Gepaid: CAD981637499
Tepaid: CAT000613893
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 0.4875
Category: Liquids with halogenated organic compounds > 1000 mg/l
Disposal Method: Transfer Station
Contact: HEUNG KYU JANG OWNER
Telephone: (000) 000-0000
Mailing Address: 26830 SECO CANYON RD
SANTA CLARITA, CA 91350 - 2216
County Los Angeles

The CA HAZNET database contains 8 additional records for this site.
Please contact your EDR Account Executive for more information.

AF192 **TEAM ENTERPRISES INC** **RCRIS-SQG** **1000118275**
NW **26830 SECO CYN RD** **CAD981637499**
> 1 **SAUGUS, CA 91350**
6113 ft.
Lower **Site 9 of 9 in cluster AF**

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number
	TEAM ENTERPRISES INC (Continued)		**1000118275**

RCRIS:
Owner: TOM JONES
(209) 555-1212
EPA ID: CAD981637499

Contact: NANCY HINDENBURG
(209) 224-7705

Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

Violation Status: No violations found

AE193 **ENE** **> 1** **6123 ft.** **Higher**	**POINTS WEST TRUCKING,INC.** **20727 SANTA CLARA ST** **SANTA CLARITA, CA** **Site 3 of 12 in cluster AE**	**LOS ANGELES CO. HMS**	**S104160053** **N/A**

HMS:

Facility Id:	011261-011280		
Facility Type:	T0		
Permit Number:	00002813T	Permit Status:	Permit
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

AE194 **ENE** **> 1** **6123 ft.** **Higher**	**POINTS WEST TRUCKING,INC.** **20727 SANTA CLARA ST** **CANYON COUNTRY, CA 91351** **Site 4 of 12 in cluster AE**	**UST**	**U003776847** **N/A**

State UST:
Facility ID: 11280
Total Tanks: 1
Region: STATE
Local Agency: 19000

AE195 **ENE** **> 1** **6123 ft.** **Higher**	**POINTS WEST** **20727 SANTA CLARA ST** **CANYON COUNTRY, CA 91351** **Site 5 of 12 in cluster AE**	**RCRIS-SQG** **FINDS** **CA FID UST** **HAZNET**	**1000595470** **CAD983594078**

POINTS WEST (Continued) **1000595470**

RCRIS:
Owner: POINTS WEST TRUCKING INC
(415) 555-1212
EPA ID: CAD983594078

Contact: JIMMIE BARTLETT
(805) 252-3306

Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

HAZNET:
Gepaid: CAC001088992
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 2.7105
Category: Waste oil and mixed oil
Disposal Method: Recycler
Contact: ZOLTAN BERECZ/PRESIDENT
Telephone: (800) 342-3602
Mailing Address: 20727 SANTA CLARA ST
CANYON COUNTRY, CA 91351 - 2424
County Los Angeles

FID:

Facility ID:	19034716	Regulate ID:	00006603
Reg By:	Active Underground Storage Tank Location		
Cortese Code:	Not reported	SIC Code:	Not reported
Status:	Active	Facility Tel:	(818) 000-0000
Mail To:	Not reported 20727 SANTA CLARA ST SANTA CLARITA, CA		
Contact:	Not reported	Contact Tel:	Not reported
DUNs No:	Not reported	NPDES No:	Not reported
Creation:	10/22/93	Modified:	00/00/00
EPA ID:	Not reported		
Comments:	Not reported		

AE196 **POINTS WEST TRUCKING, INC.** **HIST UST** **U001567752**
ENE **20727 SANTA CLARA ST** **N/A**
> 1 **CANYON COUNTRY, CA 91351**
6123 ft.
Higher **Site 6 of 12 in cluster AE**

UST HIST:

Facility ID:	6603		
Tank Num:	1	Container Num:	1
Tank Capacity:	10000	Year Installed:	Not reported
Tank Used for:	PRODUCT		
Type of Fuel:	DIESEL	Tank Construction:	Not reported
Leak Detection:	Stock Inventor		

POINTS WEST TRUCKING, INC. (Continued) **U001567752**

Contact Name:	ZOLTAN BERECZ	Telephone:	(805) 252-3306
Total Tanks:	1	Region:	STATE
Facility Type:	2	Other Type:	TRUCKING COMPANY

AC197 **SOUTHWEST INDUSTRIES** **RCRIS-SQG 1000594650**
East **26911 RUETHER AVE STE S** **FINDS CAD983585027**
> 1 **SANTA CLARITA, CA 91351**
6131 ft.
Higher **Site 13 of 13 in cluster AC**

RCRIS:
Owner: LABELLA RICHARD AND WOODWARD
(805) 251-5451
EPA ID: CAD983585027

Contact: RICHARD LABELLA
(805) 251-5451

Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

AG198 **WAREHOUSE** **HIST UST U001567734**
East **21030 GOLDEN TRIANGLE RD** **N/A**
> 1 **SAUGUS, CA 91350**
6146 ft.
Higher **Site 1 of 6 in cluster AG**

UST HIST:

Facility ID:	7943		
Tank Num:	1	Container Num:	2
Tank Capacity:	500	Year Installed:	1975
Tank Used for:	PRODUCT		
Type of Fuel:	DIESEL	Tank Construction:	Not reported
Leak Detection:	Pressure Test		
Contact Name:	ROBERT MCDOUGASL	Telephone:	(805) 259-2737
Total Tanks:	4	Region:	STATE
Facility Type:	2	Other Type:	WAREHOUSE

Facility ID:	7943		
Tank Num:	2	Container Num:	3
Tank Capacity:	4000	Year Installed:	1975
Tank Used for:	PRODUCT		
Type of Fuel:	UNLEADED	Tank Construction:	Not reported
Leak Detection:	Pressure Test		
Contact Name:	ROBERT MCDOUGASL	Telephone:	(805) 259-2737
Total Tanks:	4	Region:	STATE
Facility Type:	2	Other Type:	WAREHOUSE

Facility ID:	7943		
Tank Num:	3	Container Num:	4
Tank Capacity:	4000	Year Installed:	1975

WAREHOUSE (Continued) **U001567734**

Tank Used for:	PRODUCT		
Type of Fuel:	UNLEADED	Tank Construction:	Not reported
Leak Detection:	Pressure Test		
Contact Name:	ROBERT MCDOUGASL	Telephone:	(805) 259-2737
Total Tanks:	4	Region:	STATE
Facility Type:	2	Other Type:	WAREHOUSE

Facility ID:	7943		
Tank Num:	4	Container Num:	1
Tank Capacity:	4000	Year Installed:	1975
Tank Used for:	PRODUCT		
Type of Fuel:	UNLEADED	Tank Construction:	Not reported
Leak Detection:	Pressure Test		
Contact Name:	ROBERT MCDOUGASL	Telephone:	(805) 259-2737
Total Tanks:	4	Region:	STATE
Facility Type:	2	Other Type:	WAREHOUSE

199
SE
> 1
6170 ft.
Higher

JOHN PAUL MICHAEL SYSTEMS
26455 GOLDEN VALLEY RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS — **U003064004** / **N/A**

HMS:

Facility Id:	008329-I08889		
Facility Type:	I09		
Permit Number:	000010161	Permit Status:	Permit
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

200
West
> 1
6198 ft.
Lower

UNOCAL
502 BEAUMONT AVE
BEAUMONT, CA

LUST — **1001264000**
LOS ANGELES CO. HMS — **N/A**

LUST Region RV:

Facility ID:	891082
Region :	RIVERSIDE
Status:	Case Closed
Site Closed:	Yes
Case Type:	Soil only

HMS:

Facility Id:	020328-028928		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

AE201
ENE
> 1
6210 ft.
Higher

NATIONAL READY MIXED CONCRETE
27050 RUETHER AVE
SANTA CLARITA, CA

CA FID UST — **S101618509** / **N/A**

Site 7 of 12 in cluster AE

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

AE202 **ENE** **> 1** **6210 ft.** **Higher**

NATIONAL READY MIXED CONCRETE
27050 RUETHER AVE
CANYON COUNTRY, CA 91350

HIST UST — **U001567712** — **N/A**

Site 8 of 12 in cluster AE

UST HIST:

Facility ID:	16974		
Tank Num:	1	Container Num:	1
Tank Capacity:	6500	Year Installed:	Not reported
Tank Used for:	PRODUCT		
Type of Fuel:	DIESEL	Tank Construction:	Not reported
Leak Detection:	Stock Inventor		
Contact Name:	CHARLES J KENNEDY,GEN MGR	Telephone:	(805) 252-8181
Total Tanks:	3	Region:	STATE
Facility Type:	2	Other Type:	READY MIX CONCRETE

Facility ID:	16974		
Tank Num:	2	Container Num:	2
Tank Capacity:	7500	Year Installed:	Not reported
Tank Used for:	PRODUCT		
Type of Fuel:	UNLEADED	Tank Construction:	Not reported
Leak Detection:	Stock Inventor		
Contact Name:	CHARLES J KENNEDY,GEN MGR	Telephone:	(805) 252-8181
Total Tanks:	3	Region:	STATE
Facility Type:	2	Other Type:	READY MIX CONCRETE

Facility ID:	16974		
Tank Num:	3	Container Num:	3
Tank Capacity:	1000	Year Installed:	Not reported
Tank Used for:	PRODUCT		
Type of Fuel:	UNLEADED	Tank Construction:	Not reported
Leak Detection:	Stock Inventor		
Contact Name:	CHARLES J KENNEDY,GEN MGR	Telephone:	(805) 252-8181
Total Tanks:	3	Region:	STATE
Facility Type:	2	Other Type:	READY MIX CONCRETE

AE203 **ENE** **> 1** **6210 ft.** **Higher**

NATIONAL READY MIX
27050 RUETHER AVE
SANTA CLARITA, CA 91351

FINDS — **1005265484** — **000011031464**

Site 9 of 12 in cluster AE

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)

AE204 **ENE** **> 1** **6210 ft.** **Higher**

NATIONAL READY MIXED CONCRETE
27050 RUETHER AVE
SANTA CLARITA, CA 91380

LUST **HAZNET** **Cortese** **LOS ANGELES CO. HMS** — **S104160049** — **N/A**

Site 10 of 12 in cluster AE

State LUST:

Cross Street:	SANTA CLARA
Qty Leaked:	Not reported
Case Number	R-05519
Reg Board:	4
Chemical:	Gasoline
Lead Agency:	Regional Board

NATIONAL READY MIXED CONCRETE (Continued) **S104160049**

Local Agency : 19000
Case Type: Soil only
Status: Not reported
County: Los Angeles
Abate Method: Excavate and Dispose - remove contaminated soil and dispose in approved site
Review Date: 6/19/96 Confirm Leak: 6/19/96
Workplan: 10/2/96 Prelim Assess: 10/2/96
Pollution Char: Not reported Remed Plan: Not reported
Remed Action: Not reported Monitoring: Not reported
Close Date: 6/26/97
Release Date: Not reported
Cleanup Fund Id : Not reported
Discover Date : 6/19/96
Enforcement Dt : Not reported
Enf Type: Not reported
Enter Date : 3/28/97
Funding: Not reported
Staff Initials: Not reported
How Discovered: Tank Closure
How Stopped: Close Tank
Interim : Yes
Leak Cause: Unknown
Leak Source: Piping
MTBE Date : Not reported
Max MTBE GW : Not reported
MTBE Tested: Site NOT Tested for MTBE.Includes Unknown and Not Analyzed.
Priority: Not reported
Local Case # : Not reported
Beneficial: Not reported
Staff : JLC
GW Qualifies : Not reported
Max MTBE Soil : Not reported
Soil Qualifies : Not reported
Hydr Basin #: Not reported
Operator : Not reported
Oversight Prgm: RB Lead Underground Storage Tank
Oversight Prgm : UST
Review Date : 6/6/97
Stop Date : Not reported
Work Suspended :Not reported
Responsible PartyNATIONAL READY MIXED
RP Address: 27050 RUETHER AVE., SANTA CLARITA CA 91380
Global Id: T0603704681
Org Name: Not reported
Contact Person: Not reported
MTBE Conc: 0
Mtbe Fuel: Not reported
Water System Name: Not reported
Well Name: Not reported
Distance To Lust: 677.7441396
Waste Discharge Global ID: Not reported
Waste Disch Assigned Name: Not reported

LUST Region 4:
Report Date: 9/25/1996
Lead Agency: Regional Board
Local Agency: 19000

NATIONAL READY MIXED CONCRETE (Continued) **S104160049**

Case Number: R-05519
Substance: Gasoline
Case Type: Soil
Status: Case Closed
Region: 4
Staff: Not reported

HAZNET:
Gepaid: CAC000937432
Tepaid: CAD008252405
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .3000
Category: Off-specification, aged, or surplus organics
Disposal Method: Recycler
Contact: Not reported
Telephone: (000) 000-0000
Mailing Address: P. O. BOX 800026
SANTA CLARITA, CA 91380
County Los Angeles

Gepaid: CAR000079327
Tepaid: CAT000613893
Gen County: 0
Tsd County: Los Angeles
Tons: .4170
Category: Aqueous solution with less than 10% total organic residues
Disposal Method: Transfer Station
Contact: Not reported
Telephone: (000) 000-0000
Mailing Address: 27050 RUETHER AVE
SANTA CLARITA, CA 91351
County 0

Gepaid: CAC001187696
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 1.0633
Category: Aqueous solution with less than 10% total organic residues
Disposal Method: Recycler
Contact: A C WARNACK
Telephone: (000) 000-0000
Mailing Address: P O BOX 800026
SANTA CLARITA, CA 91380
County Los Angeles

Gepaid: CAC001187696
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 1.6680
Category: Waste oil and mixed oil
Disposal Method: Recycler
Contact: A C WARNACK
Telephone: (000) 000-0000
Mailing Address: P O BOX 800026
SANTA CLARITA, CA 91380
County Los Angeles

NATIONAL READY MIXED CONCRETE (Continued) **S104160049**

CORTESE:

Reg Id: R-05519
Region: CORTESE
Reg By: Leaking Underground Storage Tanks

HMS:

Facility Id:	005319-024283		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		
Facility Id:	005319-I05519		
Facility Type:	I05		
Permit Number:	000008421	Permit Status:	Permit
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		
Facility Id:	009050-005519		
Facility Type:	T0		
Permit Number:	00000292T	Permit Status:	Closed
Facility Status:	Closed	Area:	7A
Region:	Los Angeles County:		

AE205 **NATIONAL READY MIX CONCRETE CO** **HIST UST** **U001567711**
ENE **27050 RUETHER AVE** **N/A**
> 1 **CANYON COUNTRY, CA 91350**
6210 ft.
Higher **Site 11 of 12 in cluster AE**

UST HIST:

Facility ID:	63436		
Tank Num:	1	Container Num:	4
Tank Capacity:	2800	Year Installed:	1982
Tank Used for:	WASTE		
Type of Fuel:	Not Reported	Tank Construction:	8 inches
Leak Detection:	None		
Contact Name:	CHARLES J. KENNEDY, GEN. MGR.	Telephone:	(805) 252-8181
Total Tanks:	2	Region:	STATE
Facility Type:	2	Other Type:	READY MIX CONCRETE
Facility ID:	63436		
Tank Num:	2	Container Num:	5
Tank Capacity:	0	Year Installed:	1982
Tank Used for:	WASTE		
Type of Fuel:	Not Reported	Tank Construction:	Not reported
Leak Detection:	None		
Contact Name:	CHARLES J. KENNEDY, GEN. MGR.	Telephone:	(805) 252-8181
Total Tanks:	2	Region:	STATE
Facility Type:	2	Other Type:	READY MIX CONCRETE

AE206 **NATIONAL READY MIX** **RCRIS-SQG** **1004675967**
ENE **27050 RUETHER AVE** **CAR000079327**
> 1 **SANTA CLARITA, CA 91351**
6210 ft.
Higher **Site 12 of 12 in cluster AE**

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number

NATIONAL READY MIX (Continued) — 1004675967

RCRIS:
Owner: NATIONAL READY MIX
(661) 252-8181
EPA ID: CAR000079327

Contact: ENVIRONMENTAL MANAGER

Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

Violation Status: No violations found

AH207
WNW
> 1
6223 ft.
Lower

DR BORIS ZAK'S DENTAL OFFICE
26324 N BOUQUET CANYON RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS — **S102321790** / **N/A**

Site 1 of 3 in cluster AH

HMS:

Facility Id:	017507-023852		
Facility Type:	I01		
Permit Number:	000189685	Permit Status:	Permit
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

AG208
East
> 1
6252 ft.
Higher

LA CO DPW FLOOD DIST
21014 GOLDEN TRIANGLE RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS — **S105053483** / **N/A**

Site 2 of 6 in cluster AG

HMS:

Facility Id:	014208-014735		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

AG209
East
> 1
6252 ft.
Higher

DPW FMD SANTA CLARITA REFERRAL
21014 GOLDEN TRIANGLE RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS — **S102064041** / **N/A**

Site 3 of 6 in cluster AG

HMS:

Facility Id:	017324-023454		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

AD210
East
> 1
6283 ft.
Higher

DISCOUNT TIRE CENTERS
20737 SOLEDAD CANYON RD
CANYON COUNTRY, CA 91351

RCRIS-SQG — **1000857869**
FINDS — **CAD983673195**

Site 4 of 5 in cluster AD

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

DISCOUNT TIRE CENTERS (Continued) **1000857869**

RCRIS:
Owner: DISCOUNT TIRE CENTERS
(805) 252-0823
EPA ID: CAD983673195
Contact: SAM KECKLER
(805) 252-0823
Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported
Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

AD211 **SCV AUTO SPECIALIST** **HAZNET** **S105092984**
East **20733 SOLEDAD CANYON RD** **N/A**
> 1 **CANYON COUNTRY, CA 91351**
6304 ft.
Higher **Site 5 of 5 in cluster AD**

HAZNET:
Gepaid: CAL000215030
Tepaid: CAD099452708
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .7923
Category: Unspecified aqueous solution
Disposal Method: Recycler
Contact: MARY LICITRA
Telephone: (661) 251-7134
Mailing Address: 20733 SOLEDAD CANYON RD
CANYON COUNTRY, CA 91351
County Los Angeles

Gepaid: CAL000215030
Tepaid: CAD099452708
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .4170
Category: Unspecified aqueous solution
Disposal Method: Not reported
Contact: MARY LICITRA
Telephone: (661) 251-7134
Mailing Address: 20733 SOLEDAD CANYON RD
CANYON COUNTRY, CA 91351
County Los Angeles

AH212 **CROSSROADS DENTAL CENTER** **HAZNET** **S102826494**
WNW **26246 BOUQUET CANYON RD** **N/A**
> 1 **SAUGUS, CA 91350**
6329 ft.
Lower **Site 2 of 3 in cluster AH**

CROSSROADS DENTAL CENTER (Continued) **S102826494**

HAZNET:

Gepaid: CAL921855721
Tepaid: CAD050806850
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .0092
Category: Other inorganic solid waste
Disposal Method: Recycler
Contact: DAVID GOLDBERG DDS
Telephone: (661) 254-6044
Mailing Address: 26246 BOUQUET CANYON RD
SANTA CLARITA, CA 91350 - 2645
County Los Angeles

Gepaid: CAL921855721
Tepaid: CAD028409019
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .0001
Category: Other inorganic solid waste
Disposal Method: Transfer Station
Contact: DAVID GOLDBERG DDS
Telephone: (661) 254-6044
Mailing Address: 26246 BOUQUET CANYON RD
SANTA CLARITA, CA 91350 - 2645
County Los Angeles

Gepaid: CAL921855721
Tepaid: CAD028409019
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .0000
Category: Other inorganic solid waste
Disposal Method: Transfer Station
Contact: DAVID GOLDBERG DDS
Telephone: (661) 254-6044
Mailing Address: 26246 BOUQUET CANYON RD
SANTA CLARITA, CA 91350 - 2645
County Los Angeles

Gepaid: CAL921855721
Tepaid: CAD050806850
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .8428
Category: Other inorganic solid waste
Disposal Method: Transfer Station
Contact: DAVID GOLDBERG DDS
Telephone: (661) 254-6044
Mailing Address: 26246 BOUQUET CANYON RD
SANTA CLARITA, CA 91350 - 2645
County Los Angeles

CROSSROADS DENTAL CENTER (Continued) **S102826494**

Gepaid: CAL921855721
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .0834
Category: Photochemicals/photoprocessing waste
Disposal Method: Not reported
Contact: DAVID GOLDBERG DDS
Telephone: (661) 254-6044
Mailing Address: 26246 BOUQUET CANYON RD
SANTA CLARITA, CA 91350 - 2645
County Los Angeles

The CA HAZNET database contains 1 additional record for this site.
Please contact your EDR Account Executive for more information.

AH213 **PIP PRINTING #675** **HAZNET** **S100870896**
WNW **26240 BOUQUET CANYON RD** **N/A**
> 1 **SANTA CLARITA, CA 91350**
6338 ft.
Lower **Site 3 of 3 in cluster AH**

HAZNET:
Gepaid: CAL000044792
Tepaid: CAT080033681
Gen County: Santa Clara
Tsd County: Los Angeles
Tons: 0.5
Category: Unspecified oil-containing waste
Disposal Method: Treatment, Incineration
Contact: DONALD G CAMERON
Telephone: (000) 000-0000
Mailing Address: 26240 BOUQUET CANYON RD
SANTA CLARITA, CA 91350
County Santa Clara

Gepaid: CAL000044792
Tepaid: CAD108040858
Gen County: Santa Clara
Tsd County: Los Angeles
Tons: .1333
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: DONALD G CAMERON
Telephone: (000) 000-0000
Mailing Address: 26240 BOUQUET CANYON RD
SANTA CLARITA, CA 91350
County Santa Clara

Gepaid: CAL000044792
Tepaid: CAD108040858
Gen County: Santa Clara
Tsd County: Los Angeles
Tons: .2000
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: DONALD G CAMERON
Telephone: (000) 000-0000
Mailing Address: 26240 BOUQUET CANYON RD

PIP PRINTING #675 (Continued) **S100870896**

	SANTA CLARITA, CA 91350
County	Santa Clara
Gepaid:	CAL000044792
Tepaid:	CAT080033681
Gen County:	Santa Clara
Tsd County:	Los Angeles
Tons:	.8351
Category:	Unspecified oil-containing waste
Disposal Method:	Recycler
Contact:	DONALD G CAMERON
Telephone:	(000) 000-0000
Mailing Address:	26240 BOUQUET CANYON RD
	SANTA CLARITA, CA 91350
County	Santa Clara
Gepaid:	CAL000044792
Tepaid:	CAT080033681
Gen County:	Santa Clara
Tsd County:	Los Angeles
Tons:	.4000
Category:	Unspecified oil-containing waste
Disposal Method:	Disposal, Other
Contact:	DONALD G CAMERON
Telephone:	(000) 000-0000
Mailing Address:	26240 BOUQUET CANYON RD
	SANTA CLARITA, CA 91350
County	Santa Clara

The CA HAZNET database contains 6 additional records for this site.
Please contact your EDR Account Executive for more information.

AI214
East
> 1
6357 ft.
Higher

FRONTIER AUTO SERVICE
20723 SOLEDAD CANYON RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S103945035**
N/A

Site 1 of 5 in cluster AI

HMS:

Facility Id:	020318-028912		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

AI215
East
> 1
6357 ft.
Higher

IMPORT AUTO CARE
20723 SOLEDAD CANYON RD
CANYON COUNTRY, CA 91351

RCRIS-SQG **1000596098**
FINDS **CAD983600610**

Site 2 of 5 in cluster AI

IMPORT AUTO CARE (Continued) **1000596098**

RCRIS:
Owner: BERJ PROODIAN
(805) 298-1440
EPA ID: CAD983600610
Contact: CLAUDE GROSSET
(805) 298-1440
Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported
Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

AG216
East
> 1
6428 ft.
Higher

NATIONAL TECHNICAL SYSTEMS
20988 GOLDEN TRIANGLE RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S105053482**
N/A

Site 4 of 6 in cluster AG

HMS:

Facility Id:	003909-004053		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	Removed	Area:	7A
Region:	Los Angeles County:		

AG217
East
> 1
6428 ft.
Higher

20988 GOLDEN TRIANGLE
CANYON COUNTRY, CA 91350

CHMIRS **S100222833**
N/A

Site 5 of 6 in cluster AG

CHMIRS:

OES Control Number:	9991739	DOT ID:	2029
DOT Hazard Class:	Miscellaneous hazardous material		
Chemical Name:	HYDRAZINE		
Extent of Release:	Not reported		
CAS Number:	Not reported	Quantity Released:	Not reported
Environmental Contamination:	Air	Property Use:	Industrial, Utility
Incident Date:	19-APR-88	Date Completed:	19-APR-88

Time Completed : 1140
Physical State Stored : Liquid
Physical State Released : Gas
Release Unit : Not reported
Container Description : 1
Container Type : Drum
Container Material : Undetermined
Level Of Container : Ground Level
Container Capacity : 5
Container Capacity Units (code) : 2
Extent Of Release (code) : 6
Agency Id Number : 19110
Agency Incident Number : 76-22

(Continued) **S100222833**

OES Incident Number :	9991739
Time Notified :	933
Surrounding Area :	600
Estimated Temperature :	Not reported
Property Management :	Not reported
More Than Two Substances Involved? :	Not reported
Special Studies 1 :	Not reported
Special Studies 2 :	Not reported
Special Studies 3 :	Not reported
Special Studies 4 :	Not reported
Special Studies 5 :	Not reported
Special Studies 6 :	Not reported
Responding Agency Personel # Of Injuries :	Not reported
Responding Agency Personel # Of Fatalities :	Not reported
Resp Agncy Personel # Of Decontaminated :	Not reported
Others Number Of Decontaminated :	Not reported
Others Number Of Injuries :	Not reported
Others Number Of Fatalities :	Not reported
Vehicle Make/year :	Not reported
Vehicle License Number :	Not reported
Vehicle State :	Not reported
Vehicle Id Number :	Not reported
CA/DOT/PUC/ICC Number :	Not reported
Company Name :	Not reported
Reporting Officer Name/ID :	L MOHR
Report Date :	19-APR-88
Comments :	No
Facility Telephone Number :	213 267-2485

AG218
East
> 1
6428 ft.
Higher

NATIONAL TECHNICAL SYSTEMS
20988 W GOLDEN TRIANGLE RD STE W
SANTA CLARITA, CA 91350

HAZNET **S100940614**
LOS ANGELES CO. HMS **N/A**

Site 6 of 6 in cluster AG

HAZNET:

Gepaid:	CAL000034177
Tepaid:	CAD982444481
Gen County:	Los Angeles
Tsd County:	San Bernardino
Tons:	5.8996
Category:	Other organic solids
Disposal Method:	Transfer Station
Contact:	JACK LIN
Telephone:	(818) 591-0776
Mailing Address:	20988 W GOLDEN TRIANGLE RD STE W SANTA CLARITA, CA 91350 - 2678
County	Los Angeles

Gepaid:	CAL000034177
Tepaid:	CAT080013352
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	15.429
Category:	Waste oil and mixed oil
Disposal Method:	Recycler
Contact:	JACK LIN
Telephone:	(818) 591-0776
Mailing Address:	20988 W GOLDEN TRIANGLE RD STE W

NATIONAL TECHNICAL SYSTEMS (Continued) **S100940614**

	SANTA CLARITA, CA 91350 - 2678
County	Los Angeles
Gepaid:	CAL000034177
Tepaid:	CAD000088252
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	5.1855
Category:	Unspecified oil-containing waste
Disposal Method:	Transfer Station
Contact:	JACK LIN
Telephone:	(818) 591-0776
Mailing Address:	20988 W GOLDEN TRIANGLE RD STE W
	SANTA CLARITA, CA 91350 - 2678
County	Los Angeles
Gepaid:	CAL000034177
Tepaid:	CAT080013352
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	2.5020
Category:	Unspecified oil-containing waste
Disposal Method:	Recycler
Contact:	JACK LIN
Telephone:	(818) 591-0776
Mailing Address:	20988 W GOLDEN TRIANGLE RD STE W
	SANTA CLARITA, CA 91350 - 2678
County	Los Angeles
Gepaid:	CAL000034177
Tepaid:	CAD980883177
Gen County:	Los Angeles
Tsd County:	Kern
Tons:	1.4595
Category:	Waste oil and mixed oil
Disposal Method:	Recycler
Contact:	JACK LIN
Telephone:	(818) 591-0776
Mailing Address:	20988 W GOLDEN TRIANGLE RD STE W
	SANTA CLARITA, CA 91350 - 2678
County	Los Angeles

The CA HAZNET database contains 27 additional records for this site.
Please contact your EDR Account Executive for more information.

HMS:

Facility Id:	003909-I04053		
Facility Type:	I09		
Permit Number:	000012286	Permit Status:	Permit
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

AJ219 **SERVICE STATION 5518** **HIST UST** **U001567724**
West **26279 BOUQUET CANYON RD** **N/A**
> 1 **SAUGUS, CA 91350**
6437 ft.
Lower **Site 1 of 5 in cluster AJ**

UST HIST:

Facility ID:	8021		
Tank Num:	1	Container Num:	5518-1

SERVICE STATION 5518 (Continued) **U001567724**

Tank Capacity:	9950	Year Installed:	1965
Tank Used for:	PRODUCT		
Type of Fuel:	UNLEADED	Tank Construction:	Not reported
Leak Detection:	Stock Inventor, Pressure Test		
Contact Name:	DONALD WOLF	Telephone:	(805) 259-7676
Total Tanks:	3	Region:	STATE
Facility Type:	1	Other Type:	Not reported

Facility ID:	8021		
Tank Num:	2	Container Num:	5518-2
Tank Capacity:	9950	Year Installed:	1965
Tank Used for:	PRODUCT		
Type of Fuel:	PREMIUM	Tank Construction:	Not reported
Leak Detection:	Stock Inventor, Pressure Test		
Contact Name:	DONALD WOLF	Telephone:	(805) 259-7676
Total Tanks:	3	Region:	STATE
Facility Type:	1	Other Type:	Not reported

Facility ID:	8021		
Tank Num:	3	Container Num:	5518-4
Tank Capacity:	280	Year Installed:	1965
Tank Used for:	WASTE		
Type of Fuel:	WASTE OIL	Tank Construction:	Not reported
Leak Detection:	Stock Inventor, Pressure Test		
Contact Name:	DONALD WOLF	Telephone:	(805) 259-7676
Total Tanks:	3	Region:	STATE
Facility Type:	1	Other Type:	Not reported

AJ220
West
> 1
6437 ft.
Lower

WOLF'S BOUQUET UNION & TOW. IN
26279 BOUQUET CANYON RD
SAUGUS, CA 91350

HIST UST **U001567736**
N/A

Site 2 of 5 in cluster AJ

UST HIST:

Facility ID:	51049		
Tank Num:	1	Container Num:	1
Tank Capacity:	10000	Year Installed:	1966
Tank Used for:	PRODUCT		
Type of Fuel:	PREMIUM	Tank Construction:	Not reported
Leak Detection:	Stock Inventor		
Contact Name:	DONALD E. WOLF	Telephone:	(805) 259-7676
Total Tanks:	3	Region:	STATE
Facility Type:	1	Other Type:	Not reported

Facility ID:	51049		
Tank Num:	2	Container Num:	3
Tank Capacity:	1000	Year Installed:	1966
Tank Used for:	WASTE		
Type of Fuel:	WASTE OIL	Tank Construction:	Not reported
Leak Detection:	None		
Contact Name:	DONALD E. WOLF	Telephone:	(805) 259-7676
Total Tanks:	3	Region:	STATE
Facility Type:	1	Other Type:	Not reported

Facility ID:	51049		
Tank Num:	3	Container Num:	2
Tank Capacity:	10000	Year Installed:	1966
Tank Used for:	PRODUCT		

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

WOLF'S BOUQUET UNION & TOW. IN (Continued) **U001567736**

Type of Fuel:	UNLEADED	Tank Construction:	Not reported
Leak Detection:	Stock Inventor		
Contact Name:	DONALD E. WOLF	Telephone:	(805) 259-7676
Total Tanks:	3	Region:	STATE
Facility Type:	1	Other Type:	Not reported

AJ221 **UNOCAL #5518** **Cortese** **S105026545**
West **26279 BOUQUET CANYON RD** **N/A**
> 1 **SAUGUS, CA 91350**
6437 ft.
Lower **Site 3 of 5 in cluster AJ**

CORTESE:

Reg Id:	913500034
Region:	CORTESE
Reg By:	Leaking Underground Storage Tanks

AJ222 **UNION OIL SERVICE STATION 5518** **HIST UST** **U001567731**
West **26279 BOUQUET CANYON RD** **N/A**
> 1 **SAUGUS, CA 91350**
6437 ft.
Lower **Site 4 of 5 in cluster AJ**

UST HIST:

Facility ID:	56205		
Tank Num:	1	Container Num:	1
Tank Capacity:	0	Year Installed:	Not reported
Tank Used for:	WASTE		
Type of Fuel:	WASTE OIL	Tank Construction:	Not reported
Leak Detection:	None		
Contact Name:	DONALD WOLF	Telephone:	(805) 259-7676
Total Tanks:	1	Region:	STATE
Facility Type:	1	Other Type:	Not reported

AJ223 **UNOCAL #5518** **LUST** **S102440043**
West **26279 BOUQUET CANYON RD** **N/A**
> 1 **SAUGUS, CA 91350**
6437 ft.
Lower **Site 5 of 5 in cluster AJ**

State LUST:

Cross Street:	CENTURION		
Qty Leaked:	Not reported		
Case Number	913500034		
Reg Board:	4		
Chemical:	Gasoline		
Lead Agency:	Regional Board		
Local Agency :	19000		
Case Type:	Other ground water affected		
Status:	Not reported		
County:	Los Angeles		
Abate Method:	Excavate and Dispose - remove contaminated soil and dispose in approved site		
Review Date:	Not reported	Confirm Leak:	Not reported
Workplan:	Not reported	Prelim Assess:	Not reported
Pollution Char:	Not reported	Remed Plan:	Not reported
Remed Action:	Not reported	Monitoring:	Not reported
Close Date:	6/11/86		

UNOCAL #5518 (Continued) **S102440043**

Release Date: Not reported
Cleanup Fund Id : Not reported
Discover Date : Not reported
Enforcement Dt : Not reported
Enf Type: Not reported
Enter Date : 12/31/86
Funding: Not reported
Staff Initials: Not reported
How Discovered: Not reported
How Stopped: Not reported
Interim : Yes
Leak Cause: Unknown
Leak Source: Unknown
MTBE Date : Not reported
Max MTBE GW : Not reported
MTBE Tested: Site NOT Tested for MTBE.Includes Unknown and Not Analyzed.
Priority: Not reported
Local Case # : Not reported
Beneficial: Not reported
Staff : JLC
GW Qualifies : Not reported
Max MTBE Soil : Not reported
Soil Qualifies : Not reported
Hydr Basin #: Not reported
Operator : Not reported
Oversight Prgm: RB Lead Underground Storage Tank
Oversight Prgm : UST
Review Date : 3/30/89
Stop Date : Not reported
Work Suspended :Not reported
Responsible PartyUNOCAL
RP Address: 3701 WILSHIRE BLVD, SUITE 800, LOS ANGELES, CA 90010
Global Id: T0603702306
Org Name: Not reported
Contact Person: Not reported
MTBE Conc: 0
Mtbe Fuel: Not reported
Water System Name: Not reported
Well Name: Not reported
Distance To Lust: 785.919116
Waste Discharge Global ID: Not reported
Waste Disch Assigned Name: Not reported

LUST Region 4:
Report Date: 3/10/1986
Lead Agency: Regional Board
Local Agency: 19000
Case Number: 913500034
Substance: Gasoline
Case Type: Groundwater
Status: Case Closed
Region: 4
Staff: Not reported

AI224 **CANYON COUNTRY LUBRICATION** **HAZNET** **S103640931**
East **20703 SOLEDAD CANYON ROAD** **N/A**
> 1 **CANYON COUNTRY, CA 91351**
6469 ft.
Higher **Site 3 of 5 in cluster AI**

CANYON COUNTRY LUBRICATION (Continued) **S103640931**

HAZNET:

Gepaid:	CAL000031064
Tepaid:	CAD981696420
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	0.9382
Category:	Aqueous solution with less than 10% total organic residues
Disposal Method:	Transfer Station
Contact:	REYNOLDS BYRON
Telephone:	(000) 000-0000
Mailing Address:	20703 SOLEDAD CANYON RD CANYON COUNTRY, CA 91351 - 2440
County	Los Angeles

Gepaid:	CAL000031064
Tepaid:	CAD099452708
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.5628
Category:	Unspecified oil-containing waste
Disposal Method:	Recycler
Contact:	REYNOLDS BYRON
Telephone:	(000) 000-0000
Mailing Address:	20703 SOLEDAD CANYON RD CANYON COUNTRY, CA 91351 - 2440
County	Los Angeles

Gepaid:	CAL000031064
Tepaid:	CAD099452708
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	2.9606
Category:	Unspecified aqueous solution
Disposal Method:	Recycler
Contact:	REYNOLDS BYRON
Telephone:	(000) 000-0000
Mailing Address:	20703 SOLEDAD CANYON RD CANYON COUNTRY, CA 91351 - 2440
County	Los Angeles

Gepaid:	CAL000031064
Tepaid:	CAT080011059
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.2293
Category:	Unspecified oil-containing waste
Disposal Method:	Recycler
Contact:	REYNOLDS BYRON
Telephone:	(000) 000-0000
Mailing Address:	20703 SOLEDAD CANYON RD CANYON COUNTRY, CA 91351 - 2440
County	Los Angeles

AI225 **JIFFY LUBE** **LOS ANGELES CO. HMS** **S102064006**
East **20703 SOLEDAD CANYON RD** **N/A**
> 1 **SANTA CLARITA, CA**
6469 ft.
Higher **Site 4 of 5 in cluster AI**

JIFFY LUBE (Continued) **S102064006**

HMS:

Facility Id:	009295-009096		
Facility Type:	T0		
Permit Number:	00000071T	Permit Status:	Removed
Facility Status:	Removed	Area:	7A
Region:	Los Angeles County:		
Facility Id:	009295-028911		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

AI226
East
> 1
6469 ft.
Higher

JIFFY LUBE #680
20703 SOLEDAD CANYON RD
CANYON COUNTRY, CA 91351

HAZNET **S104581761**
AST **N/A**

Site 5 of 5 in cluster AI

HAZNET:

Gepaid:	CAL000190089
Tepaid:	CAD981696420
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	10.1121
Category:	Aqueous solution with less than 10% total organic residues
Disposal Method:	Transfer Station
Contact:	MIZAR LLC
Telephone:	(000) 000-0000
Mailing Address:	20703 SOLEDAD CANYON RD CANYON COUNTRY, CA 91351
County	Los Angeles
Gepaid:	CAL000190089
Tepaid:	CAD981696420
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	0
Category:	
Disposal Method:	Transfer Station
Contact:	MIZAR LLC
Telephone:	(000) 000-0000
Mailing Address:	20703 SOLEDAD CANYON RD CANYON COUNTRY, CA 91351
County	Los Angeles
Gepaid:	CAL000190089
Tepaid:	CAD981696420
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	0.834
Category:	Aqueous solution with less than 10% total organic residues
Disposal Method:	Not reported
Contact:	MIZAR LLC
Telephone:	(000) 000-0000
Mailing Address:	20703 SOLEDAD CANYON RD CANYON COUNTRY, CA 91351
County	Los Angeles

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

JIFFY LUBE #680 (Continued) **S104581761**

Gepaid:	CAL000190089
Tepaid:	CAD981696420
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	6.4925
Category:	Aqueous solution with less than 10% total organic residues
Disposal Method:	Transfer Station
Contact:	MIZAR LLC
Telephone:	(000) 000-0000
Mailing Address:	20703 SOLEDAD CANYON RD CANYON COUNTRY, CA 91351
County	Los Angeles

AST:

Region:	4
Owner:	JIFFY LUBE

AK227
West
> 1
6487 ft.
Lower

UNOCAL CORP SS 7344
23055 W SOLEDAD CANYON RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S105422133** **N/A**

Site 1 of 17 in cluster AK

HMS:

Facility Id:	009739-009575		
Facility Type:	T0		
Permit Number:	00000795T	Permit Status:	Closed
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

AK228
West
> 1
6487 ft.
Lower

TOSCO/UNOCAL #31309
23055 W SOLEDAD CANYON RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S105422135** **N/A**

Site 2 of 17 in cluster AK

HMS:

Facility Id:	009739-028929		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

AK229
West
> 1
6487 ft.
Lower

ACWA ASSOC - SEE FILE I09575
23055 W SOLEDAD CANYON RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S105422132** **N/A**

Site 3 of 17 in cluster AK

HMS:

Facility Id:	008430-021139		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number
AK230 **West** **> 1** **6487 ft.** **Lower**	**TOSCO CORPORATION STATION #31309** **23055 SOLEDAD CANYON RD** **SAUGUS, CA 91350** **Site 4 of 17 in cluster AK**	**HAZNET**	**S103992190** **N/A**

HAZNET:

Gepaid: CAL000135711
Tepaid: CAD028409019
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .0875
Category: Aqueous solution with less than 10% total organic residues
Disposal Method: Treatment, Tank
Contact: TOSCO MARKETING
Telephone: (602) 728-4180
Mailing Address: P O BOX 52085
PHOENIX, AZ 85072 - 2085
County Los Angeles

Gepaid: CAL000135711
Tepaid: CAD028409019
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .1668
Category: Aqueous solution with 10% or more total organic residues
Disposal Method: Treatment, Tank
Contact: TOSCO MARKETING
Telephone: (602) 728-4180
Mailing Address: P O BOX 52085
PHOENIX, AZ 85072 - 2085
County Los Angeles

Gepaid: CAL000135711
Tepaid: CAD028409019
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 0.271
Category: Aqueous solution with less than 10% total organic residues
Disposal Method: Treatment, Tank
Contact: TOSCO MARKETING
Telephone: (602) 728-4180
Mailing Address: P O BOX 52085
PHOENIX, AZ 85072 - 2085
County Los Angeles

AK231 **West** **> 1** **6487 ft.** **Lower**	**TOSCO/UNOCAL #31309** **23055 W SOLEDAD CANYON RD** **SANTA CLARITA, CA** **Site 5 of 17 in cluster AK**	**LOS ANGELES CO. HMS**	**S105422134** **N/A**

HMS:

Facility Id: 009739-024755
Facility Type: T0
Permit Number: 000191274 Permit Status: Permit
Facility Status: Permit Area: 7A
Region: Los Angeles County:

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number
AK232 **West** **> 1** **6487 ft.** **Lower**	**97436** **23055 SOLEDAD CANYON RD** **SAUGUS, CA 91350** **Site 6 of 17 in cluster AK**	**HIST UST**	**U001567684** **N/A**

UST HIST:

Facility ID: 62998
Tank Num: 1 — Container Num: 1
Tank Capacity: 3000 — Year Installed: 1963
Tank Used for: PRODUCT
Type of Fuel: Not Reported — Tank Construction: 0000170 unknown
Leak Detection: Stock Inventor
Contact Name: MORSE,JERRY P — Telephone: (805) 259-3705
Total Tanks: 5 — Region: STATE
Facility Type: 1 — Other Type: Not reported

Facility ID: 62998
Tank Num: 2 — Container Num: 2
Tank Capacity: 5000 — Year Installed: 1963
Tank Used for: PRODUCT
Type of Fuel: Not Reported — Tank Construction: 0000250 unknown
Leak Detection: Stock Inventor
Contact Name: MORSE,JERRY P — Telephone: (805) 259-3705
Total Tanks: 5 — Region: STATE
Facility Type: 1 — Other Type: Not reported

Facility ID: 62998
Tank Num: 3 — Container Num: 3
Tank Capacity: 6000 — Year Installed: 1963
Tank Used for: PRODUCT
Type of Fuel: Not Reported — Tank Construction: 0000250 unknown
Leak Detection: Stock Inventor
Contact Name: MORSE,JERRY P — Telephone: (805) 259-3705
Total Tanks: 5 — Region: STATE
Facility Type: 1 — Other Type: Not reported

Facility ID: 62998
Tank Num: 4 — Container Num: 4
Tank Capacity: 10000 — Year Installed: 1969
Tank Used for: PRODUCT
Type of Fuel: Not Reported — Tank Construction: 0000250 unknown
Leak Detection: Stock Inventor
Contact Name: MORSE,JERRY P — Telephone: (805) 259-3705
Total Tanks: 5 — Region: STATE
Facility Type: 1 — Other Type: Not reported

Facility ID: 62998
Tank Num: 5 — Container Num: 5
Tank Capacity: 550 — Year Installed: 1963
Tank Used for: WASTE
Type of Fuel: Not Reported — Tank Construction: 0000100 unknown
Leak Detection: Stock Inventor
Contact Name: MORSE,JERRY P — Telephone: (805) 259-3705
Total Tanks: 5 — Region: STATE
Facility Type: 1 — Other Type: Not reported

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

AK233
West
> 1
6487 ft.
Lower

TOSCO/UNOCAL #31309
23055 SOLEDAD CANYON RD
SANTA CLARITA, CA 91350

UST **U003777688**
N/A

Site 7 of 17 in cluster AK

State UST:
Facility ID: 24755
Total Tanks: 1
Region: STATE
Local Agency: 19000

AK234
West
> 1
6487 ft.
Lower

CHEVRON #9-7436 (FORMER)
23055 SOLEDAD CANYON RD
SAUGUS, CA 91350

Cortese **S105026560**
N/A

Site 8 of 17 in cluster AK

CORTESE:
Reg Id: I-09575
Region: CORTESE
Reg By: Leaking Underground Storage Tanks

AK235
West
> 1
6487 ft.
Lower

UNOCAL SERVICE STATION #7344
23055 SOLEDAD CANYON ROAD
SAUGUS, CA 91350

HAZNET **S103643996**
N/A

Site 9 of 17 in cluster AK

HAZNET:
Gepaid: CAL000046416
Tepaid: CAT080011059
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 1.0425
Category: Waste oil and mixed oil
Disposal Method: Recycler
Contact: UNION OIL COMPANY OF CALIFORNI
Telephone: (714) 428-6560
Mailing Address: PO BOX 25376
SANTA ANA, CA 92799 - 5376
County Los Angeles

Gepaid: CAL000046416
Tepaid: CAT080011059
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .5795
Category: Aqueous solution with 10% or more total organic residues
Disposal Method: Recycler
Contact: UNION OIL COMPANY OF CALIFORNI
Telephone: (714) 428-6560
Mailing Address: PO BOX 25376
SANTA ANA, CA 92799 - 5376
County Los Angeles

UNOCAL SERVICE STATION #7344 (Continued) **S103643996**

Gepaid: CAL000046416
Tepaid: Not reported
Gen County: Los Angeles
Tsd County: 0
Tons: .3961
Category:
Disposal Method: Not reported
Contact: UNION OIL COMPANY OF CALIFORNI
Telephone: (714) 428-6560
Mailing Address: PO BOX 25376
SANTA ANA, CA 92799 - 5376
County Los Angeles

Gepaid: CAL000046416
Tepaid: CAD028409019
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .3961
Category:
Disposal Method: Treatment, Tank
Contact: UNION OIL COMPANY OF CALIFORNI
Telephone: (714) 428-6560
Mailing Address: PO BOX 25376
SANTA ANA, CA 92799 - 5376
County Los Angeles

Gepaid: CAL000046416
Tepaid: CAD028409019
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .1959
Category: Aqueous solution with 10% or more total organic residues
Disposal Method: Treatment, Tank
Contact: UNION OIL COMPANY OF CALIFORNI
Telephone: (714) 428-6560
Mailing Address: PO BOX 25376
SANTA ANA, CA 92799 - 5376
County Los Angeles

AK236 **CHEVRON STATION 97436** **RCRIS-SQG** **1000905200**
West **23055 SOLEDAD CYN RD** **FINDS** **CA0000370890**
> 1 **SAUGUS, CA 91350** **LUST**
6487 ft.
Lower **Site 10 of 17 in cluster AK**

RCRIS:
Owner: CHEVRON USA PRODUCTS CO
(310) 694-7452
EPA ID: CA0000370890

Contact: SUZANNE SISSUNG
(310) 694-7452

Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

CHEVRON STATION 97436 (Continued) **1000905200**

Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

State LUST:

Cross Street:	BOUQUET CANYON		
Qty Leaked:	Not reported		
Case Number	I-09575		
Reg Board:	4		
Chemical:	Gasoline		
Lead Agency:	Regional Board		
Local Agency :	19000		
Case Type:	Other ground water affected		
Status:	Not reported		
County:	Los Angeles		
Abate Method:	Vapor Extraction		
Review Date:	Not reported	Confirm Leak:	Not reported
Workplan:	Not reported	Prelim Assess:	Not reported
Pollution Char:	Not reported	Remed Plan:	Not reported
Remed Action:	Not reported	Monitoring:	Not reported
Close Date:	11/4/96		
Release Date:	Not reported		
Cleanup Fund Id :	Not reported		
Discover Date :	8/13/87		
Enforcement Dt :	Not reported		
Enf Type:	Not reported		
Enter Date :	Not reported		
Funding:	Not reported		
Staff Initials:	Not reported		
How Discovered:	Not reported		
How Stopped:	Not reported		
Interim :	Yes		
Leak Cause:	Not reported		
Leak Source:	Not reported		
MTBE Date :	Not reported		
Max MTBE GW :	Not reported		
MTBE Tested:	Site NOT Tested for MTBE.Includes Unknown and Not Analyzed.		
Priority:	Not reported		
Local Case # :	Not reported		
Beneficial:	Not reported		
Staff :	JLC		
GW Qualifies :	Not reported		
Max MTBE Soil :	Not reported		
Soil Qualifies :	Not reported		
Hydr Basin #:	Not reported		
Operator :	Not reported		
Oversight Prgm:	RB Lead Underground Storage Tank		
Oversight Prgm :	UST		
Review Date :	2/18/98		
Stop Date :	Not reported		
Work Suspended :	Not reported		
Responsible Party	CHEVRON PRODUCTS CO		
RP Address:	P.O. BOX 2833, LA HABRA CA 90632-2833		
Global Id:	T0603703450		

CHEVRON STATION 97436 (Continued) **1000905200**

Org Name: Not reported
Contact Person: Not reported
MTBE Conc: 0
Mtbe Fuel: Not reported
Water System Name: Not reported
Well Name: Not reported
Distance To Lust: 703.4789309
Waste Discharge Global ID: Not reported
Waste Disch Assigned Name: Not reported

LUST Region 4:
Report Date: 10/9/1989
Lead Agency: Regional Board
Local Agency: 19000
Case Number: I-09575
Substance: Gasoline
Case Type: Groundwater
Status: Case Closed
Region: 4
Staff: Not reported

AK237 **ACWA ASSOCIATES INC** **LOS ANGELES CO. HMS** **S105422131**
West **23055 W SOLEDAD CANYON RD** **N/A**
> 1 **SANTA CLARITA, CA**
6487 ft.
Lower **Site 11 of 17 in cluster AK**

HMS:
Facility Id: 008430-I09575
Facility Type: I02
Permit Number: 000009516 Permit Status: Permit
Facility Status: Permit Area: 7A
Region: Los Angeles County:

AL238 **ACRYLLIC CUSTOMS COLLISION & BODY INC** **HAZNET** **S100943078**
ENE **20665 SANTA CLARA** **N/A**
> 1 **CANYON COUNTRY, CA 91351**
6501 ft.
Higher **Site 1 of 3 in cluster AL**

HAZNET:
Gepaid: CAD982005787
Tepaid: CAD008302903
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2293
Category: Paint sludge
Disposal Method: Recycler
Contact: CORPORATION
Telephone: (000) 000-0000
Mailing Address: 20665 SANTA CLARA ST
CANYON COUNTRY, CA 91351
County Los Angeles

ACRYLLIC CUSTOMS COLLISION & BODY INC (Continued) **S100943078**

Gepaid:	CAD982005787
Tepaid:	CAT000613893
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.0720
Category:	Oxygenated solvents (acetone, butanol, ethyl acetate, etc.)
Disposal Method:	Transfer Station
Contact:	CORPORATION
Telephone:	(000) 000-0000
Mailing Address:	20665 SANTA CLARA ST CANYON COUNTRY, CA 91351
County	Los Angeles

Gepaid:	CAD982005787
Tepaid:	CAD008252405
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	0.1459
Category:	Unspecified solvent mixture Waste
Disposal Method:	Recycler
Contact:	CORPORATION
Telephone:	(000) 000-0000
Mailing Address:	20665 SANTA CLARA ST CANYON COUNTRY, CA 91351
County	Los Angeles

Gepaid:	CAD982005787
Tepaid:	CAD008302903
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	0.5879
Category:	Paint sludge
Disposal Method:	Recycler
Contact:	CORPORATION
Telephone:	(000) 000-0000
Mailing Address:	20665 SANTA CLARA ST CANYON COUNTRY, CA 91351
County	Los Angeles

Gepaid:	CAD982005787
Tepaid:	CAD008302903
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.2293
Category:	Paint sludge
Disposal Method:	Recycler
Contact:	CORPORATION
Telephone:	(000) 000-0000
Mailing Address:	20665 SANTA CLARA ST CANYON COUNTRY, CA 91351
County	Los Angeles

The CA HAZNET database contains 3 additional records for this site.
Please contact your EDR Account Executive for more information.

AL239	**R C ACRYLICS**	**RCRIS-SQG**	**1000101292**
ENE	**20665 SANTA CLARA**	**FINDS**	**CAD982005787**
> 1	**CANYON COUNTRY, CA 91351**		
6501 ft.			
Higher	**Site 2 of 3 in cluster AL**		

R C ACRYLICS (Continued) **1000101292**

RCRIS:
Owner: RICHARD MOAT
(415) 555-1212
EPA ID: CAD982005787
Contact: ENVIRONMENTAL MANAGER
(805) 251-5401
Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported
Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

AL240 **ROBERT SAUMERS** **LOS ANGELES CO. HMS** **S102063999**
ENE **20665 W SANTA CLARA ST** **N/A**
> 1 **SANTA CLARITA, CA**
6501 ft.
Higher **Site 3 of 3 in cluster AL**

HMS:

Facility Id:	013213-013521		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	Removed	Area:	7A
Region:	Los Angeles County:		

AK241 **SAMS EXXON** **HAZNET** **S103986171**
West **23060 SOLEDAD CYN RD** **LOS ANGELES CO. HMS** **N/A**
> 1 **SAUGUS, CA 91350**
6525 ft.
Lower **Site 12 of 17 in cluster AK**

HAZNET:
Gepaid: CAL912136051
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .7297
Category: Unspecified oil-containing waste
Disposal Method: Recycler
Contact: ELHILU,ESMAT
Telephone: (805) 985-5566
Mailing Address: 23060 SOLEDAD CANYON RD
SANTA CLARITA, CA 91350 - 2634
County Los Angeles

HMS:

Facility Id:	006373-I06593		
Facility Type:	I01		
Permit Number:	000009329	Permit Status:	Removed
Facility Status:	Removed	Area:	7A
Region:	Los Angeles County:		

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number
AK242 **West** **> 1** **6525 ft.** **Lower**	**EXXON USA #7-3550** **23060 SOLEDAD CANYON RD** **SANTA CLARITA, CA** **Site 13 of 17 in cluster AK**	**LOS ANGELES CO. HMS**	**S102064168** **N/A**

HMS:

Facility Id:	006373-006593		
Facility Type:	T0		
Permit Number:	00004534T	Permit Status:	Closed
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number
AK243 **West** **> 1** **6525 ft.** **Lower**	**EXXON SERVICE STATION** **23060 SOLEDAD CANYON RD** **SAUGUS, CA 91350** **Site 14 of 17 in cluster AK**	**HIST UST**	**U001567697** **N/A**

UST HIST:

Facility ID:	29509		
Tank Num:	1	Container Num:	#1
Tank Capacity:	6000	Year Installed:	1969
Tank Used for:	PRODUCT		
Type of Fuel:	PREMIUM	Tank Construction:	Not reported
Leak Detection:	Stock Inventor		
Contact Name:	JACK RAKESTAU	Telephone:	(805) 255-6444
Total Tanks:	4	Region:	STATE
Facility Type:	1	Other Type:	Not reported

Facility ID:	29509		
Tank Num:	2	Container Num:	#2
Tank Capacity:	8000	Year Installed:	1969
Tank Used for:	PRODUCT		
Type of Fuel:	REGULAR	Tank Construction:	Not reported
Leak Detection:	Stock Inventor		
Contact Name:	JACK RAKESTAU	Telephone:	(805) 255-6444
Total Tanks:	4	Region:	STATE
Facility Type:	1	Other Type:	Not reported

Facility ID:	29509		
Tank Num:	3	Container Num:	#3
Tank Capacity:	10000	Year Installed:	1969
Tank Used for:	PRODUCT		
Type of Fuel:	UNLEADED	Tank Construction:	Not reported
Leak Detection:	Stock Inventor		
Contact Name:	JACK RAKESTAU	Telephone:	(805) 255-6444
Total Tanks:	4	Region:	STATE
Facility Type:	1	Other Type:	Not reported

Facility ID:	29509		
Tank Num:	4	Container Num:	#4
Tank Capacity:	1000	Year Installed:	1969
Tank Used for:	PRODUCT		
Type of Fuel:	WASTE OIL	Tank Construction:	Not reported
Leak Detection:	Stock Inventor		
Contact Name:	JACK RAKESTAU	Telephone:	(805) 255-6444
Total Tanks:	4	Region:	STATE
Facility Type:	1	Other Type:	Not reported

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number
AK244 **West** **> 1** **6525 ft.** **Lower**	**SAM'S MOBIL** **23060 SOLEDAD CANYON RD** **SANTA CLARITA, CA 91350** **Site 15 of 17 in cluster AK**	**UST** **LOS ANGELES CO. HMS**	**U003777412** **N/A**

HMS:

Facility Id:	006373-028931		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		
Facility Id:	006373-021517		
Facility Type:	T0		
Permit Number:	000089340	Permit Status:	Permit
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

State UST:

Facility ID:	21517
Total Tanks:	1
Region:	STATE
Local Agency:	19000

AK245 **West** **> 1** **6525 ft.** **Lower**	**EXXON #7-3550 (FORMER)** **23060 SOLEDAD CANYON RD** **SANTA CLARITA, CA 91350** **Site 16 of 17 in cluster AK**	**LUST**	**S103891181** **N/A**

State LUST:

Cross Street:	BOUQUET CANYON RD		
Qty Leaked:	Not reported		
Case Number	R-06593		
Reg Board:	4		
Chemical:	Hydrocarbons		
Lead Agency:	Regional Board		
Local Agency :	19000		
Case Type:	Other ground water affected		
Status:	Not reported		
County:	Los Angeles		
Review Date:	6/5/92	Confirm Leak:	6/5/92
Workplan:	6/5/92	Prelim Assess:	6/5/92
Pollution Char:	Not reported	Remed Plan:	Not reported
Remed Action:	Not reported	Monitoring:	Not reported
Close Date:	Not reported		
Release Date:	Not reported		
Cleanup Fund Id :	Not reported		
Discover Date :	5/26/92		
Enforcement Dt :	Not reported		
Enf Type:	Not reported		
Enter Date :	5/27/92		
Funding:	Not reported		
Staff Initials:	Not reported		
How Discovered:	Other Means		
How Stopped:	Not reported		
Interim :	Not reported		
Leak Cause:	Unknown		
Leak Source:	Unknown		
MTBE Date :	1/1/65		

EXXON #7-3550 (FORMER) (Continued) **S103891181**

Max MTBE GW : 7900
MTBE Tested: MTBE Detected. Site tested for MTBE & MTBE detected
Priority: 3A
Local Case # : Not reported
Beneficial: Not reported
Staff : JT
GW Qualifies : Not reported
Max MTBE Soil : Not reported
Soil Qualifies : Not reported
Hydr Basin #: Not reported
Operator : Not reported
Oversight Prgm: RB Lead Underground Storage Tank
Oversight Prgm : UST
Review Date : 11/15/01
Stop Date : Not reported
Work Suspended :Not reported
Responsible PartyJENNIFER C. SEDLACHEK
RP Address: 2300 CLAYTON RD., STE1250
Global Id: T0603704740
Org Name: Not reported
Contact Person: Not reported
MTBE Conc: 1
Mtbe Fuel: Not reported
Water System Name: Not reported
Well Name: Not reported
Distance To Lust: 858.0592421
Waste Discharge Global ID: Not reported
Waste Disch Assigned Name: Not reported

LUST Region 4:
Report Date: 5/26/1992
Lead Agency: Regional Board
Local Agency: 19000
Case Number: R-06593
Substance: Hydrocarbons
Case Type: Groundwater
Status: Pollution Characterization
Region: 4
Staff: JT

AM246 **BOCCHI LABORATORIES INC** **LOS ANGELES CO. HMS** **S102064449**
SE **26421 GOLDEN VALLEY RD** **N/A**
> 1 **SANTA CLARITA, CA**
6546 ft.
Higher **Site 1 of 11 in cluster AM**

HMS:
Facility Id: 008033-020233
Facility Type: I01
Permit Number: 000013077 Permit Status: Permit
Facility Status: Permit Area: 7A
Region: Los Angeles County:

AM247 **VALENCIA LABORATORY** **LOS ANGELES CO. HMS** **U003063750**
SE **26421 GOLDEN VALLEY RD** **N/A**
> 1 **SANTA CLARITA, CA**
6546 ft.
Higher **Site 2 of 11 in cluster AM**

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

VALENCIA LABORATORY (Continued) — U003063750

HMS:
Facility Id: 008033-I08532
Facility Type: Not reported
Permit Number: Not reported — Permit Status: Not reported
Facility Status: OPEN — Area: 7A
Region: Los Angeles County:

AM248 / **SE** / **> 1** / **6546 ft.** / **Higher**

STAR LABORATORIES INC
26421 N GOLDEN VALLEY RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS — **S102064450** / **N/A**

Site 3 of 11 in cluster AM

HMS:
Facility Id: 009155-008532
Facility Type: Not reported
Permit Number: Not reported — Permit Status: Not reported
Facility Status: OPEN — Area: 7A
Region: Los Angeles County:

AN249 / **West** / **> 1** / **6568 ft.** / **Lower**

U-HAUL CO.
26230 BOUQUET CANYON RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS — **S103945419** / **N/A**

Site 1 of 2 in cluster AN

HMS:
Facility Id: 019822-028293
Facility Type: Not reported
Permit Number: Not reported — Permit Status: Not reported
Facility Status: OPEN — Area: 7A
Region: Los Angeles County:

AM250 / **SE** / **> 1** / **6612 ft.** / **Higher**

26417 GOLDEN VALLEY RD
26417 GOLDEN VALLEY RD
SANTA CLARITA, CA 91350

ERNS — **91241955** / **N/A**

Site 4 of 11 in cluster AM

AM251 / **SE** / **> 1** / **6671 ft.** / **Higher**

HI-SHEAR TECHNOLOGY CORP
26413 N GOLDEN VALLEY RD
SAUGUS, CA 91350

RCRIS-SQG / **FINDS** — **1000381482** / **CAD981158561**

Site 5 of 11 in cluster AM

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number

HI-SHEAR TECHNOLOGY CORP (Continued) 1000381482

RCRIS:
Owner: HI-SHEAR TECHNOLOGY CORP
(415) 555-1212
EPA ID: CAD981158561
Contact: ENVIRONMENTAL MANAGER
(805) 259-1510
Classification: Handler transports wastes, but commercial status is unknown, Large Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported
Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

AN252
West
> 1
6683 ft.
Lower

CAR WASH USA INC
26225 BOUQUET CANYON RD
SANTA CLARITA, CA 91773

Site 2 of 2 in cluster AN

Database(s): **CA FID UST**
EDR ID Number: **S101587230**
EPA ID Number: **N/A**

FID:

Facility ID:	19055119	Regulate ID:	Not reported
Reg By:	Active Underground Storage Tank Location		
Cortese Code:	Not reported	SIC Code:	Not reported
Status:	Active	Facility Tel:	(714) 592-9562
Mail To:	Not reported 555 W BONITA AVE SANTA CLARITA, CA 91773		
Contact:	Not reported	Contact Tel:	Not reported
DUNs No:	Not reported	NPDES No:	Not reported
Creation:	10/22/93	Modified:	00/00/00
EPA ID:	Not reported		
Comments:	Not reported		

AM253
SE
> 1
6700 ft.
Higher

BLUE CROSS LABORATORIES
26411 N GOLDEN VALLEY RD
SAUGUS, CA 91350

Site 6 of 11 in cluster AM

Database(s): **RCRIS-SQG**, **FINDS**, **HAZNET**, **LOS ANGELES CO. HMS**
EDR ID Number: **1000196321**
EPA ID Number: **CAD982521122**

BLUE CROSS LABORATORIES (Continued) **1000196321**

RCRIS:
Owner: BLUE CROSS LABORATORIES
(415) 555-1212
EPA ID: CAD982521122
Contact: ENVIRONMENTAL MANAGER
(805) 255-0955
Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported
Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
National Compliance Database (NCDB)
Resource Conservation and Recovery Act Information system (RCRAINFO)
Section Seven Tracking System (SSTS)

HAZNET:
Gepaid: CAD982521122
Tepaid: CAT000613893
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 0.4292
Category: Aqueous solution with less than 10% total organic residues
Disposal Method: Transfer Station
Contact: DARRELL MAHLER
Telephone: (805) 255-0955
Mailing Address: 26411 N GOLDEN VALLEY RD
SAUGUS, CA 91350
County Los Angeles

Gepaid: CAD982521122
Tepaid: CAD980883177
Gen County: Los Angeles
Tsd County: Kern
Tons: 1.0216
Category: Unspecified oil-containing waste
Disposal Method: Recycler
Contact: DARRELL MAHLER
Telephone: (805) 255-0955
Mailing Address: 26411 N GOLDEN VALLEY RD
SAUGUS, CA 91350
County Los Angeles

Gepaid: CAD982521122
Tepaid: CAT080033681
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .4170
Category: Alkaline solution without metals (pH > 12.5)
Disposal Method: Recycler
Contact: DARRELL MAHLER
Telephone: (805) 255-0955
Mailing Address: 26411 N GOLDEN VALLEY RD
SAUGUS, CA 91350

BLUE CROSS LABORATORIES (Continued) **1000196321**

County: Los Angeles

Gepaid: CAD982521122
Tepaid: CAD008252405
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 1.4386
Category: Unspecified solvent mixture Waste
Disposal Method: Recycler
Contact: DARRELL MAHLER
Telephone: (805) 255-0955
Mailing Address: 26411 N GOLDEN VALLEY RD
SAUGUS, CA 91350
County: Los Angeles

Gepaid: CAD982521122
Tepaid: CAT080033681
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2085
Category: Liquids with pH <UN-> 2
Disposal Method: Recycler
Contact: DARRELL MAHLER
Telephone: (805) 255-0955
Mailing Address: 26411 N GOLDEN VALLEY RD
SAUGUS, CA 91350
County: Los Angeles

The CA HAZNET database contains 3 additional records for this site.
Please contact your EDR Account Executive for more information.

HMS:

Facility Id:	006660-I06884		
Facility Type:	I09		
Permit Number:	00008147B	Permit Status:	Permit
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

AM254
SE
> 1
6700 ft.
Higher

26411 GOLDEN VALLEY RD
SANTA CLARITA, CA 91350

CHMIRS **S100279259**
N/A

Site 7 of 11 in cluster AM

CHMIRS:

OES Control Number:	8905365	DOT ID:	Not reported
DOT Hazard Class:	Not Reported		
Chemical Name:	DYE		
Extent of Release:	Not reported		
CAS Number:	Not reported	Quantity Released:	100
Environmental Contamination:	Ground	Property Use:	Industrial, Utility
Incident Date:	25-MAR-89	Date Completed:	25-MAR-89

Time Completed :	1337
Physical State Stored :	Solid
Physical State Released :	Liquid
Release Unit :	Gallons
Container Description :	Not reported
Container Type :	Not reported
Container Material :	Not reported
Level Of Container :	Not reported

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

(Continued) **S100279259**

Container Capacity :	Not reported
Container Capacity Units (code) :	Not reported
Extent Of Release (code) :	7
Agency Id Number :	19110
Agency Incident Number :	34
OES Incident Number :	8905365
Time Notified :	1028
Surrounding Area :	936
Estimated Temperature :	60
Property Management :	C
More Than Two Substances Involved? :	Not reported
Special Studies 1 :	Not reported
Special Studies 2 :	Not reported
Special Studies 3 :	Not reported
Special Studies 4 :	Not reported
Special Studies 5 :	Not reported
Special Studies 6 :	Not reported
Responding Agency Personel # Of Injuries :	0
Responding Agency Personel # Of Fatalities :	0
Resp Agncy Personel # Of Decontaminated :	0
Others Number Of Decontaminated :	0
Others Number Of Injuries :	0
Others Number Of Fatalities :	0
Vehicle Make/year :	Not reported
Vehicle License Number :	Not reported
Vehicle State :	Not reported
Vehicle Id Number :	Not reported
CA/DOT/PUC/ICC Number :	Not reported
Company Name :	Not reported
Reporting Officer Name/ID :	CAPT. JOHN EVERETT
Report Date :	25-MAR-89
Comments :	Not reported
Facility Telephone Number :	213 267-2485

AK255 **UNOCAL CORP SS** **LOS ANGELES CO. HMS** **U002280350**
West **26279 N BOUQUET CANYON RD** **N/A**
> 1 **SANTA CLARITA, CA**
6711 ft.
Lower **Site 17 of 17 in cluster AK**

HMS:

Facility Id:	005834-I06048		
Facility Type:	I00		
Permit Number:	000003555	Permit Status:	Closed
Facility Status:	Closed	Area:	7A
Region:	Los Angeles County:		
Facility Id:	005834-006048		
Facility Type:	T0		
Permit Number:	00001350T	Permit Status:	Removed
Facility Status:	Removed	Area:	7A
Region:	Los Angeles County:		

AO256 **ED'S CLEANERS** **CLEANERS** **S105265842**
East **20655 SOLEDAD CANYON RD #30** **N/A**
> 1 **CANYON COUNTRY, CA 91351**
6733 ft.
Higher **Site 1 of 18 in cluster AO**

ED'S CLEANERS (Continued) **S105265842**

CA Cleaners:
Create Date: 11/14/1989
Inactive Date: 06/30/1998
EPA Id: CAL000020450
County : Los Angeles

AO257
East
> 1
6733 ft.
Higher

IVAN COHEN
20655 W SOLEDAD CANYON RD #1
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S103489699**
N/A

Site 2 of 18 in cluster AO

HMS:

Facility Id:	016212-026575		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

AO258
East
> 1
6733 ft.
Higher

SANTA CLARITA BREWING CO
20655 W SOLEDAD CANYON RD #1
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S102063997**
N/A

Site 3 of 18 in cluster AO

HMS:

Facility Id:	016212-021239		
Facility Type:	I02		
Permit Number:	000075908	Permit Status:	Closed
Facility Status:	Closed	Area:	7A
Region:	Los Angeles County:		

AO259
East
> 1
6733 ft.
Higher

EDS CLEANERS
20655 SOLEDAD CANYON RD
CANYON COUNTRY, CA 91351

RCRIS-SQG **1000472892**
FINDS **CAD982434821**
HAZNET

Site 4 of 18 in cluster AO

RCRIS:
Owner: PEDRO MARTINEZ
(805) 252-6666
EPA ID: CAD982434821

Contact: PEDRO MARTINEZ
(805) 252-6666

Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

EDS CLEANERS (Continued) **1000472892**

Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

HAZNET:

Gepaid: CAD982434821
Tepaid: CAD981397417
Gen County: Ventura
Tsd County: Los Angeles
Tons: .7572
Category: Halogenated solvents (chloroform, methyl chloride, perchloroethylene, etc.)
Disposal Method: Recycler
Contact: PHILIPOUS EDWARD
Telephone: (415) 555-1212
Mailing Address: 20655 SOLEDAD CANYON RD
CANYON COUNTRY, CA 91351 - 2434
County Ventura

Gepaid: CAD982434821
Tepaid: CAD981397417
Gen County: Ventura
Tsd County: Los Angeles
Tons: 0.8675
Category: Halogenated solvents (chloroform, methyl chloride, perchloroethylene, etc.)
Disposal Method: Recycler
Contact: PHILIPOUS EDWARD
Telephone: (415) 555-1212
Mailing Address: 20655 SOLEDAD CANYON RD
CANYON COUNTRY, CA 91351 - 2434
County Ventura

Gepaid: CAD982434821
Tepaid: CAD981397417
Gen County: Ventura
Tsd County: Los Angeles
Tons: .5840
Category: Halogenated solvents (chloroform, methyl chloride, perchloroethylene, etc.)
Disposal Method: Recycler
Contact: PHILIPOUS EDWARD
Telephone: (415) 555-1212
Mailing Address: 20655 SOLEDAD CANYON RD
CANYON COUNTRY, CA 91351 - 2434
County Ventura

Gepaid: CAD982434821
Tepaid: CAD981397417
Gen County: Ventura
Tsd County: Los Angeles
Tons: .7572
Category: Halogenated solvents (chloroform, methyl chloride, perchloroethylene, etc.)
Disposal Method: Recycler
Contact: PHILIPOUS EDWARD
Telephone: (415) 555-1212
Mailing Address: 20655 SOLEDAD CANYON RD
CANYON COUNTRY, CA 91351 - 2434
County Ventura

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

EDS CLEANERS (Continued) **1000472892**

Gepaid: CAD982434821
Tepaid: CAD981397417
Gen County: Ventura
Tsd County: Los Angeles
Tons: 21.3641
Category: Halogenated solvents (chloroform, methyl chloride, perchloroethylene, etc.)
Disposal Method: Recycler
Contact: PHILIPOUS EDWARD
Telephone: (415) 555-1212
Mailing Address: 20655 SOLEDAD CANYON RD
CANYON COUNTRY, CA 91351 - 2434
County Ventura

The CA HAZNET database contains 2 additional records for this site.
Please contact your EDR Account Executive for more information.

AO260 **ED'S CLEANERS** **CLEANERS** **S105266075**
East **20655 SOLEDAD CANYON RD #30** **N/A**
> 1 **CANYON COUNTRY, CA 91351**
6733 ft.
Higher **Site 5 of 18 in cluster AO**

CA Cleaners:
Create Date: 12/20/1993
Inactive Date: 06/30/1999
EPA Id: CAL000055441
County : Los Angeles

AO261 **CANYON COUNTRY VETERINARY** **HAZNET** **S103640884**
East **20655 SOLEDAD CANYON ROAD #18** **N/A**
> 1 **CANYON COUNTRY, CA 91351**
6733 ft.
Higher **Site 6 of 18 in cluster AO**

HAZNET:
Gepaid: CAL922594291
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .1251
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: RAFAEL VILLICANA DVM
Telephone: (818) 244-7235
Mailing Address: 431 W LOS FELIZ RD
GLENDALE, CA 91204
County Los Angeles

Gepaid: CAL922594291
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .1250
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: RAFAEL VILLICANA DVM
Telephone: (818) 244-7235
Mailing Address: 431 W LOS FELIZ RD

CANYON COUNTRY VETERINARY (Continued) **S103640884**

GLENDALE, CA 91204
County Los Angeles

Gepaid: CAL922594291
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .0583
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: RAFAEL VILLICANA DVM
Telephone: (818) 244-7235
Mailing Address: 431 W LOS FELIZ RD
GLENDALE, CA 91204
County Los Angeles

Gepaid: CAL922594291
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .0625
Category: Photochemicals/photoprocessing waste
Disposal Method: Not reported
Contact: RAFAEL VILLICANA DVM
Telephone: (818) 244-7235
Mailing Address: 431 W LOS FELIZ RD
GLENDALE, CA 91204
County Los Angeles

Gepaid: CAL922594291
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .0625
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: RAFAEL VILLICANA DVM
Telephone: (818) 244-7235
Mailing Address: 431 W LOS FELIZ RD
GLENDALE, CA 91204
County Los Angeles

The CA HAZNET database contains 4 additional records for this site.
Please contact your EDR Account Executive for more information.

AO262 **KWIK INK CREEEN PRINTING DESIGNS** **HAZNET** **S105090232**
East **26915 FURNIVALL** **N/A**
> 1 **CANYON COUNTRY, CA 91351**
6753 ft.
Higher **Site 7 of 18 in cluster AO**

HAZNET:
Gepaid: CAL000130330
Tepaid: CAT000613976
Gen County: Los Angeles
Tsd County: Orange
Tons: .1209
Category: Hydrocarbon solvents (benzene, hexane, Stoddard, etc.)
Disposal Method: Transfer Station
Contact: LINDA SPUNT

KWIK INK CREEEN PRINTING DESIGNS (Continued) **S105090232**

Telephone: (000) 000-0000
Mailing Address: 26915 FURNIVALL AVE
CANYON COUNTRY, CA 91351 - 2406
County Los Angeles

AO263
East
> 1
6753 ft.
Higher

LOLA OLSEN PROPERTIES
26917 FURNIVALL
CANYON COUNTRY, CA 91351

HAZNET **S102801965**
N/A

Site 8 of 18 in cluster AO

HAZNET:
Gepaid: CAC001013200
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2293
Category: Waste oil and mixed oil
Disposal Method: Recycler
Contact: LOLA OR LYLE OLSEN
Telephone: (000) 000-0000
Mailing Address: 24599 WAYMAN
NEWHALL, CA 91321
County Los Angeles

AO264
East
> 1
6753 ft.
Higher

KOCH'S
26917 FURNIVALL AVE
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S103945496**
N/A

Site 9 of 18 in cluster AO

HMS:
Facility Id: 019961-028480
Facility Type: Not reported
Permit Number: Not reported
Permit Status: Not reported
Facility Status: OPEN
Area: 7A
Region: Los Angeles County:

AO265
East
> 1
6753 ft.
Higher

B & D GLASS
26919 FURNIVALL AVE
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S103945497**
N/A

Site 10 of 18 in cluster AO

HMS:
Facility Id: 019962-028481
Facility Type: Not reported
Permit Number: Not reported
Permit Status: Not reported
Facility Status: OPEN
Area: 7A
Region: Los Angeles County:

AO266
East
> 1
6754 ft.
Higher

PRECISION CNC PRODUCTS
26921 1/2 FURNIVALL ST
CANYON COUNTRY, CA 91351

HAZNET **S105091015**
N/A

Site 11 of 18 in cluster AO

PRECISION CNC PRODUCTS (Continued) **S105091015**

HAZNET:
Gepaid: CAL000174103
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 1.0425
Category: Oil/water separation sludge
Disposal Method: Recycler
Contact: EMMIT NEAL
Telephone: (661) 252-6072
Mailing Address: 26921 1/2 FURNIVALL AVE
CANYON COUNTRY, CA 91351 - 2406
County Los Angeles

AO267 **DICK SANCHEZ AUTO BODY** **LOS ANGELES CO. HMS** **S103945499**
East **26935 FURNIVALL AVE** **N/A**
> 1 **SANTA CLARITA, CA**
6755 ft.
Higher **Site 12 of 18 in cluster AO**

HMS:
Facility Id: 019963-028482
Facility Type: Not reported
Permit Number: Not reported
Permit Status: Not reported
Facility Status: OPEN
Area: 7A
Region: Los Angeles County:

AO268 **BROWN AUTO BODY** **RCRIS-SQG** **1000437307**
East **26935 FURNIVALL** **FINDS** **CAD981649270**
> 1 **CANYON COUNTRY, CA 91351** **HAZNET**
6755 ft.
Higher **Site 13 of 18 in cluster AO**

RCRIS:
Owner: LAWERNCE
(415) 555-1212
EPA ID: CAD981649270

Contact: ENVIRONMENTAL MANAGER
(805) 251-5555

Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

BROWN AUTO BODY (Continued) **1000437307**

HAZNET:

Gepaid:	CAD981649270
Tepaid:	CAT000613893
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.0740
Category:	Oxygenated solvents (acetone, butanol, ethyl acetate, etc.)
Disposal Method:	Transfer Station
Contact:	Not reported
Telephone:	(000) 000-0000
Mailing Address:	26935 FURNIVALL CANYON COUNTRY, CA 91351
County	Los Angeles

AO269
East
> 1
6758 ft.
Higher

STORAGE LOT
26949 N FURNIVALL AVE
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S102321791** **N/A**

Site 14 of 18 in cluster AO

HMS:

Facility Id:	017445-023745		
Facility Type:	T1		
Permit Number:	000167815	Permit Status:	Removed
Facility Status:	Removed	Area:	7A
Region:	Los Angeles County:		

AO270
East
> 1
6758 ft.
Higher

WILLIAM ETTER & PATRICK BETZ
26949 FURNIBAL AVE
CANYON COUNTRY, CA 91351

HAZNET **S103648167** **N/A**

Site 15 of 18 in cluster AO

HAZNET:

Gepaid:	CAC001061056
Tepaid:	CAT080013352
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	2.2935
Category:	Unspecified oil-containing waste
Disposal Method:	Recycler
Contact:	WILLIAM ETTER AND PATRICK BETZ
Telephone:	(000) 000-0000
Mailing Address:	5120 VIA CUPERTINO CAMARILLO, CA 93012
County	Los Angeles

AP271
East
> 1
6758 ft.
Higher

STAATS CONSTRUCTION
26951 FURNIVAL
CANYON COUNTRY, CA 91351

HAZNET **S103648172**
LOS ANGELES CO. HMS **N/A**

Site 1 of 6 in cluster AP

STAATS CONSTRUCTION (Continued) **S103648172**

HAZNET:
Gepaid: CAL000148813
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 2.2935
Category: Unspecified oil-containing waste
Disposal Method: Recycler
Contact: WILL STAATS JR & STEVEN STAATS
Telephone: (805) 263-7688
Mailing Address: 22211 NEWHALL RANCH RD
SAUGUS, CA 91350
County Los Angeles

Gepaid: CAL000148813
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2293
Category: Unspecified aqueous solution
Disposal Method: Recycler
Contact: WILL STAATS JR & STEVEN STAATS
Telephone: (805) 263-7688
Mailing Address: 22211 NEWHALL RANCH RD
SAUGUS, CA 91350
County Los Angeles

HMS:
Facility Id: 017444-023744
Facility Type: T1
Permit Number: 000167808 Permit Status: Removed
Facility Status: Removed Area: 7A
Region: Los Angeles County:

AP272 **PACIFIC BELL CNCYCAPB/KC652** **LOS ANGELES CO. HMS** **S102064478**
East **26971 N FURNIVALL AVE** **N/A**
> 1 **SANTA CLARITA, CA**
6760 ft.
Higher **Site 2 of 6 in cluster AP**

HMS:
Facility Id: 006475-006695
Facility Type: T0
Permit Number: 00001681T Permit Status: Removed
Facility Status: Permit Area: 7A
Region: Los Angeles County:

AP273 **PACIFIC BELL CNCYCAPB/KC652** **UST** **U003776157**
East **26971 FURNIVALL AVE** **N/A**
> 1 **CANYON COUNTRY, CA 91351**
6760 ft.
Higher **Site 3 of 6 in cluster AP**

State UST:
Facility ID: 6695
Total Tanks: 1
Region: STATE
Local Agency: 19000

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number
AP274 **East** **> 1** **6760 ft.** **Higher**	**PACIFIC BELL (KC-652)** **26971 FURNIVALL AVE** **CANYON COUNTRY, CA 91350** **Site 4 of 6 in cluster AP**	**HIST UST**	**U001567715** **N/A**

UST HIST:

Facility ID:	16788		
Tank Num:	1	Container Num:	D-70-10K
Tank Capacity:	10000	Year Installed:	1970
Tank Used for:	PRODUCT		
Type of Fuel:	DIESEL	Tank Construction:	Not reported
Leak Detection:	None		
Contact Name:	E. J. KOEHLER	Telephone:	(415) 542-6758
Total Tanks:	3	Region:	STATE
Facility Type:	2	Other Type:	PHONE CO.

Facility ID:	16788		
Tank Num:	2	Container Num:	G-70-10K
Tank Capacity:	10000	Year Installed:	1970
Tank Used for:	PRODUCT		
Type of Fuel:	UNLEADED	Tank Construction:	Not reported
Leak Detection:	None		
Contact Name:	E. J. KOEHLER	Telephone:	(415) 542-6758
Total Tanks:	3	Region:	STATE
Facility Type:	2	Other Type:	PHONE CO.

Facility ID:	16788		
Tank Num:	3	Container Num:	W-700550
Tank Capacity:	550	Year Installed:	1970
Tank Used for:	WASTE		
Type of Fuel:	WASTE OIL	Tank Construction:	Not reported
Leak Detection:	None		
Contact Name:	E. J. KOEHLER	Telephone:	(415) 542-6758
Total Tanks:	3	Region:	STATE
Facility Type:	2	Other Type:	PHONE CO.

AP275 **East** **> 1** **6760 ft.** **Higher**	**PACIFIC BELL** **26971 FURNIVALL AVE** **SANTA CLARITA, CA 91350** **Site 5 of 6 in cluster AP**	**LUST** **Cortese** **LOS ANGELES CO. HMS**	**S100458324** **N/A**

State LUST:

Cross Street:	SOLIDAD ST		
Qty Leaked:	Not reported		
Case Number	I-06695		
Reg Board:	4		
Chemical:	Waste Oil		
Lead Agency:	Regional Board		
Local Agency :	19000		
Case Type:	Soil only		
Status:	Not reported		
County:	Los Angeles		
Review Date:	Not reported	Confirm Leak:	Not reported
Workplan:	12/31/91	Prelim Assess:	12/31/91
Pollution Char:	Not reported	Remed Plan:	Not reported
Remed Action:	Not reported	Monitoring:	Not reported
Close Date:	10/30/96		
Release Date:	Not reported		
Cleanup Fund Id :	Not reported		

PACIFIC BELL (Continued) **S100458324**

Discover Date : 7/18/91
Enforcement Dt : Not reported
Enf Type: Not reported
Enter Date : 3/14/92
Funding: Federal Funds
Staff Initials: Not reported
How Discovered: Other Means
How Stopped: Other Means
Interim : Not reported
Leak Cause: Unknown
Leak Source: Unknown
MTBE Date : Not reported
Max MTBE GW : Not reported
MTBE Tested: Not Required to be Tested.
Priority: Not reported
Local Case # : Not reported
Beneficial: Not reported
Staff : JLC
GW Qualifies : Not reported
Max MTBE Soil : Not reported
Soil Qualifies : Not reported
Hydr Basin #: Not reported
Operator : Not reported
Oversight Prgm: RB Lead Underground Storage Tank
Oversight Prgm : UST
Review Date : 1/22/97
Stop Date : 7/18/91
Work Suspended :Not reported
Responsible PartyPACIFIC BELL
RP Address: 177 E COLORADO BLVD, PASADENA CA 91105
Global Id: T0603703250
Org Name: Not reported
Contact Person: Not reported
MTBE Conc: 0
Mtbe Fuel: Not reported
Water System Name: Not reported
Well Name: Not reported
Distance To Lust: 823.5307398
Waste Discharge Global ID: Not reported
Waste Disch Assigned Name: Not reported

LUST Region 4:
Report Date: 12/31/1991
Lead Agency: Regional Board
Local Agency: 19000
Case Number: I-06695
Substance: Waste Oil
Case Type: Soil
Status: Case Closed
Region: 4
Staff: Not reported

CORTESE:
Reg Id: I-06695
Region: CORTESE
Reg By: Leaking Underground Storage Tanks

HMS:
Facility Id: 006475-I06695

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

PACIFIC BELL (Continued) **S100458324**

Facility Type: I01
Permit Number: 000006449 Permit Status: Closed
Facility Status: Permit Area: 7A
Region: Los Angeles County:

AM276 **CITY OF SANTA CLARITA** **HAZNET** **S105085565**
SE **26407 GOLDEN VALLEY RD** **LOS ANGELES CO. HMS** **N/A**
> 1 **SANTA CLARITA, CA 91350**
6760 ft.
Higher **Site 8 of 11 in cluster AM**

HAZNET:
Gepaid: CAC002249057
Tepaid: CAD028409019
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 42.1400
Category: Other organic solids
Disposal Method: Transfer Station
Contact: CITY OF SANTA CLARITA
Telephone: (661) 255-4994
Mailing Address: PO BOX 278
NEWHALL, CA 91322
County Los Angeles

Gepaid: CAC002249057
Tepaid: CAD009007626
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .8428
Category: Asbestos-containing waste
Disposal Method: Disposal, Land Fill
Contact: CITY OF SANTA CLARITA
Telephone: (661) 255-4994
Mailing Address: PO BOX 278
NEWHALL, CA 91322
County Los Angeles

HMS:
Facility Id: 026826-037353
Facility Type: Not reported
Permit Number: Not reported Permit Status: Not reported
Facility Status: OPEN Area: 7A
Region: Los Angeles County:

AM277 **MERLE NORMAN COSMETICS** **CA FID UST** **S101586567**
SE **26407 N GOLDEN VALLEY RD** **N/A**
> 1 **SANTA CLARITA, CA 91350**
6760 ft.
Higher **Site 9 of 11 in cluster AM**

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

MERLE NORMAN COSMETICS (Continued) **S101586567**

FID:

Facility ID:	19054074	Regulate ID:	00017414
Reg By:	Inactive Underground Storage Tank Location		
Cortese Code:	Not reported	SIC Code:	Not reported
Status:	Inactive	Facility Tel:	(805) 251-6610
Mail To:	Not reported 15180 BLEDSOE ST SANTA CLARITA, CA 91350		
Contact:	Not reported	Contact Tel:	Not reported
DUNs No:	Not reported	NPDES No:	Not reported
Creation:	10/22/93	Modified:	00/00/00
EPA ID:	Not reported		
Comments:	Not reported		

AM278 **MERLE NORMAN COSMETICS, INC.** **Cal-Sites** **S103883825**
SE **26407 N. GOLDEN VALLEY ROAD** **N/A**
> 1 **SANTA CLARITA, CA 91350**
6760 ft.
Higher **Site 10 of 11 in cluster AM**

CAL-SITES:

Facility ID	19390049	
Status:	VCP - VOLUNTARY CLEANUP PROGRAM (VCP)	
Status Date:	05/02/1999	
Lead:	Not reported	
Region:	3 - BURBANK	
Branch:	SA - SOUTHERN CA. - A	
File Name:	Not reported	
Status Name:	VOLUNTARY CLEANUP PROGRAM	
Lead Agency:	N/A	Not reported
NPL:	Not reported	
SIC:	39 MISCELLANEOUS MANUFACTURING INDUSTRIES	

Facility Type:	VOLUNTARY CLEANUP PROGRAM
Type Name:	VCP
Staff Member Responsible for Site:	RKRUG
Supervisor Responsible for Site:	HJECHE
Region Water Control Board:	Not reported
Access:	Not reported
Cortese:	Not reported
Hazardous Ranking Score:	Not reported
Date Site Hazard Ranked:	Not reported
Groundwater Contamination:	Not reported
No. of Contamination Sources:	0
Lat/Long:	0° 0′ 0.00″ / 0° 0′ 0.00″
Lat/long Method:	Not reported
State Assembly District Code:	36
State Senate District:	17

The CAL-SITES database may contain additional details for this site.
Please contact your EDR Account Executive for more information.

AM279 **SAUGUS FACILITY** **HIST UST** **U001567755**
SE **26407 GOLDEN VALLEY RD** **N/A**
> 1 **SAUGUS, CA 91351**
6760 ft.
Higher **Site 11 of 11 in cluster AM**

SAUGUS FACILITY (Continued) **U001567755**

UST HIST:

Facility ID:	17414		
Tank Num:	1	Container Num:	1
Tank Capacity:	10000	Year Installed:	1979
Tank Used for:	PRODUCT		
Type of Fuel:	PREMIUM	Tank Construction:	1/4 gauge
Leak Detection:	Visual		
Contact Name:	JAMES ARMOUR	Telephone:	(213) 367-1085
Total Tanks:	4	Region:	STATE
Facility Type:	2	Other Type:	DISTRIBUTOR

Facility ID:	17414		
Tank Num:	2	Container Num:	2
Tank Capacity:	10000	Year Installed:	1979
Tank Used for:	PRODUCT		
Type of Fuel:	PREMIUM	Tank Construction:	1/412 inches
Leak Detection:	Visual		
Contact Name:	JAMES ARMOUR	Telephone:	(213) 367-1085
Total Tanks:	4	Region:	STATE
Facility Type:	2	Other Type:	DISTRIBUTOR

Facility ID:	17414		
Tank Num:	3	Container Num:	3
Tank Capacity:	10000	Year Installed:	1979
Tank Used for:	PRODUCT		
Type of Fuel:	PREMIUM	Tank Construction:	1/4 gauge
Leak Detection:	Visual		
Contact Name:	JAMES ARMOUR	Telephone:	(213) 367-1085
Total Tanks:	4	Region:	STATE
Facility Type:	2	Other Type:	DISTRIBUTOR

Facility ID:	17414		
Tank Num:	4	Container Num:	4
Tank Capacity:	10000	Year Installed:	1979
Tank Used for:	PRODUCT		
Type of Fuel:	DIESEL	Tank Construction:	1/4 gauge
Leak Detection:	Visual		
Contact Name:	JAMES ARMOUR	Telephone:	(213) 367-1085
Total Tanks:	4	Region:	STATE
Facility Type:	2	Other Type:	DISTRIBUTOR

AP280 **PACIFIC BELL** **HAZNET** **1000250084**
East **26971 N FUNIVALL AVE** **N/A**
> 1 **CANYON COUNTRY, CA 91351**
6770 ft.
Higher **Site 6 of 6 in cluster AP**

HAZNET:

Gepaid:	CAD980891816
Tepaid:	CAT000613893
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.4083
Category:	Liquids with halogenated organic compounds > 1000 mg/l
Disposal Method:	Transfer Station
Contact:	PACIFIC BELL
Telephone:	(925) 823-6161
Mailing Address:	PO BOX 5095 RM 3E000

PACIFIC BELL (Continued) **1000250084**

	SAN RAMON, CA 94583 - 0995
County	Los Angeles
Gepaid:	CAD980891816
Tepaid:	CAD981696420
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.3961
Category:	Waste oil and mixed oil
Disposal Method:	Transfer Station
Contact:	PACIFIC BELL
Telephone:	(925) 823-6161
Mailing Address:	PO BOX 5095 RM 3E000
	SAN RAMON, CA 94583 - 0995
County	Los Angeles
Gepaid:	CAD980891816
Tepaid:	CAD981696420
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.1251
Category:	Oil/water separation sludge
Disposal Method:	Not reported
Contact:	PACIFIC BELL
Telephone:	(925) 823-6161
Mailing Address:	PO BOX 5095 RM 3E000
	SAN RAMON, CA 94583 - 0995
County	Los Angeles
Gepaid:	CAD980891816
Tepaid:	CAT080013352
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	4.2534
Category:	Unspecified oil-containing waste
Disposal Method:	Recycler
Contact:	PACIFIC BELL
Telephone:	(925) 823-6161
Mailing Address:	PO BOX 5095 RM 3E000
	SAN RAMON, CA 94583 - 0995
County	Los Angeles
Gepaid:	CAD980891816
Tepaid:	CAD044429835
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.3127
Category:	Waste oil and mixed oil
Disposal Method:	Recycler
Contact:	PACIFIC BELL
Telephone:	(925) 823-6161
Mailing Address:	PO BOX 5095 RM 3E000
	SAN RAMON, CA 94583 - 0995
County	Los Angeles

The CA HAZNET database contains 20 additional records for this site.
Please contact your EDR Account Executive for more information.

AQ281 **SANTA CLARITA CAR WASH INC** **HAZNET** **S100852736**
West **23105 VALENCIA BLVD** **Cortese** **N/A**
> 1 **SANTA CLARITA, CA 91305**
6831 ft.
Lower **Site 1 of 6 in cluster AQ**

HAZNET:
Gepaid: CAC002204865
Tepaid: CAD982484933
Gen County: Los Angeles
Tsd County: 7
Tons: .5000
Category: Empty containers less than 30 gallons
Disposal Method: Disposal, Other
Contact: SANTA CLARITA CAR WASH INC
Telephone: (000) 000-0000
Mailing Address: 23105 VALENCIA BLVD
SANTA CLARITA, CA 91305
County Los Angeles

CORTESE:
Reg Id: I-06508
Region: CORTESE
Reg By: Leaking Underground Storage Tanks

AQ282 **MICHAEL J SCANLON** **HIST UST** **U001567869**
West **23105 VALENCIA BLVD** **N/A**
> 1 **VALENCIA, CA 91355**
6831 ft.
Lower **Site 2 of 6 in cluster AQ**

UST HIST:

Facility ID:	26689		
Tank Num:	1	Container Num:	0000000001
Tank Capacity:	10000	Year Installed:	1968
Tank Used for:	PRODUCT		
Type of Fuel:	Not Reported	Tank Construction:	Not reported
Leak Detection:	Stock Inventor		
Contact Name:	Not reported	Telephone:	(000) 000-0000
Total Tanks:	6	Region:	STATE
Facility Type:	1	Other Type:	Not reported

Facility ID:	26689		
Tank Num:	2	Container Num:	0000000002
Tank Capacity:	4000	Year Installed:	1968
Tank Used for:	PRODUCT		
Type of Fuel:	Not Reported	Tank Construction:	Not reported
Leak Detection:	Stock Inventor		
Contact Name:	Not reported	Telephone:	(000) 000-0000
Total Tanks:	6	Region:	STATE
Facility Type:	1	Other Type:	Not reported

Facility ID:	26689		
Tank Num:	3	Container Num:	0000000003
Tank Capacity:	4000	Year Installed:	1968
Tank Used for:	PRODUCT		
Type of Fuel:	Not Reported	Tank Construction:	Not reported
Leak Detection:	Stock Inventor		
Contact Name:	Not reported	Telephone:	(000) 000-0000
Total Tanks:	6	Region:	STATE
Facility Type:	1	Other Type:	Not reported

MICHAEL J SCANLON (Continued) **U001567869**

Facility ID:	26689		
Tank Num:	4	Container Num:	0000000004
Tank Capacity:	6000	Year Installed:	1968
Tank Used for:	PRODUCT		
Type of Fuel:	Not Reported	Tank Construction:	Not reported
Leak Detection:	Stock Inventor		
Contact Name:	Not reported	Telephone:	(000) 000-0000
Total Tanks:	6	Region:	STATE
Facility Type:	1	Other Type:	Not reported

Facility ID:	26689		
Tank Num:	5	Container Num:	0000000005
Tank Capacity:	6000	Year Installed:	1971
Tank Used for:	PRODUCT		
Type of Fuel:	Not Reported	Tank Construction:	Not reported
Leak Detection:	Stock Inventor		
Contact Name:	Not reported	Telephone:	(000) 000-0000
Total Tanks:	6	Region:	STATE
Facility Type:	1	Other Type:	Not reported

Facility ID:	26689		
Tank Num:	6	Container Num:	0000000006
Tank Capacity:	550	Year Installed:	1978
Tank Used for:	PRODUCT		
Type of Fuel:	WASTE OIL	Tank Construction:	0000093 inches
Leak Detection:	Stock Inventor		
Contact Name:	Not reported	Telephone:	(000) 000-0000
Total Tanks:	6	Region:	STATE
Facility Type:	1	Other Type:	Not reported

AQ283 **ARCO #1974** **LUST** **S102424196**
West **23105 VALENCIA BLVD** **N/A**
> 1 **VALENCIA, CA 91355**
6831 ft.
Lower **Site 3 of 6 in cluster AQ**

State LUST:

Cross Street:	BOUQUET CYN		
Qty Leaked:	Not reported		
Case Number	I-06508		
Reg Board:	4		
Chemical:	Gasoline		
Lead Agency:	Regional Board		
Local Agency :	19000		
Case Type:	Other ground water affected		
Status:	Not reported		
County:	Los Angeles		
Review Date:	Not reported	Confirm Leak:	Not reported
Workplan:	5/21/91	Prelim Assess:	5/21/91
Pollution Char:	Not reported	Remed Plan:	Not reported
Remed Action:	Not reported	Monitoring:	Not reported
Close Date:	7/24/96		
Release Date:	Not reported		
Cleanup Fund Id :	Not reported		
Discover Date :	2/18/91		
Enforcement Dt :	Not reported		
Enf Type:	Not reported		
Enter Date :	5/22/91		

ARCO #1974 (Continued) **S102424196**

Funding: Not reported
Staff Initials: Not reported
How Discovered: Other Means
How Stopped: Other Means
Interim : Not reported
Leak Cause: Unknown
Leak Source: Unknown
MTBE Date : Not reported
Max MTBE GW : Not reported
MTBE Tested: Site NOT Tested for MTBE.Includes Unknown and Not Analyzed.
Priority: Not reported
Local Case # : Not reported
Beneficial: Not reported
Staff : JLC
GW Qualifies : Not reported
Max MTBE Soil : Not reported
Soil Qualifies : Not reported
Hydr Basin #: Not reported
Operator : Not reported
Oversight Prgm: RB Lead Underground Storage Tank
Oversight Prgm : UST
Review Date : 7/24/96
Stop Date : Not reported
Work Suspended :Not reported
Responsible PartyARCO PRODUCTS CO.
RP Address: 17315 STUDEBAKER RD., CERRITOS, 90701 C
Global Id: T0603703223
Org Name: Not reported
Contact Person: Not reported
MTBE Conc: 0
Mtbe Fuel: Not reported
Water System Name: Not reported
Well Name: Not reported
Distance To Lust: 747.4457011
Waste Discharge Global ID: Not reported
Waste Disch Assigned Name: Not reported

LUST Region 4:
Report Date: 5/21/1991
Lead Agency: Regional Board
Local Agency: 19000
Case Number: I-06508
Substance: Gasoline
Case Type: Groundwater
Status: Case Closed
Region: 4
Staff: Not reported

AQ284 **CROSS ROADS AUTO WASH** **UST** **U003777333**
West **23105 VALENCIA BLVD** **LOS ANGELES CO. HMS** **N/A**
> 1 **VALENCIA, CA 91355**
6831 ft.
Lower **Site 4 of 6 in cluster AQ**

HMS:
Facility Id: 006290-016804
Facility Type: T0
Permit Number: 00006303T Permit Status: Permit
Facility Status: Permit Area: 7

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

CROSS ROADS AUTO WASH (Continued) **U003777333**

Region: Los Angeles County:

State UST:
Facility ID: 16804
Total Tanks: 1
Region: STATE
Local Agency: 19000

AQ285
West
> 1
6865 ft.
Lower

MCDONALDS RESTAURANT
23111 W VALENCIA BLVD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S104538553**
N/A

Site 5 of 6 in cluster AQ

HMS:
Facility Id: 007721-I08155
Facility Type: I01
Permit Number: 000009230
Permit Status: Removed
Facility Status: Removed
Area: 7A
Region: Los Angeles County:

AR286
East
> 1
6875 ft.
Higher

DESIGN MASONRY INC
27121 FURNIVAL
CANYON COUNTRY, CA 91351

HAZNET **S103960561**
N/A

Site 1 of 4 in cluster AR

HAZNET:
Gepaid: CAL000068574
Tepaid: CAT000613893
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .0625
Category: Aqueous solution with less than 10% total organic residues
Disposal Method: Treatment, Tank
Contact: CARPENTER RANDALL
Telephone: (805) 298-1013
Mailing Address: 27121 FURNIVALL AVE
CANYON COUNTRY, CA 91351 - 2460
County Los Angeles

Gepaid: CAL000068574
Tepaid: CAT000613893
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2001
Category: Aqueous solution with less than 10% total organic residues
Disposal Method: Transfer Station
Contact: CARPENTER RANDALL
Telephone: (805) 298-1013
Mailing Address: 27121 FURNIVALL AVE
CANYON COUNTRY, CA 91351 - 2460
County Los Angeles

DESIGN MASONRY INC (Continued) **S103960561**

Gepaid: CAL000068574
Tepaid: CAD093459485
Gen County: Los Angeles
Tsd County: Fresno
Tons: .0625
Category: Organic liquids with metals Alkaline solution (pH <UN-> 12.5) with metals (antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc)
Disposal Method: Transfer Station
Contact: CARPENTER RANDALL
Telephone: (805) 298-1013
Mailing Address: 27121 FURNIVALL AVE
CANYON COUNTRY, CA 91351 - 2460
County Los Angeles

Gepaid: CAL000068574
Tepaid: CAT000613893
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 0.0625
Category: Aqueous solution with less than 10% total organic residues
Disposal Method: Transfer Station
Contact: CARPENTER RANDALL
Telephone: (805) 298-1013
Mailing Address: 27121 FURNIVALL AVE
CANYON COUNTRY, CA 91351 - 2460
County Los Angeles

AO287
East
> 1
6881 ft.
Higher

SANTA CLARITA CAR WASH
20625 SOLEDAD CANYON RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **U003056486** **N/A**

Site 16 of 18 in cluster AO

HMS:
Facility Id: 000026-I00026
Facility Type: I01
Permit Number: 000010382 Permit Status: Permit
Facility Status: Permit Area: 7A
Region: Los Angeles County:

AR288
ENE
> 1
6882 ft.
Higher

CALIFORNIA COLLECTIBLE COACH WORKS
27134 FURNIVALL AVE
CANYON COUNTRY, CA 91351

HAZNET **S104582536** **N/A**

Site 2 of 4 in cluster AR

HAZNET:
Gepaid: CAL000197332
Tepaid: CAD008302903
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 0.1459
Category: Oxygenated solvents (acetone, butanol, ethyl acetate, etc.)
Disposal Method: Recycler
Contact: MIKE HOGAN
Telephone: (000) 000-0000

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

CALIFORNIA COLLECTIBLE COACH WORKS (Continued) **S104582536**

Mailing Address: 27134 FURNIVALL AVE
CANYON COUNTRY, CA 91351
County Los Angeles

AR289 **ENE** **> 1** **6882 ft.** **Higher**

EUROPEAN AUTO CENTER
27134 FURNIVALL AVE
CANYON COUNTRY, CA 91351

RCRIS-SQG 1000340138
FINDS CAD981652472

Site 3 of 4 in cluster AR

RCRIS:
Owner: PFLUEGLER JACOB
(415) 555-1212
EPA ID: CAD981652472

Contact: ENVIRONMENTAL MANAGER
(805) 251-3500

Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

AR290 **ENE** **> 1** **6897 ft.** **Higher**

JERRYS AUTOMATIC TRANS RP
20601 W SANTA CLARA ST
SANTA CLARITA, CA

LOS ANGELES CO. HMS U003060708
N/A

Site 4 of 4 in cluster AR

HMS:
Facility Id: 004543-I04717
Facility Type: I00
Permit Number: 000002139 Permit Status: Closed
Facility Status: Closed Area: 7A
Region: Los Angeles County:

AS291 **WSW** **> 1** **6924 ft.** **Lower**

GERMAN AUTO CENTER
23051 DRAYTON ST
SAUGUS, CA 91350

HAZNET S104577098
N/A

Site 1 of 8 in cluster AS

HAZNET:
Gepaid: CAL000068583
Tepaid: CAD099452708
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2293
Category: Unspecified organic liquid mixture
Disposal Method: Recycler
Contact: HOLLATZ NELLY
Telephone: (000) 000-0000
Mailing Address: 23051 DRAYTON ST

GERMAN AUTO CENTER (Continued) **S104577098**

	SANTA CLARITA, CA 91350 - 2545
County	Los Angeles
Gepaid:	CAL000068583
Tepaid:	CAT000613893
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	0.1042
Category:	Aqueous solution with less than 10% total organic residues
Disposal Method:	Transfer Station
Contact:	HOLLATZ NELLY
Telephone:	(000) 000-0000
Mailing Address:	23051 DRAYTON ST
	SANTA CLARITA, CA 91350 - 2545
County	Los Angeles

AS292 **WSW** **> 1** **6924 ft.** **Lower**

GERMAN AUTO CENTERS INC.
23051 DRAYTON AVE
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S103945144** **N/A**

Site 2 of 8 in cluster AS

HMS:

Facility Id:	019951-028469		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

AO293 **East** **> 1** **6980 ft.** **Higher**

MED TRANS CORP.
20607 W SOLEDAD CANYON RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S104538366** **N/A**

Site 17 of 18 in cluster AO

HMS:

Facility Id:	016594-022070		
Facility Type:	T1		
Permit Number:	000108769	Permit Status:	Removed
Facility Status:	Removed	Area:	7A
Region:	Los Angeles County:		

AO294 **East** **> 1** **6980 ft.** **Higher**

NEW HALL AMBULANCE
20607 SOLEDAD CANYON RD
CANYON COUNTRY, CA 91351

HIST UST **U001567751** **N/A**

Site 18 of 18 in cluster AO

UST HIST:

Facility ID:	6329		
Tank Num:	1	Container Num:	333
Tank Capacity:	5000	Year Installed:	1974
Tank Used for:	PRODUCT		
Type of Fuel:	REGULAR	Tank Construction:	Not reported
Leak Detection:	Stock Inventor		
Contact Name:	Not reported	Telephone:	(805) 251-3111
Total Tanks:	1	Region:	STATE
Facility Type:	2	Other Type:	AMBULANCE SER.

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number
AS295 WSW > 1 7053 ft. Lower	**CNTY LA SANITATION DIST/SAUGUS WRP 26200 SPRINGBOOK AVE SAUGUS, CA 91350, CA 91350**	**HAZNET**	**S103647576 N/A**

Site 3 of 8 in cluster AS

HAZNET:
Gepaid: CAL000096581
Tepaid: CAL000113451
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2293
Category: Unspecified organic liquid mixture
Disposal Method: Transfer Station
Contact: LA CNTY SANITATION DIST OF LA
Telephone: (562) 699-7411
Mailing Address: PO BOX 4998
WHITTIER, CA 90607 - 4998
County Los Angeles

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number
AS296 WSW > 1 7053 ft. Lower	**LA CO SAN DIS-SAUGUS WRP 26200 SPRINGBROOK AVE SANTA CLARITA, CA 91350**	**UST**	**U003776074 N/A**

Site 4 of 8 in cluster AS

State UST:
Facility ID: 5146
Total Tanks: 1
Region: STATE
Local Agency: 19000

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number
AS297 WSW > 1 7053 ft. Lower	**LA CO., SANITATION DIST 26200 SPRINGBROOK AVE SAUGUS, CA 91350**	**FINDS**	**1004441980 110002422637**

Site 5 of 8 in cluster AS

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
National Emissions Trends (NET)
Permit Compliance System (PCS)

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number
AS298 WSW > 1 7053 ft. Lower	**SAUGUS WWRP, NPDES 26200 SPRINGBROOK AVE SAUGUS, CA 91350**	**CA WDS**	**1001612767 N/A**

Site 6 of 8 in cluster AS

WDS:
Facility ID: Santa Clara River 190107021
Facility Contact Paul Lemay — Facility Telephone (661) 259-3804
SIC Code: 4952 — SIC Code 2: Not reported
Agency Name: LOS ANGELES COUNTY SAN DIST
Agency Address: 1955 Workman Mill Rd.
Whittier 90607
Agency Contact: Earle C. Hartling — Agency Phone: (562) 699-7411
Design Flow: 7 Million Gal/Day — Baseline Flow: 7 Million Gal/Day
Facility Type: Municipal/Domestic - Facility that treats sewage or a mixture of predominantly sewage and

SAUGUS WWRP, NPDES (Continued) **1001612767**

other waste from districts, municipalities, communities, hospitals, schools, and publicly or privately owned systems (excluding individual subsurface leaching systems disposing of less than 1,000 gallons per day).

Facility Status: Active - Any facility with a continuous or seasonal discharge that is under Waste Discharge Requirements.

Agency Type: County

Waste Type: Domestic Sewage combined with Industrial Waste - Designated/Influent or Solid Wastes that pose a significant threat to water quality because of their high concentrations (E.G., BOD, Hardness, TRF, Chloride). 'Manageable' hazardous wastes (E.G., inorganic salts and heavy metals) are included in this category.

Threat to Water: Major Threat to Water Quality. A violation could render unusable a ground water or surface water resource used as a significant drink water supply, require closure of an area used for contact recreation, result in long-term deleterious effects on shell fish spawning or growth areas of aquatic resources, or directly expose the public to toxic substances.

Complexity: Category A - Any major NPDES facility, any non-NPDES facility (particularly those with toxic wastes) that would be a major if discharge was made to surface or ground waters, or any Class I disposal site. Includes any small-volume complex facility (particularly those with toxicwastes) with numerous discharge points, leak detection systems or ground water monitoring wells.

Reclamation: Producer: Reclamation requirements that have been issued to a producer of reclaimed water that does not use the product.

POTW: POTW has a local pretreatment program that has been approved by the U.S. EPA (or the regional board if the state is delegated the Federal Pretreatment Program) as being in conformance with federal prtreatment regulations [40CFR Part 403].

NPDES Number: CA0054313 The 1st 2 characters designate the state. The remaining 7 are assigned by the Regional Board

Subregion: 4

Facility ID: Santa Clara River 190107083

Facility Contact: Paul Lemay — Facility Telephone: (661) 259-3804

SIC Code: 4952 — SIC Code 2: Not reported

Agency Name: LOS ANGELES COUNTY SAN DIST

Agency Address: 1955 Workman Mill Rd.
Whittier 90607

Agency Contact: Earle C. Hartling — Agency Phone: (562) 699-7411

Design Flow: 5 Million Gal/Day — Baseline Flow: 5 Million Gal/Day

Facility Type: Municipal/Domestic - Facility that treats sewage or a mixture of predominantly sewage and other waste from districts, municipalities, communities, hospitals, schools, and publicly or privately owned systems (excluding individual subsurface leaching systems disposing of less than 1,000 gallons per day).

Facility Status: Active - Any facility with a continuous or seasonal discharge that is under Waste Discharge Requirements.

Agency Type: County

Waste Type: Domestic Sewage combined with Industrial Waste - Designated/Influent or Solid Wastes that pose a significant threat to water quality because of their high concentrations (E.G., BOD, Hardness, TRF, Chloride). 'Manageable' hazardous wastes (E.G., inorganic salts and heavy metals) are included in this category.

Threat to Water: Major Threat to Water Quality. A violation could render unusable a ground water or surface water resource used as a significant drink water supply, require closure of an area used for contact recreation, result in long-term deleterious effects on shell fish spawning or growth areas of aquatic resources, or directly expose the public to toxic substances.

Complexity: Category A - Any major NPDES facility, any non-NPDES facility (particularly those with toxic wastes) that would be a major if discharge was made to surface or ground waters, or any Class I disposal site. Includes any small-volume complex facility (particularly those with toxicwastes) with numerous discharge points, leak detection systems or ground water

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

SAUGUS WWRP, NPDES (Continued) **1001612767**

monitoring wells.

Reclamation: Producer: Reclamation requirements that have been issued to a producer of reclaimed water that does not use the product.

POTW: POTW has a local pretreatment program that has been approved by the U.S. EPA (or the regional board if the state is delegated the Federal Pretreatment Program) as being in conformance with federal prtreatment regulations [40CFR Part 403].

NPDES Number: Not reported

Subregion: 4

AS299
WSW
> 1
7053 ft.
Lower

LA CO SAN DIS-SAUGUS WRP
26200 SPRINGBROOK AVE
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S102064436** **N/A**

Site 7 of 8 in cluster AS

HMS:

Facility Id:	015503-022692		
Facility Type:	I04		
Permit Number:	CA0054313	Permit Status:	Permit
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		
Facility Id:	015503-005146		
Facility Type:	T0		
Permit Number:	0000T6322	Permit Status:	Permit
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

AQ300
West
> 1
7117 ft.
Lower

BOOK NIPPAN
1123 E DOMINGUEZ ST K
CARSON, CA

LOS ANGELES CO. HMS **S102064171** **N/A**

Site 6 of 6 in cluster AQ

HMS:

Facility Id:	023960-033305		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	22
Region:	Los Angeles County:		
Facility Id:	002117-023458		
Facility Type:	I02		
Permit Number:	000158908	Permit Status:	Permit
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

AT301
West
> 1
7121 ft.
Lower

GLORY CLEANERS
23142 VALENCIA
VALENCIA, CA 91355

RCRIS-SQG **1001111780**
FINDS **CAR000013185**
HAZNET
CLEANERS

Site 1 of 2 in cluster AT

GLORY CLEANERS (Continued) **1001111780**

RCRIS:
Owner: GURGUIS CHEHATA
(805) 222-9382
EPA ID: CAR000013185
Contact: GURGUIS CHEHATA
(805) 222-9382
Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported
Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

CA Cleaners:
Create Date: 08/26/1996
Inactive Date: 0
EPA Id: CAL000175106
County : Los Angeles

Create Date: 02/26/1997
Inactive Date: 06/30/1998
EPA Id: CAR000013185
County : Los Angeles

HAZNET:
Gepaid: CAL000175106
Tepaid: CAD981397417
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .1584
Category: Halogenated solvents (chloroform, methyl chloride, perchloroethylene, etc.)
Disposal Method: Recycler
Contact: MAGDI W RIAD
Telephone: (000) 000-0000
Mailing Address: 23142 VALENCIA BLVD
VALENCIA, CA 91355 - 1716
County Los Angeles

Gepaid: CAL000175106
Tepaid: CAD981397417
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .1584
Category: Halogenated solvents (chloroform, methyl chloride, perchloroethylene, etc.)
Disposal Method: Recycler
Contact: MAGDI W RIAD
Telephone: (000) 000-0000
Mailing Address: 23142 VALENCIA BLVD
VALENCIA, CA 91355 - 1716
County Los Angeles

Map ID
Direction
Distance
Distance (ft.)
Elevation | Site | Database(s) | EDR ID Number / EPA ID Number

GLORY CLEANERS (Continued) **1001111780**

Gepaid: CAL000175106
Tepaid: CAD981397417
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2835
Category: Halogenated solvents (chloroform, methyl chloride, perchloroethylene, etc.)
Disposal Method: Recycler
Contact: MAGDI W RIAD
Telephone: (000) 000-0000
Mailing Address: 23142 VALENCIA BLVD
VALENCIA, CA 91355 - 1716
County Los Angeles

AU302 **WORTMANN OIL CO** **Cortese** **S105026554**
NW **26954 SECO CANYON RD** **N/A**
> 1 **SAUGUS, CA 91321**
7123 ft.
Lower **Site 1 of 3 in cluster AU**

CORTESE:
Reg Id: R-09181
Region: CORTESE
Reg By: Leaking Underground Storage Tanks

AU303 **WORTMANN OIL CO** **UST** **U003776254**
NW **26954 SECO CANYON RD** **N/A**
> 1 **SANTA CLARITA, CA 91350**
7123 ft.
Lower **Site 2 of 3 in cluster AU**

State UST:
Facility ID: 9181
Total Tanks: 1
Region: STATE
Local Agency: 19000

AU304 **WORTMANN OIL CO** **LUST** **S102064477**
NW **26954 SECO CANYON RD** **N/A**
> 1 **SAUGUS, CA 91321**
7123 ft.
Lower **Site 3 of 3 in cluster AU**

State LUST:
Cross Street: GARZOTA
Qty Leaked: Not reported
Case Number R-09181
Reg Board: 4
Chemical: Hydrocarbons
Lead Agency: Local Agency
Local Agency : 19000
Case Type: Soil only
Status: Not reported
County: Los Angeles
Abate Method: Other Means
Review Date: 6/19/97 Confirm Leak: 6/19/97
Workplan: Not reported Prelim Assess: Not reported
Pollution Char: Not reported Remed Plan: Not reported

WORTMANN OIL CO (Continued) **S102064477**

Remed Action: Not reported Monitoring: Not reported
Close Date: Not reported
Release Date: Not reported
Cleanup Fund Id : Not reported
Discover Date : Not reported
Enforcement Dt : Not reported
Enf Type: Not reported
Enter Date : 7/17/97
Funding: Not reported
Staff Initials: Not reported
How Discovered: Not reported
How Stopped: Close Tank
Interim : Not reported
Leak Cause: Not reported
Leak Source: Tank
MTBE Date : Not reported
Max MTBE GW : Not reported
MTBE Tested: Not Required to be Tested.
Priority: Not reported
Local Case # : Not reported
Beneficial: Not reported
Staff : JLC
GW Qualifies : Not reported
Max MTBE Soil : Not reported
Soil Qualifies : Not reported
Hydr Basin #: Not reported
Operator : Not reported
Oversight Prgm: Local Implementing Agency UST (includes non-LOP cases within LOP jurisdiction)
Oversight Prgm : LIA
Review Date : 8/15/97
Stop Date : 3/3/97
Work Suspended :Not reported
Responsible PartyWORTMANN OIL CO
RP Address: 3044 FOOTHILL BLVD., LA CRESCENTA, CA 91214
Global Id: T0603704786
Org Name: Not reported
Contact Person: Not reported
MTBE Conc: 0
Mtbe Fuel: Not reported
Water System Name: SANTA CLARITA WATER CO
Well Name: METHODIST
Distance To Lust: 1611.415922
Waste Discharge Global ID: Not reported
Waste Disch Assigned Name: Not reported

LUST Region 4:
Report Date: 6/19/1997
Lead Agency: Local Agency
Local Agency: 19000
Case Number: R-09181
Substance: Hydrocarbons
Case Type: Soil
Status: Leak being confirmed
Region: 4
Staff: Not reported

Map ID
Direction
Distance
Distance (ft.)
Elevation | Site | Database(s) | EDR ID Number / EPA ID Number

AV305 **ANIMAL CLINIC OF SANTA CLARITA** **HAZNET** **S103647461**
WSW **26062 BOUQUET CANYON RD** **N/A**
> 1 **SAUGUS, CA 91350**
7135 ft.
Lower **Site 1 of 2 in cluster AV**

HAZNET:
Gepaid: CAL000174526
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .3127
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: JOHN BURKHARTSMEYER
Telephone: (000) 000-0000
Mailing Address: 26062 BOUQUET CANYON RD
SANTA CLARITA, CA 91350
County Los Angeles

Gepaid: CAL000174526
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .2376
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: JOHN BURKHARTSMEYER
Telephone: (000) 000-0000
Mailing Address: 26062 BOUQUET CANYON RD
SANTA CLARITA, CA 91350
County Los Angeles

Gepaid: CAL000174526
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .3668
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: JOHN BURKHARTSMEYER
Telephone: (000) 000-0000
Mailing Address: 26062 BOUQUET CANYON RD
SANTA CLARITA, CA 91350
County Los Angeles

Gepaid: CAL000174526
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: 0.0625
Category:
Disposal Method: Recycler
Contact: JOHN BURKHARTSMEYER
Telephone: (000) 000-0000
Mailing Address: 26062 BOUQUET CANYON RD
SANTA CLARITA, CA 91350
County Los Angeles

ANIMAL CLINIC OF SANTA CLARITA (Continued) **S103647461**

Gepaid:	CAL000174526
Tepaid:	CAD981402522
Gen County:	Los Angeles
Tsd County:	Kern
Tons:	0.0625
Category:	Photochemicals/photoprocessing waste
Disposal Method:	Recycler
Contact:	JOHN BURKHARTSMEYER
Telephone:	(000) 000-0000
Mailing Address:	26062 BOUQUET CANYON RD SANTA CLARITA, CA 91350
County	Los Angeles

AW306 **West** **> 1** **7135 ft.** **Lower**

VACANT
26111 N BOUQUET CANYON RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S104536193** **N/A**

Site 1 of 6 in cluster AW

HMS:

Facility Id:	007298-I07637		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

AW307 **West** **> 1** **7135 ft.** **Lower**

FRED SANDS
26111 N BOUQUET CANYON RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S102064430** **N/A**

Site 2 of 6 in cluster AW

HMS:

Facility Id:	015378-016623		
Facility Type:	T0		
Permit Number:	00006215T	Permit Status:	Removed
Facility Status:	Removed	Area:	7A
Region:	Los Angeles County:		

AW308 **West** **> 1** **7137 ft.** **Lower**

GERALD H. HEIDT CO.
23300 W CINEMA DR #112
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S103945153** **N/A**

Site 3 of 6 in cluster AW

HMS:

Facility Id:	017528-027221		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

AW309 **West** **> 1** **7137 ft.** **Lower**

M&M HARRIGAN
23300 W CINEMA DR #112
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S104733332** **N/A**

Site 4 of 6 in cluster AW

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

M&M HARRIGAN (Continued) **S104733332**

HMS:
Facility Id: 017528-032617
Facility Type: I02
Permit Number: 000323493 Permit Status: Permit
Facility Status: Permit Area: 7A
Region: Los Angeles County:

AW310 **West** **> 1** **7137 ft.** **Lower**

JUGGLES RESTAURANT
23300 W CINEMA DR #112
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S102321784** **N/A**

Site 5 of 6 in cluster AW

HMS:
Facility Id: 017528-023908
Facility Type: I02
Permit Number: 000189714 Permit Status: Closed
Facility Status: Closed Area: 7A
Region: Los Angeles County:

AW311 **West** **> 1** **7137 ft.** **Lower**

PAULI'S ITALIAN RESTAURANT
23300 CINEMA DR #109
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S102321783** **N/A**

Site 6 of 6 in cluster AW

HMS:
Facility Id: 017553-023958
Facility Type: Not reported
Permit Number: Not reported Permit Status: Not reported
Facility Status: OPEN Area: 7A
Region: Los Angeles County:

AV312 **WSW** **> 1** **7149 ft.** **Lower**

RODNEY L CUMMINGS DC CHIROPRACTIC CORP
26045 BOQUET CANYON RD.
SAUGUS, CA 91350

HAZNET **S103647442** **N/A**

Site 2 of 2 in cluster AV

HAZNET:
Gepaid: CAL921064815
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .1251
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: RODNEY L CUMMINGS
Telephone: (661) 254-6107
Mailing Address: 26045 BOUQUET CANYON RD
SANTA CLARITA, CA 91350 - 2639
County Los Angeles

RODNEY L CUMMINGS DC CHIROPRACTIC CORP (Continued) **S103647442**

Gepaid: CAL921064815
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .1875
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: RODNEY L CUMMINGS
Telephone: (661) 254-6107
Mailing Address: 26045 BOUQUET CANYON RD
SANTA CLARITA, CA 91350 - 2639
County Los Angeles

Gepaid: CAL921064815
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .2501
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: RODNEY L CUMMINGS
Telephone: (661) 254-6107
Mailing Address: 26045 BOUQUET CANYON RD
SANTA CLARITA, CA 91350 - 2639
County Los Angeles

Gepaid: CAL921064815
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .0625
Category: Photochemicals/photoprocessing waste
Disposal Method: Not reported
Contact: RODNEY L CUMMINGS
Telephone: (661) 254-6107
Mailing Address: 26045 BOUQUET CANYON RD
SANTA CLARITA, CA 91350 - 2639
County Los Angeles

Gepaid: CAL921064815
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .2417
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: RODNEY L CUMMINGS
Telephone: (661) 254-6107
Mailing Address: 26045 BOUQUET CANYON RD
SANTA CLARITA, CA 91350 - 2639
County Los Angeles

The CA HAZNET database contains 3 additional records for this site.
Please contact your EDR Account Executive for more information.

AX313 **UNITED OIL #69** **UST** **U003778193**
WSW **26015 BOUQUET CANYON RD** **LOS ANGELES CO. HMS** **N/A**
> 1 **SANTA CLARITA, CA 91350**
7177 ft.
Lower **Site 1 of 8 in cluster AX**

UNITED OIL #69 (Continued) — U003778193

HMS:

Facility Id:	009442-030670		
Facility Type:	T1		
Permit Number:	000288207	Permit Status:	Permit
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

State UST:

Facility ID:	30670
Total Tanks:	1
Region:	STATE
Local Agency:	19000

AX314
WSW
> 1
7177 ft.
Lower

MOHAWK SERVICE STATION #04061
26015 BOUQUET CANYON RD
SAUGUS, CA 91350

HIST UST — **U001567709** — **N/A**

Site 2 of 8 in cluster AX

UST HIST:

Facility ID:	6555		
Tank Num:	1	Container Num:	1
Tank Capacity:	10000	Year Installed:	1966
Tank Used for:	PRODUCT		
Type of Fuel:	UNLEADED	Tank Construction:	Not reported
Leak Detection:	Stock Inventor		
Contact Name:	TERI TOLEDO	Telephone:	(805) 253-9188
Total Tanks:	3	Region:	STATE
Facility Type:	1	Other Type:	Not reported

Facility ID:	6555		
Tank Num:	2	Container Num:	2
Tank Capacity:	10000	Year Installed:	1966
Tank Used for:	PRODUCT		
Type of Fuel:	REGULAR	Tank Construction:	Not reported
Leak Detection:	Stock Inventor		
Contact Name:	TERI TOLEDO	Telephone:	(805) 253-9188
Total Tanks:	3	Region:	STATE
Facility Type:	1	Other Type:	Not reported

Facility ID:	6555		
Tank Num:	3	Container Num:	3
Tank Capacity:	10000	Year Installed:	1966
Tank Used for:	PRODUCT		
Type of Fuel:	PREMIUM	Tank Construction:	Not reported
Leak Detection:	Stock Inventor		
Contact Name:	TERI TOLEDO	Telephone:	(805) 253-9188
Total Tanks:	3	Region:	STATE
Facility Type:	1	Other Type:	Not reported

AX315
WSW
> 1
7177 ft.
Lower

P & M #987/TEXACO (FORMER)
26015 BOUQUET CANYON RD
SANTA CLARITA, CA 91350

LUST — **S103891133** — **N/A**

Site 3 of 8 in cluster AX

State LUST:

Cross Street:	MAGIC MOUNTAIN PARKWAY

P & M #987/TEXACO (FORMER) (Continued) S103891133

Qty Leaked: Not reported
Case Number I-09249
Reg Board: 4
Chemical: Gasoline
Lead Agency: Regional Board
Local Agency : 19000
Case Type: Soil only
Status: Not reported
County: Los Angeles
Abate Method: Vapor Extraction
Review Date: 10/24/96 Confirm Leak: 10/24/96
Workplan: 12/3/86 Prelim Assess: 12/3/86
Pollution Char: 6/24/87 Remed Plan: 6/24/87
Remed Action: 8/28/00 Monitoring: 8/28/00
Close Date: Not reported
Release Date: Not reported
Cleanup Fund Id : Not reported
Discover Date : 2/20/90
Enforcement Dt : Not reported
Enf Type: Not reported
Enter Date : 4/5/90
Funding: Federal Funds
Staff Initials: Not reported
How Discovered: Tank Closure
How Stopped: Close Tank
Interim : Yes
Leak Cause: Unknown
Leak Source: Unknown
MTBE Date : 1/1/65
Max MTBE GW : Not reported
MTBE Tested: MTBE Detected. Site tested for MTBE & MTBE detected
Priority: 3A
Local Case # : Not reported
Beneficial: Not reported
Staff : JT
GW Qualifies : Not reported
Max MTBE Soil : Not reported
Soil Qualifies : Not reported
Hydr Basin #: Not reported
Operator : Not reported
Oversight Prgm: RB Lead Underground Storage Tank
Oversight Prgm : UST
Review Date : 9/11/00
Stop Date : 2/20/90
Work Suspended :Not reported
Responsible PartyJOE LENTINI/JEFF APPEL
RP Address: P.O. BOX 6249
Global Id: T0603703363
Org Name: Not reported
Contact Person: Not reported
MTBE Conc: 1
Mtbe Fuel: Not reported
Water System Name: LILY OF THE VALLEY MOBILE VILLAGE
Well Name: STANDBY
Distance To Lust: 789.5287905
Waste Discharge Global ID: Not reported
Waste Disch Assigned Name: Not reported

P & M #987/TEXACO (FORMER) (Continued) **S103891133**

LUST Region 4:

Report Date:	3/20/1990
Lead Agency:	Regional Board
Local Agency:	19000
Case Number:	I-09249
Substance:	Gasoline
Case Type:	Soil
Status:	Post remedial action monitoring
Region:	4
Staff:	JT

AX316 **P&M SERVICE STATIONS #987** **CA FID UST** **S101583043**
WSW **26015 N BOUQUET CANYON RD** **LOS ANGELES CO. HMS** **N/A**
> 1 **SANTA CLARITA, CA**
7177 ft.
Lower **Site 4 of 8 in cluster AX**

FID:

Facility ID:	19002381	Regulate ID:	00006555
Reg By:	Active Underground Storage Tank Location		
Cortese Code:	Not reported	SIC Code:	Not reported
Status:	Active	Facility Tel:	(818) 000-0000
Mail To:	Not reported 12739 LAKEWOOD BLVD SANTA CLARITA, CA		
Contact:	Not reported	Contact Tel:	Not reported
DUNs No:	Not reported	NPDES No:	Not reported
Creation:	10/22/93	Modified:	00/00/00
EPA ID:	Not reported		
Comments:	Not reported		

HMS:

Facility Id:	009442-009249		
Facility Type:	T0		
Permit Number:	00000269T	Permit Status:	Closed
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

Facility Id:	009442-030297		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

AX317 **ALERT MOBILE REPAIR SERVICE, INC** **HAZNET** **S103647410**
WSW **26011 BOUQUET CYN RD** **N/A**
> 1 **SAUGUS, CA 91350**
7181 ft.
Lower **Site 5 of 8 in cluster AX**

ALERT MOBILE REPAIR SERVICE, INC (Continued) **S103647410**

HAZNET:
- Gepaid: CAL000044834
- Tepaid: CAT080013352
- Gen County: Los Angeles
- Tsd County: Los Angeles
- Tons: 2.0850
- Category: Unspecified oil-containing waste
- Disposal Method: Recycler
- Contact: GARY DUBIN
- Telephone: (000) 000-0000
- Mailing Address: 26011 BOUQUET CANYON RD
  SANTA CLARITA, CA 91350
- County Los Angeles

AX318
WSW
> 1
7181 ft.
Lower

VALENCIA DODGE
26011 BOQUET CANYON RD
SAUGUS, CA 91350

RCRIS-SQG **1000207304**
FINDS **CAD982040339**

Site 6 of 8 in cluster AX

RCRIS:
- Owner: TERRY YORK
  (415) 555-1212
- EPA ID: CAD982040339
- Contact: ENVIRONMENTAL MANAGER
  (805) 259-8770
- Classification: Small Quantity Generator
- Used Oil Recyc: No
- TSDF Activities: Not reported
- Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

AX319
WSW
> 1
7181 ft.
Lower

DANA MOTORS
26011 BOUQUET CANYON RD
SANTA CLARITA, CA

CA FID UST **S101584779**
N/A

Site 7 of 8 in cluster AX

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number

DANA MOTORS (Continued) **S101584779**

FID:

Facility ID:	19015490	Regulate ID:	00004946
Reg By:	Active Underground Storage Tank Location		
Cortese Code:	Not reported	SIC Code:	Not reported
Status:	Active	Facility Tel:	(818) 000-0000
Mail To:	Not reported 5221 SYLMAR AVE SANTA CLARITA, CA		
Contact:	Not reported	Contact Tel:	Not reported
DUNs No:	Not reported	NPDES No:	Not reported
Creation:	10/22/93	Modified:	00/00/00
EPA ID:	Not reported		
Comments:	Not reported		

AX320 **KIRCHNER & SON, INC.** **HIST UST** **U001567705**
WSW **26011 BOUQUET CANYON RD** **N/A**
> 1 **SAUGUS, CA 91350**
7181 ft.
Lower **Site 8 of 8 in cluster AX**

UST HIST:

Facility ID:	4946		
Tank Num:	1	Container Num:	1
Tank Capacity:	550	Year Installed:	1967
Tank Used for:	WASTE		
Type of Fuel:	WASTE OIL	Tank Construction:	Not reported
Leak Detection:	None		
Contact Name:	Not reported	Telephone:	(805) 259-8770
Total Tanks:	2	Region:	STATE
Facility Type:	2	Other Type:	DODGE DEALER

Facility ID:	4946		
Tank Num:	2	Container Num:	2
Tank Capacity:	1000	Year Installed:	Not reported
Tank Used for:	PRODUCT		
Type of Fuel:	UNLEADED	Tank Construction:	Not reported
Leak Detection:	None		
Contact Name:	Not reported	Telephone:	(805) 259-8770
Total Tanks:	2	Region:	STATE
Facility Type:	2	Other Type:	DODGE DEALER

AS321 **AUTO BODY SPECIALIST** **HAZNET** **S103644063**
WSW **23108 DRAYTON ST** **N/A**
> 1 **SAUGUS, CA 91350**
7188 ft.
Lower **Site 8 of 8 in cluster AS**

HAZNET:

Gepaid:	CAL000125340
Tepaid:	CAD008252405
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	1.3466
Category:	Unspecified solvent mixture Waste
Disposal Method:	Recycler
Contact:	CONDRA DONALD
Telephone:	(661) 250-1046
Mailing Address:	23108 DRAYTON ST

AUTO BODY SPECIALIST (Continued) **S103644063**

SAUGUS, CA 91350 - 2546
County Los Angeles

Gepaid: CAL000125340
Tepaid: CAD008252405
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .1876
Category: Aqueous solution with 10% or more total organic residues
Disposal Method: Recycler
Contact: CONDRA DONALD
Telephone: (661) 250-1046
Mailing Address: 23108 DRAYTON ST
SAUGUS, CA 91350 - 2546
County Los Angeles

Gepaid: CAL000125340
Tepaid: CAD008252405
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .0500
Category: Other organic solids
Disposal Method: Transfer Station
Contact: CONDRA DONALD
Telephone: (661) 250-1046
Mailing Address: 23108 DRAYTON ST
SAUGUS, CA 91350 - 2546
County Los Angeles

Gepaid: CAL000125340
Tepaid: CAD008302903
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2710
Category: Paint sludge
Disposal Method: Not reported
Contact: CONDRA DONALD
Telephone: (661) 250-1046
Mailing Address: 23108 DRAYTON ST
SAUGUS, CA 91350 - 2546
County Los Angeles

Gepaid: CAL000125340
Tepaid: CAD008252405
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .0625
Category: Other organic solids
Disposal Method: Recycler
Contact: CONDRA DONALD
Telephone: (661) 250-1046
Mailing Address: 23108 DRAYTON ST
SAUGUS, CA 91350 - 2546
County Los Angeles

The CA HAZNET database contains 7 additional records for this site.
Please contact your EDR Account Executive for more information.

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number
AT322 **West** **> 1** **7217 ft.** **Lower**	**BACKYARD INVESTMENT GROUP** **23154 W VALENCIA BLVD** **SANTA CLARITA, CA**	**LOS ANGELES CO. HMS**	**S104828053** **N/A**

Site 2 of 2 in cluster AT

HMS:

Facility Id:	002117-I02194		
Facility Type:	I02		
Permit Number:	000010280	Permit Status:	Removed
Facility Status:	Removed	Area:	7A
Region:	Los Angeles County:		

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number
323 **WSW** **> 1** **7227 ft.** **Lower**	**DIRSHNER DODGE** **26011 BOUQUET CANYON RD A** **SANTA CLARITA, CA**	**LOS ANGELES CO. HMS**	**S102064425** **N/A**

HMS:

Facility Id:	006321-004080		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number
AY324 **WSW** **> 1** **7227 ft.** **Lower**	**HASA CHEM INC** **23119 DRAYTON ST** **SAUGUS, CA 91350**	**RCRIS-SQG** **FINDS** **CERC-NFRAP** **LUST**	**1000141826** **CAD009656075**

Site 1 of 7 in cluster AY

CERCLIS-NFRAP Classification Data:

Site Incident Category:	Not reported	Federal Facility:	Not a Federal Facility
Non NPL Code:	NFRAP		
Ownership Status:	Unknown	NPL Status:	Not on the NPL

CERCLIS-NFRAP Assessment History:

Assessment:	DISCOVERY	Completed:	03/01/1985
Assessment:	PRELIMINARY ASSESSMENT	Completed:	08/01/1985
Assessment:	ARCHIVE SITE	Completed:	09/01/1986
Assessment:	SITE INSPECTION	Completed:	09/01/1986

RCRIS:

Owner: DON WILSON
(805) 259-5848

EPA ID: CAD009656075

Contact: MICHAEL BERTRAM
(805) 259-5848

Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

HASA CHEM INC (Continued) **1000141826**

Violation Status: Violations exist

Regulation Violated:	Not reported
Area of Violation:	GENERATOR-GENERAL REQUIREMENTS
Date Violation Determined:	06/15/1994
Actual Date Achieved Compliance:	Not reported

There are 1 violation record(s) reported at this site:

Evaluation	Area of Violation	Date of Compliance
Compliance Evaluation Inspection	GENERATOR-GENERAL REQUIREMENTS	

FINDS:

Other Pertinent Environmental Activity Identified at Site:

Enforcement Docket System (DOCKET)
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)
Section Seven Tracking System (SSTS)
Toxic Chemical Release Inventory System (TRIS)

State LUST:

Cross Street:	Not reported		
Qty Leaked:	Not reported		
Case Number	R-02024		
Reg Board:	4		
Chemical:	1		
Lead Agency:	Local Agency		
Local Agency :	19000		
Case Type:	Soil only		
Status:	Not reported		
County:	Los Angeles		
Review Date:	9/5/84	Confirm Leak:	9/5/84
Workplan:	Not reported	Prelim Assess:	Not reported
Pollution Char:	Not reported	Remed Plan:	Not reported
Remed Action:	Not reported	Monitoring:	Not reported
Close Date:	Not reported		
Release Date:	Not reported		
Cleanup Fund Id :	Not reported		
Discover Date :	Not reported		
Enforcement Dt :	Not reported		
Enf Type:	Not reported		
Enter Date :	8/12/87		
Funding:	Not reported		
Staff Initials:	Not reported		
How Discovered:	Not reported		
How Stopped:	Not reported		
Interim :	Not reported		
Leak Cause:	Unknown		
Leak Source:	Unknown		
MTBE Date :	Not reported		
Max MTBE GW :	Not reported		
MTBE Tested:	Not Required to be Tested.		
Priority:	Not reported		
Local Case # :	Not reported		
Beneficial:	Not reported		
Staff :	JLC		
GW Qualifies :	Not reported		
Max MTBE Soil :	Not reported		

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

HASA CHEM INC (Continued) **1000141826**

Soil Qualifies : Not reported
Hydr Basin #: Not reported
Operator : Not reported
Oversight Prgm: Local Implementing Agency UST (includes non-LOP cases within LOP jurisdiction)
Oversight Prgm : LIA
Review Date : 9/5/84
Stop Date : Not reported
Work Suspended : Not reported
Responsible Party HASA CHEMICAL, INC
RP Address: 23119 DRAYTON STREET, SAUGUS, CA 91350
Global Id: T0603704581
Org Name: Not reported
Contact Person: Not reported
MTBE Conc: 0
Mtbe Fuel: Not reported
Water System Name: Not reported
Well Name: Not reported
Distance To Lust: 300.0010715
Waste Discharge Global ID: Not reported
Waste Disch Assigned Name: Not reported

LUST Region 4:
Report Date: 9/5/1984
Lead Agency: Local Agency
Local Agency: 19000
Case Number: R-02024
Substance: 1
Case Type: Soil
Status: Leak being confirmed
Region: 4
Staff: Not reported

AY325 **WSW** **> 1** **7227 ft.** **Lower**	**23119 DRAYTON** **SAUGUS, CA 91350** **Site 2 of 7 in cluster AY**	**CHMIRS** **Cortese**	**S100279092** **N/A**

CORTESE:
Reg Id: R-02024
Region: CORTESE
Reg By: Leaking Underground Storage Tanks

CHMIRS:
OES Control Number: 8803712 DOT ID: Not reported
DOT Hazard Class: Not Reported
Chemical Name: TRICHLORO-S-TRIAZINETRIONE
Extent of Release: Not reported
CAS Number: Not reported Quantity Released: 3
Environmental Contamination: Air Property Use: Manufacturing
Incident Date: 15-NOV-88 Date Completed: 15-NOV-88
Time Completed : 1430
Physical State Stored : Solid
Physical State Released : Solid
Release Unit : Not reported
Container Description : 1
Container Type : 02
Container Material : Wood Paper, Textile and Cellulose products
Level Of Container : Ground Level

(Continued) **S100279092**

Container Capacity :	250
Container Capacity Units (code) :	2
Extent Of Release (code) :	4
Agency Id Number :	19110
Agency Incident Number :	0A-36
OES Incident Number :	8803712
Time Notified :	1307
Surrounding Area :	700
Estimated Temperature :	70
Property Management :	P
More Than Two Substances Involved? :	Not reported
Special Studies 1 :	Not reported
Special Studies 2 :	Not reported
Special Studies 3 :	Not reported
Special Studies 4 :	Not reported
Special Studies 5 :	Not reported
Special Studies 6 :	Not reported
Responding Agency Personel # Of Injuries :	Not reported
Responding Agency Personel # Of Fatalities :	Not reported
Resp Agncy Personel # Of Decontaminated :	Not reported
Others Number Of Decontaminated :	Not reported
Others Number Of Injuries :	Not reported
Others Number Of Fatalities :	Not reported
Vehicle Make/year :	Not reported
Vehicle License Number :	Not reported
Vehicle State :	Not reported
Vehicle Id Number :	Not reported
CA/DOT/PUC/ICC Number :	Not reported
Company Name :	Not reported
Reporting Officer Name/ID :	F F ALFRED W LITTLE
Report Date :	15-NOV-88
Comments :	No
Facility Telephone Number :	213 267-2485

AY326 **23119 DRAYTON ST.** **ERNS** **88180705**
WSW **23119 DRAYTON ST.** **N/A**
> 1 **SANTA CLARITA, CA 91350**
7227 ft.
Lower **Site 3 of 7 in cluster AY**

AY327 **HASA CHEMICALS, INC.** **HIST UST** **U001567701**
WSW **23119 DRAYTON ST** **N/A**
> 1 **SAUGUS, CA 91350**
7227 ft.
Lower **Site 4 of 7 in cluster AY**

UST HIST:

Facility ID:	50567		
Tank Num:	1	Container Num:	1
Tank Capacity:	1000	Year Installed:	Not reported
Tank Used for:	PRODUCT		
Type of Fuel:	REGULAR	Tank Construction:	Not reported
Leak Detection:	None		
Contact Name:	WAYNE RANDELL	Telephone:	(805) 259-5848
Total Tanks:	6	Region:	STATE
Facility Type:	2	Other Type:	POOL PRODUCTS MANUFA

Facility ID: 50567

HASA CHEMICALS, INC. (Continued) **U001567701**

Tank Num:	2	Container Num:	2
Tank Capacity:	2000	Year Installed:	Not reported
Tank Used for:	PRODUCT		
Type of Fuel:	Not Reported	Tank Construction:	Not reported
Leak Detection:	None		
Contact Name:	WAYNE RANDELL	Telephone:	(805) 259-5848
Total Tanks:	6	Region:	STATE
Facility Type:	2	Other Type:	POOL PRODUCTS MANUFA

Facility ID:	50567		
Tank Num:	3	Container Num:	3
Tank Capacity:	0	Year Installed:	Not reported
Tank Used for:	WASTE		
Type of Fuel:	Not Reported	Tank Construction:	Not reported
Leak Detection:	None		
Contact Name:	WAYNE RANDELL	Telephone:	(805) 259-5848
Total Tanks:	6	Region:	STATE
Facility Type:	2	Other Type:	POOL PRODUCTS MANUFA

Facility ID:	50567		
Tank Num:	4	Container Num:	4
Tank Capacity:	0	Year Installed:	Not reported
Tank Used for:	WASTE		
Type of Fuel:	Not Reported	Tank Construction:	Not reported
Leak Detection:	None		
Contact Name:	WAYNE RANDELL	Telephone:	(805) 259-5848
Total Tanks:	6	Region:	STATE
Facility Type:	2	Other Type:	POOL PRODUCTS MANUFA

Facility ID:	50567		
Tank Num:	5	Container Num:	5
Tank Capacity:	10000	Year Installed:	1984
Tank Used for:	PRODUCT		
Type of Fuel:	DIESEL	Tank Construction:	1/4 inches
Leak Detection:	Vapor Sniff Well		
Contact Name:	WAYNE RANDELL	Telephone:	(805) 259-5848
Total Tanks:	6	Region:	STATE
Facility Type:	2	Other Type:	POOL PRODUCTS MANUFA

Facility ID:	50567		
Tank Num:	6	Container Num:	6
Tank Capacity:	0	Year Installed:	Not reported
Tank Used for:	WASTE		
Type of Fuel:	Not Reported	Tank Construction:	Not reported
Leak Detection:	None		
Contact Name:	WAYNE RANDELL	Telephone:	(805) 259-5848
Total Tanks:	6	Region:	STATE
Facility Type:	2	Other Type:	POOL PRODUCTS MANUFA

AY328 **HASA INC.** **TRIS** **1005452000**
WSW **23119 DRAYTON ST.** **91350HSNC 23**
> 1 **SAUGUS, CA 91350**
7227 ft.
Lower **Site 5 of 7 in cluster AY**

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number
AY329 **WSW** **> 1** **7227 ft.** **Lower**	**23119 DRAYTON ST** **SANTA CLARITA, CA 91350** **Site 6 of 7 in cluster AY**	**CHMIRS**	**S100698238** **N/A**

CHMIRS:

OES Control Number:	9991771	DOT ID:	Not reported
DOT Hazard Class:	Corrosives		
Chemical Name:	ACID, HYDROCHLORIC		
Extent of Release:	Not reported		
CAS Number:	Not reported	Quantity Released:	10
Environmental Contamination:	Ground	Property Use:	Industrial, Utility
Incident Date:	13-JUN-88	Date Completed:	13-JUN-88

Time Completed :	Not reported
Physical State Stored :	Liquid
Physical State Released :	Liquid
Release Unit :	Gallons
Container Description :	3
Container Type :	01
Container Material :	Undetermined
Level Of Container :	10
Container Capacity :	50
Container Capacity Units (code) :	2
Extent Of Release (code) :	6
Agency Id Number :	Not reported
Agency Incident Number :	Not reported
OES Incident Number :	9991771
Time Notified :	Not reported
Surrounding Area :	Not reported
Estimated Temperature :	Not reported
Property Management :	Not reported
More Than Two Substances Involved? :	Not reported
Special Studies 1 :	Not reported
Special Studies 2 :	Not reported
Special Studies 3 :	Not reported
Special Studies 4 :	Not reported
Special Studies 5 :	Not reported
Special Studies 6 :	Not reported
Responding Agency Personel # Of Injuries :	Not reported
Responding Agency Personel # Of Fatalities :	Not reported
Resp Agncy Personel # Of Decontaminated :	Not reported
Others Number Of Decontaminated :	Not reported
Others Number Of Injuries :	Not reported
Others Number Of Fatalities :	Not reported
Vehicle Make/year :	Not reported
Vehicle License Number :	Not reported
Vehicle State :	Not reported
Vehicle Id Number :	Not reported
CA/DOT/PUC/ICC Number :	Not reported
Company Name :	Not reported
Reporting Officer Name/ID :	Not reported
Report Date :	Not reported
Comments :	Not reported
Facility Telephone Number :	Not reported

AY330 **WSW** **> 1** **7227 ft.** **Lower**	**HASA CHEMICALS INC** **23119 DRAYTON STREET** **SAUGUS, CA 91350** **Site 7 of 7 in cluster AY**	**HAZNET** **LOS ANGELES CO. HMS**	**S103644077** **N/A**

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

HASA CHEMICALS INC (Continued) **S103644077**

HAZNET:

Gepaid:	CAD009656075
Tepaid:	CAD097030993
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.2293
Category:	Aqueous solution (2 < pH < 12.5) containing reactive anions (azide, bromate, chlorate, cyanide, fluoride, hypochlorite, nitrite, perchlorate, and sulfide anions)
Disposal Method:	Disposal, Other
Contact:	HASA CHEMICALS INC
Telephone:	(000) 000-0000
Mailing Address:	23119 DRAYTON ST SANTA CLARITA, CA 91350 - 2547
County	Los Angeles

Gepaid:	CAD009656075
Tepaid:	CAT080033681
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.0075
Category:	Liquids with pH <UN-> 2
Disposal Method:	Recycler
Contact:	HASA CHEMICALS INC
Telephone:	(000) 000-0000
Mailing Address:	23119 DRAYTON ST SANTA CLARITA, CA 91350 - 2547
County	Los Angeles

Gepaid:	CAD009656075
Tepaid:	CAT080013352
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	0.5004
Category:	Waste oil and mixed oil
Disposal Method:	Recycler
Contact:	HASA CHEMICALS INC
Telephone:	(000) 000-0000
Mailing Address:	23119 DRAYTON ST SANTA CLARITA, CA 91350 - 2547
County	Los Angeles

HMS:

Facility Id:	001947-I02024		
Facility Type:	I09		
Permit Number:	000010355	Permit Status:	Permit
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

Facility Id:	001947-002024		
Facility Type:	T0		
Permit Number:	00005776T	Permit Status:	Removed
Facility Status:	Removed	Area:	7A
Region:	Los Angeles County:		

AZ331 **East** **> 1** **7336 ft.** **Higher**	**NAPA AUTO PARTS** **20541 SOLEDAD CANYON RD** **SANTA CLARITA, CA** **Site 1 of 10 in cluster AZ**	**LOS ANGELES CO. HMS**	**S105053477** **N/A**

NAPA AUTO PARTS (Continued) **S105053477**

HMS:

Facility Id:	001651-028910		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

AZ332 **LIL JOHN AUTO PARTS** **LOS ANGELES CO. HMS** **U003058052**
East **20541 SOLEDAD CANYON RD** **N/A**
> 1 **SANTA CLARITA, CA**
7336 ft.
Higher **Site 2 of 10 in cluster AZ**

HMS:

Facility Id:	001651-I01726		
Facility Type:	I09		
Permit Number:	000010536	Permit Status:	Removed
Facility Status:	Removed	Area:	7A
Region:	Los Angeles County:		

AZ333 **LIL'JOHN AUTO PARTS (USED OIL COLLECTION** **HAZNET** **S103640744**
East **20541 SOLEDAD CANYON RD** **N/A**
> 1 **CANYON COUNTRY, CA 91351**
7336 ft.
Higher **Site 3 of 10 in cluster AZ**

HAZNET:

Gepaid:	CAH111000460
Tepaid:	CAD099452708
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	4.1283
Category:	Waste oil and mixed oil
Disposal Method:	Recycler
Contact:	LIL'JOHN INC.
Telephone:	(000) 000-0000
Mailing Address:	25601 WEST AVENUE STANFORD VALENCIA, CA 91355
County	Los Angeles

Gepaid:	CAH111000460
Tepaid:	CAD099452708
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.4587
Category:	Waste oil and mixed oil
Disposal Method:	Not reported
Contact:	LIL'JOHN INC.
Telephone:	(000) 000-0000
Mailing Address:	25601 WEST AVENUE STANFORD VALENCIA, CA 91355
County	Los Angeles

LIL'JOHN AUTO PARTS (USED OIL COLLECTION (Continued) **S103640744**

Gepaid:	CAH111000460
Tepaid:	CAD008252405
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.0250
Category:	Paint sludge
Disposal Method:	Not reported
Contact:	LIL'JOHN INC.
Telephone:	(000) 000-0000
Mailing Address:	25601 WEST AVENUE STANFORD VALENCIA, CA 91355
County	Los Angeles

Gepaid:	CAH111000460
Tepaid:	CAD099452708
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.4587
Category:	Waste oil and mixed oil
Disposal Method:	Recycler
Contact:	LIL'JOHN INC.
Telephone:	(000) 000-0000
Mailing Address:	25601 WEST AVENUE STANFORD VALENCIA, CA 91355
County	Los Angeles

AZ334
East
> 1
7336 ft.
Higher

CANYON AUTO SUPPLY
20541 SOLEDAD CANYON RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S102063988**
N/A

Site 4 of 10 in cluster AZ

HMS:

Facility Id:	001651-001726		
Facility Type:	T0		
Permit Number:	00000283T	Permit Status:	Removed
Facility Status:	Removed	Area:	7A
Region:	Los Angeles County:		

335
East
> 1
7382 ft.
Higher

FOLVEN BUILDING MATERIALS
26957 HONBY AVE
CANYON COUNTRY, CA 91351

HIST UST **U001567747**
N/A

UST HIST:

Facility ID:	50488		
Tank Num:	1	Container Num:	1
Tank Capacity:	1000	Year Installed:	1983
Tank Used for:	PRODUCT		
Type of Fuel:	DIESEL	Tank Construction:	1/2 inches
Leak Detection:	Stock Inventor		
Contact Name:	DENNIS FOLVEN	Telephone:	(805) 251-1325
Total Tanks:	1	Region:	STATE
Facility Type:	2	Other Type:	MAINTENANCE YARD

AZ336 **MIKE'S TIREMAN INC** **HAZNET** **S102361048**
East **20529 SOLEDAD CANYON RD** **SWF/LF** **N/A**
> 1 **CANYON COUNTRY, CA 91351**
7394 ft.
Higher **Site 5 of 10 in cluster AZ**

LF:
Facility ID: 19-TI-0138
Operator: Mike's Tireman, Inc.
Operator Phone: (661) 252-4455
Operator Addr: 20529 Soledad Canyon Rd
Canyon Country, CA 91351
Owner: Mike's Tireman, Inc.
Owner Address: Not reported
20529 Soledad Canyon Rd
Canyon Country, CA 91351
Owner Telephone: (661) 252-4455
Activity: Tire Dealer
Operator's Status: Active
Regulation Status: Permitted
Region: STATE
Lat/Long: 34 / -118
Permit Date: 12/9/99
Accepted Waste: Tires,Tires, Oversize,Tires, Passenger,Tires, Tractor,Tires, Truck
Permitted Throughput with Units: 4999
Permitted Throughput with Units: 4999
Permitted Throughput with Units: 4999
Actual Throughput with Units: Tires
Actual Capacity with Units: 0
Permitted Capacity with Units: 0
Remaining Capacity with Units: Not reported
Permitted Total Acreage: 4
Inspection Frequency: 30 Months
Landuse Name: Not reported
GIS Source: Map
Permit Status: Permitted
Category: Waste Tire Site
Unit Number: 01
Last Waste Tire Inspection Count : 0
Last Waste Tire Inspection Date: 8/10/00
Original Waste Tire Count: Not reported
Original Waste Tire Count Date: 2/1/95
Closure Date: / /
Closure Type: Not reported
Disposal Acreage: Not reported
Remaining Capacity: Not reported

HAZNET:
Gepaid: CAD983594060
Tepaid: CAT000613893
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 0.2709
Category: Aqueous solution with less than 10% total organic residues
Disposal Method: Transfer Station
Contact: MICHAEL L CONE
Telephone: (661) 252-4455
Mailing Address: 20529 SOLEDAD CANYON RD
CANYON COUNTRY, CA 91351 - 2436
County Los Angeles

MIKE'S TIREMAN INC (Continued) **S102361048**

Gepaid: CAD983594060
Tepaid: CAT000613893
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .3418
Category: Aqueous solution with less than 10% total organic residues
Disposal Method: Transfer Station
Contact: MICHAEL L CONE
Telephone: (661) 252-4455
Mailing Address: 20529 SOLEDAD CANYON RD
CANYON COUNTRY, CA 91351 - 2436
County Los Angeles

AZ337 **MIKE'S TIRE MAN** **LOS ANGELES CO. HMS** **S103945028**
East **20529 SOLEDAD CANYON RD** **N/A**
> 1 **SANTA CLARITA, CA**
7394 ft.
Higher **Site 6 of 10 in cluster AZ**

HMS:
Facility Id: 020317-028909
Facility Type: Not reported
Permit Number: Not reported Permit Status: Not reported
Facility Status: OPEN Area: 7A
Region: Los Angeles County:

AZ338 **MIKES TIREMAN** **RCRIS-SQG** **1000595469**
East **20529 SOLEDAD CANYON RD** **FINDS** **CAD983594060**
> 1 **CANYON COUNTRY, CA 91351**
7394 ft.
Higher **Site 7 of 10 in cluster AZ**

RCRIS:
Owner: MICHAEL L CONE
(415) 555-1212
EPA ID: CAD983594060

Contact: MICHAEL CONE
(805) 252-4455

Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

BA339 **KEYSOR-CENTURY CORPORATION** **Cal-Sites** **S101480583**
SW **26000 SPRINGBROOK ROAD** **N/A**
> 1 **SAUGUS, CA 91350**
7442 ft.
Lower **Site 1 of 5 in cluster BA**

CAL-SITES:

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

KEYSOR-CENTURY CORPORATION (Continued) **S101480583**

Facility ID: 19280025
Status: REFRC - DOES NOT REQUIRE DTSC ACTION. REFERRED TO RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) LEAD
Status Date: 08/28/1995
Lead: Not reported
Region: 3 - BURBANK
Branch: SA - SOUTHERN CA. - A
File Name: Not reported
Status Name: PROPERTY/SITE REFERRED TO RCRA
Lead Agency: N/A Not reported
NPL: Not reported
SIC: 28 MANU - CHEMICALS & ALLIED PRODUCTS
Facility Type: N/A
Type Name: Not reported
Staff Member Responsible for Site: Not reported
Supervisor Responsible for Site: MMONROY
Region Water Control Board: LA - LOS ANGELES
Access: Not reported
Cortese: Not reported
Hazardous Ranking Score: Not reported
Date Site Hazard Ranked: Not reported
Groundwater Contamination: Not reported
No. of Contamination Sources: 0
Lat/Long: 0° 0´ 0.00˝ / 0° 0´ 0.00˝
Lat/long Method: Not reported
State Assembly District Code: Not reported
State Senate District: Not reported

The CAL-SITES database may contain additional details for this site.
Please contact your EDR Account Executive for more information.

BA340 **SW** **> 1** **7442 ft.** **Lower**	**KEYSOR-CENTURY CORPORATIO** **26000 SPRINGBROOK** **SAUGUS, CA 91350** **Site 2 of 5 in cluster BA**	**Cortese** **CA WDS**	**S103617362** **N/A**

CORTESE:
Reg Id: 19280025
Region: CORTESE
Reg By: CALSI

WDS:
Facility ID: Santa Clara River 192000001
Facility Contact: Paul M. Boren — Facility Telephone: (661) 259-2360
SIC Code: 2821 — SIC Code 2: Not reported
Agency Name: KEYSOR-CENTURY CORP
Agency Address: 0
Agency Contact: Not reported — Agency Phone: 0
Design Flow: 0 Million Gal/Day — Baseline Flow: 0 Million Gal/Day
Facility Type: Industrial - Facility that treats and/or disposes of liquid or semisolid wastes from any servicing, producing, manufacturing or processing operation of whatever nature, including mining, gravel washing, geothermal operations, air conditioning, ship building and repairing, oil production, storage and disposal operations, water pumping.
Facility Status: Active - Any facility with a continuous or seasonal discharge that is under Waste Discharge Requirements.
Agency Type: Private
Waste Type: Stormwater Runoff - Designated/Influent or Solid Wastes that pose a significant threat to water quality because of their high concentrations (E.G., BOD, Hardness, TRF, Chloride).

KEYSOR-CENTURY CORPORATIO (Continued) **S103617362**

'Manageable' hazardous wastes (E.G., inorganic salts and heavy metals) are included in this category.

Threat to Water: Moderate Threat to Water Quality. A violation could have a major adverse impact on receiving biota, can cause aesthetic impairment to a significant human population, or render unusable a potential domestic or municipal water supply. Awsthetic impairment would include nuisance from a waste treatment facility.

Complexity: Category C - Facilities having no waste treatment systems, such as cooling water dischargers or thosewho must comply through best management practices, facilities with passive waste treatment and disposal systems, such as septic systems with subsurface disposal, or dischargers having waste storage systems with land disposal such as dairy waste ponds.

Reclamation: No reclamation requirements associated with this facility.

POTW: The facility is not a POTW.

NPDES Number: CA0057126 The 1st 2 characters designate the state. The remaining 7 are assigned by the Regional Board

Subregion: 4

BA341
SW
> 1
7442 ft.
Lower

KEYSOR CENTURY CORPORATION — **HIST UST** — **U001567703** / **N/A**
26000 SPRINGBROOK AVE
SAUGUS, CA 91350

Site 3 of 5 in cluster BA

UST HIST:

Facility ID:	479		
Tank Num:	1	Container Num:	1
Tank Capacity:	10000	Year Installed:	1974
Tank Used for:	PRODUCT		
Type of Fuel:	DIESEL	Tank Construction:	Not reported
Leak Detection:	Visual, Stock Inventor		
Contact Name:	Not reported	Telephone:	(805) 259-2360
Total Tanks:	8	Region:	STATE
Facility Type:	2	Other Type:	MANUFACTURER

Facility ID:	479		
Tank Num:	2	Container Num:	2
Tank Capacity:	10000	Year Installed:	1974
Tank Used for:	PRODUCT		
Type of Fuel:	DIESEL	Tank Construction:	Not reported
Leak Detection:	Visual, Stock Inventor		
Contact Name:	Not reported	Telephone:	(805) 259-2360
Total Tanks:	8	Region:	STATE
Facility Type:	2	Other Type:	MANUFACTURER

Facility ID:	479		
Tank Num:	3	Container Num:	3
Tank Capacity:	10000	Year Installed:	1974
Tank Used for:	PRODUCT		
Type of Fuel:	DIESEL	Tank Construction:	Not reported
Leak Detection:	Visual, Stock Inventor		
Contact Name:	Not reported	Telephone:	(805) 259-2360
Total Tanks:	8	Region:	STATE
Facility Type:	2	Other Type:	MANUFACTURER

Facility ID:	479		
Tank Num:	4	Container Num:	4
Tank Capacity:	10000	Year Installed:	1974
Tank Used for:	PRODUCT		
Type of Fuel:	DIESEL	Tank Construction:	Not reported

KEYSOR CENTURY CORPORATION (Continued) **U001567703**

Leak Detection:	Visual, Stock Inventor		
Contact Name:	Not reported	Telephone:	(805) 259-2360
Total Tanks:	8	Region:	STATE
Facility Type:	2	Other Type:	MANUFACTURER

Facility ID:	479		
Tank Num:	5	Container Num:	7
Tank Capacity:	1000	Year Installed:	1974
Tank Used for:	PRODUCT		
Type of Fuel:	DIESEL	Tank Construction:	Not reported
Leak Detection:	Visual, Stock Inventor		
Contact Name:	Not reported	Telephone:	(805) 259-2360
Total Tanks:	8	Region:	STATE
Facility Type:	2	Other Type:	MANUFACTURER

Facility ID:	479		
Tank Num:	6	Container Num:	8
Tank Capacity:	1000	Year Installed:	1972
Tank Used for:	PRODUCT		
Type of Fuel:	DIESEL	Tank Construction:	Not reported
Leak Detection:	Visual, Stock Inventor		
Contact Name:	Not reported	Telephone:	(805) 259-2360
Total Tanks:	8	Region:	STATE
Facility Type:	2	Other Type:	MANUFACTURER

Facility ID:	479		
Tank Num:	7	Container Num:	9
Tank Capacity:	6000	Year Installed:	1974
Tank Used for:	PRODUCT		
Type of Fuel:	DIESEL	Tank Construction:	Not reported
Leak Detection:	Visual, Stock Inventor		
Contact Name:	Not reported	Telephone:	(805) 259-2360
Total Tanks:	8	Region:	STATE
Facility Type:	2	Other Type:	MANUFACTURER

Facility ID:	479		
Tank Num:	8	Container Num:	10
Tank Capacity:	6000	Year Installed:	1974
Tank Used for:	PRODUCT		
Type of Fuel:	UNLEADED	Tank Construction:	Not reported
Leak Detection:	Visual, Stock Inventor		
Contact Name:	Not reported	Telephone:	(805) 259-2360
Total Tanks:	8	Region:	STATE
Facility Type:	2	Other Type:	MANUFACTURER

BA342	**KEYSOR-CENTURY CORP.**	**RCRIS-SQG**	**1000385455**
SW	**26000 SPRINGBROOK AVE.**	**FINDS**	**91350KYSRC26**
> 1	**SAUGUS, CA 91350**	**TRIS**	
7442 ft.		**TSCA**	
Lower	**Site 4 of 5 in cluster BA**	**CERC-NFRAP**	
		CA FID UST	
		HAZNET	
		LOS ANGELES CO. HMS	

KEYSOR-CENTURY CORP. (Continued) **1000385455**

CERCLIS-NFRAP Classification Data:
Site Incident Category: Not reported
Non NPL Code: NFRAP
Ownership Status: Unknown
Federal Facility: Not a Federal Facility
NPL Status: Not on the NPL

CERCLIS-NFRAP Assessment History:

Assessment:	DISCOVERY	Completed:	11/01/1979
Assessment:	PRELIMINARY ASSESSMENT	Completed:	11/01/1984
Assessment:	PRELIMINARY ASSESSMENT	Completed:	11/23/1988
Assessment:	ARCHIVE SITE	Completed:	10/15/1990
Assessment:	SITE INSPECTION	Completed:	10/15/1990

RCRIS:
Owner: NOT REQUIRED
(415) 555-1212
EPA ID: CAD009531591
Contact: ENVIRONMENTAL MANAGER
(805) 259-2360
Classification: Handler transports wastes, but commercial status is unknown, Large Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported
Violation Status: Violations exist

Regulation Violated: 262.10-12.A
Area of Violation: GENERATOR-ALL REQUIREMENTS (OVERSIGHT)
Date Violation Determined: 01/09/1986
Actual Date Achieved Compliance: Not reported

There are 1 violation record(s) reported at this site:

Evaluation	Area of Violation	Date of Compliance
Non-Financial Record Review	GENERATOR-ALL REQUIREMENTS (OVERSIGHT)	

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
National Emissions Trends (NET)
National Toxics Inventory (NTI)
Permit Compliance System (PCS)
Resource Conservation and Recovery Act Information system (RCRAINFO)
Toxic Chemical Release Inventory System (TRIS)

HAZNET:
Gepaid: CAD009531591
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2502
Category: Unspecified oil-containing waste
Disposal Method: Recycler
Contact: KEYSOR-CENTURY CORPORATION
Telephone: (805) 259-2360
Mailing Address: PO BOX 924
SANTA CLARITA, CA 91380 - 9024
County Los Angeles

KEYSOR-CENTURY CORP. (Continued) **1000385455**

Gepaid:	CAD009531591
Tepaid:	UTD981552177
Gen County:	Los Angeles
Tsd County:	99
Tons:	.2293
Category:	Off-specification, aged, or surplus organics
Disposal Method:	Transfer Station
Contact:	KEYSOR-CENTURY CORPORATION
Telephone:	(805) 259-2360
Mailing Address:	PO BOX 924 SANTA CLARITA, CA 91380 - 9024
County	Los Angeles

Gepaid:	CAD009531591
Tepaid:	CAD008252405
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.8548
Category:	Unspecified solvent mixture Waste
Disposal Method:	Recycler
Contact:	KEYSOR-CENTURY CORPORATION
Telephone:	(805) 259-2360
Mailing Address:	PO BOX 924 SANTA CLARITA, CA 91380 - 9024
County	Los Angeles

Gepaid:	CAD009531591
Tepaid:	CAD008302903
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.2293
Category:	Unspecified oil-containing waste
Disposal Method:	Recycler
Contact:	KEYSOR-CENTURY CORPORATION
Telephone:	(805) 259-2360
Mailing Address:	PO BOX 924 SANTA CLARITA, CA 91380 - 9024
County	Los Angeles

Gepaid:	CAD009531591
Tepaid:	CAD008252405
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.7088
Category:	Oxygenated solvents (acetone, butanol, ethyl acetate, etc.)
Disposal Method:	Recycler
Contact:	KEYSOR-CENTURY CORPORATION
Telephone:	(805) 259-2360
Mailing Address:	PO BOX 924 SANTA CLARITA, CA 91380 - 9024
County	Los Angeles

The CA HAZNET database contains 45 additional records for this site.
Please contact your EDR Account Executive for more information.

KEYSOR-CENTURY CORP. (Continued) **1000385455**

FID:

Facility ID:	19000029	Regulate ID:	00000479
Reg By:	Active Underground Storage Tank Location		
Cortese Code:	Not reported	SIC Code:	Not reported
Status:	Active	Facility Tel:	(818) 000-0000
Mail To:	Not reported 26000 SPRINGBROOK RD SANTA CLARITA, CA		
Contact:	Not reported	Contact Tel:	Not reported
DUNs No:	Not reported	NPDES No:	Not reported
Creation:	10/22/93	Modified:	00/00/00
EPA ID:	Not reported		
Comments:	Not reported		

HMS:

Facility Id:	004102-I04248		
Facility Type:	I02		
Permit Number:	000003627	Permit Status:	Permit
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

Facility Id:	004102-004248		
Facility Type:	T0		
Permit Number:	00000245T	Permit Status:	Removed
Facility Status:	Removed	Area:	7A
Region:	Los Angeles County:		

BB343
WSW
> 1
7447 ft.
Lower

J I GANDARA TRUCKING REPAIR — **LOS ANGELES CO. HMS** — **S105053521** / **N/A**
25885 SAN FERNANDO RD
SANTA CLARITA, CA

Site 1 of 4 in cluster BB

HMS:

Facility Id:	020245-036177		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

BB344
WSW
> 1
7447 ft.
Lower

LUNA'S TIRE SERVICE — **LOS ANGELES CO. HMS** — **S103945400** / **N/A**
25885 SAN FERNANDO RD
SANTA CLARITA, CA

Site 2 of 4 in cluster BB

HMS:

Facility Id:	020245-028826		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number
345 NNW > 1 7490 ft. Higher	**22520 BARBACOA DR. 22520 BARBACOA DR. SANTA CLARITA, CA 91350**	**ERNS**	**90181601 N/A**

BB346 WSW > 1 7533 ft. Lower

HI TECH TRANSMISSION
25845 SAN FERNANDO RD
SAUGUS, CA 91350

RCRIS-SQG, FINDS — **1000594969, CAD983588567**

Site 3 of 4 in cluster BB

RCRIS:
Owner: G&K MANAGEMENT CO INC
(415) 555-1212
EPA ID: CAD983588567

Contact: JONES MATTHEW
(805) 254-8060

Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

BB347 WSW > 1 7533 ft. Lower

PLAZA CLARITA
25845 SAN FERNANDO RD
SANTA CLARITA, CA

LOS ANGELES CO. HMS — **U002281903, N/A**

Site 4 of 4 in cluster BB

HMS:

Facility Id:	008466-I12315		
Facility Type:	I01		
Permit Number:	000010006	Permit Status:	Closed
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		
Facility Id:	008466-012315		
Facility Type:	T0		
Permit Number:	00004605T	Permit Status:	Removed
Facility Status:	Removed	Area:	7A
Region:	Los Angeles County:		

BC348 WSW > 1 7535 ft. Lower

PURRFECT AUTO SERVICE #69
25843 SAN FERNANDO RD
SANTA CLARITA, CA 91350

HAZNET, LOS ANGELES CO. HMS — **S103647177, N/A**

Site 1 of 7 in cluster BC

PURRFECT AUTO SERVICE #69 (Continued) **S103647177**

HAZNET:

Gepaid:	CAL000163437
Tepaid:	CAL000113451
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	1.8347
Category:	Unspecified organic liquid mixture
Disposal Method:	Transfer Station
Contact:	NAJEB JAMILI
Telephone:	(805) 222-7477
Mailing Address:	25843 SAN FERNANDO RD STE 35 SANTA CLARITA, CA 91350 - 2560
County	Los Angeles

Gepaid:	CAL000163437
Tepaid:	CAD099452708
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	3.7530
Category:	Waste oil and mixed oil
Disposal Method:	Recycler
Contact:	NAJEB JAMILI
Telephone:	(805) 222-7477
Mailing Address:	25843 SAN FERNANDO RD STE 35 SANTA CLARITA, CA 91350 - 2560
County	Los Angeles

Gepaid:	CAL000163437
Tepaid:	CAL000113451
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.7923
Category:	Unspecified organic liquid mixture
Disposal Method:	Transfer Station
Contact:	NAJEB JAMILI
Telephone:	(805) 222-7477
Mailing Address:	25843 SAN FERNANDO RD STE 35 SANTA CLARITA, CA 91350 - 2560
County	Los Angeles

Gepaid:	CAL000163437
Tepaid:	CAL000113451
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.3336
Category:	Unspecified organic liquid mixture
Disposal Method:	Transfer Station
Contact:	NAJEB JAMILI
Telephone:	(805) 222-7477
Mailing Address:	25843 SAN FERNANDO RD STE 35 SANTA CLARITA, CA 91350 - 2560
County	Los Angeles

PURRFECT AUTO SERVICE #69 (Continued) **S103647177**

Gepaid: CAL000163437
Tepaid: CAD099452708
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 0.4587
Category: Unspecified aqueous solution
Disposal Method: Recycler
Contact: NAJEB JAMILI
Telephone: (805) 222-7477
Mailing Address: 25843 SAN FERNANDO RD STE 35
SANTA CLARITA, CA 91350 - 2560
County Los Angeles

HMS:
Facility Id: 020241-028822
Facility Type: Not reported
Permit Number: Not reported Permit Status: Not reported
Facility Status: OPEN Area: 7A
Region: Los Angeles County:

BC349 **INTERSTATE BATTERIES** **LOS ANGELES CO. HMS** **S104538154**
WSW **25835 SAN FERNANDO RD #24** **N/A**
> 1 **SANTA CLARITA, CA**
7553 ft.
Lower **Site 2 of 7 in cluster BC**

HMS:
Facility Id: 020238-028819
Facility Type: Not reported
Permit Number: Not reported Permit Status: Not reported
Facility Status: OPEN Area: 7A
Region: Los Angeles County:

BC350 **ACE AUTOMOTIVE** **LOS ANGELES CO. HMS** **S104538155**
WSW **25835 SAN FERNANDO RD #29** **N/A**
> 1 **SANTA CLARITA, CA**
7553 ft.
Lower **Site 3 of 7 in cluster BC**

HMS:
Facility Id: 020240-028821
Facility Type: Not reported
Permit Number: Not reported Permit Status: Not reported
Facility Status: OPEN Area: 7A
Region: Los Angeles County:

BC351 **VALENCIA AUTOMOTIVE CENTER MD MORTAGE** **RCRIS-SQG** **1000207308**
WSW **25835 SAN FERNANDO RD** **FINDS** **CAD982524738**
> 1 **SAUGUS, CA 91350** **HAZNET**
7553 ft.
Lower **Site 4 of 7 in cluster BC**

VALENCIA AUTOMOTIVE CENTER MD MORTAGE (Continued) **1000207308**

RCRIS:
Owner: DAN MIRI TEPPER
(415) 555-1212
EPA ID: CAD982524738

Contact: ENVIRONMENTAL MANAGER
(213) 986-6110

Classification: Large Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

HAZNET:
Gepaid: CAD982524738
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 1.1259
Category: Aqueous solution with less than 10% total organic residues
Disposal Method: Recycler
Contact: Not reported
Telephone: (000) 000-0000
Mailing Address: 15910 VENTURA BLVD 1813
ENCINO, CA 91436
County Los Angeles

Gepaid: CAD982524738
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 11.9095
Category: Unspecified oil-containing waste
Disposal Method: Recycler
Contact: Not reported
Telephone: (000) 000-0000
Mailing Address: 15910 VENTURA BLVD 1813
ENCINO, CA 91436
County Los Angeles

Gepaid: CAD982524738
Tepaid: CAD089446710
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 5.8380
Category: Unspecified oil-containing waste
Disposal Method: Transfer Station
Contact: Not reported
Telephone: (000) 000-0000
Mailing Address: 15910 VENTURA BLVD 1813
ENCINO, CA 91436
County Los Angeles

VALENCIA AUTOMOTIVE CENTER MD MORTAGE (Continued) **1000207308**

Gepaid: CAD982524738
Tepaid: CAD980883177
Gen County: Los Angeles
Tsd County: Kern
Tons: 22.5180
Category: Unspecified oil-containing waste
Disposal Method: Recycler
Contact: Not reported
Telephone: (000) 000-0000
Mailing Address: 15910 VENTURA BLVD 1813
ENCINO, CA 91436
County Los Angeles

Gepaid: CAD982524738
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 1.1050
Category: Unspecified oil-containing waste
Disposal Method: Recycler
Contact: Not reported
Telephone: (000) 000-0000
Mailing Address: 15910 VENTURA BLVD 1813
ENCINO, CA 91436
County Los Angeles

The CA HAZNET database contains 1 additional record for this site.
Please contact your EDR Account Executive for more information.

BC352 **LIONS TOWING AND MOTORS** **HAZNET** **S104583143**
WSW **25835 SAN FERNANDO ROAD** **N/A**
> 1 **SANTA CLARITA, CA 91250**
7553 ft.
Lower **Site 5 of 7 in cluster BC**

HAZNET:
Gepaid: CAL000209243
Tepaid: CAT000613893
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 0.0834
Category: Aqueous solution with less than 10% total organic residues
Disposal Method: Transfer Station
Contact: SAEED MAHABADI
Telephone: (805) 253-2700
Mailing Address: PO BOX 802585
SANTA CLARITA, CA 91380 - 2585
County Los Angeles

BA353 **HASA PRODUCTS CO INC** **LOS ANGELES CO. HMS** **U003060734**
SW **25950 SPRINGBROOK AVE** **N/A**
> 1 **SANTA CLARITA, CA**
7566 ft.
Lower **Site 5 of 5 in cluster BA**

HMS:
Facility Id: 004572-I04747
Facility Type: I00

Map ID
Direction
Distance
Distance (ft.)
Elevation | Site | Database(s) | EDR ID Number / EPA ID Number

HASA PRODUCTS CO INC (Continued) **U003060734**

Permit Number: 000002163 Permit Status: Closed
Facility Status: Closed Area: 7A
Region: Los Angeles County:

AZ354 **JERRY HIDDER** **HAZNET** **S103971986**
East **20501 SOLEDA CANYON ROAD** **N/A**
> 1 **CANYON COUNTRY, CA 91351**
7576 ft.
Higher **Site 8 of 10 in cluster AZ**

HAZNET:
Gepaid: CAC001169736
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 1.3761
Category: Unspecified oil-containing waste
Disposal Method: Recycler
Contact: JERRY HIDDEN
Telephone: (818) 834-4662
Mailing Address: PO BOX 2148
CANYON COUNTRY, CA 91386 - 2148
County Los Angeles

Gepaid: CAC001169736
Tepaid: CAD982444481
Gen County: Los Angeles
Tsd County: San Bernardino
Tons: .3250
Category: Other organic solids
Disposal Method: Not reported
Contact: JERRY HIDDEN
Telephone: (818) 834-4662
Mailing Address: PO BOX 2148
CANYON COUNTRY, CA 91386 - 2148
County Los Angeles

AZ355 **JERRY'S TRANSMISSIONS** **HAZNET** **S103972007**
East **20501 SOLEDAD CANYON RD** **N/A**
> 1 **CANYON COUNTRY, CA 91351**
7576 ft.
Higher **Site 9 of 10 in cluster AZ**

HAZNET:
Gepaid: CAL000157993
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .1459
Category: Unspecified oil-containing waste
Disposal Method: Recycler
Contact: GARY L GUMBEL
Telephone: (805) 252-7200
Mailing Address: 20501 SOLEDAD CANYON RD
CANYON COUNTRY, CA 91351 - 2436
County Los Angeles

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number
AZ356 **East** **> 1** **7576 ft.** **Higher**	**JERRY AUTOMATIC TRANSMISSIONS INCORPORATED** **20501 SOLEDAD CYN ROAD** **CANYON COUNTRY, CA 91351** **Site 10 of 10 in cluster AZ**	**RCRIS-SQG** **FINDS** **HIST UST** **HAZNET**	**1000372041** **CAD981407331**

RCRIS:

Owner: GERALD W. HIDER JR.
(415) 555-1212
EPA ID: CAD981407331

Contact: ENVIRONMENTAL MANAGER
(805) 252-7200

Classification: Large Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

Violation Status: No violations found

FINDS:

Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

HAZNET:

Gepaid: CAD981407331
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .2085
Category: Unspecified oil-containing waste
Disposal Method: Recycler
Contact: JERRY'S AUTOMATIC TRANS INC
Telephone: (805) 252-7200
Mailing Address: 20501 SOLEDAD CANYON RD
CANYON COUNTRY, CA 91351 - 2436
County Los Angeles

Gepaid: CAD981407331
Tepaid: CAD980883177
Gen County: Los Angeles
Tsd County: Kern
Tons: .4378
Category: Unspecified oil-containing waste
Disposal Method: Recycler
Contact: JERRY'S AUTOMATIC TRANS INC
Telephone: (805) 252-7200
Mailing Address: 20501 SOLEDAD CANYON RD
CANYON COUNTRY, CA 91351 - 2436
County Los Angeles

Gepaid: CAD981407331
Tepaid: CAD980883177
Gen County: Los Angeles
Tsd County: Kern
Tons: .3753
Category: Unspecified oil-containing waste
Disposal Method: Not reported
Contact: JERRY'S AUTOMATIC TRANS INC
Telephone: (805) 252-7200
Mailing Address: 20501 SOLEDAD CANYON RD

JERRY AUTOMATIC TRANSMISSIONS INCORPORATED (Continued) **1000372041**

CANYON COUNTRY, CA 91351 - 2436
County: Los Angeles

Gepaid: CAD981407331
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .6046
Category: Unspecified oil-containing waste
Disposal Method: Recycler
Contact: JERRY'S AUTOMATIC TRANS INC
Telephone: (805) 252-7200
Mailing Address: 20501 SOLEDAD CANYON RD
CANYON COUNTRY, CA 91351 - 2436
County: Los Angeles

Gepaid: CAD981407331
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 2.3768
Category: Unspecified oil-containing waste
Disposal Method: Recycler
Contact: JERRY'S AUTOMATIC TRANS INC
Telephone: (805) 252-7200
Mailing Address: 20501 SOLEDAD CANYON RD
CANYON COUNTRY, CA 91351 - 2436
County: Los Angeles

The CA HAZNET database contains 1 additional record for this site.
Please contact your EDR Account Executive for more information.

UST HIST:

Facility ID:	67087		
Tank Num:	1	Container Num:	#1
Tank Capacity:	450	Year Installed:	1982
Tank Used for:	WASTE		
Type of Fuel:	Not Reported	Tank Construction:	X inches
Leak Detection:	None		
Contact Name:	G.W. HIDER	Telephone:	(805) 252-7200
Total Tanks:	1	Region:	STATE
Facility Type:	2	Other Type:	TRANSMISSIONS

BC357 **AAMCO TRANSMISSION** **HAZNET** **S105088712**
WSW **25825 SAN FERNANDO RD** **N/A**
> 1 **SAUGUS, CA 91350**
7576 ft.
Lower **Site 6 of 7 in cluster BC**

HAZNET:
Gepaid: CAD982315129
Tepaid: CAT000613893
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .3251
Category: Aqueous solution with less than 10% total organic residues
Disposal Method: Transfer Station
Contact: BEAULIEU FIN CORP.
Telephone: (661) 259-3013
Mailing Address: 25825 SAN FERNANDO RD

AAMCO TRANSMISSION (Continued) **S105088712**

SANTA CLARITA, CA 91350
County: Los Angeles

358
West
> 1
7737 ft.
Lower

WESTERN BAGEL TOO
23170 W VALENCIA BLVD
VALENCIA, CA 91355

HAZNET **S103995489**
N/A

HAZNET:
- Gepaid: CAC001185976
- Tepaid: CAL000027741
- Gen County: Los Angeles
- Tsd County: 5
- Tons: 5.8996
- Category: Asbestos-containing waste
- Disposal Method: Disposal, Land Fill
- Contact: WESTERN BAGEL TOO
- Telephone: (000) 000-0000
- Mailing Address: 23170 W VALENCIA BLVD
  VALENCIA, CA 91355
- County: Los Angeles

BD359
NNE
> 1
7754 ft.
Higher

BONGIOVANNI CHIROPRACTIC
27600 BOUQUET CANYON RD,
SAUGUS, CA 91350

HAZNET **S100930965**
CLEANERS **N/A**

Site 1 of 6 in cluster BD

CA Cleaners:
- Create Date: 05/09/1990
- Inactive Date: 06/01/1996
- EPA Id: CAL000029375
- County : Los Angeles

HAZNET:
- Gepaid: CAL000087549
- Tepaid: CAD981402522
- Gen County: Los Angeles
- Tsd County: Kern
- Tons: .1250
- Category: Photochemicals/photoprocessing waste
- Disposal Method: Recycler
- Contact: MATTHEW BONGIOVANNI
- Telephone: (805) 296-2131
- Mailing Address: 27600 BOUQUET CANYON RD,
  SAUGUS, CA 91350
- County: Los Angeles

- Gepaid: CAL000087549
- Tepaid: CAD981402522
- Gen County: Los Angeles
- Tsd County: Kern
- Tons: .0625
- Category: Photochemicals/photoprocessing waste
- Disposal Method: Not reported
- Contact: MATTHEW BONGIOVANNI
- Telephone: (805) 296-2131
- Mailing Address: 27600 BOUQUET CANYON RD,

BONGIOVANNI CHIROPRACTIC (Continued) **S100930965**

SAUGUS, CA 91350
County: Los Angeles

Gepaid: CAL000087549
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .1876
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: MATTHEW BONGIOVANNI
Telephone: (805) 296-2131
Mailing Address: 27600 BOUQUET CANYON RD,
SAUGUS, CA 91350
County: Los Angeles

Gepaid: CAL000087549
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .1876
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: MATTHEW BONGIOVANNI
Telephone: (805) 296-2131
Mailing Address: 27600 BOUQUET CANYON RD,
SAUGUS, CA 91350
County: Los Angeles

Gepaid: CAL000087549
Tepaid: CAD981402522
Gen County: Los Angeles
Tsd County: Kern
Tons: .1875
Category: Photochemicals/photoprocessing waste
Disposal Method: Recycler
Contact: MATTHEW BONGIOVANNI
Telephone: (805) 296-2131
Mailing Address: 27600 BOUQUET CANYON RD,
SAUGUS, CA 91350
County: Los Angeles

The CA HAZNET database contains 2 additional records for this site.
Please contact your EDR Account Executive for more information.

BD360 **LA RUMBA** **LOS ANGELES CO. HMS** **S105421917**
NNE **27600 N BOUQUET CANYON RD #100** **N/A**
> 1 **SANTA CLARITA, CA**
7754 ft.
Higher **Site 2 of 6 in cluster BD**

HMS:
Facility Id: 016648-037047
Facility Type: Not reported
Permit Number: Not reported Permit Status: Not reported
Facility Status: OPEN Area: 7A
Region: Los Angeles County:

BD361 **JIM DANDY CLEANERS** **HAZNET** **S104574793**
NNE **27600 BOUGUET CYN RD** **CLEANERS** **N/A**
> 1 **SAUGUS, CA 91350**
7754 ft.
Higher **Site 3 of 6 in cluster BD**

CA Cleaners:

Create Date:	05/16/1990
Inactive Date:	06/30/1996
EPA Id:	CAL000031260
County :	Los Angeles
Create Date:	03/20/1991
Inactive Date:	0
EPA Id:	CAD982439366
County :	Los Angeles

HAZNET:

Gepaid:	CAD982439366
Tepaid:	CAD981397417
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	1.2180
Category:	Halogenated solvents (chloroform, methyl chloride, perchloroethylene, etc.)
Disposal Method:	Recycler
Contact:	YONG CHUN KIM
Telephone:	(818) 780-5314
Mailing Address:	27600 BOUQUET CANYON RD SANTA CLARITA, CA 91350 - 3711
County	Los Angeles
Gepaid:	CAD982439366
Tepaid:	CAD981397417
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	0.2793
Category:	Halogenated solvents (chloroform, methyl chloride, perchloroethylene, etc.)
Disposal Method:	Recycler
Contact:	YONG CHUN KIM
Telephone:	(818) 780-5314
Mailing Address:	27600 BOUQUET CANYON RD SANTA CLARITA, CA 91350 - 3711
County	Los Angeles
Gepaid:	CAD982439366
Tepaid:	CAD981397417
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.4252
Category:	Halogenated solvents (chloroform, methyl chloride, perchloroethylene, etc.)
Disposal Method:	Recycler
Contact:	YONG CHUN KIM
Telephone:	(818) 780-5314
Mailing Address:	27600 BOUQUET CANYON RD SANTA CLARITA, CA 91350 - 3711
County	Los Angeles

JIM DANDY CLEANERS (Continued) **S104574793**

Gepaid:	CAD982439366
Tepaid:	CAD981397417
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	1.3264
Category:	Halogenated solvents (chloroform, methyl chloride, perchloroethylene, etc.)
Disposal Method:	Recycler
Contact:	YONG CHUN KIM
Telephone:	(818) 780-5314
Mailing Address:	27600 BOUQUET CANYON RD SANTA CLARITA, CA 91350 - 3711
County	Los Angeles

Gepaid:	CAD982439366
Tepaid:	CAD981397417
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.0000
Category:	
Disposal Method:	Recycler
Contact:	YONG CHUN KIM
Telephone:	(818) 780-5314
Mailing Address:	27600 BOUQUET CANYON RD SANTA CLARITA, CA 91350 - 3711
County	Los Angeles

The CA HAZNET database contains 3 additional records for this site.
Please contact your EDR Account Executive for more information.

BD362
NNE
> 1
7754 ft.
Higher

JIM DANDY
27600 BOUGUET CYN RD
SAUGUS, CA 91350

RCRIS-SQG **1000593317**
FINDS **CAD982439366**
LOS ANGELES CO. HMS

Site 4 of 6 in cluster BD

RCRIS:

Owner:	YONG CHUN KIM (805) 296-0397
EPA ID:	CAD982439366
Contact:	KIM YONG CHUN (805) 296-0397
Classification:	Small Quantity Generator
Used Oil Recyc:	No
TSDF Activities:	Not reported
Violation Status:	No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

HMS:

Facility Id:	008360-108925		
Facility Type:	101		
Permit Number:	00010206A	Permit Status:	Closed
Facility Status:	Closed	Area:	7A
Region:	Los Angeles County:		

JIM DANDY (Continued) **1000593317**

Facility Id: 008360-021195
Facility Type: I01
Permit Number: 000086769 Permit Status: Permit
Facility Status: Permit Area: 7A
Region: Los Angeles County:

BD363
NNE
> 1
7754 ft.
Higher

CAFE BOUQUET — **LOS ANGELES CO. HMS** — **S102064508** / **N/A**
27600 N BOUQUET CANYON RD #100
SANTA CLARITA, CA

Site 5 of 6 in cluster BD

HMS:
Facility Id: 016648-022168
Facility Type: I01
Permit Number: 000115305 Permit Status: Suspended
Facility Status: Permit Area: 7A
Region: Los Angeles County:

364
North
> 1
7786 ft.
Higher

WM S HART USD SAUGUS HS — **RCRIS-SQG, FINDS, HAZNET** — **1000374912** / **CAD981624059**
21900 W CENTURION WY
SAUGUS, CA 91350

RCRIS:
Owner: WM S HART UNION HSC
(415) 555-1212
EPA ID: CAD981624059

Contact: ENVIRONMENTAL MANAGER
(805) 259-5442

Classification: Large Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

HAZNET:
Gepaid: CAD981624059
Tepaid: CAD008364432
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 0.0667
Category:
Disposal Method: Treatment, Tank
Contact: WM. S. HART UNION HS DISTRICT
Telephone: (805) 259-0033
Mailing Address: 21515 REDVIEW DR
SANTA CLARITA, CA 91350 - 2947
County Los Angeles

WM S HART USD SAUGUS HS (Continued) **1000374912**

Gepaid: CAD981624059
Tepaid: CAD008364432
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 0.05
Category: Other organic solids
Disposal Method: Disposal, Land Fill
Contact: WM. S. HART UNION HS DISTRICT
Telephone: (805) 259-0033
Mailing Address: 21515 REDVIEW DR
SANTA CLARITA, CA 91350 - 2947
County Los Angeles

Gepaid: CAD981624059
Tepaid: CAD008364432
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 0.05
Category: Laboratory waste chemicals
Disposal Method: Disposal, Land Fill
Contact: WM. S. HART UNION HS DISTRICT
Telephone: (805) 259-0033
Mailing Address: 21515 REDVIEW DR
SANTA CLARITA, CA 91350 - 2947
County Los Angeles

Gepaid: CAD981624059
Tepaid: CAD008364432
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 0.005
Category: Laboratory waste chemicals
Disposal Method: Transfer Station
Contact: WM. S. HART UNION HS DISTRICT
Telephone: (805) 259-0033
Mailing Address: 21515 REDVIEW DR
SANTA CLARITA, CA 91350 - 2947
County Los Angeles

Gepaid: CAD981624059
Tepaid: CAD008364432
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 0.9591
Category: Laboratory waste chemicals
Disposal Method: Recycler
Contact: WM. S. HART UNION HS DISTRICT
Telephone: (805) 259-0033
Mailing Address: 21515 REDVIEW DR
SANTA CLARITA, CA 91350 - 2947
County Los Angeles

The CA HAZNET database contains 11 additional records for this site.
Please contact your EDR Account Executive for more information.

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number

BC365 **WSW** **> 1** **7791 ft.** **Lower**

CORNER SAN FERNANDO RD. AND DRAYTON ST
CORNER SAN FERNANDO RD. AND DRAYTON ST
SANTA CLARITA, CA

ERNS **90168505** **N/A**

Site 7 of 7 in cluster BC

BD366 **NNE** **> 1** **7817 ft.** **Higher**

MAIN STREET VIDIO
27611 BOUQUET CYN RD
SANTA CLARITA, CA 91350

HAZNET **S103976029** **N/A**

Site 6 of 6 in cluster BD

HAZNET:
Gepaid: CAL000126273
Tepaid: CAT000613976
Gen County: Los Angeles
Tsd County: Orange
Tons: .0416
Category: Photochemicals/photoprocessing waste
Disposal Method: Transfer Station
Contact: MAIN STREET VIDIO
Telephone: (805) 297-7767
Mailing Address: 27611 BOUQUET CANYON RD
SANTA CLARITA, CA 91350 - 1793
County Los Angeles

BE367 **SW** **> 1** **7822 ft.** **Lower**

BEE & BEE MACHINE SHOP
25852 SPRINGBROOK AVE
SANTA CLARITA, CA

LOS ANGELES CO. HMS **U003059896** **N/A**

Site 1 of 10 in cluster BE

HMS:
Facility Id: 003639-I03763
Facility Type: I00
Permit Number: 000001671 Permit Status: Closed
Facility Status: Closed Area: 7A
Region: Los Angeles County:

BE368 **SW** **> 1** **7822 ft.** **Lower**

FOOTHILL ELECTRIC MOTORS
25852 SPRINGBROOK AVE
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S103945399** **N/A**

Site 2 of 10 in cluster BE

HMS:
Facility Id: 020341-028945
Facility Type: Not reported
Permit Number: Not reported Permit Status: Not reported
Facility Status: OPEN Area: 7A
Region: Los Angeles County:

BE369 **SW** **> 1** **7832 ft.** **Lower**

25848 SPRINGBROOK RD
SANTA CLARITA, CA 91350

CHMIRS **S100279183** **N/A**

Site 3 of 10 in cluster BE

(Continued) **S100279183**

CHMIRS:

OES Control Number:	8904376	DOT ID:	Not reported
DOT Hazard Class:	Not Reported		
Chemical Name:	POLYVINYLCHLORIDE		
Extent of Release:	Not reported		
CAS Number:	9003-22-9	Quantity Released:	500
Environmental Contamination:	Ground	Property Use:	Industrial, Utility
Incident Date:	13-JAN-89	Date Completed:	13-JAN-89

Time Completed :	845
Physical State Stored :	Solid
Physical State Released :	Solid
Release Unit :	Lbs.
Container Description :	1
Container Type :	03
Container Material :	Aluminum and Aluminium alloys
Level Of Container :	10
Container Capacity :	Not reported
Container Capacity Units (code) :	Not reported
Extent Of Release (code) :	7
Agency Id Number :	19110
Agency Incident Number :	1-10
OES Incident Number :	8904376
Time Notified :	742
Surrounding Area :	700
Estimated Temperature :	Not reported
Property Management :	Not reported
More Than Two Substances Involved? :	Not reported
Special Studies 1 :	Not reported
Special Studies 2 :	Not reported
Special Studies 3 :	Not reported
Special Studies 4 :	Not reported
Special Studies 5 :	Not reported
Special Studies 6 :	Not reported
Responding Agency Personel # Of Injuries :	0
Responding Agency Personel # Of Fatalities :	0
Resp Agncy Personel # Of Decontaminated :	0
Others Number Of Decontaminated :	0
Others Number Of Injuries :	0
Others Number Of Fatalities :	0
Vehicle Make/year :	Not reported
Vehicle License Number :	Not reported
Vehicle State :	Not reported
Vehicle Id Number :	Not reported
CA/DOT/PUC/ICC Number :	Not reported
Company Name :	Not reported
Reporting Officer Name/ID :	LYNN A. MOHR
Report Date :	13-JAN-89
Comments :	Not reported
Facility Telephone Number :	213 267-2485

BF370 **NW** **> 1** **7836 ft.** **Higher**	**DRIVE-IN DAIRY** **26954 N SECO CANYON RD** **SANTA CLARITA, CA** **Site 1 of 2 in cluster BF**	**LOS ANGELES CO. HMS**	**U003061939** **N/A**

HMS:

Facility Id: 005965-I06179

DRIVE-IN DAIRY (Continued) **U003061939**

Facility Type:	I00		
Permit Number:	000003714	Permit Status:	Closed
Facility Status:	Closed	Area:	7A
Region:	Los Angeles County:		

BF371
NW
> 1
7836 ft.
Higher

WORTMANN OIL CO — **LOS ANGELES CO. HMS** — **S104538244** / **N/A**
26954 N SECO CANYON RD
SANTA CLARITA, CA

Site 2 of 2 in cluster BF

HMS:

Facility Id:	009374-009181		
Facility Type:	T0		
Permit Number:	00000165T	Permit Status:	Permit
Facility Status:	Permit	Area:	7A
Region:	Los Angeles County:		

BE372
SW
> 1
7836 ft.
Lower

LEONARD'S MOLDED PRODUCTS — **LOS ANGELES CO. HMS** — **S103945396** / **N/A**
25847 SPRINGBROOK AVE
SANTA CLARITA, CA

Site 4 of 10 in cluster BE

HMS:

Facility Id:	020338-028942		
Facility Type:	Not reported		
Permit Number:	Not reported	Permit Status:	Not reported
Facility Status:	OPEN	Area:	7A
Region:	Los Angeles County:		

373
East
> 1
7851 ft.
Higher

RIO VISTA ELEMENTARY SCHOOL — **HAZNET** — **S102815974** / **N/A**
20417 CEDARCREEK ST
CANYON COUNTRY, CA 91351

HAZNET:

Gepaid:	CAL000082498
Tepaid:	CAD067786749
Gen County:	Los Angeles
Tsd County:	Los Angeles
Tons:	.8428
Category:	Asbestos-containing waste
Disposal Method:	Not reported
Contact:	SAUGUS UNION SCHOOL DISTRICT
Telephone:	(805) 297-8800
Mailing Address:	SAUGUS, CA 91350
County	Los Angeles

RIO VISTA ELEMENTARY SCHOOL (Continued) **S102815974**

Gepaid: CAL000082498
Tepaid: CAD067786749
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 20.2272
Category: Asbestos-containing waste
Disposal Method: Disposal, Land Fill
Contact: SAUGUS UNION SCHOOL DISTRICT
Telephone: (805) 297-8800
Mailing Address: SAUGUS, CA 91350
County Los Angeles

BE374
SW
> 1
7861 ft.
Lower

FOOTHILL ELECTRIC MOTORS
25838 SPRINGBROOK AVE
SANTA CLARITA, CA

Site 5 of 10 in cluster BE

LOS ANGELES CO. HMS **S103945392**
N/A

HMS:
Facility Id: 020337-028941
Facility Type: Not reported
Permit Number: Not reported
Permit Status: Not reported
Facility Status: OPEN
Area: 7A
Region: Los Angeles County:

BE375
SW
> 1
7872 ft.
Lower

A & K BODY & FENDER
25834 SPRINGBROOK AVE
SAUGUS, CA 91350

Site 6 of 10 in cluster BE

RCRIS-SQG **1000121178**
FINDS **CAD982005233**
HAZNET

RCRIS:
Owner: RICHIE KOCH
(415) 555-1212
EPA ID: CAD982005233

Contact: ENVIRONMENTAL MANAGER
(415) 555-1212

Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

HAZNET:
Gepaid: CAD982005233
Tepaid: CAD009452657
Gen County: Los Angeles
Tsd County: San Mateo
Tons: .0417
Category: Unspecified solvent mixture Waste
Disposal Method: Not reported
Contact: RICHARD J & CANDICE KOCH

A & K BODY & FENDER (Continued) **1000121178**

Telephone: (000) 000-0000
Mailing Address: 25834 SPRINGBROOK AVE
SANTA CLARITA, CA 91350
County Los Angeles

Gepaid: CAD982005233
Tepaid: CAD006452657
Gen County: Los Angeles
Tsd County: 0
Tons: .1668
Category: Unspecified solvent mixture Waste
Disposal Method: Not reported
Contact: RICHARD J & CANDICE KOCH
Telephone: (000) 000-0000
Mailing Address: 25834 SPRINGBROOK AVE
SANTA CLARITA, CA 91350
County Los Angeles

Gepaid: CAD982005233
Tepaid: CAT000613893
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 0.2208
Category: Aqueous solution with less than 10% total organic residues
Disposal Method: Transfer Station
Contact: RICHARD J & CANDICE KOCH
Telephone: (000) 000-0000
Mailing Address: 25834 SPRINGBROOK AVE
SANTA CLARITA, CA 91350
County Los Angeles

Gepaid: CAD982005233
Tepaid: CAD009452657
Gen County: Los Angeles
Tsd County: San Mateo
Tons: .4252
Category: Unspecified solvent mixture Waste
Disposal Method: Recycler
Contact: RICHARD J & CANDICE KOCH
Telephone: (000) 000-0000
Mailing Address: 25834 SPRINGBROOK AVE
SANTA CLARITA, CA 91350
County Los Angeles

Gepaid: CAD982005233
Tepaid: CAD009452657
Gen County: Los Angeles
Tsd County: San Mateo
Tons: .1251
Category: Unspecified solvent mixture Waste
Disposal Method: Not reported
Contact: RICHARD J & CANDICE KOCH
Telephone: (000) 000-0000
Mailing Address: 25834 SPRINGBROOK AVE
SANTA CLARITA, CA 91350
County Los Angeles

Map ID / Direction / Distance / Distance (ft.) / Elevation | Site | Database(s) | EDR ID Number / EPA ID Number

A & K BODY & FENDER (Continued) **1000121178**

The CA HAZNET database contains 3 additional records for this site.
Please contact your EDR Account Executive for more information.

BE376
SW
> 1
7872 ft.
Lower

A & K FRAME ALIGNMENT
25834 SPRINGBROOK AVE
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S103945386**
N/A

Site 7 of 10 in cluster BE

HMS:
Facility Id: 020336-028940
Facility Type: Not reported
Permit Number: Not reported   Permit Status: Not reported
Facility Status: OPEN   Area: 7A
Region: Los Angeles County:

BE377
SW
> 1
7901 ft.
Lower

MYERS PUMPING CO.
25824 SPRINGBROOK AVE
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S103945383**
N/A

Site 8 of 10 in cluster BE

HMS:
Facility Id: 020335-028939
Facility Type: Not reported
Permit Number: Not reported   Permit Status: Not reported
Facility Status: OPEN   Area: 7A
Region: Los Angeles County:

BE378
SW
> 1
7908 ft.
Lower

AUTO BODY SPECIALISTS
25823 SPRINGBROOK AVE
SANTA CLARITA, CA

LOS ANGELES CO. HMS **S103945382**
N/A

Site 9 of 10 in cluster BE

HMS:
Facility Id: 020334-028938
Facility Type: Not reported
Permit Number: Not reported   Permit Status: Not reported
Facility Status: OPEN   Area: 7A
Region: Los Angeles County:

BG379
SW
> 1
7913 ft.
Lower

MYFRAN INC DBA MIDAS MUFFLER
25745 SAN FERNANDO RD
SAUGUS, CA 91351

HAZNET **S104574919**
N/A

Site 1 of 3 in cluster BG

HAZNET:
Gepaid: CAD983599069
Tepaid: CAT000613893
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 0.3125
Category: Aqueous solution with less than 10% total organic residues
Disposal Method: Transfer Station
Contact: MYFRAN INC

MYFRAN INC DBA MIDAS MUFFLER (Continued) S104574919

Telephone: (000) 000-0000
Mailing Address: 25745 SAN FERNANDO RD
SAUGUS, CA 91351
County Los Angeles

Gepaid: CAD983599069
Tepaid: CAT000613893
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .0500
Category: Aqueous solution with less than 10% total organic residues
Disposal Method: Transfer Station
Contact: MYFRAN INC
Telephone: (000) 000-0000
Mailing Address: 25745 SAN FERNANDO RD
SAUGUS, CA 91351
County Los Angeles

Gepaid: CAD983599069
Tepaid: CAT000613893
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: .0417
Category: Aqueous solution with less than 10% total organic residues
Disposal Method: Treatment, Tank
Contact: MYFRAN INC
Telephone: (000) 000-0000
Mailing Address: 25745 SAN FERNANDO RD
SAUGUS, CA 91351
County Los Angeles

Gepaid: CAD983599069
Tepaid: CAD093459485
Gen County: Los Angeles
Tsd County: Fresno
Tons: .0625
Category: Organic liquids with metals Alkaline solution (pH <UN-> 12.5) with metals (antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc)
Disposal Method: Transfer Station
Contact: MYFRAN INC
Telephone: (000) 000-0000
Mailing Address: 25745 SAN FERNANDO RD
SAUGUS, CA 91351
County Los Angeles

Gepaid: CAD983599069
Tepaid: CAT080013352
Gen County: Los Angeles
Tsd County: Los Angeles
Tons: 2.6104
Category: Oil/water separation sludge
Disposal Method: Recycler
Contact: MYFRAN INC
Telephone: (000) 000-0000
Mailing Address: 25745 SAN FERNANDO RD
SAUGUS, CA 91351
County Los Angeles

Map ID
Direction
Distance
Distance (ft.)
Elevation | Site | Database(s) | EDR ID Number / EPA ID Number

MYFRAN INC DBA MIDAS MUFFLER (Continued) — **S104574919**

The CA HAZNET database contains 1 additional record for this site.
Please contact your EDR Account Executive for more information.

BG380 **MIDAS MUFFLER & BRAKE SHOP** — **LOS ANGELES CO. HMS** — **S103945377** / **N/A**
SW **25745 SAN FERNANDO RD**
> 1 **SANTA CLARITA, CA**
7913 ft.
Lower **Site 2 of 3 in cluster BG**

HMS:
Facility Id: 020233-028814
Facility Type: Not reported
Permit Number: Not reported — Permit Status: Not reported
Facility Status: OPEN — Area: 7A
Region: Los Angeles County:

BG381 **MIDAS MUFFLER** — **RCRIS-SQG** / **FINDS** — **1000595948** / **CAD983599069**
SW **25745 SAN FERNANDO RD**
> 1 **SAUGUS, CA 91351**
7913 ft.
Lower **Site 3 of 3 in cluster BG**

RCRIS:
Owner: GOLDRICH TRUST NO 1
(415) 555-1212
EPA ID: CAD983599069
Contact: SCOTT DAVIS
(805) 255-0855
Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported
Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

BE382 **VIKING AUTO UPHOLSTERY** — **LOS ANGELES CO. HMS** — **S103945381** / **N/A**
SW **25819 SPRINGBROOK AVE**
> 1 **SANTA CLARITA, CA**
7919 ft.
Lower **Site 10 of 10 in cluster BE**

HMS:
Facility Id: 020333-028937
Facility Type: Not reported
Permit Number: Not reported — Permit Status: Not reported
Facility Status: OPEN — Area: 7A
Region: Los Angeles County:

MAP FINDINGS - EDR PROPRIETARY HISTORICAL DATABASES

YEAR	NAME	ADDRESS	CITY	ST	DIR.	DIST.	ELEV.	TYPE

Coal Gas Site Search: No site was found in a search of Real Property Scan's ENVIROHAZ database.

EDR Historical Gas Station & Dry Cleaner Search: No mapped sites were found in EDR's search of the EDR Historical Gas Station & Dry Cleaner Database within 0.250 mile of the Target Property.

City	EDR ID	Site Name	Site Address	Zip	Database(s)
ACTON	S103674992	LOS ANGELES COUNTY FIRE DEPT	8800 W SOLEDAD CYN RDC-11	91350	HAZNET
CANYON	S102797745	SAUGUS UNION SCHOOL DISTRICT	CEDARCREEK SCHOOL	91351	HAZNET
CANYON COUNTRY	S103648041	OAK COLOR	26752 OAK AVE STE E	91351	HAZNET
CANYON COUNTRY	S105092734	JEMCO ELECTRICAL	26752 OAK AVE STE H	91351	HAZNET
CANYON COUNTRY	S105092175	AMERICAN GRAFFITII	26821 RUETHER AVE UNIT I	91351	HAZNET
CANYON COUNTRY	S105093086	A & S EXCHANGE	26911 RUETHER AVE UNIT D	91351	HAZNET
CANYON COUNTRY	S105085203	SHARON KENNEALLY	27367 SAN CANYON RD	91351	HAZNET
CANYON COUNTRY	S103637390	LOS ANGELES COUNTY FIRE DEPT	18239 W SOLEDAD CYN RD - STATI	91351	HAZNET
CANYON COUNTRY	S105030846	MINNIE MAX CLEANERS	20655 SOLEDAD CANYON RD UNIT 3	91351	CLEANERS
CANYON COUNTRY	S105265668	ACE CLEANERS	18835 SOLEDAD	91351	CLEANERS
LOS ANGELES	S104575199	CITY OF LA - ENVIRO SVCS DEPT	SOLEDAD CANYON RD	91351	HAZNET
SANTA CLARITA	S102532002	WOK EXPRESS	26570 N BOUQUET CANYON RD A	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S103945406	GOOD GUYS AUTO REPAIR	26015 BOUQUET CANYON RD A	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S103945413	AQUA-FLO SUPPLY	26081 BOUQUET CANYON RD A	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S103945414	SAUGUS SUZUKI	26081 BOUQUET CANYON RD B	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S103995295	WELLS FARGO BANK	26007 26011 BOUQUET CANYON	91350	HAZNET
SANTA CLARITA	S104827210	UNITED OIL CO.	26015 N BOUQUET CANYON RD B	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S105053522	ALERT MOBILE REPAIR	26011 BOUQUET CANYON RD A	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S105053523	ALERT MOBILE REPAIR	26011 BOUQUET CANYON RD A	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S105193537	IN-N-OUT BURGER	26401 N BOUQUET CANYON RD	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S105193538	PANDA EXPRESS	26409 N BOUQUET CANYON RD	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S105193539	LOWE'S HOME IMPROVMNT WRHOUSE	26415 N BOUQUET CANYON RD	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S105421916	CAR WASH USA INC	26225 N BOUQUET CANYON RD	91350	LOS ANGELES CO. HMS
SANTA CLARITA	U003060611	LUSTGARTEN OIL CO	BOUQUET CYN		LOS ANGELES CO. HMS
SANTA CLARITA	S105512328	RIO VISTA WTP PUMPING STA	25401 N BOUQUET CANYON RD		LOS ANGELES CO. HMS
SANTA CLARITA	S105421919	BOUQUET CYN OILFIELD	BOUQUET CYN OF		LOS ANGELES CO. HMS
SANTA CLARITA	S104735491	J. MICHAEL MCGRATH NEW ELEM. SCH.	SW CORNER DOCKWEILER DR. / V	91355	Cal-Sites
SANTA CLARITA	S103340303	BILL SMALL'S MUD SUMP	END OF AVENUE OF THE OAKS		SWF/LF
SANTA CLARITA	S103340253	BILL SMALL'S MUD SUMP	AT END OF AVENUE OF THE OAKS		SWF/LF
SANTA CLARITA	S103945508	BONELLI & SONS PRCSN	27134 FURNIVALL AVE A	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945509	LON'S DIESEL REPAIR	27134 FURNIVALL AVE B	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S102592980	ARB ENTERPRISES	26516 GOLDEN VALLEY RD 310	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S102685273	PROJEX	26516 GOLDEN VALLEY RD 112	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S102685274	KARS BODY & PAINT	26516 GOLDEN VALLEY RD 116	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S102685275	STARR AUTO DETAIL	26516 GOLDEN VALLEY RD 205	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S103317771	GOLDEN VALLEY INDUSTRIAL	26521 GOLDEN VALLEY RD B	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S103945083	AUTO DISCOUNT CENTER	21704 GOLDEN TRIANGLE RD A	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S103945084	THE AUTOLINE	21704 GOLDEN TRIANGLE RD B	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S103945427	R & R ENGINEERING COMPANY	26477 GOLDEN VALLEY RD A	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S103945428	GALAXY DIE & ENGINEERING INC.	26477 GOLDEN VALLEY RD B	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S103945431	ALL AROUND SHEET METAL	26502 GOLDEN VALLEY RD A	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S103945432	HMV MOLDES & TOOLS	26502 GOLDEN VALLEY RD B	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S103945433	PACIFIC AUTOMOTIVE	26502 GOLDEN VALLEY RD C	91350	LOS ANGELES CO. HMS

ORPHAN SUMMARY

City	EDR ID	Site Name	Site Address	Zip	Database(s)
SANTA CLARITA	S103945434	C & N AUTOMOTIVE	26516 GOLDEN VALLEY RD B	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S103945435	A SUPERIOR WOODWORKS	26516 GOLDEN VALLEY RD A	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S103945439	ACCURATE TRAILER HITCH & WELD	26536 GOLDEN VALLEY RD A	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S103945441	C & F SHEET METAL	26536 GOLDEN VALLEY RD C	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S103977194	MERLE NORMAN COSMETICS SAUGUS	25407 N GOLDEN VALLEY RD	91350	HAZNET
SANTA CLARITA	S104569851	EXECUTIVE AUTOMOTIVE	26536 GOLDEN VALLEY RD STE 613	91350	HAZNET
SANTA CLARITA	S105087850	THE CROISDALE GROUP	2144 GOLDEN TRIANGLE RD	91350	HAZNET
SANTA CLARITA	U003064866	CALIF COLLECTABLE COACHCRAFT	26521 GOLDEN VALLEY RD B	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S105193684	MERLE NORMAN COSMETICS	C6407 GOLDEN VALLEY RD		LOS ANGELES CO. HMS
SANTA CLARITA	S105193685	MERLE NORMAN COSMETICS	C6407 GOLDEN VALLEY RD		LOS ANGELES CO. HMS
SANTA CLARITA	S104913198	CITY OF SANTA CLARITA	C6407 GOLDEN VALLEY RD		LOS ANGELES CO. HMS
SANTA CLARITA	S104791966	GOLDEN VALLEY RD. SANTA CLARITA	GOLDEN VALLEY ROAD		CA SLIC
SANTA CLARITA	U003060717	GOLDEN TRIANGLE INDL PARK	HONBY STATION		LOS ANGELES CO. HMS
SANTA CLARITA	S104857806	SOUTHERN CALIFORNIA GAS CO.	MCBEAN PARKWAY / VALENCIA BL	91355	CA WDS
SANTA CLARITA	U003057315	NEWHALL OIL FIELD	NEWHALL OLFD		LOS ANGELES CO. HMS
SANTA CLARITA	U003057317	KERNVIEW OIL CO	NEWHALL OLFD		LOS ANGELES CO. HMS
SANTA CLARITA	S103317738	WILLIAM S HART REGIONAL PARK	24151 NEWHALL AVE		LOS ANGELES CO. HMS
SANTA CLARITA	S105422050	HOME DEPOT, INC	28033 NEWHALL RANCHO RD		LOS ANGELES CO. HMS
SANTA CLARITA	U003057316	GATE KING PROPERTIES INC	NEWHALL OLFD		LOS ANGELES CO. HMS
SANTA CLARITA	S102055323	ATLANTIC OIL CO	NEWHALL OLFD		LOS ANGELES CO. HMS
SANTA CLARITA	S103945449	PREMIER AUTOBODY FRAME	26724 OAK AVE A	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945450	BODEN'S CYLINDER HEADS	26724 OAK AVE B	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945451	CANYON AUTO ELECTRIC	26724 OAK AVE B	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945452	ARNECKES AUTOMOTIVE MACH. SHOP	26740 OAK AVE A	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945453	FINE CABINETS	26740 OAK AVE B	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945454	STRAIGHT LINE PERFORMANCE	26740 OAK AVE C	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945456	MICHAEL'S SHUTTER MFG.	26752 OAK AVE A	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945457	CHEMEX EXTERMINATORS	26752 OAK AVE B	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945458	PATROL SECURITY	26752 OAK AVE C	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945463	CYCLE ENGINEERING	26810 OAK AVE A	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945464	AMT SYSTEMS INC	26810 OAK AVE B	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945466	ACTION WOODWORKS	26818 OAK AVE A	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945480	C B C	26845 OAK AVE A	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945481	EXCLUSIVELY BRITISH & IMPORTS	26845 OAK AVE B	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945482	SKIN TIGHT	26845 OAK AVE C	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945483	TLC WOODWORKS	26846 OAK AVE A	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S104537773	THE BLOWERS SHOP	26846 OAK AVE C	91351	LOS ANGELES CO. HMS
SANTA CLARITA	U003064942	TLC WOODWORK	26846 OAK AVE B	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103489706	WM HART UHSD - TRANSPORT DEPT	21429 REDVIEW DR	91350	LOS ANGELES CO. HMS, CA SLIC
SANTA CLARITA	S103945469	SANTA CLARITA AUTO AIR & RADTR	26821 RUETHER AVE C	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945470	ALL VALLEY CARBURETORS	26831 RUETHER AVE J	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945474	ADVANCED HONDA-ACURA	26831 RUETHER AVE K	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945475	ARENS INDUSTRIES INC.	26841 RUETHER AVE A	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945476	BARBS QUALITY REPAIR SERVICE	26841 RUETHER AVE B	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945477	CYCLE CONCEPTS INC.	26841 RUETHER AVE C	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945478	HERMANN MW CO.	26841 RUETHER AVE D	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945488	SCV TOYOTA	26911 RUETHER AVE A	91351	LOS ANGELES CO. HMS

City	EDR ID	Site Name	Site Address	Zip	Database(s)
SANTA CLARITA	S103945489	BRITISH CUSTOMS	26911 RUETHER AVE B	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945490	CLASSIC MANTELS	26911 RUETHER AVE C	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945491	A & S EXCHANGE	26911 RUETHER AVE D	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945493	PACIFIC WOOD PRODUCTS	26911 RUETHER AVE F	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945495	SERVICE MASTER	26911 RUETHER AVE H	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945501	BLACKSTOCK WOODWORKS	26943 RUETHER AVE D	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945502	JOHN TOMMY WOODWORKS	26943 RUETHER AVE C	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945503	STANDARD FASTENERS MFG.	26951 RUETHER AVE A	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945504	TOM'S AUTOMOTIVE SERVICE	26951 RUETHER AVE B	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945505	VALENCIA VOLVO INDEPENDENT	26951 RUETHER AVE J	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S104538077	SOLAR DESIGN WINDOW TINTING	26831 RUETHER AVE C	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S105085906	ROTO-JET OF AMERICA CO INC	26943 RUETHER AVE UNIT S	91351	HAZNET
SANTA CLARITA	S105092361	AUTOMOTIVE FITNESS CENTER INC.	26911 RUETHER AVE STE S	91351	HAZNET
SANTA CLARITA	S103945385	SC CUSTOM CYCLES	25825 SAN FERNANDO RD B	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S103945387	AJ AUTO DETAIL & ACCESSORIES	25835 SAN FERNANDO RD 32	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S103945388	CALIFORNIA TINT	25835 SAN FERNANDO RD 33	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S103945394	SANTA CLARITA VALLEY HUBCAPS	25845 SAN FERNANDO RD 6	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S103945395	WINDSHIELDS WHOLESALE AUTO GLS	25845 SAN FERNANDO RD C	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S104538153	AAMCO TRANSMISSIONS	25825 SAN FERNANDO RD A	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S104913314	NICK'S AUTO REPAIR	25835 SAN FERNANDO RD D	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S105053520	GASOLINE ALLEY	25845 SAN FERNANDO RD A	91350	LOS ANGELES CO. HMS
SANTA CLARITA	S104538167	MANJON AUTO BODY & PAINT	24404 SAN FERNANDO RD B		LOS ANGELES CO. HMS
SANTA CLARITA	S103945171	CUSTOM SPECIALTIES	23919 SAN FERNANDO RD A		LOS ANGELES CO. HMS
SANTA CLARITA	S103945172	HAVE YOU SEEN MY TRUCK	23919 SAN FERNANDO RD B		LOS ANGELES CO. HMS
SANTA CLARITA	S103945173	KWIK RIG INC.	23919 SAN FERNANDO RD B		LOS ANGELES CO. HMS
SANTA CLARITA	S103945181	J & S AUTOBODY & PAINT SUPPLY	23953 SAN FERNANDO RD A		LOS ANGELES CO. HMS
SANTA CLARITA	S103945199	CANYON MOTORS INC.	24254 SAN FERNANDO RD A		LOS ANGELES CO. HMS
SANTA CLARITA	S103945216	AUTOMOTIVE TECHNOLOGY	24404 SAN FERNANDO RD A		LOS ANGELES CO. HMS
SANTA CLARITA	S103945033	ACRYLIC CUSTOM CLLSN & BODY	20665 SANTA CLARA ST A	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103945034	SAUMERS WELDING	20665 SANTA CLARA ST B	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S103866442	DEL LAGO DEWATERING PROJ.	SANTA CLARA RIVER	91355	CA WDS
SANTA CLARITA	S105422099	SANTA CLARA RIVER BRIDGE CONST	SANTA CLARA RIVER		LOS ANGELES CO. HMS
SANTA CLARITA	1004675784	V P MANUFACTURING INC	20732 SOLEDAD ST UNITS	91351	RCRIS-SQG
SANTA CLARITA	S103944998	NORTH OAKS SHELL	19223 SOLEDAD CANYON RD A	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S105053472	SHELL OIL CO	19223 SOLEDAD CANYON RD A	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S105094177	VP MANUFACTURING INC	20732 SOLEDAD ST UNITS ABCDE	91351	HAZNET
SANTA CLARITA	S105193896	CANYON CLEANERS	18635 SOLEDAD CYN	91351	LOS ANGELES CO. HMS
SANTA CLARITA	S104571178	CARDINAL RESTAURANT SUPPLY	SOLEDAD / LUTHER		HAZNET
SANTA CLARITA VALLEY	S103985800	S C RADIATOR & BODY PARTS	26821 RUETHER UNIT D	91351	HAZNET
SAUGUS	S103679198	USDA FOREST SERVICE	LOS PINETOS STORAGE RT 1	91350	HAZNET
SAUGUS	1000398169	HI TECH TRANSMISSION	258825 SAN FERNANDO	91350	RCRIS-SQG
SAUGUS	S103648095	LOS ANGELES COUNTY FIRE DEPT	26829 SECO CANYON - STATION 11	91350	HAZNET
SAUGUS	1004678097	SHELL SERVICE STATION	19223 SOLEDAD	91350	RCRIS-SQG
SAUGUS	S105126708	SHELL	19223 SOLEDAD	91350	HAZNET
SAUGUS	U001567732	USA PETROLEUM COMPANY #82	19443 W. SOLEDAD	91350	HIST UST
SCV	S104493053	CANYON SQUARE SHOP. CTR/MOBIL	18507 597 SOLEDAD CANYON RD	91351	LA Co. Site Mitigation
VALENCIA	S103958717	COUNTRY CLEANERS	27674 NEWHALL RANCH RD UNIT 25	91355	HAZNET, CLEANERS

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

To maintain currency of the following federal and state databases, EDR contacts the appropriate governmental agency on a monthly or quarterly basis, as required.

Elapsed ASTM days: Provides confirmation that this EDR report meets or exceeds the 90-day updating requirement of the ASTM standard.

FEDERAL ASTM STANDARD RECORDS

NPL: National Priority List
Source: EPA
Telephone: N/A
National Priorities List (Superfund). The NPL is a subset of CERCLIS and identifies over 1,200 sites for priority cleanup under the Superfund Program. NPL sites may encompass relatively large areas. As such, EDR provides polygon coverage for over 1,000 NPL site boundaries produced by EPA's Environmental Photographic Interpretation Center (EPIC) and regional EPA offices.

Date of Government Version: 07/18/02
Date Made Active at EDR: 09/20/02
Database Release Frequency: Semi-Annually

Date of Data Arrival at EDR: 08/01/02
Elapsed ASTM days: 50
Date of Last EDR Contact: 08/01/02

NPL Site Boundaries

Sources:

EPA's Environmental Photographic Interpretation Center (EPIC)
Telephone: 202-564-7333

EPA Region 1
Telephone 617-918-1143

EPA Region 3
Telephone 215-814-5418

EPA Region 4
Telephone 404-562-8033

EPA Region 6
Telephone: 214-655-6659

EPA Region 8
Telephone: 303-312-6774

Proposed NPL: Proposed National Priority List Sites
Source: EPA
Telephone: N/A

Date of Government Version: 05/29/02
Date Made Active at EDR: 09/20/02
Database Release Frequency: Semi-Annually

Date of Data Arrival at EDR: 08/01/02
Elapsed ASTM days: 50
Date of Last EDR Contact: 08/01/02

CERCLIS: Comprehensive Environmental Response, Compensation, and Liability Information System
Source: EPA
Telephone: 703-413-0223
CERCLIS contains data on potentially hazardous waste sites that have been reported to the USEPA by states, municipalities, private companies and private persons, pursuant to Section 103 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). CERCLIS contains sites which are either proposed to or on the National Priorities List (NPL) and sites which are in the screening and assessment phase for possible inclusion on the NPL.

Date of Government Version: 05/15/02
Date Made Active at EDR: 08/08/02
Database Release Frequency: Quarterly

Date of Data Arrival at EDR: 06/24/02
Elapsed ASTM days: 45
Date of Last EDR Contact: 06/24/02

CERCLIS-NFRAP: CERCLIS No Further Remedial Action Planned
Source: EPA
Telephone: 703-413-0223
As of February 1995, CERCLIS sites designated "No Further Remedial Action Planned" (NFRAP) have been removed from CERCLIS. NFRAP sites may be sites where, following an initial investigation, no contamination was found, contamination was removed quickly without the need for the site to be placed on the NPL, or the contamination was not serious enough to require Federal Superfund action or NPL consideration. EPA has removed approximately 25,000 NFRAP sites to lift the unintended barriers to the redevelopment of these properties and has archived them as historical records so EPA does not needlessly repeat the investigations in the future. This policy change is part of the EPA's Brownfields Redevelopment Program to help cities, states, private investors and affected citizens to promote economic redevelopment of unproductive urban sites.

Date of Government Version: 05/15/02
Date Made Active at EDR: 08/08/02
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 06/24/02
Elapsed ASTM days: 45
Date of Last EDR Contact: 06/24/02

CORRACTS: Corrective Action Report
Source: EPA
Telephone: 800-424-9346
CORRACTS identifies hazardous waste handlers with RCRA corrective action activity.

Date of Government Version: 05/02/02
Date Made Active at EDR: 07/15/02
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 05/06/02
Elapsed ASTM days: 70
Date of Last EDR Contact: 09/09/02

RCRIS: Resource Conservation and Recovery Information System
Source: EPA/NTIS
Telephone: 800-424-9346
Resource Conservation and Recovery Information System. RCRIS includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA).

Date of Government Version: 07/10/02
Date Made Active at EDR: 09/20/02
Database Release Frequency: Varies
Date of Data Arrival at EDR: 07/26/02
Elapsed ASTM days: 56
Date of Last EDR Contact: 06/20/02

ERNS: Emergency Response Notification System
Source: EPA/NTIS
Telephone: 202-260-2342
Emergency Response Notification System. ERNS records and stores information on reported releases of oil and hazardous substances.

Date of Government Version: 12/31/01
Date Made Active at EDR: 07/15/02
Database Release Frequency: Varies
Date of Data Arrival at EDR: 07/02/02
Elapsed ASTM days: 13
Date of Last EDR Contact: 07/24/02

FEDERAL ASTM SUPPLEMENTAL RECORDS

BRS: Biennial Reporting System
Source: EPA/NTIS
Telephone: 800-424-9346
The Biennial Reporting System is a national system administered by the EPA that collects data on the generation and management of hazardous waste. BRS captures detailed data from two groups: Large Quantity Generators (LQG) and Treatment, Storage, and Disposal Facilities.

Date of Government Version: 12/31/99
Database Release Frequency: Biennially
Date of Last EDR Contact: 09/16/02
Date of Next Scheduled EDR Contact: 12/16/02

CONSENT: Superfund (CERCLA) Consent Decrees
Source: EPA Regional Offices
Telephone: Varies
Major legal settlements that establish responsibility and standards for cleanup at NPL (Superfund) sites. Released periodically by United States District Courts after settlement by parties to litigation matters.

Date of Government Version: N/A
Database Release Frequency: Varies
Date of Last EDR Contact: N/A
Date of Next Scheduled EDR Contact: N/A

ROD: Records Of Decision
Source: EPA
Telephone: 703-416-0223
Record of Decision. ROD documents mandate a permanent remedy at an NPL (Superfund) site containing technical and health information to aid in the cleanup.

Date of Government Version: 12/21/01
Database Release Frequency: Annually
Date of Last EDR Contact: 07/09/02
Date of Next Scheduled EDR Contact: 10/07/02

DELISTED NPL: National Priority List Deletions
Source: EPA
Telephone: N/A
The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) establishes the criteria that the EPA uses to delete sites from the NPL. In accordance with 40 CFR 300.425.(e), sites may be deleted from the NPL where no further response is appropriate.

Date of Government Version: 07/18/02
Database Release Frequency: Quarterly
Date of Last EDR Contact: 08/01/02
Date of Next Scheduled EDR Contact: 11/04/02

FINDS: Facility Index System/Facility Identification Initiative Program Summary Report
Source: EPA
Telephone: N/A
Facility Index System. FINDS contains both facility information and 'pointers' to other sources that contain more detail. EDR includes the following FINDS databases in this report: PCS (Permit Compliance System), AIRS (Aerometric Information Retrieval System), DOCKET (Enforcement Docket used to manage and track information on civil judicial enforcement cases for all environmental statutes), FURS (Federal Underground Injection Control), C-DOCKET (Criminal Docket System used to track criminal enforcement actions for all environmental statutes), FFIS (Federal Facilities Information System), STATE (State Environmental Laws and Statutes), and PADS (PCB Activity Data System).

Date of Government Version: 03/21/02
Database Release Frequency: Quarterly
Date of Last EDR Contact: 07/08/02
Date of Next Scheduled EDR Contact: 10/07/02

HMIRS: Hazardous Materials Information Reporting System
Source: U.S. Department of Transportation
Telephone: 202-366-4555
Hazardous Materials Incident Report System. HMIRS contains hazardous material spill incidents reported to DOT.

Date of Government Version: 05/31/02
Database Release Frequency: Annually
Date of Last EDR Contact: 07/22/02
Date of Next Scheduled EDR Contact: 10/21/02

MLTS: Material Licensing Tracking System
Source: Nuclear Regulatory Commission
Telephone: 301-415-7169
MLTS is maintained by the Nuclear Regulatory Commission and contains a list of approximately 8,100 sites which possess or use radioactive materials and which are subject to NRC licensing requirements. To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 04/12/02
Database Release Frequency: Quarterly
Date of Last EDR Contact: 07/08/02
Date of Next Scheduled EDR Contact: 10/07/02

MINES: Mines Master Index File
Source: Department of Labor, Mine Safety and Health Administration
Telephone: 303-231-5959

Date of Government Version: 06/05/02
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 07/01/02
Date of Next Scheduled EDR Contact: 09/30/02

NPL LIENS: Federal Superfund Liens
Source: EPA
Telephone: 205-564-4267
Federal Superfund Liens. Under the authority granted the USEPA by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980, the USEPA has the authority to file liens against real property in order to recover remedial action expenditures or when the property owner receives notification of potential liability. USEPA compiles a listing of filed notices of Superfund Liens.

Date of Government Version: 10/15/91
Database Release Frequency: No Update Planned
Date of Last EDR Contact: 08/26/02
Date of Next Scheduled EDR Contact: 11/25/02

PADS: PCB Activity Database System
Source: EPA
Telephone: 202-564-3887
PCB Activity Database. PADS Identifies generators, transporters, commercial storers and/or brokers and disposers of PCB's who are required to notify the EPA of such activities.

Date of Government Version: 03/01/02
Database Release Frequency: Annually
Date of Last EDR Contact: 08/02/02
Date of Next Scheduled EDR Contact: 11/11/02

RAATS: RCRA Administrative Action Tracking System
Source: EPA
Telephone: 202-564-4104
RCRA Administration Action Tracking System. RAATS contains records based on enforcement actions issued under RCRA pertaining to major violators and includes administrative and civil actions brought by the EPA. For administration actions after September 30, 1995, data entry in the RAATS database was discontinued. EPA will retain a copy of the database for historical records. It was necessary to terminate RAATS because a decrease in agency resources made it impossible to continue to update the information contained in the database.

Date of Government Version: 04/17/95
Database Release Frequency: No Update Planned
Date of Last EDR Contact: 09/10/02
Date of Next Scheduled EDR Contact: 12/09/02

TRIS: Toxic Chemical Release Inventory System
Source: EPA
Telephone: 202-260-1531
Toxic Release Inventory System. TRIS identifies facilities which release toxic chemicals to the air, water and land in reportable quantities under SARA Title III Section 313.

Date of Government Version: 12/31/00
Database Release Frequency: Annually
Date of Last EDR Contact: 06/24/02
Date of Next Scheduled EDR Contact: 09/23/02

TSCA: Toxic Substances Control Act
Source: EPA
Telephone: 202-260-5521
Toxic Substances Control Act. TSCA identifies manufacturers and importers of chemical substances included on the TSCA Chemical Substance Inventory list. It includes data on the production volume of these substances by plant site.

Date of Government Version: 12/31/98
Database Release Frequency: Every 4 Years
Date of Last EDR Contact: 09/09/02
Date of Next Scheduled EDR Contact: 12/09/02

FTTS INSP: FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
Source: EPA
Telephone: 202-564-2501

Date of Government Version: 04/25/02
Database Release Frequency: Quarterly
Date of Last EDR Contact: 07/03/02
Date of Next Scheduled EDR Contact: 09/23/02

SSTS: Section 7 Tracking Systems
Source: EPA
Telephone: 202-564-5008
Section 7 of the Federal Insecticide, Fungicide and Rodenticide Act, as amended (92 Stat. 829) requires all registered pesticide-producing establishments to submit a report to the Environmental Protection Agency by March 1st each year. Each establishment must report the types and amounts of pesticides, active ingredients and devices being produced, and those having been produced and sold or distributed in the past year.

Date of Government Version: 12/31/00
Database Release Frequency: Annually
Date of Last EDR Contact: 07/19/02
Date of Next Scheduled EDR Contact: 10/21/02

FTTS: FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
Source: EPA/Office of Prevention, Pesticides and Toxic Substances
Telephone: 202-564-2501
FTTS tracks administrative cases and pesticide enforcement actions and compliance activities related to FIFRA, TSCA and EPCRA (Emergency Planning and Community Right-to-Know Act). To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 04/25/02
Database Release Frequency: Quarterly
Date of Last EDR Contact: 07/03/02
Date of Next Scheduled EDR Contact: 09/23/02

STATE OF CALIFORNIA ASTM STANDARD RECORDS

AWP: Annual Workplan Sites
Source: California Environmental Protection Agency
Telephone: 916-323-3400
Known Hazardous Waste Sites. California DTSC's Annual Workplan (AWP), formerly BEP, identifies known hazardous substance sites targeted for cleanup.

Date of Government Version: 07/05/02
Date Made Active at EDR: 08/12/02
Database Release Frequency: Annually
Date of Data Arrival at EDR: 07/08/02
Elapsed ASTM days: 35
Date of Last EDR Contact: 07/08/02

CAL-SITES: Calsites Database
Source: Department of Toxic Substance Control
Telephone: 916-323-3400
The Calsites database contains potential or confirmed hazardous substance release properties. In 1996, California EPA reevaluated and significantly reduced the number of sites in the Calsites database.

Date of Government Version: 10/01/00
Date Made Active at EDR: 11/22/00
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 10/30/00
Elapsed ASTM days: 23
Date of Last EDR Contact: 07/08/02

CHMIRS: California Hazardous Material Incident Report System
Source: Office of Emergency Services
Telephone: 916-845-8400
California Hazardous Material Incident Reporting System. CHMIRS contains information on reported hazardous material incidents (accidental releases or spills).

Date of Government Version: 12/31/94
Date Made Active at EDR: 04/24/95
Database Release Frequency: No Update Planned
Date of Data Arrival at EDR: 03/13/95
Elapsed ASTM days: 42
Date of Last EDR Contact: 08/26/02

CORTESE: "Cortese" Hazardous Waste & Substances Sites List
Source: CAL EPA/Office of Emergency Information
Telephone: 916-323-9100
The sites for the list are designated by the State Water Resource Control Board (LUST), the Integrated Waste Board (SWF/LS), and the Department of Toxic Substances Control (Cal-Sites).

Date of Government Version: 04/01/01
Date Made Active at EDR: 07/26/01
Database Release Frequency: Varies
Date of Data Arrival at EDR: 05/29/01
Elapsed ASTM days: 58
Date of Last EDR Contact: 07/24/02

NOTIFY 65: Proposition 65 Records
Source: State Water Resources Control Board
Telephone: 916-445-3846
Proposition 65 Notification Records. NOTIFY 65 contains facility notifications about any release which could impact drinking water and thereby expose the public to a potential health risk.

Date of Government Version: 10/21/93
Date Made Active at EDR: 11/19/93
Database Release Frequency: No Update Planned
Date of Data Arrival at EDR: 11/01/93
Elapsed ASTM days: 18
Date of Last EDR Contact: 07/19/02

TOXIC PITS: Toxic Pits Cleanup Act Sites
Source: State Water Resources Control Board
Telephone: 916-227-4364
Toxic PITS Cleanup Act Sites. TOXIC PITS identifies sites suspected of containing hazardous substances where cleanup has not yet been completed.

Date of Government Version: 07/01/95
Date Made Active at EDR: 09/26/95
Database Release Frequency: No Update Planned
Date of Data Arrival at EDR: 08/30/95
Elapsed ASTM days: 27
Date of Last EDR Contact: 07/25/02

SWF/LF (SWIS): Solid Waste Information System
Source: Integrated Waste Management Board
Telephone: 916-341-6320
Active, Closed and Inactive Landfills. SWF/LF records typically contain an inve ntory of solid waste disposal facilities or landfills. These may be active or i nactive facilities or open dumps that failed to meet RCRA Section 4004 criteria for solid waste landfills or disposal sites.

Date of Government Version: 06/14/02
Date Made Active at EDR: 07/19/02
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 06/17/02
Elapsed ASTM days: 32
Date of Last EDR Contact: 09/16/02

WMUDS/SWAT: Waste Management Unit Database
Source: State Water Resources Control Board
Telephone: 916-227-4448
Waste Management Unit Database System. WMUDS is used by the State Water Resources Control Board staff and the Regional Water Quality Control Boards for program tracking and inventory of waste management units. WMUDS is composed of the following databases: Facility Information, Scheduled Inspections Information, Waste Management Unit Information, SWAT Program Information, SWAT Report Summary Information, SWAT Report Summary Data, Chapter 15 (formerly Subchapter 15) Information, Chapter 15 Monitoring Parameters, TPCA Program Information, RCRA Program Information, Closure Information, and Interested Parties Information.

Date of Government Version: 04/01/00
Date Made Active at EDR: 05/10/00
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 04/10/00
Elapsed ASTM days: 30
Date of Last EDR Contact: 09/11/02

LUST: Leaking Underground Storage Tank Information System
Source: State Water Resources Control Board
Telephone: 916-341-5740
Leaking Underground Storage Tank Incident Reports. LUST records contain an inventory of reported leaking underground storage tank incidents. Not all states maintain these records, and the information stored varies by state.

Date of Government Version: 07/11/02
Date Made Active at EDR: 09/03/02
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 07/18/02
Elapsed ASTM days: 47
Date of Last EDR Contact: 07/09/02

CA BOND EXP. PLAN: Bond Expenditure Plan
Source: Department of Health Services
Telephone: 916-255-2118
Department of Health Services developed a site-specific expenditure plan as the basis for an appropriation of Hazardous Substance Cleanup Bond Act funds. It is not updated.

Date of Government Version: 01/01/89
Date Made Active at EDR: 08/02/94
Database Release Frequency: No Update Planned
Date of Data Arrival at EDR: 07/27/94
Elapsed ASTM days: 6
Date of Last EDR Contact: 05/31/94

CA UST:

UST: Active UST Facilities
Source: SWRCB
Telephone: 916-341-5700
Active UST facilities gathered from the local regulatory agencies

Date of Government Version: 01/17/02
Date Made Active at EDR: 02/12/02
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 01/21/02
Elapsed ASTM days: 22
Date of Last EDR Contact: 07/09/02

CA FID UST: Facility Inventory Database
Source: California Environmental Protection Agency
Telephone: 916-445-6532
The Facility Inventory Database (FID) contains a historical listing of active and inactive underground storage tank locations from the State Water Resource Control Board. Refer to local/county source for current data.

Date of Government Version: 10/31/94
Date Made Active at EDR: 09/29/95
Database Release Frequency: No Update Planned
Date of Data Arrival at EDR: 09/05/95
Elapsed ASTM days: 24
Date of Last EDR Contact: 12/28/98

HIST UST: Hazardous Substance Storage Container Database
Source: State Water Resources Control Board
Telephone: 916-341-5700
The Hazardous Substance Storage Container Database is a historical listing of UST sites. Refer to local/county source for current data.

Date of Government Version: 10/15/90
Date Made Active at EDR: 02/12/91
Database Release Frequency: No Update Planned
Date of Data Arrival at EDR: 01/25/91
Elapsed ASTM days: 18
Date of Last EDR Contact: 07/26/01

STATE OF CALIFORNIA ASTM SUPPLEMENTAL RECORDS

AST: Aboveground Petroleum Storage Tank Facilities
Source: State Water Resources Control Board
Telephone: 916-227-4382
Registered Aboveground Storage Tanks.

Date of Government Version: 05/21/02
Database Release Frequency: Quarterly
Date of Last EDR Contact: 07/29/02
Date of Next Scheduled EDR Contact: 11/04/02

CLEANERS: Cleaner Facilities
Source: Department of Toxic Substance Control
Telephone: 916-225-0873
A list of drycleaner related facilities that have EPA ID numbers. These are facilities with certain SIC codes: power laundries, family and commercial; garment pressing and cleaner's agents; linen supply; coin-operated laundries and cleaning; drycleaning plants, except rugs; carpet and upholster cleaning; industrial launderers; laundry and garment services.

Date of Government Version: 03/18/02
Database Release Frequency: Annually
Date of Last EDR Contact: 07/08/02
Date of Next Scheduled EDR Contact: 10/07/02

CA WDS: Waste Discharge System
Source: State Water Resources Control Board
Telephone: 916-657-1571
Sites which have been issued waste discharge requirements.

Date of Government Version: 06/17/02
Database Release Frequency: Quarterly
Date of Last EDR Contact: 06/24/02
Date of Next Scheduled EDR Contact: 09/23/02

DEED: List of Deed Restrictions
Source: Department of Toxic Substances Control
Telephone: 916-323-3400
The use of recorded land use restrictions is one of the methods the DTSC uses to protect the public from unsafe exposures to hazardous substances and wastes.

Date of Government Version: 07/05/02
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 07/08/02
Date of Next Scheduled EDR Contact: 10/07/02

HAZNET: Hazardous Waste Information System
Source: California Environmental Protection Agency
Telephone: 916-255-1136
Facility and Manifest Data. The data is extracted from the copies of hazardous waste manifests received each year by the DTSC. The annual volume of manifests is typically 700,000 - 1,000,000 annually, representing approximately 350,000 - 500,000 shipments. Data are from the manifests submitted without correction, and therefore many contain some invalid values for data elements such as generator ID, TSD ID, waste category, and disposal method.

Date of Government Version: 12/31/00
Database Release Frequency: Annually
Date of Last EDR Contact: 08/26/02
Date of Next Scheduled EDR Contact: 11/11/02

LOCAL RECORDS

ALAMEDA COUNTY:

Local Oversight Program Listing of UGT Cleanup Sites
Source: Alameda County Environmental Health Services
Telephone: 510-567-6700

Date of Government Version: 07/12/02
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 07/12/02
Date of Next Scheduled EDR Contact: 10/28/02

Underground Tanks
Source: Alameda County Environmental Health Services
Telephone: 510-567-6700

Date of Government Version: 06/01/02
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 07/22/02
Date of Next Scheduled EDR Contact: 10/28/02

CONTRA COSTA COUNTY:

Site List
Source: Contra Costa Health Services Department
Telephone: 925-646-2286
List includes sites from the underground tank, hazardous waste generator and business plan/2185 programs.

Date of Government Version: 06/05/02
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 09/03/02
Date of Next Scheduled EDR Contact: 12/02/02

FRESNO COUNTY:

CUPA Resources List
Source: Dept. of Community Health
Telephone: 559-445-3271
Certified Unified Program Agency. CUPA's are responsible for implementing a unified hazardous materials and hazardous waste management regulatory program. The agency provides oversight of businesses that deal with hazardous materials, operate underground storage tanks or aboveground storage tanks.

Date of Government Version: 07/31/02
Database Release Frequency: Semi-Annually

Date of Last EDR Contact: 07/30/02
Date of Next Scheduled EDR Contact: 11/11/02

KERN COUNTY:

Underground Storage Tank Sites & Tanks Listing
Source: Kern County Environment Health Services Department
Telephone: 661-862-8700
Kern County Sites and Tanks Listing.

Date of Government Version: 06/01/02
Database Release Frequency: Quarterly

Date of Last EDR Contact: 09/16/02
Date of Next Scheduled EDR Contact: 12/02/02

LOS ANGELES COUNTY:

List of Solid Waste Facilities
Source: La County Department of Public Works
Telephone: 818-458-5185

Date of Government Version: 11/09/99
Database Release Frequency: Varies

Date of Last EDR Contact: 08/28/02
Date of Next Scheduled EDR Contact: 11/18/02

City of El Segundo Underground Storage Tank
Source: City of El Segundo Fire Department
Telephone: 310-607-2239

Date of Government Version: 08/01/02
Database Release Frequency: Semi-Annually

Date of Last EDR Contact: 08/19/02
Date of Next Scheduled EDR Contact: 11/18/02

City of Long Beach Underground Storage Tank
Source: City of Long Beach Fire Department
Telephone: 562-570-2543

Date of Government Version: 05/30/02
Database Release Frequency: Annually

Date of Last EDR Contact: 08/26/02
Date of Next Scheduled EDR Contact: 11/25/02

City of Torrance Underground Storage Tank
Source: City of Torrance Fire Department
Telephone: 310-618-2973

Date of Government Version: 08/01/02
Database Release Frequency: Semi-Annually

Date of Last EDR Contact: 08/19/02
Date of Next Scheduled EDR Contact: 11/18/02

City of Los Angeles Landfills
Source: Engineering & Construction Division
Telephone: 213-473-7869

Date of Government Version: 03/01/02
Database Release Frequency: Varies

Date of Last EDR Contact: 09/16/02
Date of Next Scheduled EDR Contact: 12/16/02

HMS: Street Number List
Source: Department of Public Works
Telephone: 626-458-3517
Industrial Waste and Underground Storage Tank Sites.

Date of Government Version: 05/30/02
Database Release Frequency: Semi-Annually

Date of Last EDR Contact: 08/19/02
Date of Next Scheduled EDR Contact: 11/18/02

Site Mitigation List
Source: Community Health Services
Telephone: 323-890-7806
Industrial sites that have had some sort of spill or complaint.

Date of Government Version: 02/28/02
Database Release Frequency: Annually
Date of Last EDR Contact: 08/19/02
Date of Next Scheduled EDR Contact: 11/18/02

San Gabriel Valley Areas of Concern
Source: EPA Region 9
Telephone: 415-744-2407
San Gabriel Valley areas where VOC contamination is at or above the MCL as designated by region 9 EPA office.

Date of Government Version: 12/31/98
Database Release Frequency: No Update Planned
Date of Last EDR Contact: 06/29/99
Date of Next Scheduled EDR Contact: N/A

MARIN COUNTY:

Underground Storage Tank Sites
Source: Public Works Department Waste Management
Telephone: 415-499-6647
Currently permitted USTs in Marin County.

Date of Government Version: 08/06/02
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 07/29/02
Date of Next Scheduled EDR Contact: 11/04/02

NAPA COUNTY:

Sites With Reported Contamination
Source: Napa County Department of Environmental Management
Telephone: 707-253-4269

Date of Government Version: 04/01/02
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 07/01/02
Date of Next Scheduled EDR Contact: 09/30/02

Closed and Operating Underground Storage Tank Sites
Source: Napa County Department of Environmental Management
Telephone: 707-253-4269

Date of Government Version: 04/01/02
Database Release Frequency: Annually
Date of Last EDR Contact: 07/01/02
Date of Next Scheduled EDR Contact: 09/30/02

ORANGE COUNTY:

List of Underground Storage Tank Cleanups
Source: Health Care Agency
Telephone: 714-834-3446
Orange County Underground Storage Tank Cleanups (LUST).

Date of Government Version: 11/27/01
Database Release Frequency: Quarterly
Date of Last EDR Contact: 09/10/02
Date of Next Scheduled EDR Contact: 12/09/02

List of Underground Storage Tank Facilities
Source: Health Care Agency
Telephone: 714-834-3446
Orange County Underground Storage Tank Facilities (UST).

Date of Government Version: 11/27/01
Database Release Frequency: Quarterly

Date of Last EDR Contact: 09/10/02
Date of Next Scheduled EDR Contact: 12/09/02

List of Industrial Site Cleanups
Source: Health Care Agency
Telephone: 714-834-3446
Petroleum and non-petroleum spills.

Date of Government Version: 10/24/00
Database Release Frequency: Annually

Date of Last EDR Contact: 09/10/02
Date of Next Scheduled EDR Contact: 12/09/02

PLACER COUNTY:

Master List of Facilities
Source: Placer County Health and Human Services
Telephone: 530-889-7312
List includes aboveground tanks, underground tanks and cleanup sites.

Date of Government Version: 07/18/02
Database Release Frequency: Semi-Annually

Date of Last EDR Contact: 06/24/02
Date of Next Scheduled EDR Contact: 09/23/02

RIVERSIDE COUNTY:

Listing of Underground Tank Cleanup Sites
Source: Department of Public Health
Telephone: 909-358-5055
Riverside County Underground Storage Tank Cleanup Sites (LUST).

Date of Government Version: 03/27/02
Database Release Frequency: Quarterly

Date of Last EDR Contact: 07/22/02
Date of Next Scheduled EDR Contact: 10/21/02

Underground Storage Tank Tank List
Source: Health Services Agency
Telephone: 909-358-5055

Date of Government Version: 03/01/02
Database Release Frequency: Quarterly

Date of Last EDR Contact: 07/22/02
Date of Next Scheduled EDR Contact: 10/21/02

SACRAMENTO COUNTY:

CS - Contaminated Sites
Source: Sacramento County Environmental Management
Telephone: 916-875-8406

Date of Government Version: 06/11/02
Database Release Frequency: Quarterly

Date of Last EDR Contact: 07/24/02
Date of Next Scheduled EDR Contact: 11/04/02

ML - Regulatory Compliance Master List
Source: Sacramento County Environmental Management
Telephone: 916-875-8406
Any business that has hazardous materials on site - hazardous material storage sites, underground storage tanks, waste generators.

Date of Government Version: 06/11/02
Database Release Frequency: Quarterly

Date of Last EDR Contact: 07/24/02
Date of Next Scheduled EDR Contact: 11/04/02

SAN BERNARDINO COUNTY:

Hazardous Material Permits
Source: San Bernardino County Fire Department Hazardous Materials Division
Telephone: 909-387-3041
This listing includes underground storage tanks, medical waste handlers/generators, hazardous materials handlers, hazardous waste generators, and waste oil generators/handlers.

Date of Government Version: 06/27/02
Database Release Frequency: Quarterly
Date of Last EDR Contact: 09/10/02
Date of Next Scheduled EDR Contact: 12/10/02

SAN DIEGO COUNTY:

Solid Waste Facilities
Source: Department of Health Services
Telephone: 619-338-2209
San Diego County Solid Waste Facilities.

Date of Government Version: 08/01/00
Database Release Frequency: Varies
Date of Last EDR Contact: 08/26/02
Date of Next Scheduled EDR Contact: 11/25/02

Hazardous Materials Management Division Database
Source: Hazardous Materials Management Division
Telephone: 619-338-2268
The database includes: HE58 - This report contains the business name, site address, business phone number, establishment 'H' permit number, type of permit, and the business status. HE17 - In addition to providing the same information provided in the HE58 listing, HE17 provides inspection dates, violations received by the establishment, hazardous waste generated, the quantity, method of storage, treatment/disposal of waste and the hauler, and information on underground storage tanks. Unauthorized Release List - Includes a summary of environmental contamination cases in San Diego County (underground tank cases, non-tank cases, groundwater contamination, and soil contamination are included.)

Date of Government Version: 03/31/02
Database Release Frequency: Quarterly
Date of Last EDR Contact: 07/08/02
Date of Next Scheduled EDR Contact: 10/07/02

SAN FRANCISCO COUNTY:

Local Oversite Facilities
Source: Department Of Public Health San Francisco County
Telephone: 415-252-3920

Date of Government Version: 06/12/02
Database Release Frequency: Quarterly
Date of Last EDR Contact: 09/10/02
Date of Next Scheduled EDR Contact: 12/09/02

Underground Storage Tank Information
Source: Department of Public Health
Telephone: 415-252-3920

Date of Government Version: 06/12/02
Database Release Frequency: Quarterly
Date of Last EDR Contact: 09/10/02
Date of Next Scheduled EDR Contact: 12/09/02

SAN MATEO COUNTY:

Fuel Leak List
Source: San Mateo County Environmental Health Services Division
Telephone: 650-363-1921

Date of Government Version: 04/04/02 | Date of Last EDR Contact: 07/23/02
Database Release Frequency: Semi-Annually | Date of Next Scheduled EDR Contact: 10/28/02

Business Inventory
Source: San Mateo County Environmental Health Services Division
Telephone: 650-363-1921
List includes Hazardous Materials Business Plan, hazardous waste generators, and underground storage tanks.

Date of Government Version: 05/01/02 | Date of Last EDR Contact: 07/15/02
Database Release Frequency: Annually | Date of Next Scheduled EDR Contact: 10/14/02

SANTA CLARA COUNTY:

Fuel Leak Site Activity Report
Source: Santa Clara Valley Water District
Telephone: 408-265-2600

Date of Government Version: 07/23/02 | Date of Last EDR Contact: 07/01/02
Database Release Frequency: Semi-Annually | Date of Next Scheduled EDR Contact: 09/30/02

Hazardous Material Facilities
Source: City of San Jose Fire Department
Telephone: 408-277-4659

Date of Government Version: 01/03/02 | Date of Last EDR Contact: 09/10/02
Database Release Frequency: Annually | Date of Next Scheduled EDR Contact: 12/09/02

SOLANO COUNTY:

Leaking Underground Storage Tanks
Source: Solano County Department of Environmental Management
Telephone: 707-421-6770

Date of Government Version: 06/01/02 | Date of Last EDR Contact: 09/17/02
Database Release Frequency: Quarterly | Date of Next Scheduled EDR Contact: 12/16/02

Underground Storage Tanks
Source: Solano County Department of Environmental Management
Telephone: 707-421-6770

Date of Government Version: 06/01/02 | Date of Last EDR Contact: 09/17/02
Database Release Frequency: Quarterly | Date of Next Scheduled EDR Contact: 12/16/02

SONOMA COUNTY:

Leaking Underground Storage Tank Sites
Source: Department of Health Services
Telephone: 707-565-6565

Date of Government Version: 11/29/01 | Date of Last EDR Contact: 07/22/02
Database Release Frequency: Quarterly | Date of Next Scheduled EDR Contact: 10/28/02

SUTTER COUNTY:

Underground Storage Tanks
Source: Sutter County Department of Agriculture
Telephone: 530-822-7500

Date of Government Version: 07/01/01
Database Release Frequency: Semi-Annually

Date of Last EDR Contact: 07/08/02
Date of Next Scheduled EDR Contact: 10/07/02

VENTURA COUNTY:

Inventory of Illegal Abandoned and Inactive Sites
Source: Environmental Health Division
Telephone: 805-654-2813
Ventura County Inventory of Closed, Illegal Abandoned, and Inactive Sites.

Date of Government Version: 04/02/01
Database Release Frequency: Annually

Date of Last EDR Contact: 08/26/02
Date of Next Scheduled EDR Contact: 11/25/02

Listing of Underground Tank Cleanup Sites
Source: Environmental Health Division
Telephone: 805-654-2813
Ventura County Underground Storage Tank Cleanup Sites (LUST).

Date of Government Version: 05/08/02
Database Release Frequency: Quarterly

Date of Last EDR Contact: 09/16/02
Date of Next Scheduled EDR Contact: 12/16/02

Underground Tank Closed Sites List
Source: Environmental Health Division
Telephone: 805-654-2813
Ventura County Operating Underground Storage Tank Sites (UST)/Underground Tank Closed Sites List.

Date of Government Version: 04/22/02
Database Release Frequency: Quarterly

Date of Last EDR Contact: 07/15/02
Date of Next Scheduled EDR Contact: 10/14/02

Business Plan, Hazardous Waste Producers, and Operating Underground Tanks
Source: Ventura County Environmental Health Division
Telephone: 805-654-2813
The BWT list indicates by site address whether the Environmental Health Division has Business Plan (B), Waste Producer (W), and/or Underground Tank (T) information.

Date of Government Version: 07/23/02
Database Release Frequency: Quarterly

Date of Last EDR Contact: 09/16/02
Date of Next Scheduled EDR Contact: 12/16/02

YOLO COUNTY:

Underground Storage Tank Comprehensive Facility Report
Source: Yolo County Department of Health
Telephone: 530-666-8646

Date of Government Version: 05/01/02
Database Release Frequency: Annually

Date of Last EDR Contact: 07/22/02
Date of Next Scheduled EDR Contact: 10/21/02

California Regional Water Quality Control Board (RWQCB) LUST Records

LUST REG 1: Active Toxic Site Investigation
Source: California Regional Water Quality Control Board North Coast (1)
Telephone: 707-576-2220
Del Norte, Humboldt, Lake, Mendocino, Modoc, Siskiyou, Sonoma, Trinity counties. For more current information, please refer to the State Water Resources Control Board's LUST database.

Date of Government Version: 02/01/01
Database Release Frequency: No Update Planned

Date of Last EDR Contact: 08/26/02
Date of Next Scheduled EDR Contact: 11/25/02

LUST REG 2: Fuel Leak List
Source: California Regional Water Quality Control Board San Francisco Bay Region (2)
Telephone: 510-286-0457

Date of Government Version: 07/01/02
Database Release Frequency: Quarterly
Date of Last EDR Contact: 07/15/02
Date of Next Scheduled EDR Contact: 10/14/02

LUST REG 3: Leaking Underground Storage Tank Database
Source: California Regional Water Quality Control Board Central Coast Region (3)
Telephone: 805-549-3147

Date of Government Version: 08/19/02
Database Release Frequency: Quarterly
Date of Last EDR Contact: 08/19/02
Date of Next Scheduled EDR Contact: 11/18/02

LUST REG 4: Underground Storage Tank Leak List
Source: California Regional Water Quality Control Board Los Angeles Region (4)
Telephone: 213-266-6600
Los Angeles, Ventura counties. For more current information, please refer to the State Water Resources Control Board's LUST database.

Date of Government Version: 08/09/01
Database Release Frequency: No Update Planned
Date of Last EDR Contact: 07/01/02
Date of Next Scheduled EDR Contact: 09/30/02

LUST REG 5: Leaking Underground Storage Tank Database
Source: California Regional Water Quality Control Board Central Valley Region (5)
Telephone: 916-255-3125

Date of Government Version: 07/01/02
Database Release Frequency: Quarterly
Date of Last EDR Contact: 07/12/02
Date of Next Scheduled EDR Contact: 10/07/02

LUST REG 6L: Leaking Underground Storage Tank Case Listing
Source: California Regional Water Quality Control Board Lahontan Region (6)
Telephone: 916-542-5424
For more current information, please refer to the State Water Resources Control Board's LUST database.

Date of Government Version: 01/02/02
Database Release Frequency: No Update Planned
Date of Last EDR Contact: 07/08/02
Date of Next Scheduled EDR Contact: 10/07/02

LUST REG 6V: Leaking Underground Storage Tank Case Listing
Source: California Regional Water Quality Control Board Victorville Branch Office (6)
Telephone: 760-346-7491

Date of Government Version: 07/26/02
Database Release Frequency: Quarterly
Date of Last EDR Contact: 07/08/02
Date of Next Scheduled EDR Contact: 10/07/02

LUST REG 7: Leaking Underground Storage Tank Case Listing
Source: California Regional Water Quality Control Board Colorado River Basin Region (7)
Telephone: 760-346-7491

Date of Government Version: 07/02/02
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 07/01/02
Date of Next Scheduled EDR Contact: 09/30/02

LUST REG 8: Leaking Underground Storage Tanks
Source: California Regional Water Quality Control Board Santa Ana Region (8)
Telephone: 909-782-4498
California Regional Water Quality Control Board Santa Ana Region (8). For more current information, please refer to the State Water Resources Control Board's LUST database.

Date of Government Version: 07/23/01
Database Release Frequency: No Update Planned
Date of Last EDR Contact: 08/16/02
Date of Next Scheduled EDR Contact: 11/11/02

LUST REG 9: Leaking Underground Storage Tank Report
Source: California Regional Water Quality Control Board San Diego Region (9)
Telephone: 858-467-2980
Orange, Riverside, San Diego counties. For more current information, please refer to the State Water Resources Control Board's LUST database.

Date of Government Version: 03/01/01
Database Release Frequency: No Update Planned
Date of Last EDR Contact: 07/22/02
Date of Next Scheduled EDR Contact: 10/21/02

California Regional Water Quality Control Board (RWQCB) SLIC Records

SLIC REG 1: Active Toxic Site Investigations
Source: California Regional Water Quality Control Board, North Coast Region (1)
Telephone: 707-576-2220

Date of Government Version: 02/01/01
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 08/26/02
Date of Next Scheduled EDR Contact: 11/25/02

SLIC REG 2: Spills, Leaks, Investigation & Cleanup Cost Recovery Listing
Source: Regional Water Quality Control Board San Francisco Bay Region (2)
Telephone: 510-286-0457
Any contaminated site that impacts groundwater or has the potential to impact groundwater.

Date of Government Version: 07/01/02
Database Release Frequency: Quarterly
Date of Last EDR Contact: 07/15/02
Date of Next Scheduled EDR Contact: 10/14/02

SLIC REG 3: Spills, Leaks, Investigation & Cleanup Cost Recovery Listing
Source: California Regional Water Quality Control Board Central Coast Region (3)
Telephone: 805-549-3147
Any contaminated site that impacts groundwater or has the potential to impact groundwater.

Date of Government Version: 08/19/02
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 08/19/02
Date of Next Scheduled EDR Contact: 11/18/02

SLIC REG 4: Spills, Leaks, Investigation & Cleanup Cost Recovery Listing
Source: Region Water Quality Control Board Los Angeles Region (4)
Telephone: 213-576-6600
Any contaminated site that impacts groundwater or has the potential to impact groundwater.

Date of Government Version: 08/01/02
Database Release Frequency: Quarterly
Date of Last EDR Contact: 07/23/02
Date of Next Scheduled EDR Contact: 10/28/02

SLIC REG 5: Spills, Leaks, Investigation & Cleanup Cost Recovery Listing
Source: Regional Water Quality Control Board Central Valley Region (5)
Telephone: 916-855-3075
Unregulated sites that impact groundwater or have the potential to impact groundwater.

Date of Government Version: 07/01/02
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 07/08/02
Date of Next Scheduled EDR Contact: 10/07/02

SLIC REG 6V: Spills, Leaks, Investigation & Cleanup Cost Recovery Listing
Source: Regional Water Quality Control Board, Victorville Branch
Telephone: 619-241-6583

Date of Government Version: 07/19/01
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 07/08/02
Date of Next Scheduled EDR Contact: 10/07/02

SLIC REG 8: Spills, Leaks, Investigation & Cleanup Cost Recovery Listing
Source: California Region Water Quality Control Board Santa Ana Region (8)
Telephone: 909-782-3298

Date of Government Version: 06/01/02
Database Release Frequency: Semi-Annually

Date of Last EDR Contact: 07/08/02
Date of Next Scheduled EDR Contact: 10/07/02

SLIC REG 9: Spills, Leaks, Investigation & Cleanup Cost Recovery Listing
Source: California Regional Water Quality Control Board San Diego Region (9)
Telephone: 858-467-2980

Date of Government Version: 03/01/02
Database Release Frequency: Annually

Date of Last EDR Contact: 09/03/02
Date of Next Scheduled EDR Contact: 12/02/02

EDR PROPRIETARY HISTORICAL DATABASES

EDR Historical Gas Station and Dry Cleaners: EDR has searched select national collections of business directories and has collected listings of potential dry cleaner and gas station/filling station/service station sites that were available to EDR researchers. EDR's review was limited to those categories of sources that might, in EDR's opinion, include dry cleaning and gas station/filling station/service station establishments. The categories reviewed included, but were not limited to: *gas, gas station, gasoline station, filling station, auto, automobile repair, auto service station, service station, dry cleaner, cleaners, laundry, laundromat, cleaning/laundry, wash & dry, etc.*

This information is meant to assist and complement environmental professionals in their conduct of environmental site assessments, and is not meant to be a substitute for a full historical investigation as defined in ASTM E1527. The information provided in this proprietary database may or may not be complete; i.e., the absence of a dry cleaner or gas station/filling station/service station site does not necessarily mean that such a site did not exist in the area covered by this report.

(A note on "dry cleaning" sites: it is not possible for EDR to differentiate between establishments that use PERC on-site as a cleaning solvent and sites that function simply as drop-off and pick-up locations or that are traditional wet cleaning/laundry facilities. Therefore, it is essential for environmental professionals to incorporate professional judgment in the evaluation of each site.)

Former Manufactured Gas (Coal Gas) Sites: The existence and location of Coal Gas sites is provided exclusively to EDR by Real Property Scan, Inc. ©Copyright 1993 Real Property Scan, Inc. For a technical description of the types of hazards which may be found at such sites, contact your EDR customer service representative.

Disclaimer Provided by Real Property Scan, Inc.

The information contained in this report has predominantly been obtained from publicly available sources produced by entities other than Real Property Scan. While reasonable steps have been taken to insure the accuracy of this report, Real Property Scan does not guarantee the accuracy of this report. Any liability on the part of Real Property Scan is strictly limited to a refund of the amount paid. No claim is made for the actual existence of toxins at any site. This report does not constitute a legal opinion.

OTHER DATABASE(S)

Depending on the geographic area covered by this report, the data provided in these specialty databases may or may not be complete. For example, the existence of wetlands information data in a specific report does not mean that all wetlands in the area covered by the report are included. Moreover, the absence of any reported wetlands information does not necessarily mean that wetlands do not exist in the area covered by the report.

Oil/Gas Pipelines/Electrical Transmission Lines: This data was obtained by EDR from the USGS in 1994. It is referred to by USGS as GeoData Digital Line Graphs from 1:100,000-Scale Maps. It was extracted from the transportation category including some oil, but primarily gas pipelines and electrical transmission lines.

Sensitive Receptors: There are individuals deemed sensitive receptors due to their fragile immune systems and special sensitivity to environmental discharges. These sensitive receptors typically include the elderly, the sick, and children. While the location of all sensitive receptors cannot be determined, EDR indicates those buildings and facilities - schools, daycares, hospitals, medical centers, and nursing homes - where individuals who are sensitive receptors are likely to be located.

Flood Zone Data: This data, available in select counties across the country, was obtained by EDR in 1999 from the Federal Emergency Management Agency (FEMA). Data depicts 100-year and 500-year flood zones as defined by FEMA.

NWI: National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 2002 from the U.S. Fish and Wildlife Service.

STREET AND ADDRESS INFORMATION

APPENDIX 4.18

Cultural Resources Reports

Phase I Archaeological Assessment

PHASE I ARCHAEOLOGICAL SURVEY FOR THE 750 ACRES SOLEDAD CANYON PANHANDLE STUDY AREA, LOS ANGLES COUNTY, CALIFORNIA

Prepared For:

Mr. Glenn Adamick
Newhall Land and Farming Company
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Prepared By:

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805-581-3577

3 August 2001

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MANAGEMENT SUMMARY

A Phase I archaeological survey was conducted on the 750 acres Soledad Canyon Panhandle study area, northern Los Angeles County, California. This investigation involved an archival records search, a review of existing published and unpublished references on local prehistory and history, and an on-foot, intensive survey of the subject property. Archival records indicated that portions of the study area had been previously surveyed and that four cultural resources were or at one time had been present and recorded within the property: CA-LAN-351, a prehistoric habitation site; CA-LAN-1824 and -1829, both previously identified as isolated prehistoric artifacts; and CA-LAN-2105H, the Los Angeles Aqueduct, which is currently in use. On-foot survey of the study area resulted in the discovery and recording of two additional isolated prehistoric artifacts. Recommendations for the treatment of these cultural resources are provided.

1.0 INTRODUCTION

Pursuant to a request from Mr. Glenn Adamick, Newhall Land and Farming Company, Valencia, California, an intensive Phase I archaeological survey and cultural resources assessment were conducted for the 750 acres Panhandle property in Soledad Canyon, Los Angeles County, California (Figure 1). The Phase I archaeological survey was intended to provide a background studies and an archival records search to determine if any known archaeological sites were present in the study area and/or whether the area had been previously and systematically studied by archaeologists; an on-foot, intensive survey of the study area to identify previously unrecorded cultural resources; and a preliminary assessment of such resources, should any be found within the subject property. This manuscript constitutes a report on this Phase I archaeological study. Subsequent sections provide background to the study; the findings of the archival records search; a summary of the field surveying techniques employed; and the results of the fieldwork.

2.0 BACKGROUND TO THE PROJECT

2.1 Project Location and Environmental Setting

The Soledad Canyon Panhandle study area consists of 750 acres lying immediately east of Bouquet Junction, northern Los Angeles County, California (Figure 1). It includes the flood channel and river course of the Santa Clara River from its confluence with Bouquet Canyon, eastwards (upstream) along Soledad Canyon for roughly 4.4 kms, and from Soledad Canyon Road northwards, or across the flood and stream channel to include the northern canyon sides of Soledad Canyon. In the central portion of the study area this includes a series of broad river terraces.

The study area currently consists primarily of undeveloped open-space, although there are pipeline corridors across and minor structures within it. Moreover, the large majority of the 750 acres consists of the stream course and floodplain of the Santa Clara River; due to the potential for seasonal flooding, these zones have experienced little or no former use.

Vegetation in the study area, accordingly, consists of a riparian association on the river bottom and sage-scrub in the flood channel and canyon sides. The flat river terraces on the northern side of the study area in some cases have been graded and/or cultivated, and are currently covered with oat hay, wild mustard and other non-indigenous species.

2.2 Ethnographic Background

The Upper Santa Clara Valley region, including the Santa Clarita/Newhall area, appears to have been inhabited during the ethnographic past by an ethnolinguistic group known as the Tataviam. Some controversy exists in reference to this attribution, as the Tataviam are now extinct and were effectively so prior to the initiation of systematic anthropological studies at the turn of the century. But, based on a few existing word lists, descriptions provided by early travelers, mission placenames, and the recollections of other aboriginal informants, Tataviam is generally accepted as representing a Takic language of the Uto-Aztecan family (King and Blackburn 1978). In this sense, it was related to other Takic languages in the Los Angeles County region, such as Gabrieleño/Fernandeño of the Los Angeles Basin proper, and Kitanemuk of the Antelope Valley.

The Tataviam are thought to have inhabited the upper Santa Clara River drainage from about Piru eastwards to just beyond the Vasquez Rocks/Agua Dulce area; southwards as far as Newhall; and northwards to include the middle reaches of Piru Creek, the Liebre Mountains and the southwesternmost fringe of the Antelope Valley (ibid; Kroeber 1925; Earle 1990; Johnson and Earle 1990). Their northern boundary most likely ran along the northern foothills of the Liebre Mountains (i.e., the edge of the Antelope Valley), and then crossed to the southern slopes of the Sawmill Mountains and the Sierra Pelona, extending as far east as Soledad Pass (Earle 1990:94). Ethnographically, at least, they do not appear to have controlled the Leona Valley or areas to the north, with the Elizabeth Lake area proper a zone of uncertainty. The southern boundary ran approximately along the crest of the western arm of the San Gabriel Mountains, north of San Fernando, and westward beyond Fremont and San Fernando Pass to the Santa Susana Mountains (Johnson and Earle 1990:196).

Known Tataviam villages during the historic period include: pi?irukung and ?akavaya, both near modern Piru; tsavayu(?u)ng, San Francisquito; etseng, kuvung and huyung, on Piru Creek above Piru; tochonanga, near Newhall at the head of the south fork of the Santa Clara River; and kwarung, Elizabeth Lake. At kamulus, near modern Rancho Camulos, a mixed Chumash-Tataviam population lived (King and Blackburn 1978:535-6; Johnson and Earle 1990). No historical sites have been recorded near the juncture of Bouquet and Soledad Canyon (cf. Johnson and Earle 1990:193); that is, on or near the study area.

Culturally-speaking, the Tataviam were in most respects similar to their Fernandeño and Chumash neighbors, to the south and west, respectively (King and Blackburn 1978). In this sense, they were hunters-gatherers, with subsistence emphasizing yucca, acorns, juniper berries, sage seeds and islay. Game was also hunted, with small animals, such as rabbits/hares and rodents, probably representing more significant contributions of meat protein than larger game, such as deer.

Almost nothing is known of Tataviam social and political organization. Based on analogies with surrounding groups, however, it can be suggested that they were organized in a series of tribelets, similar to the naciones described by Earle (1990) for the Antelope Valley, and found to be characteristic of much of California aboriginal socio-political organization (cf. Kroeber 1925). The tribelet represented an autonomous land-holding unit, minimally controlled by a head-chief or big-man. They usually included one large, 'capital' village, sometimes occupied year-around, and a series of smaller, seasonally employed hamlets. Whether the Tataviam may have had exogomous clans and moieties, like the Cahuilla and Serrano to the east, is unknown. However, it is estimated that the Tataviam population was less than 1000 people at the time of Euro-American contact, and that only two or three of the largest villages existed throughout their territory (King and Blackburn 1978).

It is also likely that Tataviam religion followed the patterns of their surrounding neighbors. In this case, shamanism would have functioned as the central element. This posits a direct and personal relationship between each individual and the supernatural world, with this relationship enacted by entering a trance or hallucinatory state (usually based on the ingestion of psychotomimetic plants, such as jimsonweed or native tobacco). Shamans, per se, who were considered individuals with an unusual degree of supernatural power, served as ritual specialists: ceremonies and rites were infrequent in occassion and limited in type. Perhaps most importantly, shamans served as healers or curers, with the etiology of disease as well as its cure held to lie in the supernatural world. Shamans are also known to have produced the rock art of this region (Whitley 1992), which depicted the hallucinations and spirits they observed during their vision quests.

Although the Tataviam were one of the earliest groups contacted by Spanish missionaries, with a number of their briefly villages described by members of the Portolá expedition of 1769, a general lack of information on this group exists because, by 1810, all Tataviam had been baptized at Mission San Fernando and were quickly absorbed by other groups through intermarriage. The last speaker of Tataviam died in 1916 (King and Blackburn 1978).

2.3 Archaeological Background

Archaeologically speaking, more information is available on the Upper Santa Clara River area, although here, too, less is known than for many of the surrounding regions of southern California. In general terms, the prehistory of this inland area appears to parallel that of the Santa Barbara Channel/southern California coastal zone (cf. McIntyre 1990), with William Wallace's (1955) cultural historical framework appropriate as a chronological system of reference.

Correspondingly, the earliest evidence for human occupation of this region corresponds to Wallace's Early Millingstone Period (or, alternatively, the Early Horizon), dated from about 7000 to 4000 years before present (B.P.). This represents a period during which subsistance and adaptation are said to have emphasized the collecting and processing of hard seeds, with inland artifact assemblages, correspondingly, dominated by manos and metates. Evidence for an Early Millingstone occupation of this specific region is, admittedly, very limited, and has been found at only two sites. Both of these are located near Vasquez Rocks, with temporal attribution based on the presence of a small number of Olivella barrel beads (McIntyre 1990). Such bead types have subsequently proven unreliable temporal indicators, throwing doubt on human inhabitation of this region before about 4000 years ago. Further, recent excavations at one of these putative early locales, the Escondido Canyon Site, failed to uncover evidence for occupation prior to about 2700 years B.P. (Love 1990).

The second temporal unit in Wallace's chronology is the Intermediate Period (or Middle Horizon), dated from 3500 to 1500 years B.P. It is marked by a shift to the mortar and pestle, with an increased emphasis on hunting and hunting tools in artifact assemblages. Population appears to have increased during this period, with more temporary camps founded. Evidence for Intermediate Period occupation of the Upper Santa Clara Valley region is substantial, in that it has been found at a number of sites and has been based on radiocarbon, obsidian hydration and typological dating (McIntyre 1990). The Agua Dulce village complex, for example, includes occupation extending back to the Intermediate Period, at which time population of the village may have been 50 or more people (King et al n.d.). Furthermore, the Intermediate Period appears to represent a time during which a substantial exploitation of mid-altitude environments first began, with considerable use, for example, of portions of the nearby Hathaway Ranch (located northwest of the study area) beginning at this time.

Assuming that the Upper Santa Clara River region was first significantly occupied during the Intermediate Period, as existing evidence now suggests, a parallel can be drawn with the inland Ventura County region, where a similar pattern has been identified (Whitley and Beaudry 1991), as well as possibly the Antelope Valley and western Mojave Desert (Sutton 1988a, 1988b). In all of these areas a major expansion in settlement, the establishment of large site complexes, and an increase in the range of environments exploited, appear to have occurred sometime roughly around 3000 years ago. Although most efforts to explain this expansion have focussed on very local circumstances and events, it is increasingly clear that this was a major southern California-wide occurrence, and therefore that explanation of it must be sought at a larger level of analysis.

There is a continuity in the inland regions between the Intermediate Period and subsequent times, labelled the Late Prehistoric Period, lasting from 1500 years B.P. to historic contact, at about 200 years B.P. Site complexes first occupied in the Intermediate Period continued to be inhabited, although they increased in size, with more specialized and diversified sites added to the kinds of sites present. In fact, the principal distinction between Intermediate and Late Prehistoric sites in the inland regions is a change in certain diagnostic artifact types (notably, projectile points, with a shift from spear points to bow and arrow points), which in fact may not signify consequential changes in culture, adaptation or subsistence, although the trends begun in the Intermediate accelerate over time during the Late Prehistoric. For example, a large number of Late Prehistoric Period sites are known from the Upper Santa Clara River/Agua Dulce region (McIntyre 1990), with the Agua Dulce village complex estimated to have grown to a population of 200 to 300 people around A.D. 1500 - 1600 (King et al n.d.). Sometime during this period the Tataviam can be hypothesized to have occupied this region, although it is possible that they may have appeared somewhat earlier. However, the important point is that, during the Late Prehistoric Period, the patterns of lifeways recorded for the ethnographic period were fully in operation.

During the Historic Period, the aboriginal population appears to have dropped considerably. This, without doubt, can be attributed to the effects of missionization and its attendant relocation of the aboriginal population at centralized locales, along with the depredations of introduced Old World diseases. The Upper Santa Clara River region appears to be one of those inland zones, like the Antelope Valley to the northeast, that quickly and completely lost its aboriginal population.

2.4 Historical Background

As noted previously, Euro-American mention of the Santa Clarita region first apparently occurred in the chronicles of the Portolá expedition of 1769, which passed through the San Fernando Valley to Newhall, then to the Castaic Junction area, and then down the Santa Clara River, to Ventura, on its way to Monterey (Cleland 1940). Although the region was traversed by a number of Spanish explorers in subsequent years, it initially remained isolated due to rugged topography, even though it had been suggested as a locale for a mission. Thus, with the establishment of Missions San Buenaventura, in 1782, and San Fernando, in 1797, late-18th century historical events largely occurred in areas to the west and south of the upper Santa Clara Valley proper.

However, as the missions increased in size and their herds grew, it became necessary for many of them to establish mission ranchos, or _estancias_, to allow their cattle to graze some distance from the mission vineyards and fields, per se. With this geographical expansion of mission influence and activities, the upper Santa Clara Valley region became important, if not pivotal, in a number of events central to the development of southern California. Rancho San Francisco, comprising the upper reaches of the Santa Clara Valley down to Piru, served as the _estancia_ for Mission San Fernando (Cleland 1940; Smith 1977), and was established a few years after the founding of the mission itself. (Subsequently, it was elevated to the status of _asistencia_, or sub-mission, apparently around 1804). The Soledad Canyon study area is located just inside the northeastern boundary of the rancho.

Rancho San Francisco remained an adjunct to Mission San Fernando until 1839, when it was granted to Antonio del Valle by Governor Alvarado, and six years thereafter passed to his son, Ygnacio. Notably, Antonio del Valle had served as majordomo and later administrator of Mission San Fernando and its lands from 1834 to 1837, and the family had made supplications to the governor in 1835 and 1837 to obtain a grant in the Santa Clara Valley. When finally granted, the rancho contained slightly more than 46,000 acres which, as Smith (1977) acknowledges, was just under the maximum of 11 square leagues then legally allowed. Headquarters for the rancho was originally at the site of the old asistencia, near Magic Mountain. In addition to having served as the original and then asistencia headquarters, it was to site of the old asistencia that the lead group of the Manly-Walker party - the "Death Valley '49ers" - first emerged out of the wilderness from their efforts to cross the Mojave Desert.

Ygnacio del Valle ultimately became a prominent politician in southern California, serving as _alcalde_ (mayor) of Los Angeles during the Mexican period, as a member of the Territorial Deputation when California was admitted into the Union in 1850, and ultimately in the State Legislature. Forced to fight off efforts by Pedro Carrillo to obtain the western portions of Rancho San Francisco, Ygnacio built a corral at Camulos (the approximate site of the Chumash-Tataviam village of kamulus) in 1841, and finally the Camulos Adobe in 1864, as well as one of the first commercial wineries in the state in 1867 (Smith 1977). Although previously they had resided in Los Angeles, the Camulos Adobe then became the del Valle family home, and was visited by Helen Hunt Jackson in 1882. It served as the setting for her famous early California novel Ramona. (The D.W. Griffith film "Ramona", starring Mary Pickford, was also filmed at the adobe in 1911).

The Rancho San Francisco and the upper reaches of the Santa Clara Valley figured in three other important episodes in southern California history, two of which are landmarks in the economic history of the state. The first of these is the discovery of gold. Although the history of gold discovery and exploitation in California is often linked with James Marshall's 1848 discovery of gold in John Sutter's Coloma mill-race, it is a well-known fact that gold was found in California 1842, in Placeritas Canyon, by Francisco Lopez, Manuel Cota and Domingo Bermudez (Smith 1977; Outland 1986). But it is by no means clear that even this well-documented incident represents the first true discovery of gold in the state; instead, a variety of lines of evidence suggest that gold may have been mined in the Santa Clara Valley region one or two decades earlier.

According to an account published by Outland (1986), a local tale indicates that a group of about 20 men, led by one Santiago Feliciano, left Mission San Fernando in 1820 to explore the Castaic region. After reaching the Castaic Junction area, they headed up Hasley Canyon for about 10 miles. There they discovered gold, and a mining camp, "San Feliciano" (from which San Feliciano Canyon apparently gets its name), was born. The region from San Feliciano to Soledad Canyon was subsequently prospected and mined (mostly for placer deposits) for a number of years, with little record of these efforts presumably resulting because of the legal complications involved in recording gold claims in Mexican California: while the granting of land for agricultural purposes could be effected by the Governor of California, the recording of a gold claim under Mexican law required a trip to Mexico City, a lengthy effort none were apparently willing to gamble.

Although, as Outland notes, there is no clear verification for this tale (which ultimately derives from the prominent early Ventura settler and local historian S.P. Guiberson), there is nonetheless fairly strong evidence that the Placeritas discovery in 1842 was by no means the first in this region (Smith 1977; Outland 1986). In 1832, for example, Ewing Young discovered an old ore smelting oven in San Emigdio Canyon (Outland 1986), suggesting that gold mining in the area had occurred for one or two decades prior to the 1842 event, and a number of other sources indicate that the presence of gold in the area was known at least a few years prior to the famous 1842 Placeritas Canyon incident (Smith 1977). One of these is an early manuscript map of California, dated 1841, but of unknown original provenance (Preston 1988:2). It locates gold as present in the San Gabriel Mountains one year before its putative discovery in Placerita Canyon in 1842.

Be this as it may, the 1842 discovery did have one important repercussion: it resulted in the granting of Rancho Temescal, to Francisco Lopez and Jose Arellanes, in 1843. This included most of Piru Creek, as well as Placerita and San Feliciano Canyons, and totalled over 13,000 acres. Apparently, the legality of this grant under Mexican law has always been a point of some question for, as noted previously, the Governor of California only held the right to award agricultural but not mining grants. However, Thompson and West (1886:74) record that the area was worked by miners from Sonora, Mexico, between 1842 and 1846, at which time they returned to Mexico, and that they extracted between six and eight thousand dollars of gold per year during that period. Nonetheless, about a dozen years later, Rancho Temescal was acquired by Ygnacio del Valle and added to his Rancho San Francisco holdings.

Not only was the upper Santa Clara Valley area the first in California in which gold was discovered, it was also the first where true oil drilling occurred (Smith 1977), which was the second historical event in the region. Petroleum exploration began about 1865, when oil seeps were discovered in Pico Canyon. This led to discoveries of oil on Rancho San Francisco and, ultimately, throughout the valley. This first historic discovery of oil precipitated Ygnacio del Valle's sale of the majority of his Rancho San Francisco holdings to Thomas Bard, partner with Senator Thomas A. Scott in the Philadelphia and California Petroleum Company, for $1.25/acre, in 1865. Del Valle retained only 1500 acres around Camulos and, seven weeks later, the first oil well came in on the south side of the Santa Clara River, on property acquired by Bard, near the del Valle adobe (Wallace 1977).

Following accepted perceptions of that period, Bard and Scott assumed that petroleum production and ranching would not be compatible. Accordingly, they sold 40,000 acres of Rancho San Francisco to Henry Mayo Newhall in 1875. Newhall was a San Francisco financier who originated in Saugus, Massachussetts, and who, after acquiring the ranch, quickly placed it into wheat and barley farming (Rolle 1991). This represented the beginnings of what would become the Newhall Land and Farming Company, one of the most successful land and farming ventures in the state.

Petroleum production continued in the region, even with Newhall's apparently successful efforts at farming. Lack of a local market and cost of shipping, however, prevented major development of this natural resource until 1876, when the Southern Pacific Railroad crossed the region (Franks and Lambert 1985). This initiated an oil boom in the area, with the development of the

Newhall oil field, and the establishment of the Pioneer Oil Refinery (ultimately, the predecessor to Chevron Oil) in 1876 (Rolle 1991).

The entry of the railroad also resulted in the laying-out of the first town of Newhall, to the south of the Soledad Canyon study area. Efforts to sell lots were stymied by dust and sand storms so severe that, in 1878, the town was moved three miles to the south, to the site of the existing nucleus of Newhall. The original town site, sometimes referred to as "Old Town" was ultimately renamed Saugus, after Mr. Newhall's place of origin (Wallace 1977; Rolle 1991). In 1880 the "new" Newhall was described as having "an exceedingly handsome hotel - with store attached, out-buildings, barns, warehouses, several dwellings, a depot, blacksmith shop, lumber-yard, school-house, and the inevitable following of small saloons" (Thompson and West 1880:104). Still, growth was apparently slow: by 1887 population remained under 100 people (Rolle 1991:96).

The third local event of historical importance was the collapse of the St. Francis Dam and the resulting flood of the Santa Clara River Valley on March 12 and 13, 1928. With the failure of the dam close to midnight on the 12th of March, water raged down San Francisquito Canyon, through the the confluence of the canyon with the Santa Clara, to Castaic Junction, which it effectively leveled, and then on to Fillmore, Santa Paula and ultimately to the Pacific, causing great loss of life and destruction along the way. At Castaic Junction, the only survivor of the flood was George McIntyre, son of the owner of McIntyre's motel and gas station. George was washed northwards by a great arc of the floodwaters, towards Castaic Canyon, where he grabbed hold of a power pole and avoided drowning; the bodies of his father and one brother were found in Santa Paula; another brother's body was never recovered. All told, at least 336 deaths were caused by the flood (undoubtedly more occurred but were never entered into coroner's statistics), 909 homes were destroyed, and countless acres of orchards were flattened (Outland 1963).

If there were any benefits resulting from the great flood, one may have been to the Newhall Land and Farming Company, started by Henry Mayo Newhall, as noted previously, in 1875. Combined with the beginning of the Depression, the company's assets and capital had eroded over the years, and it was facing liquidation when taken over by Athol McBean in 1930. McBean was married to a granddaughter of Henry Mayo Newhall, and was an accomplished businessman in his own right. Because the flood had damaged considerable acreage within the farm, the company received three-quarters of a million dollars in restitution from the City of Los Angeles. McBean was able to use this in his reorganization of the company, and to place it on the sound financial track which it has followed to this day (Rolle 1991). It is, of course, the Newhall Land and Farming Company which has provided the impetus for the recent suburban and urban development of the upper Santa Clara Valley region.

The study area, however, is peripheral to all of the historical events and discoveries in this region, and probably did not specifically figure in the history of this part of Los Angeles County. In this sense, the study area can be considered peripheral to and isolated from the historical events of northern Los Angeles County, and probably did not participate directly in any of them.

3.0 ARCHIVAL RECORDS SEARCH

An archival records search was conducted at the California State University, Fullerton, Archaeological Information Center (AIC), by AIC staff members to determine: (i) if prehistoric or historical archaeological sites had previously been recorded within the 750 acres Soledad Canyon Panhandle study area; (ii) if all or portions of the project area had been systematically surveyed by archaeologists prior to the initiation of this field study; and/or (iii) whether the region of the field project was known to contain archaeological sites and to thereby be archaeologically sensitive. The results of this archival records search are included in this document as Appendix A.

The records search at the AIC indicated that portions of the study area had been previously surveyed by archaeologists. Specifically, five surveys had investigated portions of the study area, principally the western end of the study area, excluding the upper river terraces along the northern side of the canyon and the eastern one-third of the property. These surveys had resulted in the discovery and recording of three prehistoric archaeological sites. A summary of the nature and current conditions of each of these prehistoric sites is provided below.

CA-LAN-351: This is a large site first recorded by N. Leonard in 1968. It is located in the approximate center of the study area (Figure 2), on a series of three river terraces on the north side of Soledad Canyon. The site was revisited and site update forms were completed by L. Tartaglia in 1986, and subsequently by J. Romani and G. Romani in 1991. The estimate for site size on this latest update was 309 meters N-S by 185 meters E-W, with a projected 60 cm of depth for the archaeological deposit present at the site. According to the 1991 update, the site was believed to contain a midden deposit along its southeastern side. An inventory of artifacts noted on the groundsurface at that time comprised a wide range of tools and debitage, including groundstone, core tools, bifaces, debitage and burnt bone. From the size of the site, its diversity of artifacts, the presence of a midden deposit, burnt bone and fire-cracked rocks, CA-LAN-351 can be inferred to represent a village or habitation site. Furthermore, the presence of mortar/bowl fragments suggests that it at least in part post-dates the Early Horizon; that is, that it is approximately 3500 years, or less, in age.

CA-LAN-1824: L. Tartaglia recorded this site in 1986 and conducted a Phase II test on it in 1990 (Tartaglia 1986, 1990). It was revisited and a site update was completed for it by Greenwood and Associates (Romani et al 1991) in 1991. According to the documents resulting from these studies and visits, when first discovered CA-LAN-1824 was described as a lithic scatter, located on the south side of the Santa Clara River, within the active flood channel area. It contained one rhyolite core, one quartzite cobble tools and one metavolcanic flake. When tested in 1990 these artifacts could not be re-located, perhaps due to seasonal innundations of the flood channel. A single mano and piece of shellfish were found on and collected from the site, however, but sub-surface testing failed to reveal the presence of any buried archaeological deposit. When re-visited in 1991 by Greenwood and Associates, no additional cultural materials could be found on the site area.

It is apparent that any cultural materials once present on this site have been removed. The area of CA-LAN-1824, therefore, can no longer be considered an archaeological site. Following the guidelines of the California Environmental Quality Act (CEQA), furthermore, the previous archaeological work at this locality has served to completely and adequately mitigate any adverse impacts to cultural resources at this site.

CA-LAN-1829: This site was also discovered and recorded by L. Tartaglia in 1986, and was re-visited and evaluated in 1991 by Greenwood and Associates (cf. Tartaglia 1986; Romani et al 1991). The site was originally described as an "extremely sparse lithic scatter", consisting of one rhyolite and one quartz flake located along a power line road in the flood channel immediately north of the Santa Clara River. During the 1991 re-visit and evaluation of the site, Romani et al (1991) noted that, since the site consisted only of two waste flakes, it originally should have been recorded as two isolates, following the State of California Office of Historic Preservation (OHP) guidelines; that is, that it did not rightly meet the primary criterion used to define an archaeological site. Moreover neither the two original flakes nor any additional archaeological remains could be found in the area of the site during the 1991 re-visit.

Inasmuch as CA-LAN-1829 apparently represents isolated artifacts rather than a site per se, and following OHP and CEQA guidelines, the recording of the two waste flakes originally constituting the extant cultural resources present at this locality has served to completely and adequately mitigate any adverse impacts that it might experience due to development or use of the area.

The archival records search also considered the possibility that historical archaeological resources might be present within the study area. Historical records in the form of the Santa Susana (1903 and 1941) and San Fernando (1900 and 1940) USGS 15' topographical quadrangles were examined to determine whether historical resources might be present on the property. No evidence of historical development in the study area, per se, was found on these maps, although roads and the Southern Pacific Railroad were present in the region by the turn of the century, and Saugus (original locale for Newhall) had been developed. However, one historical site has been recorded within the study area. This is CA-LAN-2105H, the Los Angeles Aqueduct.

Although this active water line strictly lies within the study area, it is important to note that it sits within a utility easement, and therefore lies outside of any proposed development or use.

4.0 FIELD SURVEY METHODS

A field survey of the 750 acres Soledad Canyon Panhandle study area, Los Angeles County, California, was conducted by David S. Whitley, Ph.D., Joseph M. Simon, and Tamara K. Whitley, M.A., of the W & S Consultants staff, in July, 2001. The groundsurface was examined with transects spaced at approximate 10 - 15 meter intervals; these were walked across the study area to identify artifacts or other archaeological indicators that might be present on the groundsurface. Particular attention was paid to localized micro-geomorphological contexts favorable for the preservation or burial of archaeological remains, such as aggradational environments at the toeslopes of grades and hills, and stable surfaces such as captured fans. Further, cut-banks and animal burrows were examined to determine whether buried cultural deposits might be present on the property.

5.0 SURVEY RESULTS

The Phase I archaeological survey of the Soledad Canyon Panhandle study area, Los Angeles County, California, resulted in the discovery of two isolated artifacts within the study area. It also allowed for a re-examination of site CA-LAN-351 and the areas originally containing sites CA-LAN-1824 and -1829. With the exception of the two newly discovered isolates, no additional cultural resources were found within the study area. We discuss these cultural resources in turn.

5.1 Newly Discovered Cultural Resources

Two isolated artifacts were discovered during the Phase I survey of the Soledad Canyon study area, both of which represent examples of lithic debitage. Appendix B contains isolate records for these two finds.

Isolate #1: This was a small piece of chert debitage found on a low knoll immediately north and overlooking the Santa Clara River on the eastern side of the study area (Figure 2). The specimen appears to be a piece of angular shatter. Inasmuch as chert does not occur locally within the study area, it must be inferred that this specimen was transported by human hands onto this locality. An intensive search in the immediate area of its discovery failed to uncover any additional evidence of cultural remains.

Isolate-#2: This specimen was found on a low terrace on the north side of the river, east of the Los Angeles Aquaduct easement (Figure 2). It consists of a single chert primary flake. This is a large cortical flake, with evidence of fire-spalling, which may have resulted from a brush fire, or from heat-treatment in manufacture. No additional cultural resources could be found at the location of this waste flake, although the area was examined intensively.

5.2 Previously Recorded Cultural Resources

As noted previously, three prehistoric and one historical archaeological sites had been recorded within the study area. Each of these was visited and evaluated during the Phase I survey. We discuss the status of each of these four sites in turn.

CA-LAN-351:

Examination of this site revealed field conditions much in agreement with those described in the 1991 visit and evaluation by Greenwood and Associates (Romani et al 1991). The site is apparently a large habitation, with archaeological remains spread over three river terraces which are immediately adjacent to a bend in the course of the Santa Clara River. There is a particularly lush riparian area on this bend, filled with introduced arundu cane, suggesting that a seep may be present near this site.

We noted artifacts on CA-LAN-351 similar in diversity and number to those reported by the 1991 fieldcrew. In addition to debitage, they included groundstone (manos, metate and pestle fragments), cobble chopping tools, flaked stone tools (biface knife and biface edges), fire-cracked rock and burnt bone. Although the primary surface expression of the midden is currently on the eastern side of the middle terrace, it is very likely that downslope colluviation is mantling midden extending further to the west. Those portions of the site located on the lower and middle terraces appear to maintain high integrity and therefore are in good condition.

As noted in previous evaluations of the site, the upper terrace was graded sometime prior to the 1986 update, and was used for a model airplane runway. A berm of the graded material currently rims the upper terrace on its eastern and southern sides. Judging from the fact that portions of the terrace immediately inside the berm have developed stands of sage and buckwheat, this grading probably occurred a few decades or more ago. A brow-ditch, presumably for erosion control, also runs along the rim of this terrace. It is apparent that this ditch cuts into an intact, non-cultural deposit of (probably early or middle Pleistocene age) alluvial cobbles. Although this rim of the upper terrace has been identified as an area of high artifact density, it is apparent that it has suffered from considerable disturbance. Further, although at one time this rim area may have been a zone of high artifact density, the exposed Pleistocene cobble lens indicates that there was no sub-surface archaeological deposit in this immediate area, and we noted only three surface artifacts along this rim area. On the other hand, we observed intact pockets of midden on the upper terrace, northwest of the berm and brow-ditch. Thus, although we found portions of the upper terrace to be more heavily disturbed than previously noted, it is also clear that there are more extant archaeological remains in this area than originally believed.

As noted previously, the presence of midden and the artifact assemblage observed on the groundsurface of the site indicate that CA-LAN-351 represents a village or habitation site. The presence of mortars/bowls and pestles suggest that it has a maximum age of about 3500 years, although it may be considerably younger. There is, however, no ethnohistorical evidence that there was a historical village in the area of the site, thus indicating that it is prehistoric and not potentially historical in age.

CA-LAN-1824:

This site was a small surface scatter that consisted solely of a mano and a single piece of shellfish when tested in 1990 (see Tartaglia 1990). Based on that Phase II test, no additional archaeological work was recommended as necessary at this site. As noted by Romani et al (1991), however, the sparsity of artifacts at this locale indicate that it did not meet the OHP definitional criterion for an archaeological site, but instead comprised solely isolated finds, the recording of which serves to adequately and completely mitigate any adverse impacts resulting from development or use of the area.

During the current Phase I survey the area of site CA-LAN-1824 was re-visited and intensively examined. We found no evidence of additional extant artifacts at this locale, thus confirming the results of an earlier, 1991 re-examination (see Romani et al 1991).

CA-LAN-1829:

Circumstances at CA-LAN-1829 were very similar to those at CA-LAN-1824: originally recorded as a lithic scatter of two flakes, no cultural materials could be re-located in 1991 and, at that time, it was noted that the site should have been recorded originally as two isolated artifacts, rather than as a site, per se (see Romani et al 1991).

Although we visited and intensively examined the area of CA-LAN-1829, we also could not find any extant evidence of cultural materials at this locale, thus confirming the results of the 1991 re-examination.

CA-LAN-2105H:

This historical site is the Los Angeles Aqueduct, which is currently in use. Lying within a utility easement, it is outside of any proposed development.

6.0 RECOMMENDATIONS

An archival records search, background studies, and an intensive, on-foot surface reconnaissance of the Soledad Canyon Panhandle study area, northern Los Angeles County, California, were conducted as part of an intensive Phase I archaeological survey and cultural resources assessment. The following cultural resources are or at one time were present within this study area: CA-LAN-351, a prehistoric habitation site that is currently in good to fair condition; CA-LAN-1824 and -1829, both of which were recorded in 1986 but are no longer present on the property, and both of which represent isolated artifacts; Isolates #1 and #2, which were recorded during the current field study and which represent isolated finds of single chert flakes; and CA-LAN-2105H, the Los Angeles Aqueduct, which is still in use. Based on CEQA, we recommend the following with regard to each of these cultural resources:

CA-LAN-351: This is a large prehistoric site that has the potential to contain scientific information useful for the reconstruction of prehistoric lifeways in the Santa Clara Valley region, and/or artifacts or features that may be of religious importance to Native Americans. Development of the area containing CA-LAN-351, therefore, has the potential to result in adverse impacts to cultural resources. We recommend that a Phase II test excavation and determination of site significance be conducted prior to any development of the area of the site, to provide baseline data from which an acurate estimate of the nature, size and significance of CA-LAN-351 can be established, and from which final management recommendations can be made.

CA-LAN-1824: CA-LAN-1824 represents an isolated artifact rather than an archaeological site, per se, as noted by Romani et al (1991), and there are currently no extant cultural remains at this locale. Following CEQA guidelines, all potential impacts to this cultural resource have been mitigated by the recording of this artifact. In concurrence with Tartaglia (1986) we recommend, therefore, that no additional archaeological work be required at the former locale of CA-LAN-1824.

CA-LAN-1829: As with the previous site, CA-LAN-1829 correctly represents an isolated artifact occurrence rather than an archaeological site, per se (see Romani et al 1991), with no extant remains now present at this locale. All potential adverse impacts to this cultural resource, therefore, have been completely and adequately mitigated. We recommend that no additional archaeological work be required or performed at this locale.

CA-LAN-2105H: This site, the Los Angeles Aqueduct, is currently in use, and lies in an easement across the study area. There is, therefore, no potential for adverse impacts to this historical cultural resource. We recommend no additional archaeological work for this site.

Isolate #1: This isolated piece of lithic debitage has been recorded as part of the current Phase I study. According to CEQA, this has served to completely and adequately mitigate all potential adverse impacts to this cultural resource. We recommend, therefore, that no additional archaeological work be required or performed at this locale.

Isolate #2: A recording of this isolated specimen of lithic debitage was completed during the current Phase I study. We recommend, following CEQA guidelines, that no additional archaeological work be required or performed at this locale.

7.0 CITED REFERENCES

Cleland, R.G.

1940 The Called Sespe: The History of a California Ranch. Privately printed.

Earle, D.

1990 New Evidence on the Political Geography of the Antelope Valley and the Western Mojave Desert at Spanish Contact. In B. Love and W.H. DeWitt, eds., Archaeology and Ethnohistory of the Antelope Valley and Vicinity, Antelope Valley Archaeological Society, Occasional Papers No. 2, pp. 87-104.

Franks, K.A. and P.F. Lambert

1985 Early California Oil: A Photographic Essay, 1865-1940. Texas A. and M., College Station.

Johnson, J. and D. Earle

1990 Tataviam Geography and Ethnohistory. Journal of California and Great Basin Anthropology 12:191-214.

King, C. and T.C. Blackburn

1978 Tataviam. In R.F. Heizer, ed., Handbook of North American Indians, Volume 8, California, pp. 535-537. Washington, D.C.: Smithsonian Institution.

King, C., C. Smith and T. King

n.d. Archaeologial Report Related to the Interpretation of Archaeological Resources Present at the Vasquez Rocks County Park. Report on file, UCLA AIC.

Kroeber, A.L.

1925 Handbook of the Indians of California. Bureau of

American Ethnology, Bulletin 78. Washington, D.C.

Love, B.

1990 Archaeological Testing of a Portion of LAn-618, the Escondido Canyon Site, Near Agua Dulce, Los Angeles County, California. In B. Love and W.H. DeWitt, eds., Archaeology and Ethnohistory of the Antelope Valley and Vicinity, Antelope Valley Archaeological Society, Occasional Papers No. 2, pp.21-42.

McIntyre, M.

1990 Cultural Resources of the Upper Santa Clara River Valley, Los Angeles and Ventura Counties, California. In B. Love and W.H. DeWitt, eds., Archaeology and Ethnohistory of the Antelope Valley and Vicinity, Antelope Valley Archaeological Society, Occasional Papers No. 2, pp. 1-20.

Outland, C.F.

1963 Man-Made Disaster: the story of the St. Francis Dam. Glendale: Arthur H. Clark.

1986 Mines, Murders and Grizzlies: Tales of California's Ventura Back Country. Ventura: Ventura County Historical Society.

Preston, R.N.

1988 Early California Atlas - Southern Edition. (Second edition). Binford and Mort, Portland.

Romani, J., G. Romani and R. Greenwood

1991 Archaeological Survey Report for the Route 126 Location Study from Interstate 5 to State Route 14, in the Santa Clarita Valley, California. Unpublished manuscript on file, UCLA AIC.

Rolle, A.

1991 Henry Mayo Newhall and His Times: A California Legacy. Huntington Library, San Marino.

Smith, W.E.
1977 This Land Was Ours: The del Valles and Camulos. Ventura: Ventura County Historical Society.

Sutton, M.Q.
1988a An Introduction to the Archaeology of the Western Mojave Desert, California. Archives of California Prehistory, No. 14. Salinas: Coyote Press.
1988b On the Late Prehistory of the Western Mojave Desert. Pacific Coast Archaeological Society Quarterly 24(1):22-29.

Tartaglia, L.
1986 Cultural Resource Survey Report: Soledad Canyon Project. Unpublished manuscript on file, CSUF AIC.
1990 Archaeological Site Assessment, Site A, Soledad Canyon Project, Tentative Tract Map 20838, Saugus, California. Unpublished manuscript on file, CSUF AIC.

Thompson, T.H. and A.A. West
1880 History of Los Angeles County, California, With Illustrations and Biographical Sketches of Its Prominent Men and Pioneers. Oakland.

Wallace, W.J.
1955 A Suggested Chronology fpr Southern California Coastal Archaeology. southwestern Journal of Anthropology 11:214-230.

Whitley, D.S.
1992 Shamanism and Rock Art in Far Western North America. Cambridge Archaeological Journal 2:89-113.

Whitley, D.S. and M.P. Beaudry
1991 Chiefs on the Coast: The Development of Complex Society in the Tiquisate Region in Ethnographic Perspective. In W. Fowler, ed., The Development of Complex Civilizations in Southeastern Mesoamerica, pp. 101-120. CRC Press.

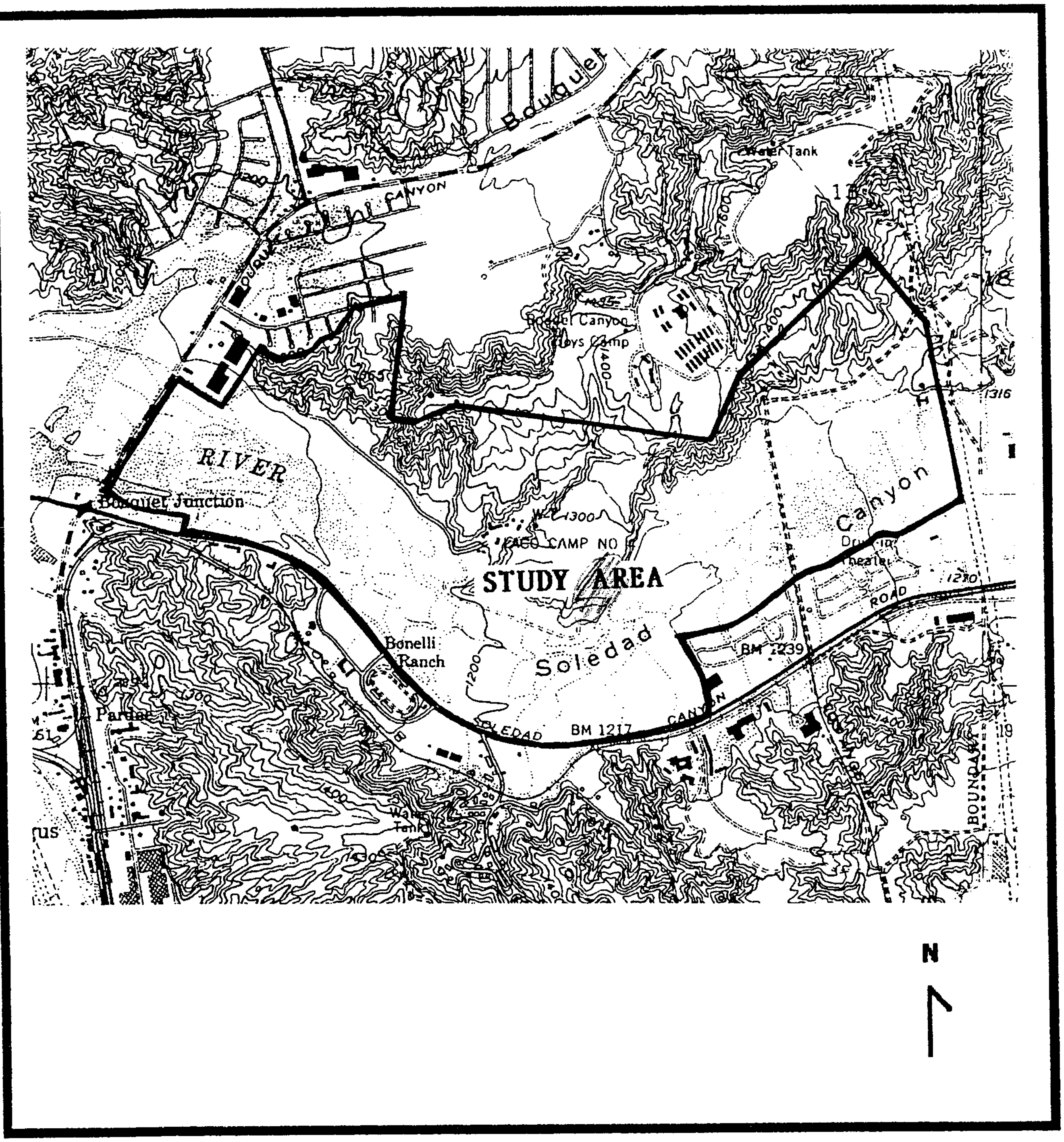

FIGURE 1: Soledad Canyon study area, northern Los Angeles County, California (base map: USGS Newhall 7.5' quadrangle; scale - 1 : 24,000).

9.0 APPENDIX A: ARCHIVAL RECORDS SEARCH

South Central Coastal Information Center
California Historical Resources Information System
California State University, Fullerton
Department of Anthropology
800 North State College Boulevard
Fullerton, CA 92834-6846
(714) 278-5395 / FAX (714) 278-5542
anthro.fullerton.edu / sccic.html

Los Angeles
Orange
Ventura

July 13, 2001

Mr. Joseph M. Simon
W and S Consultants
2242 Stinson Street
Simi Valley, CA 93605
805-581-3577

RE: Records Search for a Phase I Archaeological Resource Survey of the Pan Handle Project Site (750 ac.) in Santa Clarita, Los Angeles County, California

Dear Mr. Simon,

As per your request received on June 13, 2001, we have conducted a records search for the above referenced project. This search includes a review of all recorded historic and prehistoric archaeological sites within a ½ -mile radius of the project area as well as a review of all known cultural resource reports. In addition, we have checked our file of historic maps, the California State Historic Resources Inventory, the National Register of Historic Places, the listing of California Historical Landmarks in the region, and the California Points of Historical Interest. The following is a discussion of our findings.

PREHISTORIC RESOURCES:

Newhall 7.5' USGS Quadrangle

Three prehistoric archeological sites (19-000351, 19-001824, and 19-001829) have been identified within the project area. One prehistoric archaeological resource noted in report LA643 has been identified within a ½-mile radius of the project area, but was never formally recorded (19-120063). Six prehistoric isolates (19-100341, 19-100342, 19-100343, 19-100344, 19-100345, and 19-100346) have been identified within a ½-mile radius of the project. None of the resources have been identified on the National Register Determination of Eligibility list.

Mint Canyon 7.5' USGS Quadrangle

No prehistoric sites have been identified within a ½ -mile radius of the project area.

HISTORIC RESOURCES:

Newhall 7.5' USGS Quadrangle

Two (19-002105 and 19-002132H) historic archaeological sites have been identified within a ½-mile radius of the project area. None of the resources have been identified on the National Register Determination of Eligibility list.

Mint Canyon 7.5' USGS Quadrangle

No historic archaeological sites have been identified within a ½-mile radius of the project area.

Newhall and Mint Canyon 7.5' USGS Quadrangle

Copies of the historic maps - Santa Susana 15' 1908, 1941, and 1948) - for your project area have been enclosed for you review (see enclosed maps)

A copy of the California State Historic Resources Inventory list for the city of Santa Clarita has been enclosed for your review (see enclosure).

The National Register of Historic Places lists no properties within a ½ -mile radius of the project area.

The California Historical Landmarks (1990) of the Office of Historic Preservation, California Department of Parks and Recreation, lists no landmarks within a ½ -mile radius of the project area.

The California Points of Historical Interest (1992), of the Office of Historic Preservation California Department of Parks and Recreation, lists no properties within a ½ -mile radius of the project area.

The listings of the City of Los Angeles Historic-Cultural Monuments indicated that there are no landmarks within a ½ -mile radius of the project area.

PREVIOUS ARCHAEOLOGICAL INVESTIGATIONS:

Newhall 7.5' USGS Quadrangle

Thirty-seven studies (LA54*, LA127, LA210, LA326, LA584, LA643, LA1032, LA1152, LA1342, LA1447, LA1751, LA1752, LA1775, LA1784, LA1896*, LA1951, LA2117, LA2118*, LA2477, LA2503*, LA2562, LA2783, LA2979, LA2996, LA3154, LA3387*, LA3690*, LA3840, LA3890, LA3895, LA3913*, LA3915, LA4104, LA4158, LA4159, LA4251*, LA4506) have been conducted within a ½ -mile radius of the project area. There are four additional investigations located on the Newhall 7.5' USGS quadrangle potentially within a ½ -mile radius of the project area. These reports are not mapped due to insufficient locational information. A bibliography of these reports is available upon request.
(* = Located within the project area.)

Mint Canyon 7.5' USGS Quadrangle

Six studies (LA54, LA1032, LA2503, LA2996, LA3840, and LA3960) have been conducted within a ½ -mile radius of the project area. There are six additional investigations located on the Mint Canyon 7.5' USGS quadrangle potentially within a ½ -mile radius of the project area. These reports are not mapped due to insufficient locational information. A bibliography of these reports is available upon request.

Please forward a copy of any reports resulting from this project to our office as soon as possible. Due to the sensitive nature of site location data, we ask that you do not include record search maps in your report. If you have any questions regarding the results presented herein, please feel free to contact our office at (714) 278-5395.

Invoices are mailed approximately two weeks after records searches are completed. This enables your firm to request further information under the same invoice number. **Please reference the invoice number listed below when making inquiries.** Requests made after invoicing will result in the preparation of a separate invoice with a $15.00 handling fee.

Sincerely,

Margaret López
Coordinator

Enclosures:
(X) Primary Number Explanation
(X) Map – Newhall and Mint Canyon 7.5' USGS Quadrangles, Santa Susana 15' USGS Quadrangles (3)
(X) Bibliography - 15 pages
( ) Site list
(X) HRI - 3 pages
(X) National Register Status Codes - 4 pages
( ) Site records
( ) Survey reports
(X) Confidentiality Form
( ) Invoice # 9674

Phase II Archaeological Assessment

PHASE II ARCHAEOLOGICAL TEST EXCAVATIONS FOR THE RIVER PARK PROJECT AREA, NORTHERN LOS ANGELES COUNTY, CALIFORNIA

Prepared For:

Mr. Glenn Adamick
Newhall Land and Farming Company
23823 Valencia Boulevard
Valencia, CA 91355

Prepared By:

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2242 Stinson Street
Simi Valley, California 93065
805-581-3577

23 April, 2002

DRAFT

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MANAGEMENT SUMMARY

Phase II archaeological test excavations were conducted at CA-LAN-351 and site NLF/W&S-1 within the River Park project area, Saugus, northern Los Angeles County, California. For CA-LAN-351, which is slated for preservation, this involved the determination of the site boundary along its southwestern margin; geomorphological constraints limit the site in the other directions. Testing at site NLF/W&S-1 involved the hand excavation of fifteen 1x1 meter test pits along with surface collection and mapping. This site proved to contain a subsurface archaeological deposit and is believed to date to approximately 4000 - 2000 YBP. Recommendations for the further management of these sites are provided.

CHAPTER 1
INTRODUCTION

1.1 Summary and Background to the Project

At the request of The Newhall Land and Farming Company, Valencia, California, Phase II archaeological test excavations were conducted at sites CA-LAN-315 and NLF/W&S-1 (temporary designation). Both sites are located within the River Park project area in northern Los Angeles County, California (Figure 1). This archaeological study was intended to determine the size and significance of these two prehistoric archaeological sites and thereby to provide baseline data from which an assessment of potential adverse impacts to these resources could be made. These data have been employed to develop final management recommendations for the treatment of these cultural resources.

This study was conducted by W & S Consultants during March, 2002. David S. Whitley, Ph.D., and Joseph M. Simon served as principal investigators for the project; while the laboratory analyses were conducted by Tamara K. Whitley, M.A. This report was prepared by D.S. Whitley. Richard Angulo, representing the California Indian Foundation, served as Native American monitor for the project.

The remainder of this chapter provides environmental and cultural background to the prehistory of the region, including a summary of previous archaeological research conducted in this region; and descriptions of the two sites considered in this study. This is followed by the field methods used, along with summaries of the field results. We then turn to an assessment of the recovered artifact assemblage, and certain of the analytical conclusions derived therefrom. We conclude with final recommendations for the cultural resources considered during this Phase II study.

1.2 Environmental and Cultural Overview

1.21 Site Descriptions & Environmental Background

Archaeological sites CA-LAN-351 and NLF/W&S-1 are located on the north bank of the upper Santa Clara River in Saugus, northwestern Los Angeles County, California (Figure 1). This portion of the river channel is a relatively restricted stream bed known as Soledad Canyon. Originally both sites were considered part of a single cultural resource, designated CA-LAN-351. For reasons discussed below, it became apparent during our Phase II fieldwork that, more correctly, each warranted its own designation.

CA-LAN-351 was first recorded as a large site by N. Nelson Leonard in 1968. It was located on a series of three river terraces with elevations ranging from about 1210 to 1280 feet a.m.s.l.. The site was revisited and site update forms were completed by L. Tartaglia in 1986, and then by J. Romani and G. Romani in 1991. The estimate for site size on the 1991 update was 309 meters N-S by 185 meters E-W, with a projected 60 cm of depth for the archaeological deposit present at the site. According to the 1991 update, the site was believed to contain a midden deposit along its southeastern side. An inventory of artifacts noted on the groundsurface at that time comprised a wide range of tools and debitage, including groundstone, core tools, bifaces, debitage and burnt bone. From the size of the site, its diversity of artifacts, the presence of a midden deposit, burnt bone and fire-cracked rocks, CA-LAN-351 can be inferred to represent a village or habitation site. Furthermore, the presence of mortar/bowl fragments suggests that it at least in part post-dates the Early Horizon; that is, that it is approximately 3500 years, or less, in age.

The site was revisited and examined recently by W&S Consultants (2001). Although generally concurring with the previous studies, the possibility of a separate sub-surface archaeological deposit on the upper of the three terraces was noted. Moreover, the soils context of the upper terrace appeared different from that seen in the lower two. Combined with the fact that the two areas were separated by a a distance of roughly 100 feet on a steep slope with an elevational change of over 25 feet, these circumstances suggested that the large area originally recorded as a single site perhaps should more correctly be considered two distinct archaeological sites. However, it was recognized that a decision on this point would best be made during archaeological testing, when the distribution of artifacts and deposits could be confirmed or clarified.

Phase II fieldwork at this location quickly confirmed these suppositions: two archaeological deposits are present and these are geographically distinct and appear to differ (for reasons discussed subsequently) in cultural-historical terms. We have therefore retained the designation of CA-LAN-351 for the primary area of original discovery, which is the archaeological deposit on the lower terraces (Figure 2). This covers the first and second terraces above the stream bottom, which range from 1210 to almost 1260 feet in elevation. The second site area, given the temporary designation of NLF/W&S-1, is located on the third terrace above the stream bed. Elevation for this site ranges from about 1280 to 1285 feet (Figure 3).

Although historic and recent land-use changes have altered the environment considerably from what existed during prehistoric times, at least four major plant associations probably characterized the region containing these two sites during the aboriginal period. These are chaparral, coastal sage scrub, southern oak woodlands, and riparian associations (cf. Muntz 1974).

The chaparral association covers steeper slopes with poorly developed soils and xeric conditions. It includes the following species: California sagebrush (Artemisia californica), white sage (Salvia mellifera), black sage (S. apliana), purple or white-leaved sage (S. Leucophylla), California encilia

(Encilia californica), California buckwheat (Eriogonum fasciculatum), chamise (Adneostoma fasciculatum), buckbrush (Ceanothus cuneatus), scrub oak (Quercus dumosa), toyon (Heteromeles arbutifolia), mountain mahogony (Cercocarpus betuloides), lemonade sumac (Rhus integrifolia) and sugar sumac (R. ovata). This is a particularly common association in the West Ranch study area.

The coastal sage scrub community is the climax community for portions of inland-coastal southern California. It is generally composed of coast buckwheat (Eriogonum cinereum) and wild buckwheat (E. fasciculatum), along with black sage (Salvia apliana), common hazardia (Haplopappus squarrosus), prickly phlox (Leptodactylon californicum), yucca (Yucca whipplei) and California sagebrush (Artemisia californica) as major constituents.

Although both of the above plant associations were undoubtedly of subsistence importance to the aboriginal population of the region, the third association, the southern oak woodland, may have been of primary significance in the inland zones adjacent to the coastal strip. This results because of the great importance placed on the acorn as a food staple by Native Californians (Kroeber 1925), and the rarity of this resource on the coastal side of the Santa Monica Mountains. The association is characterized by the coast live oak (Quercus lobata) and the valley oak (Q. agrifolia), but also would have included various species of native grasses. Although currently restricted in distribution, this association may once have been found across much of the wide, upper reaches of Potrero Canyon and the mesas on the south side of the Santa Clara River. Currently, stands of oak woodlands are still found at higher elevations on the less precipitous ridge/hilltops on the southern side of the property.

The fourth and final plant association consists of riparian habitats, which are localized and poorly diversified woodlands found in areas of perennial moisture. They include such species as arroyo willow (Salix lasiolepsi), mule fat (Baccharis glutinosa), willow dock (Rumex salicifolius), swamp knotweed (Polygonum coccineum), nettle (Urtica holosericea), cocklebur (Xanthium strumarium) and rabbitsfoot grass (Polypogon monspeiensis). Though this plant association is limited in distribution, it can still be considered to have had significant economic importance in aboriginal times, especially in terms of the acquisition of raw materials for items like baskets, cordage and netting.

While riparian habitat is present in the Santa Clara River, immediately adjacent to the two sites, the site areas otherwise can be characterized by introduced species (primary grass and wild mustard). Both site areas have been periodically disked, if not plowed, and used as agricultural fields. Recent disking appears to have been completed for purposes of fire safety.

1.22 Ethnographic Background

The Upper Santa Clara Valley region, including the Newhall Ranch, appears to have been inhabited during the ethnographic past by an ethnolinguistic group known as the Tataviam. Some controversy exists in reference to this attribution, as the Tataviam are now extinct and were effectively so prior to the initiation of systematic anthropological studies at the turn of the century (King and Blackburn 1976). But, based on a few existing word lists, descriptions provided by early travelers, mission placenames, and the recollections of other aboriginal informants, the Tataviam are generally accepted as the aboriginal inhabitants of this region. Their language is believed to represent a member of the Takic branch of the Uto-Aztecan linguistic family. In this sense, it was related to other Takic languages in the Los Angeles County region, such as Gabrielino/Fernandeño of the Los Angeles Basin proper, and Kitanemuk of the Antelope Valley.

The Tataviam are thought to have inhabited the upper Santa Clara River drainage from about Piru eastwards to just beyond the Vasquez Rocks/Agua Dulce area; southwards as far as Newhall and the crests of the San Gabriel and Santa Susana Mountains; and northwards to include the middle reaches of Piru Creek, the Liebre Mountains and the southwesternmost fringe of the Antelope Valley (ibid; Kroeber 1925; Earle 1990; Johnson and Earle 1990). Their northern boundary most likely ran along the northern foothills of the Liebre Mountains (i.e., the edge of the Antelope Valley), and then crossed to the southern slopes of the Sawmill Mountains and the Sierra Pelona, extending as far east as Soledad Pass (Earle 1990:94). Ethnographically, at least, the Tataviam do not appear to have controlled the Leona Valley or areas to the north, with the Elizabeth Lake area proper a zone of uncertainty.

Known Tataviam villages during the historic period include: pi?irukung and ?akavaya, both near modern Piru; tsavayu(?u)ng, San Francisquito; etseng, kuvung and huyung, on Piru Creek above Piru; tochonanga, near Newhall; kwarung, Elizabeth Lake; and tsawayung, near Castaic Junction. At kamulus, near modern Rancho Camulos, a mixed Chumash-Tataviam population lived (King and Blackburn 1976:535-6). Because the name kamulus is unquestionably Chumash and not Tataviam, however, the toponym has been viewed as problematical (Johnson and Earle 1990:197); that is, as not reflecting the original (Tataviam) name for this village. Regardless of original name, however, the Spanish missionary Señan, writing in 1804, indicated that the Chumash inhabitants of the village of sécpey had migrated to kamulos, accounting for this admixture (Señan 1962:15). Sécpey is of course now known as Sespe, near the modern town of Fillmore.

The Tataviam, culturally-speaking, were in most respects similar to their Fernandeño and Chumash neighbors, to the south and west, respectively (King and Blackburn 1976). In this sense, they were hunters-gatherers, with subsistence emphasizing yucca, acorns, juniper berries, sage seeds and islay. Game was also hunted, with small animals, such as rabbits/hares and rodents, probably representing more significant contributions of meat protein than larger game, such as deer.

Almost nothing is known of Tataviam social and political organization. Based on analogies with surrounding groups, however, it can be suggested that they were organized in a series of tribelets, similar to the naciones described by Earle (1990) for the Antelope Valley, and found to be characteristic of much of California aboriginal socio-political organization (cf. Kroeber 1925). The tribelet represented an autonomous land-holding unit, minimally controlled by a head-chief or big-man. They usually included one large, 'capital' village, sometimes occupied year-around, and a series of smaller, seasonally inhabited hamlets. Whether the Tataviam may have had exogamous clans and moieties, like the Cahuilla and Serrano to the east, is unknown. However, it is estimated that the Tataviam population was less than 1000 people at the time of Euro-American contact, and that only two or three of the largest villages throughout their territory were inhabited at any given time (King and Blackburn 1976).

It is also likely that Tataviam religion followed the patterns of their surrounding neighbors. In this case, shamanism would have functioned as the central element. This posits a direct and personal relationship between each individual and the supernatural world, with this relationship enacted by entering a trance or hallucinatory state (usually based on the ingestion of psychotomimetic plants, such as jimsonweed or native tobacco). Shamans, per se, who were considered individuals with an unusual degree of supernatural power, served as ritual specialists: ceremonies and rites were infrequent in occasion and limited in type. Perhaps most importantly, shamans served as healers or curers, with the etiology of disease as well as its cure held to lie in the supernatural world. Shamans are also known to have produced the rock art of this region (Whitley 1992), which depicted the hallucinations and spirits they observed in their vision quests.

Although the Tataviam were one of the earliest groups contacted by Spanish missionaries, with a number of their villages described by members of the Portolá expedition of 1769, a general lack of information on this group exists because, by 1810, all Tataviam had been baptized at Mission San Fernando and were quickly absorbed by other groups through intermarriage. The last speaker of Tataviam died in 1916 (King and Blackburn 1976).

1.23 Archaeological Background

Archaeologically speaking, more information is available on the Upper Santa Clara River area, although here, too, less is known than for many of the surrounding regions of southern California. In general terms, the prehistory of this inland area appears to parallel that of the Santa Barbara Channel/southern California coastal zone (cf. McIntyre 1990), with William Wallace's (1955) cultural historical framework appropriate as a chronological system of reference.

Correspondingly, the earliest evidence for human occupation of this region corresponds to Wallace's Early Millingstone Period (or, alternatively, the Early Horizon), dated from about 7000 to 3500 years before present (B.P.). This represents a period during which subsistence and adaptation are said to have emphasized the collecting and processing of hard seeds, with inland artifact assemblages, correspondingly, dominated by mullers and millingstones known as manos and metates. Evidence for an Early Millingstone occupation of the Upper Santa Clara Valley region is, admittedly, limited, and has been found at only two sites. Both of these are located near Vasquez Rocks, with temporal attribution based on the presence of a small number of *Olivella* barrel beads (McIntyre 1990). Such bead types have subsequently proven unreliable temporal indicators, throwing doubt on human inhabitation of this region before about 4000 years ago. Further, recent excavations at one of these putative early locales, the Escondido Canyon Site, failed to uncover evidence for occupation prior to about 2700 years B.P. (Love 1990). Although it is thus likely that this region was used during the Early Millingstone, problems with site preservation or low population numbers have limited our evidence.

The second temporal unit in Wallace's chronology is the Intermediate Period (or Middle Horizon), dated from 3500 to 800 years B.P. It is marked by a shift to the mortar and pestle, with an increased emphasis on hunting and hunting tools in artifact assemblages. Population appears to have increased during this period, with more temporary camps founded. Evidence for Intermediate Period occupation of the Upper Santa Clara Valley region is substantial, in that it has been found at a number of sites and has been based on radiocarbon, obsidian hydration and typological dating (McIntyre 1990). The Agua Dulce village complex, for example, includes occupation extending back to the Intermediate Period, at which time population of the village may have been 50 or more people (King et al n.d.). Furthermore, the Intermediate Period appears to represent a time during which a substantial exploitation of mid-altitude environments first began, with considerable use, for example, of portions of the nearby Hathaway Ranch (located to northwest of the study area) beginning at this time. It is likely that the movement of Takic peoples into the region may have occurred at this time.

Assuming that the Upper Santa Clara River region was first significantly occupied during the Intermediate Period, as existing evidence now suggests, a parallel can be drawn with the inland Ventura County region, where a similar pattern has been identified (Whitley and Beaudry 1991), as well as possibly the Antelope Valley and western Mojave Desert (Sutton 1988a, 1988b). In all of these areas a major expansion in settlement, the establishment of large site complexes, and an increase in the range of environments exploited, appear to have occurred sometime roughly around 3000 years ago. Although most efforts to explain this expansion have focussed on very local circumstances and events, it is increasingly clear that this was a major southern California-wide occurrence, and therefore that explanation of it must be sought at a larger level of analysis.

There is cultural continuity in the inland regions between the Intermediate Period and subsequent times, labeled the Late Prehistoric Period, lasting from 800 years B.P. to historic contact, at about 200 years B.P. However, despite this continuity there is increasing evidence for important changes of certain kinds. The most significant of these involved population sizes: many Intermediate Period villages were abandoned roughly between AD 1000 and 1200. It is not yet clear whether this reflected a reduction of total population numbers or instead just a redistribution of the existing population into fewer but larger villages. What is clear, however, is that while known Late Prehistoric Period villages are often found at existing springs, the early Intermediate Period sites occur at locations that currently lack water. Moreover, it is clear from paleoenvironmental reconstructions that world climate has experienced a period of drought for the last 800 years. It is highly likely that the onset of this cycle of drought contributed to the changes seen in the Intermediate to Late Prehistoric periods transition.

During the Historic Period, the aboriginal population appears to have dropped even more. This, without doubt, can be attributed to the effects of missionization and its attendant relocation of the aboriginal population to centralized locales, along with the depredations of introduced Old World diseases. The Upper Santa Clara River region appears to be one of those inland zones, like the Antelope Valley to the north, that quickly and completely lost its aboriginal population. In particular, the aboriginal population from the Upper Santa Clara Valley was moved into Mission San Fernando, in the San Fernando Valley, and the area was effectively depopulated.

CHAPTER 2
FIELD METHODS

2.1 Introduction

Phase II archaeological fieldwork at sites CA-LAN-351 and NLF/W&S-1 was intended to establish boundaries as well as the significance of each site, and to thereby provide baseline data from which a determination of the ultimate disposition of these cultural resources could be made.

Procedures followed in the collection of data useful for establishing the nature and significance of the sites included mapping, surface collecting of artifacts lying on the groundsurface, and test excavation of pits and/or auger holes to establish the presence or absence of a subsurface archaeological deposit, as well as to characterize such a deposit if found to be present. Because site conditions and our goals differed slightly for the two sites, we discuss these field methods below, on a site by site basis.

2.2 CA-LAN-351

Circumstances with respect to the management issues and therefore the nature of the fieldwork at CA-LAN-351 were somewhat different than those at NLF/W&S-1, and hence warrant a separate discussion. Prior to our fieldwork, the Newhall Land and Farming Company made the decision to preserve CA-LAN-351, in perpetuity, in open-space. The primary goal of our work at this site therefore was exclusively to define its maximum boundaries, meanwhile minimizing any impacts to the site that otherwise might result from archaeological testing (as required by CEQA). Moreover, because of the setting of the site, boundary definition primarily concerned the southwestern quarter of the site: the northern and northwestern edges of the site are clearly defined by steep slopes leading to the third terrace above the river; the eastern and southern boundaries are defined by the stream bed itself. Definition of the southwestern site boundary was particularly important because of the high likelihood that a bridge will one-day be constructed across the Santa Clara river to the west of the site.

Fieldwork at CA-LAN-351 therefore involved two procedures. The first was an intensive visual examination of the surface artifact distribution on the site. This was completed using crew members walking transects across the site spaced at 2 meter intervals, placing pin flags at the locations of surface artifacts and archaeological specimens. This provided a maximum extent for the surface component, which is invariably larger than any subsurface deposit (due to natural and cultural spreading of artifacts, for example by disking or plowing, or downslope movement). Moreover, because the surface scatter associated with a subsurface deposit is typically twice as large as the buried deposit, this also meant that site boundary definition would result in a substantial buffer around the midden deposit.

Once the maximum size of the surface component was established, a series of three auger holes were hand-excavated along the identified southwestern site limit, with soils from these auger holes screened through 1/8th inch mesh. This confirmed that no subsurface archaeological deposit was present along this southwestern edge which might extend beyond the defined site limit.

No artifacts or archaeological specimens, thus, were collected from CA-LAN-351.

2.3 NLF/W&S-1

Fieldwork at site NLF/W&S-1 involved surface collecting, mapping and subsurface excavation. In order to determine the maximum areal extent of the site, the initial field procedure was to locate, map and collect all surface remains present on the groundsurface. In order to identify all such remains, the general area of the site was walked by crew-members spaced in approximate two meter intervals. Identified artifacts and archaeological indicators were then marked with flagging tape. Surface remains found within an area of approximately 3 meters-square in size (i.e., within a circle with a one-meter radius) were treated as discrete artifact associations and collected as clusters. Transit, stadia and surveyor's chain were subsequently used to map all remains or clusters of remains, which were numbered and collected by these provenience points.

Fifteen 1x1 m test pits were hand excavated on the site. Excavation units were designated numerically. Each unit was dug with pick, shovel and trowel in arbitrary ten centimeter spits or levels. Spoils from each of these levels was screened through one-eighth inch mesh. All artifacts and archaeological indicators were collected and bagged by unit level. In the initial excavated units, digging was continued for approximately 50 cm beyond the apparent termination of the cultural deposit and/or an auger was excavated in the bottom of the pit, in order to obtain a clear indication of the soils stratigraphy present. Subsequent to stratigraphic definition and profiling, excavation was continued through two culturally sterile levels (i.e., 20 centimeters), or until parent material was encountered.

Mapping on both sites was provided by Psomas Engineering. This not only provided for very accurate measurement of the two site areas, but also allowed for the delineation of the boundaries of CA-LAN-351 for purposes of preservation.

CHAPTER 3
FIELD RESULTS

3.1 Introduction

Using the procedures outlined above, Phase II fieldwork at sites CA-LAN-351 and NLF/W&S/-1 resulted in the collection of a small but interesting quantity of archaeological remains (although, for reasons discussed previously, the recovered remains were restricted to site NLF/W&S/-1). In the next chapter we discuss the recovered archaeological remains from this site in detail, including a summary of the laboratory procedures by which this collection was processed and analyzed, a review of the site assemblage in typological terms, and an outline of certain of the analytical concerns and conclusions the collection allows us to draw. However, prior to considering the artifact collection in specific terms, below we present a summary of the field results in a more general sense, particularly in reference to the size of the surface manifestations of the site, the presence/absence of subsurface remains, the nature of the soils present, and what these features imply about each cultural resource.

3.2 CA-LAN-351

For the reasons discussed previously, fieldwork at CA-LAN-351 did not involve any artifact collection or excavation but instead was directed towards accurate site boundary definition. This was based on three lines of evidence.

(1) Geomorphological constraints, including the river bottom and steep slopes, conclusively define the limits of the site deposit on the north, south and east, as well as along the northwest quarter; that is, natural conditions which limit the size of the two stream terraces establish all but the boundary along the southwestern edge of the site.

(2) Surface artifact distributions were used to identify the maximum extent of the surface artifact scatter. Surface artifact concentrations were highest along the eastern edge of the deposit, which is formed by a bend in the Santa Clara River. Because the site area overall slopes upwards towards the north, reflecting the fact that it extends across two stream terraces, the eastern site limit represents a cut-bank that is increasingly high towards the north. (Indeed, at the site's northeastern limit this is essentially a cliff-brow.) Surface artifact distribution was continuous across the two lower stream terraces but, on average, did not exceed more than one artifact per meter square, and thinned laterally towards the south and southwest. The maximum southwestern extent of surficial remains – waste flakes – was essentially immediately beyond (and west of) the lowest stream terrace, in the sandy stream bottom (and flood zone).

(3) Auger testing occurred along the southwestern site boundary, as defined by the

surface artifact distribution, to ensure that the subsurface deposit did not extend to this limit. This supposition was proven correct by the auger results, which lacked any evidence of subsurface archaeological remains at the limits of the surface finds.

Using these procedures the site area was defined as a maximum of 215 m NE-SW by 92 m SE-NW. The site area is generally ovoid, and is thus less than 19,780 meters square in size.

Note that, because of the planned preservation of this site, there was no justification for subsurface testing given CEQA's requirement for minimizing adverse effects during environmental evaluations; that is, because archaeological testing is itself inherently destructive. Although we thus did not estimate the size of the subsurface deposit, it is clear that it is substantially smaller than the size of the surface component provided above.

3.3 Site NLF/W&S-1

As noted above, fieldwork at site NLF/W&S-1 involved surface collecting and the excavation of 15 1x1 m pits (Figure 4). In both cases slightly complex and unusual geomorphological conditions at the site were important influences on the field results.

In summary form, the third terrace above the river consists of a large open area that appears relatively flat but, in fact, contains a minor, internally draining central depression. The site area had been disked and graded in some areas, and (unsuccessful) efforts appear to have been made to remove the boulders and cobbles from portions of the surface soil – as evidenced by a large boulder pile to the north of the site. Furthermore, the southern site edge, along the brow of the terrace, appears to have been graded and lowered, suggesting that the internally draining central depression was once more significant than it currently appears; alternatively, this edge may have been reduced by wind but, regardless of cause, the result is a slight lag deposit of coarser clasts and cobbles – a condition with archaeological implications, discussed below. (A dirt road also skirts the southern terrace edge, further contributing to disturbance in this area).

We discuss the excavation and surface collecting in turn below.

3.31 Test excavations at Site NLF/W&S-1

Soils on the site were essentially uniform. Figure 5 is a profile for the most deeply excavated pit, Unit #4. Descriptions of the soil horizons are as follows:

A Horizon: This is a loose, structureless silty loam that ranges from about 30 to 50 cm depth. It is Munsell 10 YR 4/3 (Brown), and it is disturbed by grading, disking and rodents across the entirety of the site area, with rodent disturbance constituting about 30% of the horizon by volume. The A Horizon appears almost aeolian or loess-like. The plow pan extends to about 25 cm depth. The contact between A and the lower B Horizon is gradual. The A Horizon is artifact bearing in portions of the tested area.

B Horizon: This is clayey loam with 1 - 3 cm blocky angular peds. Its thickness ranges from 20 to 90 cm and it appears to be intact, with no evidence for disturbance of any kind. (For example, in addition to the absence of krotovinas, all recovered modern intrusive materials were obtained above the B Horizon.) The color of this paleosol varies slightly, including the following Munsell designations: 10 YR 4/3 (Brown); 7.5 YR 5/4 (Brown); and 7.5 YR 4/4 (Dark Brown). Portions of the B Horizon are artifact bearing.

C Horizon: The parent material is a Pleistocene unit of alluvial cobbles, gravel and sand which has received significant secondary clay enrichment from the B Horizon (as a Holocene imprint). It is Munsell 7.5 YR 4/4 (Dark Brown). The C Horizon is culturally sterile.

Using these soil descriptions for reference, the excavation unit results can be summarized as follows:

Unit #1: This was dug to 40 cm depth; B Horizon was encountered at 30 cm. A Horizon contained 3 pieces of debitage; 1 piece was also recovered from the top of the B Horizon.

Unit #2: Excavated to sterile alluvium at 70 cm depth. A Horizon, from 0 - 30 cm depth, contained 9 pieces of debitage and 1 worked artifact. B Horizon, 30 - 70 cm, contained 19 pieces of debitage and 6 worked artifacts.

Unit #3: Excavated to 40 cm, with B Horizon encountered at 30 cm. Two pieces of debitage recovered from A Horizon; otherwise unit was sterile.

Unit #4: This unit was hand excavated to 100 cm and an auger was then excavated in the pit bottom to 140 cm. This pit location represents the approximate bottom or low point of the central depression. A Horizon extended to 50 cm depth and contained 39 pieces of debitage and 1 worked artifact. B Horizon extended to 140 cm depth, where alluvium was encountered, but artifacts were restricted to 90 cm depth. These consisted of 21 pieces of debitage, 2 worked artifacts and 1 piece of animal bone.

Unit #5: Excavated to 40 cm depth. A Horizon extended to 30 cm and contained 3 pieces of debitage and 1 worked artifact; B Horizon was culturally sterile.

Unit #6: Dug to 30 cm depth (limit of A Horizon). One piece of debitage recovered above 20 cm.

Unit #7: Excavated to 50 cm depth; B Horizon encountered at 30 cm. Five pieces of debitage recovered from A Horizon; B Horizon was sterile.

Unit #8: This pit was taken to 80 cm depth, where Pleistocene alluvium was encountered. B Horizon present from 40 to 80 cm. A Horizon contained 19 pieces of debitage and 2 worked artifacts; B Horizon had 4 pieces of debitage.

Unit #9: Dug to the top of the B Horizon at 30 cm depth. A Horizon had 3 pieces of debitage above 20 cm.

Unit #10: Sterile alluvium encountered at only 40 cm depth and B Horizon present from 30 - 40 cm. Cultural remains limited to 1 piece of debitage in A Horizon, from 0 - 30 cm depth.

Unit #11: This was dug to alluvium, encountered at 60 cm depth. A Horizon extended to 30 cm depth and contained 7 pieces of debitage. B Horizon, from 30 - 60 cm depth, also had 7 pieces of debitage.

Unit #12: Excavated to the top of the B Horizon at 30 cm depth; only 1 piece of debitage encountered from 0 - 30 cm.

Unit #13: Dug to sterile Pleistocene alluvium at 110 cm. A Horizon, from 0 - 50 cm, contained 23 pieces of debitage. B Horizon, from 50 - 110 cm, contained 19 pieces of debitage and 2 animal bones.

Unit #14: This pit was culturally sterile and was dug to the top of the B Horizon at 30 cm depth.

Unit #15: Sterile alluvium encountered at 50 cm depth. A Horizon, from 0 - 30 cm depth, had 10 pieces of debitage. B Horizon, from 30 - 50 cm, contained 8 pieces of debitage.

These excavation results suggest the following. First, soils have accumulated in the central portion of the defined site area (Figure 4), which is essentially a slight depression. Unit #4 is the approximate low point for this depression and the depth of the ancient, culturally sterile Pleistocene alluvium at this spot is the greatest (140 cm below modern groundsurface), as is the thickness of the A (50 cm) and B (90 cm) Horizons. Depth of alluvium and thickness of the A and B Horizons reduce outward from this point, towards the edges of the depression. This is seen most dramatically towards the north where at Unit #10, for example, the alluvium is only 40 cm deep and the B Horizon is only 10 cm thick.

Second, a low density subsurface archaeological deposit is contained within portions of the A and

B Horizons of some of the units. This is best illustrated by Units #2, 4, 11, 13 and 15, although some of the additional pits have traces of subsurface archaeological remains, or remains restricted exclusively to the upper A Horizon alone.

Third, the vertical distribution of the recovered artifacts (which, like most sites, are heavily predominated by lithic debitage or waste flakes) suggests that use of the site as represented by A Horizon materials reflects a continuation of the same areal use seen in the B Horizon; that is, the same units tend to have significant numbers of artifacts in both the A and B Horizons. This prehistoric use centered around Unit #4, and thus the center of the depression.

Fourth, overall site area can be estimated at 210 m E-W by 135 m N-S. The site area is irregular in shape, partly because the eastern and southern boundaries are formed by the terrace edges, but overall site size can be estimated at about 28,350 meters square.

3.32 Surface Collecting at Site NLF/W&S-1

The distribution of surface artifacts (formal tools) was found to correspond to a disturbed band along the southern edge of the site and the terrace that contains it. A total of 26 specimens were recovered during this procedure, almost all of which are groundstone artifacts. Because of the context of recovered artifacts – on the surface in a disturbed area – the interpretation of them is ambiguous. They may represent a "true" surface scatter that is younger than the subsurface deposit; alternatively, they may represent a lag deposit derived from the underlying, deflated cultural deposit. In either case their restricted distribution may reflect a kind of specialized activity zone within the larger site area: as is discussed subsequently, groundstone artifacts recovered from the subsurface deposit also tend to concentrate in this same area, suggesting that the terrace rim – where prevailing winds would optimize seed winnowing – served as the locus for plant processing.

CHAPTER 4
ARTIFACT ASSEMBLAGE AND ANALYTICAL CONCERNS

4.0 Introduction

Although the general patterns of artifact distributions, enumerated in the previous chapter, provide important information relative to the size and nature of site NLF/W&S-1, proper determination of the significance and scientific importance of this resource can only be obtained with a more intensive analysis of the recovered artifact assemblage. Accordingly, in this chapter we consider the assemblage in some analytical detail, and what it implies about the site as well as aspects of the prehistory of the region. We begin by detailing the laboratory procedures followed in the processing and curation of the recovered remains. Subsequently we outline the taxonomic system employed to categorize and classify the artifact collection. This is followed by a typological summary of the artifacts and archaeological indicators recovered from the site, and an interpretation of its age and function.

4.1 Laboratory Procedures

Following the completion of the Phase II fieldwork at NLF/W&S-1, the recovered artifact assemblage was taken to the W & S Consultants' laboratory for washing, processing and analysis. (Note that no artifact collection was obtained at CA-LAN-351, for reasons discussed previously, and thus this site is not considered in this chapter). After each specimen was washed and labeled, metrical and typological analyses were performed. We provide measurements and weights for the various artifacts and archaeological indicators in the site catalogs (Table 1) and artifact class tables (Tables 2 and 3) included in this report. In order to facilitate typological comparisons between this site and others from this same region, we have employed a standardized taxonomic system. We describe this classificatory system in some detail below.

4.12 Taxonomic and Analytical Considerations

In considering the artifacts recovered from the Phase II investigations at site NLF/W&S-1, we employ a morphological stone tool typology first published by Whitley et al (1979) and now widely used in the region. This affords a number of advantages. First, because of its widespread use (e.g., Johnson 1979; W & S Consultants 1984, 1989a, 1989b) it permits easy comparability between existing studies. Second, because it is morphologically rather than functionally based, it provides greater objectivity in taxonomic assignments. Specifically, it avoids the dangers inherent in inferring dubious functional purposes for stone tools that may have had multiple uses, and that often exhibit little in the way of formal attributes. In the inland southern California region, in particular, it is increasingly clear that most sites are characterized by expedient or casual tool assemblages, probably reflecting the fact that the sites resulted from dispersal phase activities that little emphasized formal patterns of behavior (W & S Consultants 1989b). Thus, a typology based on the elucidation of tool manufacturing stages, rather than one assuming final function of the implements, stands less chance of leading interpretations astray. However, this is not to imply that functional interpretations are unwarranted or undesired. Such is not the case; instead, it is simply to emphasize that functional interpretations must be made somewhat independent of - and therefore including other lines of evidence from - the typological assignments alone.

The morphological typology employed here is based on four major categories of stone artifacts (cf. Whitley et al 1979). These are: (i) groundstone implements; (ii) core/cobble tools; (iii) flaked stone tools; and (iv) tool manufacturing waste, or debitage. Groundstone implements are tools that have been pecked and/or ground into shape. They include manos (or mullers) and metates (or basal grinding slabs), along with mortars, pestles, basket hopper mortars, stone bowls and comals (or griddles). Although there is a general association between groundstone artifacts and plant grinding, pulping and processing, as in the case of manos, metates, mortars and pestles, this is not invariably so: stone bowls and comals, for example, had other uses, with certain kinds of bowls, in particular, sometimes reserved for ceremonial purposes.

Groundstone artifacts are usually (but not invariably) made of coarsely grained lithic materials. Metates, for example, are often made from sandstone or grano-diorite; bowls and comals are typically manufactured from steatite (soapstone or talc schist). In the Santa Clara River drainage, Sierra Pelona schist is a particularly common material for flat slab or shallow basin metates, and this is not steatite-grade talc schist. Manos, however, were often derived directly from river cobbles of appropriate size, so that quartzite is a common material source, as are sandstone and granodiorite.

Core/cobble tools are generally large, bulky implements made by the re-use and/or modification of a river cobbles and lithic cores. They include 'hammerstones', 'choppers' and 'scraper planes'. Hammerstones are usually unshaped or minimally shaped, roughly fist-sized, stones that exhibit characteristic battering and pounding scars, but often otherwise lack modification. Choppers are cobbles or cores that have been unifacially or bifacially flaked to create a relatively sharp edge. Scraper planes are high-backed, unifacially flaked tools that are usually 'biscuit-shaped' in plan, with edge angles near perpendicular, and with heavy use-scars along their convex face.

All of these tools were apparently employed for heavy pounding, scraping and/or battering tasks. There is a frequent association of core/cobble tools with groundstone artifacts (specifically manos and metates) in the nearby Conejo Corridor region (Whitley 1979b), suggesting that the two categories may have been functionally related; that is, that core/cobble tools may have served as part of a plant acquisition and processing toolkit. This is supported in reference to the scraper planes, in particular, which are argued to represent special yucca processing tools (Kowta 1969; Salls 1985). Further, this suggests in turn that the core/cobble tools were part of a woman's plant gathering toolkit (W & S Consultants 1989b).

Flaked or chipped stone tools are secondary reductions from cores and cobbles. That is, they represent tools manufactured from flakes struck-off the primary sources of lithic materials. These flakes may be used without modification as 'utilized flakes'; they may be bifacially flaked; or they may be unifacially flaked. It is apparent that the majority of the flaked or chipped stone tools in the region are either utilized flakes with no modification, or have edges that have been flaked unifacially or bifacially, but exhibit little or no effort for further edge modification or shape regularization (W & S Consultants 1989b). Again, this further emphasizes the casual or expedient nature of these tools, and also implies that they may have been used for a variety of tasks with little functional specialization.

Correspondingly, the majority of the chipped stone tools from this region are what we have defined as biface or uniface 'edges', and they may have been used for any number of general cutting, scraping and abrading tasks. Of course, occasional projectile points and drills represent special types of bifaces with specific and known functions, whereas biface 'knives' (large leaf or knife-shaped tools) are presumed to have been used for cutting and piercing/stabbing tasks.

Generally, chipped stone tools were made from material with particular flaking characteristics; specifically, those subject to conchoidal fracture. Crypto-crystallates such as chert, chalcedony and jasper, therefore, are common raw materials, but fused shale, quartzite, cherty-siltstone, rhyolite, andesite, basalt and occasionally obsidian may also be present in a collection. Because small hand specimens of rhyolite, andesite and basalt are, in fact, only distinguishable with petrographic analysis, we treat them all as "fine-grained volcanics". And, as we have recently discovered (W & S Consultants 1991b), "fused sandstone", resulting from contact metamorphism between Miocene Conejo Volcanics and sedimentary beds, was also a lithic material of common use in the region. Because of its similarities to fused shale (based, of course, on similar metamorphic origins), it has often been mistaken for this latter material. This would be inconsequential, save for the assumption that the putative fused shale has its sole origins in Grimes and Happy Camp Canyons, north of Moorpark along the southern edge of the Santa Clara River Valley. Instead, it is apparent that a number of fused sandstone quarries are present in the nearby Conejo Corridor; that their respective lithic materials are widely mis-recognized as fused shale; and that, therefore, lithic exploitation was probably much more widely ranging than the often inferred simple exploitation of major quarries at Grimes Canyon might suggest (W & S Consultants 1991b).

The final category of stone artifacts is what can be considered lithic waste or debitage. It includes spent cores, waste flakes, and angular shatter. There are a number of different kinds of cores and flakes, and the presence of these varieties at a site tends to signify different types of tool reduction or manufacturing techniques. For example, the presence of large numbers of secondary and tertiary flakes usually indicates that chipped stone tool manufacture occurred at a locale, whereas primary flakes alone might be associated with the making of the cruder chipped stone tools, or might be expected at quarries where only the preliminary stages of tool manufacturing were conducted. Similarly, relatively large proportions of tertiary flakes correlate with habitation/campsites, in that tool maintenance and finishing occurred at these locales. Furthermore, because different lithic materials tend to correlate with different categories of tools, the material present in the debitage collection can also be a clue to a site's function. Quartzite and other 'crude' lithic materials, for example, are often found where core/cobble tools are manufactured, whereas crypto-crystallates tend to occur where chipped stone tools are manufactured. And, in a general way, there is an association between these last materials, chipped stone artifacts, and habitation sites (W & S Consultants 1989c).

In addition to the lithic tool typology, other classes of artifacts may be present at southern California sites. Dietary remains, in the form of shellfish and faunal bones, are sometimes present, as are ornaments, usually in the form of shell beads. Faunal remains, in particular, entail a series of analytical problems and issues, however, and therefore warrant some discussion. The most important analytical concern is the taphonomic history of the collection. That is, because bones may occur naturally in the subsoil – especially bones of small mammals such as pocket gophers and ground squirrels that commonly reside and die in burrows – it is not always a straightforward process to determine which specimens in a faunal collection are truly archaeological and which are present as the result of normal animal activities. This problem is compounded by the fact that certain of these same burrowing animals may have been employed as parts of the prehistoric aboriginal diet. Furthermore, domestic dogs and wild coyotes may take or leave bones on sites, while large mammals can die on them after their prehistoric occupation. And, in the case of caves and rockshelters, a very wide range of animals may have lived and died in these sheltered habitats, or have been dropped there by other non-human predators.

Because of these confounding factors we have developed a series of short and general guidelines to aid in determining which specimens are most likely 'cultural', in the sense of having resulted from aboriginal behavior, and which bones are most probably unrelated to the archaeological remains and therefore only within the archaeological deposit due to serendipitous circumstances. In terms of positively determining that a given bone was brought onto a site by human agency we consider the following as useful criteria: (i) butchering and cutting marks; (ii) evidence of burning and charring; (iii) knowledge of the habits of a given species, indicating a low probability of its remains being naturally interred in a particular type of deposit; and (iv) ethnographic information concerning the diet and butchering habits of local aboriginal groups. Information counting against the inclusion of a given bone in a reconstruction of prehistoric diet includes: (a) knowledge concerning the behavior of a given species, indicating a high likelihood of natural deposition in the type of deposit in question; (b) 'freshness' of the bone; (c) absence of butchering marks and burning, or the presence of modern saw-cut marks; and (d) ethnographic data discounting the use of that species by local groups.

Thus, a cut long bone of a deer or a charred rabbit femur both would be considered most probably as 'cultural' specimens, and of course any marine mammal or fish bones could only have been deposited in an archaeological deposit by human activities. By contrast, pocket gopher and ground squirrel bones would be considered with suspicion if derived from an open-air deposit, particularly if they lacked any evidence of butchering or charring.

A second important issue concerns species identification; specifically the problems that complicate it. As is typical of the sites in the region (cf. Reynolds 1978), the large majority of archaeological faunal collections are composed of very small fragments, resulting from a heavy processing of the bones (probably by breaking and smashing) to extract the marrow. The result are faunal collections that are very difficult, if not essentially impossible, to speciate, especially since there are few articulations upon which to base a positive species identification. Consequently, we typically organize faunal specimens into a series of size categories that provide some idea of the probable species (or range of species) from which they were derived. Except in cases in which the bone is so fragmentary so as to preclude any categorization whatsoever, unspeciated bone is assigned to an appropriate size grouping; where possible, the skeletal element is also identified as well. The size categories, with the range of species potentially observable in southern California sites along with certain of their live weights (cf. Reynolds 1978), are as follows:

Small mammal:
Pocket gopher (2.5 - 8.8 ozs)
Kangaroo rat (1.6 - 2.7 ozs)
Harvest mouse (0.3 - 0.6 ozs)
Dusky-footed woodrat (8 - 13.75 ozs)
Meadow mouse (1.5 - 3.5 ozs)
Audobon cottontail (912 gms)
Brush rabbit (1.25 - 1.8 lbs)
Ground squirrel (0.2 - 0.5 lbs)
Western grey squirrel (average = 1.75 lbs)

Medium mammal:
Black-tailed hare (4.4 - 6.1 lbs)
Grey fox (7 - 13 lbs)
Coyote (20 - 50 lbs)
Domestic dog
Racoon (1.8 - 22.2 kg)
Badger (3.6 - 10 kg)
Striped skunk (6 - 14 lbs)
Bobcat (15 - 35 lbs)

Large mammal:
Mule deer (125 - 200 lbs)
Guadalupe fur seal (50 - 100 lbs)
California sea lion (males to 600 lbs, females to 400 lbs)
Grey wolf (60 - 100 lbs)
Horse Domestic sheep Domestic cow

Finally, we are careful to recover, process and catalog all modern or contemporary 'artifacts' recovered during excavations. Such items are important not for any intrinsic reasons, but instead because they provide a clear sign of soil disturbance, typically within the last 100 years.

4.3 Artifact Assemblage: NLF/W&S-1

The artifacts from NLF/W&S-1 are summarized in Table 1. A total of 238 prehistoric specimens was recovered from the site. Twenty-six of these were collected from the site surface. Of the remainder, 125 originated in the A Horizon deposit while 87 were excavated from the B Horizon. All but two of the prehistoric specimens were lithic tools or debitage. The two exceptions are pieces of animal bone. We discuss the artifact assemblage below, in terms of major artifact classes.

4.31 Groundstone artifacts

A total of 28 pieces of groundstone was recovered from NLF/W&S-1 (Table 2). Nineteen of these are manos or mano fragments (Figure 6); eight are metate or metate fragments (Figure 7); one appears to be the base of a basket-hopper mortar (Figure 6). The manos consist of three general types: unshaped unifaces, and shaped and unshaped bifaces (see Whitley et al. 1979).

By far the most common mano type is the shaped biface, which alone contributed 11 of the 19 handstone specimens (~58%). Nine of these correspond to Type 4A, which have domed grinding surfaces and pecked edges (ibid:43). The remaining two are Type 4B, which have parallel grinding surfaces.

Five of the manos (~26%) are Type 3A specimens; that is, unshaped bifaces with domed opposing surfaces. Two manos are type 1, unshaped unifaces, and one mano fragment is untypeable.

The majority (11 or ~58%) of the manos are made of locally available grano-diorite (found in the cobble alluvial deposits along the Santa Clara River). Quartzite is the next most common material with 4 examples (21%). Two manos apiece are made of sandstone and fine-grained volcanics (10.5% each).

A possible basket-hopper mortar was recovered from the surface of the site (Figure 6, left). This consists essentially of a shaped biface mano (Type 4B) that has one grinding surface that is rimmed with an asphaltum stain; asphaltum is also present on the observe side, and seems in fact to cover it, although this is more diffuse. (Alternatively, this may be fire blackening.) The side with the clear rim of asphaltum (shown in the figure) has a series of small central peck marks, suggesting that it was pounded with a pestle. But it lacks the clear central depression that commonly characterizes hopper mortars, and in fact these kinds of pecking marks could have resulted simply from efforts to roughen the grinding surface, to make it more effective as a grinding tool. The functional identification of this implement, hence, must remain provisional.

Eight metate fragments were found at the site. The large majority (6 or 75%) of these were small and untypeable fragments of these basal grinding stones. The two typeable fragments are both Type 2 shallow basin metates (Whitley et al. 1979:33). Grano-diorite is, again, the most common lithic material (4 or 50%), but two examples (25%) are Sierra Pelona schist, with one each (12.5%) of sandstone and quartzite. Sierra Pelona schist is available in the Sierra Pelona, north of the Agua Dulce region, within the upper Santa Clara River drainage.

4.32 Core/cobble complex tools

Seven core/cobble complex tools were found at NLF/W&S-1 (Table 2). Four of these are worked artifacts, per se; the remainder are cores and, thus, strictly are a kind of debitage. Three of the four worked artifacts are hammerstones (Figure 8). All of these are Type 1 unmodified cobble hammerstones (ibid:15). All of the hammerstones are made of quartz. While quartz is the most common mineral on earth, and is locally available in cobble form in many sedimentary deposits, it is somewhat unusual as a tool stone on local archaeological sites. The relatively high proportion of quartz in the core/cobble complex assemblage, however, is matched by its importance in the debitage collection (below).

The other worked tool in the core/cobble complex assemblage is a Type 2 cobble scraper plane (ibid:19). This is made of jasper, which is a common crypto-crystallate in the nearby Mojave Desert. As noted above, scraper planes appear to have been used for pulping purposes, most likely of agave.

The cores are all Type 1 multiplatform cores (ibid:24), and thus show no evidence of systematic lithic reduction. One is chert and the other two are fine-grained volcanic. The larger of these last two specimens is, in fact, a melon-sized piece of basalt that has had just a few flakes removed from it at different spots. As is then clear, lithic reduction was somewhat unsystematic on the site, at least with respect to the primary stage of stone flaking.

4.33 Flaked stone tools

Only two flaked stone tools were recovered from NLF/W&S-1 (Table 1). These consisted of a large and crude uniface "edge;" that is, a primary flake that has experienced a minor amount of unifacial retouch along one edge but is otherwise unshaped. Befitting its large and crude characteristics, this artifact is made of a fine-grained volcanic material.

The second flaked stone tool is a finely flaked biface mid-section (Figure 9). It is made of greenish chert; insofar as we can judge qualitatively, this appears to be tabular Temblor chert that is common to the southern San Joaquin Valley and Carrizo Plain region, rather than Monterey or Franciscan cherts which, otherwise, are more typical in this region.

Bifacially-flaked tool mid-sections (and terminal ends) may derive from knives, in the general sense of the term, projectile points, or drills, while projectile points may be either arrow points or spear/atlatl dart points. Although there are potential overlaps on the dimensions of many of these different types of bifacial tools, as a general rule spear and atlatl points are substantially more robust than arrow points or drills, and they are thicker in cross-section relative to width than knives. (In this portion of southern California knives are typically wide and flat or thin.) Although the assessment is again somewhat qualitative, based on our experience in the region this particular specimen appears to represent a spear or atlatl point, not a knife fragment, and it is clearly neither a drill of arrow fragment. As such, it is then greater than 1500 years old (the point at which the bow and arrows were introduced), although how much older than this datum is unknown.

4.34 Lithic debitage

Waste flakes, per se, are summarized in Table 3. With respect to the total of 236 lithic artifacts recovered from the site (i.e., excluding the 2 pieces of animal bone), the 199 waste flakes and shatter constituted 84% of the lithic assemblage. In fact, this is a relatively low percentage for debitage; a circumstance that is no doubt caused by the large proportion of groundstone and core/cobble complex that were surface collected on the site, and which may pertain to a separate component of the site. A more reliable assessment, accordingly, may be obtained by considering the excavated sample alone (from which all of the debitage was recovered). In this case the excavated debitage constitutes essentially 95% of the total lithics – a figure that is more typical for sites in the region.

When the debitage is classified, angular shatter proves to be the most common waste type, with 100 examples or 50% of the waste stone. This is followed by tertiary flakes, 51 or 26%, secondary flakes, 32 or 16%, and finally primary flakes, 16 or 8%. A preponderance of secondary and especially tertiary flakes is characteristic of habitation sites in the region. Typically, high relative numbers of primary flakes correlate with significant quantities of angular shatter (and cores), and this signifies primary lithic reduction which commonly occurs at quarry workshops, located at or near lithic sources, rather than camps. Site NLF/W&S-1 is somewhat unusual in this regard, having very few primary flakes but a high proportion of angular shatter.

The cause for the relatively large quantity of shatter is explained by the lithic materials themselves. Chert is the most common lithic material in the debitage, with 90 examples or 45%. This is followed by fine-grained volcanics, with 42 or 21%. But quartz is a very close third, with 41 examples or ~21% too. Quartz is useable for stone tools, but it flakes very poorly and is difficult to work. Work with quartz thus will yield high quantities of shatter. A total of 35 examples of quartz angular shatter was recovered from this site; this alone is almost 18% of the debitage total. Angular shatter, in other words, appears to be particularly common in the debitage assemblage because of the kind of lithics being used rather than just because of the lithic reduction activities being followed.

In addition to these three primary lithic sources, five other materials are also included. There are 13 jasper flakes, or ~6.5%, two quartzite flakes for ~4.5%, two fused shale flakes, 1%, and one each of siliceous sandstone and obsidian.

The obsidian is particularly notable, for two reasons. First, the closest obsidian source is the Coso Range near Death Valley in eastern California, roughly 125 miles northeast of the site. Additional desert lithics are present at the site in the form of jasper and, most likely, some of the fine-grained volcanics. While only one small obsidian flake was recovered, the important contrast is the fact that only two fused shale flakes were found. The closest source of fused shale is at the mouth of Grimes Canyon, near Fillmore, only about 25 miles west and downstream of the site; i.e., one-fifth the distance to Coso. In light of the relative proximity of this fused shale source, the quantity of desert lithics appear to stand-out. That is, trade (or at least the acquisition of resources at distance) appears to have favored the east rather than west.

This last conclusion is supported by some negative evidence from the site. While negative archaeological evidence can be difficult to interpret – e.g., because it can result from differential preservational factors rather than by human behavior – it is nonetheless worth noting that NLF/W&S-1 lacked any evidence of western trade (or direct seashore exploitation) in the form of shellfish, fish bone, marine mammal bone or shell ornaments, all of which are common at many inland southern California sites. Provisionally, then, we can suggest that the inhabitants of the site were more closely allied with groups to the east and perhaps north than to the west.

Second, obsidian can be dated by hydration analysis and sourced with XRF. The sample from the site has been submitted to the Northwest Research Obsidian Studies Laboratory in Corvallis, OR, for dating and sourcing, although the results are not yet available for this report.

4.35 Faunal remains

Two small pieces of animal bone were recovered from the site (Table 1), in both cases from the B Horizon. Both examples are small mammal in size and derive from shaft fragments. Both are also burnt and calcined, supporting their origin as cultural rather than natural in the deposit.

The presence of these two specimens suggests that bone preservation can occur within the site soil and thus that the negative evidence – the truly limited amount of faunal remains – is reflective of dietary patterns at this location. That is, this suggests that plant foods rather than hunted game were by far the emphasis in subsistence at NLF/W&S-1. This conclusion is also supported by the presence of groundstone and core/cobble complex tools, which often reflect plant processing activities.

4.4 Age and Function of NLF/W&S-1

Pending receipt of the obsidian hydration dating results, two kinds of information provide evidence concerning the age of NLF/W&S-1. The first of these is the artifact assemblage itself. Three of the recovered artifacts are temporally diagnostic, at least in very general terms. Obsidian is the first of these. Although hydration dating will test this inference, almost all obsidian from this portion of southern California dates before about AD 1200, at which point the desert to inland obsidian trade essentially terminated. The presence of obsidian on the site therefore suggests that it is Intermediate Period or older in age.

The second diagnostic artifact is the possible basket-hopper mortar base, which was found on the site surface. Artifacts of this type occur in Intermediate Period and later contexts, and thus are less than about 3500 years old. Combined with the obsidian, this brackets the site between 3500 and 800 YBP.

Two caveats, however, need to be noted about this age assignment. First, the identification of the specimen at the site as a hopper mortar is provisional inasmuch as it does not have all of the attributes typical of this artifact type. Second, and assuming that the artifact identification is correct, the chronological relationship between the surface assemblage and the subsurface deposit is still somewhat uncertain. The surface artifacts, including this specimen, were found in a restricted and disturbed area. This may reflect locational task specialization on the site; alternatively the surface component may be later dating than the subsurface deposit, potentially quite significantly. Note however that the horizontal distribution of groundstone and core/cobble complex tools recovered during excavation tends to follow the same pattern as the surface concentration, with the majority found in Unit #2 nearest to the terrace edge. There is thus reason to infer that the surface component and subsurface components are functionally and probably temporally related.

The third temporal diagnostic is the projectile point, which is clearly a spear or atlatl dart fragment rather than the remnants of an arrow point. This indicates that the specimen is greater than about 1500 years B.P., although how much greater in age is unknown. We may thus provide a minimal age bracket for NLF/W&S-1 between 3500 and 1500 YBP, which is the Intermediate Period. Note that this is a minimum estimate for the site age; it could contain artifacts that are both younger and older than this 2000 years stretch.

Note that in addition to these positive lines of evidence within the artifact assemblage, there is also negative evidence in support of this age estimate. This concerns the absence of later dating artifacts, especially arrow points and shell beads.

The second type of information useful for dating the site is the soils context of the subsurface component. As described above, the artifacts extended into an undisturbed B Horizon or paleosol. Soils such as this are formed in wetter climates than we are experiencing today and they are most common in contexts that are 3000 or more years in age, thus dating from the middle Holocene (or earlier).

Based on these different lines of evidence, the age of site NLF/W&S-1 can be inferred minimally to pertain to the middle Holocene. Assuming that the identification of the hopper mortar is correct, it extends into the last 3500 years and thus is all or at least partly Intermediate Period in age. Whether it extends back into Early Millingstone times is unknown although the nature of the soils suggests that this is possible.

That is, we hypothesize that the site is terminal Early Millingstone/early Intermediate Period in age. Assuming this is correct, it then appears contemporaneous with site CA-LAN-2233, located at Chiquito Canyon roughly 10 miles downstream from NLF/W&S-1. The early component of CA-LAN-2233 is argued to date from 4000 - 3000 YBP (Waugh 1999), and this appears to represent the initial occupation of the region.

Functionally, site NLF/W&S-1 is best interpreted as a small campsite. This is indicated by the diversity of artifact types, which includes hunting tools (projectile point) and evidence of lithic reduction (cores, debitage and hammerstones), in addition to plant processing artifacts (groundstone, scraper plane). Plant foods, however, were clearly the subsistence emphasis. Judging from the preponderance of manos and metates (as opposed to mortars and pestles), hard seeds as opposed to acorns appear to have been the focus of the prehistoric diet at the site.

Given its size and the relatively low subsurface density of artifacts, site NLF/W&S-1 appears to have been occupied by a small group of individuals (perhaps a single extended family), sporadically for a long period. Logically, the site would have been used seasonally as a dispersal phase camp. This last conclusion is supported by the negative archaeological evidence at the site, which includes the absence of features like housepits, hearths and burials, as well as more formal types of tools, including shell beads and ornaments. NLF/W&S-1, then, is likely one seasonal component of the early prehistoric settlement system for the upper Santa Clara River drainage.

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary and Conclusions

Phase II archaeological studies were conducted at two prehistoric archaeological sites, designated CA-LAN-351 and NLF/W&S-1, within the River Park project area, northern Los Angeles County, California. This Phase II fieldwork involved mapping, the surface collecting of groundsurface artifacts and archaeological indicators, and the hand excavation of test pits on site NLF/W&S-1, along with laboratory processing, cataloging and analyses of the recovered artifact collection. Because CA-LAN-351 was already designated for in-situ preservation, fieldwork at it was limited to boundary definition.

CA-LAN-351 was found to cover two low terraces along the north side of the Santa Clara River. Site area is 215 m NE-SW by 92 m SE-NW, and thus totals about 19,780 meters square in size.

Site NLF/W&S-1 was found to be a small, low density campsite localized on the third terrace above the river. The site area was determined to be 210 m E-W by 135 m N-S, or about 28,350 meters square, and the site includes a low density subsurface deposit that averages about 50 cm in depth. Based on the recovered artifact assemblage, the site appears to represent a terminal Early Millingstone/early Intermediate Period settlement dating from circa 4000 to 2000 YBP. It further appears to have been seasonally occupied by a small group of people, whose subsistence practices emphasized plant foods, probably hard seeds.

5.2 Final recommendations for CA-LAN-351

CA-LAN-351 contains a subsurface archaeological deposit and intact prehistoric artifacts that can contribute to the scientific reconstruction of prehistoric lifeways in the Santa Clara River Valley. Development at this locale has the potential to result in adverse impacts to cultural resources. Following the California Environmental Quality Act (CEQA), therefore, we recommend that any such adverse impacts to this site be mitigated by avoidance and preservation. Should preservation of this site be unfeasible, however, we recommend that a Phase III data recovery (salvage excavation) project be completed at CA-LAN-351, to collect and preserve the scientific information contained therein.

5.3 Final recommendations for site NLF/W&S-1 CA-LAN-3043

Archaeological site NLF/W&S-1 contains an intact subsurface deposit and artifacts which hold the potential for contributing to our understanding of the prehistory of this portion of California.

Construction or development on this site therefore has the potential to result in adverse impacts to significant cultural resources. We recommend that any such adverse impacts be mitigated by avoidance and preservation. Should this be unfeasible, we recommend that a Phase III data recovery (salvage excavation) be conducted on the site.

6.0
CITED REFERENCES

Earle, D.
1990 New Evidence on the Political Geography of the Antelope Valley and the Western Mojave Desert at Spanish Contact. In B. Love and W.H. DeWitt, eds., Archaeology and Ethnohistory of the Antelope Valley and Vicinity, Antelope Valley Archaeological Society, Occasional Papers No. 2, pp. 87-104.

Eberhart, H.
1961 The Cogged Stones of Southern California. American Antiquity 26:361-370.

Elsasser, A.B. and R.F. Heizer
1963 The Archaeology of Bowers Cave, Los Angeles County, California. University of California, Archaeological Survey, Reports, No. 59. Berkeley.

Glassow, M.A.
1965 The Conejo Rockshelter: An Inland Chumash Site in Ventura County. Archaeological Survey, Annual Report 7:19-80. UCLA.

Heizer, R.F. and E.M. Lemert
1947 Observations on Archaeological Sites in Topanga Canyon, California. University of California Publication in American Archaeology and Ethnology 44(2):237-258.

Holmer, R.
1986 Common Projectile Points of the Intermountain West. In Anthropology of the Desert West, ed. by CJ Condie and DD Fowler, pp. 89-116. University of Utah Press, Anthropological Papers, Number 110.

Horne, S.P.
1981 The Inland Chumash: Ethnography, Ethnohistory and Archeology. Ph.D. dissertation, UCSB.

Johnson, J.
1978 The Road to Kashtiq. Journal of California Anthropology 5:188-198.

Johnson, J. and D. Earle
1990 Tataviam Geography and Ethnohistory. Journal of California and Great Basin Anthropology 12:191-214.

Johnson, K.L.
1966 Site LAN-2: A Late Manifestation of the Topanga Complex in Southern California Prehistory. Anthropological Records 23. UC Berkeley.

Johnson, M.
1980 Archaeological Investigations at Ven-271. In Inland Chumash Archaeological Investigations, edited by D.S. Whitley, E. McCann and C.W. Clewlow, Jr. Institute of Archaeology, Monograph 15, UCLA.

King, C.D.
1981 The Evolution of Chumash Society: A Comparative Study of Artifacts Used in Social System Maintenance in the Santa Barbara Channel Region. PhD dissertation, UCD.

King, C.D. and T. Blackburn
1976 Tataviam. In: Handbook of North American Indians, Volume 8, California. R. Heizer, editor, pp. 535-537. Smithsonian Institution.

King, C., C. Smith and T. King
n.d. Archaeologial Report Related to the Interpretation Archaeological Resources Present at the Vasquez Rocks County Park. Report on file, UCLA AIC

Kowta, M.
1969 The Sayles Complex: A Late Milling Stone Assemblage from the Cajon Pass and the Ecological Implications of Its Scraper Planes. Publications In Anthropology, 6. University of California, Berkeley.

Kroeber, A. L.
1925 Handbook of the Indians of California. Bureau of American Ethnology, Bulletin 78.

Love, B.
1990 Archaeological Testing of a Portion of LAn-618, the Escondido Canyon Site, Near Agua Dulce, Los Angeles County, California. In B. Love and W.H. DeWitt, eds., Archaeology and Ethnohistory of the Antelope Valley and Vicinity, Antelope Valley Archaeological Society, Occasional Papers No. 2, pp.21-42.

McIntyre, M.
1990 Cultural Resources of the Upper Santa Clara River Valley, Los Angeles and Ventura Counties, California. In B. Love and W.H. DeWitt, eds., Archaeology and Ethnohistory of the Antelope Valley and Vicinity, Antelope Valley Archaeological Society, Occasional Papers No. 2,

pp. 1-20.

Moratto, M.
1984 California Archaeology. Academic Press, New York.

Muntz, P.A.
1974 A Flora of Southern California. Berkeley: University of California.

Reynolds, R.
1979 Faunal Analysis. In J. Pritchett and A. McIntyre, The Running Springs Ranch Site: Archaeological Investigations at Ven-65 and Ven-261. Institute of Archaeology Monograph 12, UCLA.

Rogers, D.B.
1929 Prehistoric Man of the Santa Barbara Coast. Santa Barbara Museum of Natural History. Santa Barbara, California.

Rosen, M.D.
1978 Archaeological Investigations at Ven-294, an Inland Chumash Village Site. In The Archaeology of Oak Park, Ventura County, California, Vol. II, ed. by C.W. Clewlow, H.F. Wells and A.G. Pastron, pp. 7-114. UCLA Institute of Archaeology, Monograph V.

Salls, R.
1985 The Scraper Plane: A Functional Interpretation. Journal of Field Archaeology 12(1):99-106.

Señán, J.
1962 The Letters of José Señán, OFM: Mission San Buenaventura 1796-1823. (Translated by P.D. Nathan, Edited by L.B. Simpson). Ventura: Ventura County Historical Society.

Sutton, M.Q.
1988a An Introduction to the Archaeology of the Western Mojave Desert, California. Archives of California Prehistory, No. 14. Salinas: Coyote Press.

1988b On the Late Prehistory of the Western Mojave Desert. Pacific Coast Archaeological Society Quarterly 24(1):22-29.

Treganza, A.E. and A. Bierman
1958 The Topanga Culture: Final Report on Excavations, 1948. Anthropological

Records 20:2. UC Berkeley.

Treganza, A.E. and C.G. Malamud
1950 The Topanga Culture: First Season's Excavations at the Tank Site, 1947. Anthropological Records 12:4.

W & S Consultants
1984 Archaeological Investigations at Sites CA-Ven-315, -323, -324, -325, -326 and -327, Thousand Oaks, Ventura County, California. Manuscript on file, City of Thousand Oaks.

1989a Archaeological Test Excavations at Fifteen Prehistoric Sites in the Lake Sherwood Development Area, Ventura County, California. Manuscript on file, County of Ventura.

1989b Phase II Archaeological Test Excavations at CA-Ven-982 and -983, Dos Vientos Ranch, Newbury Park, Ventura County, California. Manuscript on file, City of Thousand Oaks.

1989c Preliminary Archaeological Investigations at Sites CA-VEN-221, -222, -705, -706, -708, -709, and -710 on the Ahmanson Ranch, Ventura County, California. Manuscript on file, County of Ventura.

1991a Phase II Archaeological Test Excavations at CA-KER-1115, -1118 and -1947, Near Cache Peak, Kern County, California. Manuscript on file, CSUB AIC.

1991b Phase II Archaeological Test Excavations at CA-VEN-478, -1038, -1042/H, -1043, -1044, -1045 and -1046, TPM 4687, Ventura County, California. Manuscript on file, County of Ventura.

1992a Phase III Data Recovery at Archaeological Site CA-VEN-654, Thousand Oaks, Ventura County, California. Manuscript on file, UCLA AIC.

1992b Phase II Archaeological Test Excavations at CA-LAN-1884, -1886 and -1887, VTT #49856, Calabasas, Los Angeles County, California. Manuscript on file, UCLA AIC.

1993 Phase II Archaeological Test Excavations at CA-LAN-760A/H, -760B, -760C, -866, -867A and -867B, Calabasas, Western Los Angeles County, California. Manuscript on file, W & S Consultants.

1994a Phase I Archaeological Survey of the West Ranch Study Area, Western Los Angeles County, California. Manuscript on file, W & S Consultants.

1994b Phase III Data Recovery at CA-SBA-1661, Santa Barbara County, California.

Manuscript on file, W & S Consultants.

Wallace, W.
1955 A Suggested Chronology for Southern California Coastal Archaeology. Southwestern Journal of Anthropology 11 (3):214-230.

Waugh, G.
1999 A Study in the Prehistory of the Santa Clara River Valley: Archaeological Data Recovery at CA-LAN-2233, Los Angeles County, California. CALTRANS, Sacramento.

Whitley, D.S.
1979a A Historical Perspective on the Research at Oak Park. In The Archaeology of Oak Park, Ventura County, California, Volume 3. Edited by C.W. Clewlow and D.S. Whitley. Institute of Archaeology, Monograph 11. UCLA.

1979b Subsurface Features, Toolkits and a Sweathouse Pit at the Ring Brothers Complex. In Archaeological Investigations at the Ring Brothers Site Complex, Thousand Oaks, California, edited by C.W. Clewlow, Jr., D.S. Whitley and E.L. McCann, pp. 101-110. Institute of Archaeology, Monograph 13. UCLA.

1992 Shamanism and Rock Art in Far Western North America. Cambridge Archaeological Journal 2(1):89-113.

1994 By the Hunter, For the Gatherer: Art, Social Relations and Subsistence Change in the Western Great Basin. World Archaeology 25:356-373.

Whitley, D.S. and M.P. Beaudry
1991 Chiefs on the Coast: Developing Chiefdoms in the Tiquisate Region in Ethnographic Perspective. In The Development of Complex Societies in Southeastern Mesoamerica, edited by W. Fowler. CRC Press, Orlando.

Whitley, D.S., G. Gumerman IV, J. Simon and T. Rose
1988 The Late Prehistoric Period in the Coso Range and Environs. Pacific Coast Archaeological Society, Quarterly 24(1):2-20.

Whitley, D.S., E.L. McCann, J.M. Simon and M.P. Drews
1979a Artifacts from the Ring Brothers Complex. In Archaeological Investigations at the Ring Brothers Site Complex, Thousand Oaks, California, edited by C.W. Clewlow, Jr., D.S. Whitley and E.L. McCann, pp. 11-100. Institute of Archaeology, Monograph 13. UCLA.

Whitley, D.S., J. Simon and G. Gumerman IV
n.d. Out West at 3500 Years B.P. Manuscript.

Yohe, R.M.
1992 A Reevaluation of Western Great Basin Cultural Chronology and Evidence for the Timing of the Introduction of the Bow and Arrow to Eastern California Based on New Excavations at the Rose Spring Site (CA-INY-372). PhD dissertation, UCR.

7.0
TABLES

List of Tables

TABLE 1: W&S / NLF-1 ARTIFACT CATALOG

Cat#	Unit/Level	Material	L x W x T	#/wt.(gms.)	Description
1	surface	grano-diorite			mano fragment- type 3A
2	surface	grano-diorite			mano- type 4A
3	surface	fgv			wasted core- type 1
4	surface	quartzite			mano- type 3A
5	surface	grano-diorite			mano- type 4A
6	surface	fgv			mano fragment- type 3A
7	surface	fgv			mano fragment- type 4A
8	surface	quartzite			metate fragment- untypeable
9	surface	chert			core- type 1
10	surface	grano-diorite			mano fragment- type 3A
11	surface	grano-diorite			metate fragment- untypeable
12	surface	grano-diorite			mano- type 3A
13	surface	grano-diorite			mano- type 4A
14	surface	grano-diorite			metate fragment- untypeable
15	surface	quartzite			mano- type 4B
16	surface	sandstone			mano/hopper morter?
17	surface	sandstone			metate fragment- untypeable
18	surface	grano-diorite			mano- type 1
19	surface	grano-diorite			mano- type 4A
20	surface	grano-diorite			mano- type 4A
21	surface	quartzite			mano- type 1
22	surface	schist			metate fragment- untypeable
23	surface	basalt			core- type 1
24	surface	schist			metate fragment- type 2
25	surface	grano-diorite			metate fragment- type 2
45	surface	quartz	6.02x4.51x3.84	112.4	hammerstone- type 1
26	1/10-20	lithic		1/3.8	debitage
27	1/20-30	lithic		2/1.9	debitage
28	1/30-40	lithic		1/26.0	debitage
29	2/0-10	lithic		6/17.1	debitage
30	2/10-20	grano-diorite			mano fragment- untypeable
31	2/10-20	lithic		2/82.0	debitage
32	2/20-30	lithic		1/26.8	debitage
33	2/30-40	lithic		6/47.0	debitage
34	2/30-40	quartzite			mano fragment- type 4A
35	2/30-40	sandstone			mano- type 4B
36	2/30-40	chert	4.56*x2.71x1.12	15.6	biface fragment
44	2/30-40	fgv	7.95x4.95x5.17	86.1	crude uniface
37	2/40-50	quartz	7.50x5.51x5.42	321.7	hammerstone- type 1
38	2/40-50	quartz	7.09x6.17x4.52	209.7	hammerstone- type 1
39	2/40-50	lithic		7/57.50	debitage
40	2/50-60	lithic		6/56.4	debitage
41	3/20-30	lithic		2/2.9	debitage
42	4/0-10	glass		1/41.8	bottle fragment
43	4/0-10	lithic		3/1.6	debitage
46	4/0-10	sandstone	5.54x5.38x3.03	141.0	scraper plane
47	4/10-20	lithic		6/10.9	debitage
48	4/20-30	lithic		8/15.9	debitage

TABLE 1: W&S / NLF-1 ARTIFACT CATALOG

49	4/30-40	lithic		13/40.6	debitage
50	4/40-50	lithic		7/10.5	debitage
51	4/50-60	lithic		7/10.4	debitage
73	4/60-70	lithic		8/102.0	debitage
52	4/60-70	jasper	5.34x4.35x2.81	71.5	scraper plane
53	4/60-70	grano-diorite			mano fragment- type 4A
54	4/70-80	lithic		4/4.8	debitage
55	4/70-80	bone		1/2.1	faunal remains- shaft frag.
56	4/80-90	lithic		2/4.3	debitage
57	5/0-10	lithic		1/.3	debitage
58	5/10-20	lithic		1/.1	debitage
59	5/10-20	sandstone			mano fragment- type 4A
60	5/20-30	lithic		1/4.2	debitage
61	6/10-20	lithic		1/4.9	debitage
62	7/0-10	lithic		1/1.0	debitage
63	7/10-20	lithic		1/1.2	debitage
64	7/20-30	lithic		3/2.4	debitage
65	8/0-10	lithic		4/20.6	debitage
66	8/10-20	lithic		3/4.2	debitage
67	8/20-30	lithic		3/8.5	debitage
68	8/20-30	gneiss			metate fragment- untypeable
69	8/30-40	lithic		9/18.0	debitage
70	8/30-40	quartzite	7.39x6.71x6.09	396.7	hammerstone- type 1
93	8/40-50	lithic		2/20.4	debitage
71	8/50-60	lithic		1/1.2	debitage
72	8/60-70	lithic		1/22.0	debitage
74	9/0-10	lithic		1/4.1	debitage
75	9/10-20	lithic		2/1.5	debitage
76	10/20-30	lithic		1/3.6	debitage
77	10/20-30	plastic		1/.2	non-i.d. fragment
78	11/0-10	lithic		4/10.2	debitage
79	11/10-20	lithic		2/1.3	debitage
80	11/20-30	lithic		1/9.4	debitage
81	11/30-40	lithic		5/8.8	debitage
82	11/40-50	lithic		2/10.4	debitage
83	12/10-20	lithic		1/2.2	debitage
84	13/0-10	metal		3/9.7	wire-cut nails
85	13/0-10	lithic		4/6.2	debitage
86	13/10-20	lithic		4/4.4	debitage
87	13/20-30	lithic		4/6.1	debitage
88	13/30-40	lithic		3/4.5	debitage
89	13/40-50	lithic		5/33.8	debitage
90	13/50-60	lithic		5/40.8	debitage
91	13/60-70	lithic		6/11.8	debitage
92	13/60-70	bone		1/.7	faunal remains- shaft frag.
94	13/70-80	lithic		5/14.5	debitage
95	13/80-90	lithic		2/5.8	debitage
96	13/80-90	bone		1/.7	faunal remains- shaft frag.
97	13/90-100	lithic		1/2.0	debitage

TABLE 1: W&S / NLF-1 ARTIFACT CATALOG

98	14/0-10	glass	4/3.2	bottle fragments
99	15/0-10	lithic	6/16.1	debitage
100	15/10-20	lithic	2/1.7	debitage
101	15/20-30	lithic	2/1.5	debitage
102	15/30-40	lithic	5/3.8	debitage
103	15/40-50	lithic		debitage

TABLE 1: W&S / NLF-1 ARTIFACT CATALOG

98	14/0-10	glass	4/3.2	bottle fragments
99	15/0-10	lithic	6/16.1	debitage
100	15/10-20	lithic	2/1.7	debitage
101	15/20-30	lithic	2/1.5	debitage
102	15/30-40	lithic	5/3.8	debitage
103	15/40-50	lithic	3/28.4	debitage

TABLE 2: W&S / NLF-1 GROUNDSTONE & CORE/COBBLE COMPLEX TOOLS

Cat#	Unit/Level	Material	L x W x T	#/wt.(gms.)	Description
1	surface	grano-diorite	11.38x6.31*x6.46	682.6	mano fragment- type 3A
2	surface	grano-diorite	12.10x10.12x5.91	1286.6	mano- type 4A
3	surface	fgv	9.78x10.08x7.65	596.8	wasted core- type 1
4	surface	quartzite	11.98x9.73x5.41	1115.7	mano- type 3A
5	surface	grano-diorite	13.25x9.11x5.50	1048.1	mano- type 4A
6	surface	fgv	9.45*x7.99x4.32*	365.7	mano fragment- type 3A
7	surface	fgv	3.49*x4.33*x5.84	113.2	mano fragment- type 4A
8	surface	quartzite	8.51*x7.53*x6.55*	585.9	metate fragment- untypeable
9	surface	chert	7.68x5.37x3.86	161.1	core- type 1
10	surface	grano-diorite	13.08x10.29*x4.45	796.9	mano fragment- type 3A
11	surface	grano-diorite	11.15*x10.03*x5.85*	658.2	metate fragment- untypeable
12	surface	grano-diorite	13.13x10.27x5.93	1082.9	mano- type 3A
13	surface	grano-diorite	10.45x8.49x4.94	639.6	mano- type 4A
14	surface	grano-diorite	18.3*x11.6*x11.3*	1907.2	metate fragment- untypeable
15	surface	quartzite	15.19x9.78x5.30	1254.4	mano- type 4B
16	surface	sandstone	12.44x9.76x5.27	989.2	mano/hopper morter?
17	surface	sandstone	14.5*x8.9*x6.6*	1218.6	metate fragment- untypeable
18	surface	grano-diorite	14.05x8.37x6.36	1085.2	mano- type 1
19	surface	grano-diorite	13.76x9.77x6.67	1407.2	mano- type 4A
20	surface	grano-diorite	12.22x7.38x5.57	771.2	mano- type 4A
21	surface	quartzite	12.26x10.97x8.29	1547.2	mano- type 1
22	surface	schist	21.2x13.3x4.8	1897.9	metate fragment- untypeable
23	surface	basalt	14.37x8.43x6.52	1276.6	core- type 1
24	surface	schist	34.2x17.2x3.9	6 lbs.	metate fragment- type 2
25	surface	grano-diorite	26.7x25.8x9.7	13 lbs.	metate fragment- type 2
45	surface	quartz	6.02x4.51x3.84	112.4	hammerstone- type 1
30	2/10-20	grano-diorite	9.81*x4.61*x5.82*	371.9	mano fragment- untypeable
34	2/30-40	quartzite	7.29*x5.34*x5.49*	265.6	mano fragment- type 4A
35	2/30-40	sandstone	12.22x9.42x4.22	728.6	mano- type 4B
53	4/60-70	grano-diorite	7.69*x8.54x4.38	556.4	mano fragment- type 4A
59	5/10-20	sandstone	9.65*x9.43x4.87	595.9	mano fragment- type 4A
68	8/20-30	gneiss	19.1x7.6x5.4	1252.2	metate fragment- untypeable

TABLE 3: W&S / NLF-1 DEBITAGE

Cat#	Unit/Level	Material	#/wt.(gms.)	Type
26	1/10-20	chert	1/3.8	S-1
27	1/20-30	chert	1/.8	AS-1
		jasper	1/1.1	AS-1
28	1/30-40	quartzite	1/26.0	P-1
29	2/0-10	chert	4/8.6	AS-4
		jasper	1/2.5	AS-1
		quartzite	1/6.0	P-1
31	2/10-20	chert	1/4.2	AS-1
		quartzite	1/77.8	P-1
32	2/20-30	jasper	1/26.8	AS-1
33	2/30-40	chert	3/12.2	P-1, T-1, AS-1
		fgv	2/8.6	S-2
		quartz	1/26.2	AS-1
39	2/40-50	chert	1/25.3	P-1
		quartz	1/2.0	AS-1
		jasper	1/18.2	P-1
		fgv	4/12.0	S-4
40	2/50-60	jasper	2/48.8	AS-2
		fgv	3/6.7	S-3
		fused shale	1/1.9	S-1
41	3/20-30	chert	2/2.9	S-1, AS-1
43	4/0-10	chert	1/.5	T-1
		jasper	1/1.0	T-1
		fgv	1/.1	T-1
47	4/10-20	chert	4/6.1	T-3, AS-2
		jasper	1/3.5	S-1
		fgv	1/1.3	S-1
48	4/20-30	chert	4/3.9	AS-4
		quartz	1/8.0	P-1
		fgv	1/2.7	S-1
		jasper	2/1.3	T-1,AS-1
49	4/30-40	chert	5/1.7	T-2,AS-3
		quartz	3/6.5	AS-3
		fgv	5/32.4	P-2, S-1,T-2
50	4/40-50	chert	1/.1	T-1
		quartz	3/7.2	AS-3
		fgv	3/3.1	T-2, AS-1
51	4/50-60	chert	2/.2	T-2
		fgv	2/.4	T-1
		sandstone	1/3.6	S-1
73	4/60-70	chert	1/4.9	AS-1
		quartz	5/152.0	P-2, AS-3
		quartzite	1/84.6	P-1
		fgv	1/.5	T-1
54	4/70-80	quartz	1/1.4	AS-1
		fgv	1/2.5	AS-1
		chert	2/.9	T-2
56	4/80-90	chert	1/.3	T-1

TABLE 3: W&S / NLF-1 DEBITAGE

		fgv	1/4.0	S-1
57	5/0-10	chert	1/.3	T-1
58	5/10-20	obsidian	1/.1	T-1
60	5/20-30	chert	1/4.2	AS-1
61	6/10-20	chert	1/4.9	AS-1
62	7/0-10	chert	1/1.0	AS-1
63	7/10-20	chert	1/1.2	AS-1
64	7/20-30	chert	1/.8	S-1
		fgv	2/1.6	S-1, T-1
65	8/0-10	chert	2/5.8	AS-2
		jasper	1/2.5	AS-1
		quartz	1/12.3	AS-1
66	8/10-20	chert	3/4.2	T-1, AS-2
67	8/20-30	quartz	1/.4	T-1
		fgv	1/4.3	S-1
		jasper	1/3.8	AS-1
69	8/30-40	chert	2/15.2	AS-2
		quartz	6/11.8	AS-6
		quartzite	1/1.0	AS-1
93	8/40-50	chert	2/20.4	AS-2
71	8/50-60	quartz	1/1.2	AS-1
72	8/60-70	quartz	1/22.0	AS-1
74	9/0-10	chert	1/4.1	AS-1
75	9/10-20	chert	1/.1	T-1
		fgv	1/1.4	S-1
76	10/20-30	fgv	1/3.6	S-1
78	11/0-10	chert	1/.1	T-1
		quartzite	1/4.8	S-1
		jasper	2/5.3	T-1, AS-1
79	11/10-20	chert	2/1.3	T-2
80	11/20-30	chert	1/9.4	AS-1
81	11/30-40	chert	2/1.4	T-1, AS-1
		quartzite	1/4.0	AS-1
		fgv	1/3.0	AS-1
		jasper	1/.4	T-1
82	11/40-50	quartzite	1/.6	T-1
		fgv	1/9.8	P-1
83	12/10-20	quartz	1/2.2	AS-1
85	13/0-10	chert	3/5.8	T-1, AS-2
		quartz	1/.4	AS-1
86	13/10-20	chert	3/1.9	T-2, AS-1
		fgv	1/2.5	S-1
87	13/20-30	chert	3/4.3	T-1, AS-2
		fgv	1/1.8	AS-1
88	13/30-40	chert	2/4.2	S-1, AS-1
		quartz	1/.3	AS-1
89	13/40-50	quartz	2/21.6	AS-2
		fgv	3/11.2	S-3
90	13/50-60	quartz	3/34.7	P-1, AS-2

TABLE 3: W&S / NLF-1 DEBITAGE

		chert	2/6.1	T-1, AS-1
91	13/60-70	chert	4/7.3	T-2, AS-2
		fgv	1/.8	T-1
		quartz	1/3.7	AS-1
94	13/70-80	chert	2/1.9	T-1, AS-1
		fgv	1/.5	T-1
		quartz	1/.3	AS-1
		quartzite	1/11.8	P-1
95	13/80-90	chert	1/2.1	AS-2
		quartz	1/3.7	AS-1
97	13/90-100	quartz	1/2.0	AS-1
99	15/0-10	chert	5/14.5	S-1, T-2, AS-2
		quartz	1/1.6	AS-1
100	15/10-20	fgv	1/1.0	T-1
		quartz	1/.7	T-1
101	15/20-30	chert	2/1.5	T-1, AS-1
102	15/30-40	quartz	2/2.4	AS-2
		fgv	2/1.2	T-2
		fused shale	1/.2	T-1
103	15/40-50	chert	2/6.9	S-2
		fgv	1/21.3	P-1

ADDENDUM TO
PHASE II ARCHAEOLOGICAL TEST EXCAVATIONS FOR THE RIVER PARK PROJECT AREA, NORTHERN LOS ANGELES COUNTY, CALIFORNIA

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23 November 2003

ADDENDUM TO
PHASE II ARCHAEOLOGICAL TEST EXCAVATIONS FOR THE RIVER PARK PROJECT AREA, NORTHERN LOS ANGELES COUNTY, CALIFORNIA

Introduction

In 2002, Phase II archaeological test excavations were conducted at sites CA-LAN-315 and CA-LAN-3043, within the River Park project area, for the Newhall Land and Farming Company, Valencia, California (W&S Consultants 2002). Following a request by the City of Santa Clarita, W&S Consultants conducted additional test excavations on CA-LAN-3043 for NLFC in 2003. This document is a report on this additional fieldwork, completed in October of this year, and it is intended to serve as an addendum to the previous report on the site. Note that, at the time of the initial test excavation in 2002, site CA-LAN-3043 was given the temporary designation of NLF/W&S-1, and is so-referenced in the previous report.

Background and Field Methods

Archaeological site CA-LAN-3043 is located on the north bank of the upper Santa Clara River in Saugus, northwestern Los Angeles County, California. Recorded by W&S Consultants in 2001, the site is located on the third terrace above the stream bed at an elevation ranging from about 1280 to 1285 feet. The site is separated by a steep slope from site CA-LAN-351, found on the first and second terraces of the river in this same area.

Previous Phase II testing at site CA-LAN-3043, completed in 2002, involved the hand excavation of fifteen 1x1 meter test pits along with surface collection and mapping. This site proved to contain a subsurface archaeological deposit and was believed to date to approximately 4000 - 2000 YBP (W&S Consultants 2002).

Mr. Charlie Cooke, representing the local Native American community, requested that five additional test pits be excavated in the southeastern portion of the stream terrace and site, to further assess the site. These were 1x1 meter in size and, following the pit designations employed in the initial Phase II test, were labeled Units #16 - 20. Excavation techniques during this supplementary testing duplicated those employed during the previous Phase II. Layout of the five test pits is illustrated in Figure 1.

Field Results

The excavation of the five additional test pits revealed equivalent soils and archaeological conditions across the area tested. We summarize these results by unit below:

Unit #16: The westernmost of the test pits was located a short distance east of the N-S dirt road onto the site. It was excavated to 40 cm depth, at which point ancient (i.e., millions of years in age), culturally sterile alluvial gravel was encountered. The soils above the alluvial gravels were an A Horizon consisting of a compact indurated silty loam containing a large quantity of fist- to pea-sized gravels and cobbles. The top 20 - 30 cm of this horizon has been disturbed by disking. The color of this soil horizon was Munsell Grayish Brown (10YR5/2).

Cultural materials within this pit were limited to three pieces of debitage, two of which were recovered in the 0 - 10 cm level, and the third from the 10 - 20 cm level. In both cases these levels represent the disturbed disk or plow zone.

Unit #17: This pit was placed 15 meters (~50 feet) east of Unit #16. Soil conditions were identical to the first unit, with excavation terminated at ancient alluvial gravels, also encountered at 40 cm in depth.

A total of 23 specimens were recovered from this pit, 18 (78%) of which are archaeological while 5 (22%) are pieces of modern intrusive glass. Sixteen (70%) of the total were found in the top 20 cm; 21 (91%) above 30 cm depth. Archaeological remains in this portion of the site, in other words, are primarily restricted to the plow zone, which has also introduced modern glass into the sub-soil.

Unit #18: Spaced 15 m east of the previous unit, this unit was also dug to ancient alluvial gravels although, in this location, these were encountered at 45 cm depth. Soils were otherwise identical to the first two pits.

Seven archaeological specimens were recovered from this test unit, five of which were found above 20 cm. The remaining three specimens included two in the 20 - 30 cm level, and one in the 30 - 40 cm level. Again, archaeological specimens are primarily restricted to the disturbed plow zone.

Unit #19: As with the previous units, this was placed 15 m east of the previous pit. It was excavated to ancient alluvial gravels, encountered in this area at 50 cm depth. Soils otherwise were identical to those in the other test pits.

A low density of archaeological specimens was recovered from each level in this unit. This peaked at 17 specimens in the 30 to 30 cm level, but 14 specimens were also present in the level below, which was immediately above the culturally sterile gravel layer.

Unit #20: This pit was placed 15 m north of the previous unit. Soils in Unit #20 were fully equivalent to those in Unit #19, with sterile alluvial gravels also encountered at 50 cm in depth. A low density of archaeological specimens was present in every level, along with in certain cases a large number of animal bones.

The general results of the five test pits confirm the findings of the previous Phase II test: (1) a low density subsurface archaeological deposit is present at the site; but (2) this is deepest in the central portion of the site, north of the area tested during this current assessment, where in some cases a B Horizon has developed.

Artifact Assemblage

The artifacts and archaeological specimens recovered during the 2003 test at CA-LAN-3043 are summarized in Table 1, the artifact catalog for the project. (Again, following the numeration of the test pits, assigned artifact numbers began after 103, the last number used for the previous test on the site). A total of 247 specimens was recovered; 120 of these were lithics; 122 were fragments of animal bones; and five were intrusive modern glass fragments.

The lithic specimens included 8 formal or worked artifacts and 112 pieces of lithic debitage or waste material. Five of these are groundstone artifacts and the remaining three are flaked stone tools.

Two of the formal groundstone artifacts in fact were collected from the surface of the site, and only three pieces of groundstone were recovered during the excavations. Following the typology outlined for the initial Phase II test (W&S Consultants 2002), both of the surface groundstone artifacts are sandstone manos. One is a Type 3A unshaped biface mano; the other is an untypable fragment.

The remaining examples of groundstone, all recovered from excavations, include two manos. Both of these are Type 4A shaped bifaces, and both are made of quartzite. The last groundstone specimen is made of Sierra Pelona talc schist -- steatite -- and is unidentifiable as to original form. It may have been part of a bowl or, alternatively (but less likely), a comal or griddle, but it does not appear to have been part of a metate (even though flat slab metates made of Sierra Pelona schist are common at sites in the region).

All three of the flaked stone tools are projectile point/point fragments, and all are portions of atlatl points, or throwing spears. This makes them all greater than 1500 years in age, based on the date of the introduction of the bow and arrow into this region. One chert specimen (#3043-110) is triangular and, although complete, appears to have been reworked from a once larger form. The second (#3043-128) is much smaller, is also chert but is tanged and squat. It too appears to have been reworked at some point and, for this reason, is difficult to assign to a specific type. The final example (#3043-131) is an unusual red and black obsidian. The specimen represents a small latitudinal "slice" across the juncture of the body and the base, and it appears to include the remnants of both sides of corner-notching. The specimen thus appears to be similar to an Elko corner-notched point, dating from about 3500 to 1500 YBP.

As is normally the case, debitage was common on the site and 112 specimens of it were recovered (Table 2). Chert was the most common material, contributing 86 pieces or 77% of the total. This was followed by obsidian, 11 or 10%, quartzite, 8 or 7%, metavolcanic 6 or 5% and one piece of jasper (<1%).

With respect to debitage type, tertiary flakes were by far the most common, contributing 71 examples or 63%. This was followed by angular shatter, 32 for 29%, with the remaining contributions roughly split between primary and secondary flakes. Notable here is the fact that chert tertiary flakes and angular shatter were the dominant components of the debitage assemblage. There were 57 chert tertiary flakes in the collection, representing fully 57% of the grand total, and 25 (for 22%) specimens of angular shatter. These two classes represent almost three-quarters of the entire debitage assemblage.

The final class of archaeological specimen is animal bone, or faunal remains. These have been classified by size, following the categories outlined in the Phase II report (W&S Consultants 2002).

A total of 122 animal bones was recovered from the site during this test (Table 1). Most of these appear to be cultural as opposed to natural in origin, with a number exhibiting cut marks and burning. Almost all of the bones are very fragmentary, reflecting the heavy processing (for marrow extraction) involved in animal cooking that was common in this region. Particularly notable however is the relatively large number of large mammal (deer size) bone fragments in the assemblage. A total of 36 of these are present.

The faunal remains from the site are further notable because, during the previous test, only two specimens were recovered -- despite the fact that three times as much excavation occurred during that phase of fieldwork. The paucity of faunal remains from the first test excavation supported the interpretation that subsistence on the site was largely directed towards plant foods. The results from the current test suggest instead that mammals also contributed to the diet of the site's inhabitants, and that the processing of these kinds of resources may have been localized in the southeastern portion of the site.

That said, it is important to emphasize that, because of the way that meat and bones were processed prehistorically -- by systematic pounding and breaking to extract marrow -- counts of bone fragments can be somewhat misleading. In this respect, total weight of bone fragments rather than numbers may be more revealing. The total weight of the faunal remains from the five test units is in fact only 22.8 grams -- less than an ounce. While some mammal resources then were apparently included in the diet of the inhabitants of CA-LAN-3043, this still does not appear to have been a large (let alone dominant) component of their diet.

Plant processing, in other words, is still supported as the primary subsistence practice at the site, although the results of this test excavation also indicate that hunting was also undertaken. The site's occupants were not specialists, in other words, but instead followed a more generalized subsistence strategy.

One final comment needs to be made about the artifact assemblage from the site. CA-LAN-3043 contains a small but noticeable amount of obsidian, reflecting the coastal to desert trade that occurred during the Middle Period, with this obsidian originating in the Coso Range at the southern end of Owens Valley. The age of obsidian artifacts can be determined through obsidian hydration dating, although these analyses take a considerable length of time and, for this reason, the results of obsidian hydration tests are rarely included in reports. It is for that reason important to mention in this addendum the previously unreported chronometric results of an obsidian hydration analysis from a sample that was submitted from the previous test excavation at this site.

This analysis yielded a hydration value of 5.7 $\pm$ 0.1 microns. There are various proposed calibrations for Coso obsidian, with 280 years per micron suggested for inland areas (Meighan 19801). Using this calibration rate, the age of the site can be chronometrically estimated at approximately 1596 YBP. This places the age of the site at about A.D. 354 -- within the Middle Period. This date correlates perfectly with the age of the site inferred from the projectile points.

Summary and Conclusions

Additional Phase II testing was conducted at site CA-LAN-3043, within the River Park project area, Saugus, Los Angeles County, California. This involved the hand-excavation of five 1x1 m pits in the southeastern portion of this site.

This additional Phase II testing largely confirmed and corroborated the results of the previous excavations on the site (W&S Consultants 2002). A low density subsurface deposit is present at the site, with the top portions of the deposit disturbed by disking and grading. The deepest portion of this deposit appears to be in the approximate center of the site. Based on three newly recovered projectile points and an obsidian hydration date, this deposit dates to the Middle Period, as previously surmised. A small but significant quantity of animal bone was however recovered. This suggests that the site's inhabitants followed a generalized subsistence strategy: while the evidence still supports the dominance of plant processing on the site, some hunting also clearly occurred.

Final recommendations for CA-LAN-3043

Based on the fact that the additional Phase II testing confirmed and corroborated the results of the first test, the previous recommendations for the site are appropriate. These are the mitigation of adverse effects either through preservation in open space, or with a Phase III Data Recovery (salvage excavation).

Cited References

Meighan, C.W.
1981 The Little Lake Site, Pinto Points, and Obsidian Hydration Dating in the Great Basin. Journal of California and Great Basin Anthropology 3:200-214.

W & S Consultants
2002 Phase II Archaeological Test Excavations for the River Park Project Area, Northern Los Angeles County, California. Report on file, City of Santa Clarita.

TABLE 1: ARTIFACT CATALOG, LAn-3043

Cat#	Unit/Level	Material	LxWxT(cm)	#/wt.(gms.)	Description	
104	16/0-10	lithic		2/2.8	debitage	
105	16/10-20	lithic		1/.7	debitage	
106	17/0-10	lithic		4/.8	debitage	
107	17/10-20	lithic		7/41.3	debitage	
108	17/10-20	glass		5/3.0	bottle glass	
109	17/20-30	lithic		4/1.4	debitage	
110	17/20-30	chert	3.67x2.71x.66	1/5.9	atlatl dart point	
111	17/30-40	lithic		2/11.0	debitage	
112	18/0-10	lithic		1/.9	debitage	
113	18/0-10	bone		1/.7	faunal remains- lrg. mammal	
114	18/10-20	lithic		2/7.1	debitage	
115	18/10-20	steatite	8.82x4.67x3.00	1/191.9	groundstone fragment, ? type	
116	18/20-30	lithic		2/1.1	debitage	
117	18/30-40	lithic		1/.6	debitage	
118	19/0-10	lithic		1/.3	debitage	
119	19/10-20	lithic		9/10.3	debitage	
120	19/10-20	bone		6/.9	fauna-lrg. mm. (2/.5),	
					sm. mam. (4/.4)	
121	19/20-30	lithic		8/10.1	debitage	
122	19/20-30	bone		2/.1	faunal remains- small mammal	
123	19/30-40	lithic		10/2.9	debitage	
124	19/30-40	bone		7/1.1	fauna- lrg. mam. (4/1.7),	
					sm. mam. (3/.4)	
125	19/40-50	lithic		8/4.7	debitage	
126	19/40-50	bone		5/1.1	fauna- lrg mam. (4/1.0),	
127					sm. mam. (1/.1)	
128	19/40-50	chert	2.69x1.85x.77	1/3.8	atlatl base fragment	
129	20/0-10	chert		14/5.5	debitage	
130	20/0-10	bone		1/.3	fauna- lrg. mammal	
131	20/0-10	obsidian	.65x2.59x.64	1/1.2	atlatl base fragment	
132	20/10-20	lithic		11/71.7	debitage	
133	20/10-20	bone		6/3.4	fauna- lrg. mam. (4/3.0),	
					sm. mam. (2/.4)	
134	20/20-30	lithic		11/16.5	debitage	
135	20/20-30	bone		29/5.6	fauna- lrg. mam. (8/4.2),	
					sm. mam. (21/1.4)	
136	20/20-30	quartzite	8.75x5.77x5.44	1/294.3	shaped biface mano frag.- 4A	
137	20/30-40	lithic		8/13.1	debitage	
138	20/30-40	bone		55/6.8	fauna- lrg. mam. (10/3.9),	
					sm. mam. (45/2.9)	
139	20/30-40	quartzite	9.99x7.54x4.14	1/453.4	shaped biface mano- type 4A	
140	20/40-50	lithic		6/1.5	debitage	
141	20/40-50	bone		10/2.8	fauna- lrg. mam. (2/2.3),	
					sm. mam. (8/.5)	
142	surface/S.A.-1	sandstone	7.67x9.87x5.84	1/628.8	unshaped biface- type 3A	
143	surface/S.A.-2	sandstone	10.11x7.14x6.56	1/564..1	mano fragment- ? type	

TABLE 2: CA-LAN-3043 - Debitage

Cat#	Unit/Level	Material	#/wt.(gms.)	Description		
104	16/0-10	chert	2/2.9	P-1,T-1		
105	16/10-20	jasper	1/.7	T-1		
106	17/0-10	chert	3/.7	T-2, AS-1		
		obsidian	1/.1	T-1		
107	17/10-20	chert	6/3.3	T-4, AS-2		
		metavolcanic	1/38.0	P-1		
109	17/20-30	chert	4/1.4	T-3, AS-1		
111	17/30-40	chert	2/11.0	P-1, AS-1		
112	18/0-10	chert	1/.4	AS-1		
114	18/10-20	chert	2/7.1	T-1, AS-1		
116	18/20-30	chert	2/1.1	T-2		
117	18/30-40	chert	1/.6	T-1		
118	19/0-10	obsidian	1/.3	T-1		
119	19/10-20	chert	6/4.6	T-5, AS-1		
		quartzite	1/4.2	AS-1		
		obsidian	2/1.5	AS-2		
121	19/20-30	chert	6/6.9	T-4, AS-2		
		quartzite	2/3.2	S-1,T-1		
123	19/30-40	chert	7/2.8	T-2, AS-5		
		obsidian	3/.1	T-3		
125	19/40-50	chert	8/4.7	T-6, AS-2		
129	20/0-10	chert	13/5.1	T-10, AS-3		
		obsidian	1/.4	AS-1		
132	20/10-20	chert	9/3.6	T-7, AS-2		
		quartzite	1/68.0	P-1		
		obsidian	1/.1	T-1		
134	20/20-30	chert	7/14.0	S-1, T-4, AS-2		
		obsidian	2/.1	T-2		
		metavolcanic	2/1.5	S-1, T-1		
137	20/30-40	chert	6/5.1	S-1, T-4, AS-1		
		metavolcanic	2/7.0	P-1, AS-1		
140	20/40-50	chert	1/.4	T-1		
		quartzite	4/.7	T-4		
		metavolcanic	1/.4	T-1		

APPENDIX 4.19

Agricultural Resources Storie Index

Capability Grouping

Finally, the SCS classifies soils by their suitability for most kinds of field crops. The groups are made according to the limitations of the soils when used for field crops, the risk of damage when they are used and the way they respond to treatment. In the capability system all kinds of soils are grouped at three levels: capability class, subclass and unit. These are discussed in the following paragraphs:

Capability Classes are defined as follows:

Classes	Description
I	Soils have few limitations that restrict their use
II	Soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices
III	Soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both
IV	Soils have very severe limitations that reduce the choice of plants or that require very careful management, or both
V	Soils are not likely to erode, but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland or wildlife
VI	Soils have severe limitations that make them generally unsuited to cultivation and that limit their use largely to pasture, range, woodland, or wildlife habitat
VII	Soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture, range, woodland, or wildlife habitat
VIII	Soils and landforms have limitations that preclude their use for commercial plants and that restrict their use to recreation, wildlife, or water supply, or to aesthetic purposes.

Capability Subclasses are soil groups within one class and are designated by adding a small letter (e.g., *e*, *w*, *s*, or *c*) to the class numeral. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; the letter *w* shows that water in or on the soil interferes with plant growth or cultivation; *s* shows that the soil is limited mainly because it is shallow, droughty, clayey or stony; and *c* shows that the chief limitation is climate that is too cold or too dry.

Capability Units are soil groups within the subclasses that represent soils that are enough alike to be suited to the same crops and pasture plants to require similar management and to have similar productivity and other responses to management. Capability units are defined as follows:

Unit Number	Description
0.	Sand and gravel in the substratum limit root penetration
1.	Actual or potential erosion hazard
2.	Wetness caused by poor drainage or flooding
3.	Slow or very slow permeability in the subsoil or substratum
4.	Coarse soil texture or excessive gravel
5.	Fine textured or very fine textured surface soil
6.	Salt or alkali
7.	Cobbles, stones or rocks
8.	Nearly impervious bedrock or hardpan within the effective rooting depth
9.	Low fertility or toxicity

Vegetative Soil Groups

The Soil Conservation Service (SCS) also groups soils relative to their crop production to provide an estimate of the limitation and suitability of each soil.

Soil Grouping	Description
A	Choice of plants not limited by soils
B	Choice of plants limited by droughtiness and low fertility
C	Choice of plants limited by fine texture
D	Choice of plants limited by very slowly permeable (claypan) subsoil
E	Choice of plants limited by wetness
F	Choice of plants limited by salinity or alkalinity
G	Choice of plants limited by depth
H	No information available
I	No information available
J	Choice of plants depends upon on-site investigation

Storie Index

The U.S.D.A. rates soil types according to the Storie Index which numerically expresses the relative degree of suitability of a soil for general intensive agriculture. Four general factors are considered in the index rating:

- the characteristics of the soil profile and soil depth,
- the texture of the soil surface,
- the dominant slope of the soil body, and
- other factors more readily subject to management or modification (i.e., drainage, flooding, salinity, sodicity, general nutrient level of the soil, and surface microrelief).

Each of these four general factors is evaluated on the basis of 100 percent. A rating of 100 percent expresses the most favorable or ideal condition for general crop production, while lower percentage ratings are assigned for conditions that are less favorable.

Soils are placed in grades according to their suitability for general intensive agriculture as shown by their Storie Index rating. The six grades and their range in index ratings are:

Grade	Index Rating
1	80 to 100
2	60 to 80
3	40 to 60
4	20 to 40
5	10 to 20
6	less than 10

Soils of Grade 1 are excellent or well-suited to general intensive agriculture. Grade 2 soils are good and also well-suited to agriculture, although they are not as desirable as soils of Grade 1. Grade 3 soils are only fairly well-suited, Grade 4 soils are poorly suited, Grade 5 soils are very poorly suited, and Grade 6 consists of soils and miscellaneous areas that are not suited for agriculture.

Prime Farmland Criteria

Prime farmland must meet all of the following criteria:[1]

1. Water: The soils have xeric, ustic, or aridic moisture regimes[2] in which the available water capacity is at least 4.0 inches per 40 to 60 inches of soil, and a developed irrigation water supply that is dependable and of adequate quality. A dependable water supply is one which is available for the production of the commonly grown crops in 8 out of 10 years; and

2. Soil Temperature Range: The soils have a temperature regime that is frigid, mesic, thermic, or hyperthermic.[3] These are soils that, at a depth of 20 inches, have a mean annual temperature higher than 32° F. In addition, the mean summer temperature at this depth in soils with an O horizon[4] is higher than 47° F; in soils that have no O horizon, the mean summer temperature is higher than 59° F; and

3. Acid-Alkali Balance: The soils have a pH between 4.5 and 8.4 in all horizons within a depth of 40 inches; and

4. Water Table: The soils have no water table or have a water table that is maintained at a sufficient depth during the cropping season to allow cultivated crops common to the area to be grown; and

5. Soil Sodium Content: The soils can be managed so that, in all horizons within a depth of 40 inches, during part of each year the conductivity of the saturation extract is less than 4 mmhos/cm[5] and the exchangeable sodium percentage is less than 15; and

6. Flooding: Flooding of the soil (uncontrolled runoff from natural precipitation) during the growing season occurs infrequently, taking place less often than once every two years; and

7. Erodibility: The product of K (the erodibility factor) x percent of slope is less than 2.0; and

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1 California Department of Conservation, Division of Land Resource Protection. Advisory Guidelines for the Farmland Mapping and Monitoring Program (Sacramento: April 1984), pp. 7-8.

2 Soil moisture regimes are used in defining soil classes at various levels in the soil taxonomy system. Xeric soil moisture regime is typically found in Mediterranean climates where winters are moist and cool, and summers are warm and dry; Ustic soil moisture regime involves the concept of limited, but effective, soil moisture; and Aridic (torric) soils moisture regime is generally found in arid climates with hot and dry summers.

3 Soil temperature regimes are used in defining soil classes at various levels in the soil taxonomy system. Frigid - mean annual soil temperature is less than 47° F and the difference between mean winter and mean summer temperature is more than 41° F. Mesic - Mean annual soil temperature is 47° F or higher, but lower than 59° F, and the difference between mean summer and mean winter soil temperature is more than 41° F. Thermic - the mean annual soil temperature is 59° F or higher, but lower than 72° F, and the difference between mean summer and mean winter soil temperature is more than 41° F. Hyperthermic - the mean annual soil temperature is 72° F or higher, and the difference between mean summer and mean winter soil temperature is more than 41° F.

4 An O Horizon is an organic layer of fresh and decaying plan residue at the surface of a mineral soil.

5 Mmhos/cm is a unit of electrical conductivity, which is a measure of the salinity of soil.

8. Permeability: The soils have a permeability rate of at least 0.06 inch per hour in the upper 20 inches and the mean annual soil temperature at a depth of 20 inches is less than 59° F; the permeability rate is not a limited factor if the mean annual soil temperature is 59° F or higher; and

9. Rock Fragment Content: Less than 10 percent of the upper 6 inches in these soils consists of rock fragments coarser than 3 inches; and

10. Rooting Depth: The soils have a minimum rooting depth of 40 inches.

Prime Farmland

Prime farmland is land with the best combination of physical and chemical features able to sustain long term production of agricultural crops. This land has the soil quality, growing season, and moisture supply needed to produce sustained high yields. The land must have been used for the production of irrigated crops at some time during the two update cycles prior to the mapping date of 1992 (or since 1988).[1]

Farmland of Statewide Importance

Farmland of statewide importance is land similar to prime farmland, but with minor shortcomings, such as greater slopes or with less ability to hold and store moisture. The land must have been used for the production of irrigated crops at some time during the two update cycles prior to the mapping date (or since 1988).

Unique Farmland

Unique farmland is land of lesser quality soils used for the production of the State's leading agricultural crops.[2] This land is usually irrigated, but may include non-irrigated orchards or vineyards as found in some climatic zones in California. The land must have been cultivated at some time during the two update cycles prior to the mapping date (or since 1988).

Farmland of Local Importance

Farmland of local importance is land of importance to the local agricultural economy, as determined by each county's board of supervisors and a local advisory committee. According to the Farmland Conversion Report, farmland of local importance in Los Angeles County includes producing lands that would meet the standard criteria for prime farmland or farmland of statewide importance, but which are not irrigated.

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[1]Since the farmland mapping date for Los Angeles County is 1992, and since update cycles occur biennially, this definition implies that land on the project site must have been used for the production of irrigated crops at some time since 1988 in order to qualify as prime farmland.

[2]Leading agricultural crops include those of high economic value, such as oranges, olives, avocadoes, rice, grapes, and cut flowers. Los Angeles County's leading agricultural crop includes flowers and foliage.

Grazing Land

Grazing land is land on which the existing vegetation is suited to the grazing of livestock. The minimum mapping unit for this category is 40 acres.

APPENDIX 4.20

Floodplain Modifications

SENSITIVE AQUATIC SPECIES ASSESSMENT
UPPER SANTA CLARA RIVER

RIVERPARK PROJECT
SANTA CLARITA, CALIFORNIA

Prepared for:
Newhall Land & Farming Company
Valencia, CA

Prepared by:
ENTRIX, Inc.
Ventura, CA

Project No. 3109001

February 25, 2004

Sensitive Aquatic Species Assessment
Upper Santa Clara River

Riverpark Project
Santa Clarita, California

Prepared for:
Newhall Land & Farming Company
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Project No. 3109001

February 25, 2004

TABLE OF CONTENTS

1. INTRODUCTION

This report summarizes the focused assessment of potential effects of the Riverpark Project (Project) on threatened or endangered aquatic species inhabiting the Santa Clara Valley reach of the Santa Clara River. Specifically, this report focused on potential impacts to unarmored threespine stickleback, arroyo toad, and California red-legged frog as these species are listed as threatened or endangered by the State and Federal Endangered Species Act. The primary focus of this assessment examines potential impacts to their habitat associated with alterations to local hydrology and corresponding habitat area through implementation of the project.

The Santa Clara River within the project site is dry for most of the year. Surface flows are present in this stretch of the River on an infrequent basis typically during and after a storm event or a series of storms. During El Nino years, or years where yearly rainfall is substantially more than the average, surface flows have persisted into late spring or early summer.

1.1 RIVERPARK PROJECT

Newhall Land proposes the development of a 695.4-acre site at the terminus of Newhall Ranch Road, east of Bouquet Canyon Road between the Castaic Lake Water Agency property and the Santa Clara River, north of Soledad Canyon Road (Figure 1). The proposal is titled Riverpark. A 29-acre park is also proposed along and adjacent to the Santa Clara River and approximately 330 acres of river area will remain in a natural state. The project includes the extension of Newhall Ranch Road, including the Newhall Ranch Road/Golden Valley Road bridge, and the construction of bank stabilization along the Santa Clara River. The site will require 5.2 million cubic yards (mcy) of grading (plus 3.6 mcy of removal and recompaction, overexcavation, and landslide remediation) which will be balanced on-site.

Bank stabilization will be constructed along the Santa Clara River for approximately 3,000 linear feet for the east-west extension of Newhall Ranch Road and approximately 6,000 linear feet for residential and commercial development. Accessory storm drain outlets would be provided for in the bank stabilization. An additional 1,500 linear feet of toe or erosion protection would be installed adjacent to Area B (a residential area). The proposed bank stabilization technique is primarily buried soil cement with other portions reinforced by ungrouted rock riprap, and exposed concrete gunite at the Newhall Ranch/Golden Valley Bridge abutment. The toe or erosion protection would consist of Ajax or exposed soil cement.

This assessment report focuses on potential impacts of the Riverpark Project to the three identified protected species and their habitat within the Santa Clara River. The bank stabilization, Newhall Ranch Road/Golden Valley Road bridge, and the toe or erosion protection are the primary Project features that could potentially affect aquatic and terrestrial habitat used by the three species of focus in this document.

1.2 BACKGROUND

Unarmored Threespine Stickleback

The unarmored threespine stickleback (UTS), *Gasterosteus aculeatus williamsoni*, was designated a federally endangered species in 1970 (U. S. Fish and Wildlife Service 1985) and is restricted to three sections of the upper Santa Clara River including areas both above and below, but not within, the Riverpark Project site. Currently, Critical Habitat for unarmored threespine stickleback has not been formally designated under the Endangered Species Act.

The fish is a small, largely annual fish that requires shallow, slow, marginal (define marginal) stream flows with abundant aquatic vegetation for cover. The male guards territories, and builds a small nest of decaying vegetation where he guards the eggs until they hatch. When there is suitable habitat, as described above, large numbers of stickleback can exist in the summer and fall with the long breeding season in southern California, and breeding can be almost all year in dry years when a stream is minimally disrupted by flood flows. Up to a few hundred stickleback per 10 meters of stream can exist under optimum conditions. Strong storm flows usually severely decimate the population until the streams stabilize in spring and the numbers can build up again.

Populations occur in the following areas: 1) upstream or east of the project in Soledad Canyon above Lang Station (about 8 miles upstream); 2) downstream or west of the project site beginning generally west of the McBean Parkway Bridge and the confluence with San Francisquito Creek; 3) San Francisquito Creek, a tributary to the Santa Clara River, northwest of the project site from just below Drinkwater Reservoir upstream to the vicinity of the old St. Francis Dam location (about 7.5 miles upstream of the Santa Clara River); and 4) Bouquet Canyon Creek, a tributary of the Santa Clara River, approximately 11 miles above its confluence with the Santa Clara River (Jonathan Baskin, personal communication). The latter two locations are in tributaries to the Santa Clara River and their hydrology and habitat would clearly not be affected by the project.

Arroyo Toad

Arroyo toads (*Bufo californicus*) occupy the margins of permanent and seasonal streams in coastal foothill canyons and valleys and to a limited extent in the desert, but they require extremely specialized and limited microhabitat within that general habitat type. Most spawning occurs in shallow overflow pools adjacent to inflow channels of third and higher-order streams, and during the remainder of the year adults occupy adjacent sand bars and sandy terraces, nearly always within 100 meters of suitable spawning pools. Suitable spawning pools lack suspended silt, aquatic predators, and dense woody bordering vegetation (Sweet 1993). Suitable bordering sandbars are usually dampened by capillarity and include some emergent vegetation. The moist substratum keeps metamorphosing juveniles from desiccating during warm weather (Sweet 1993; Jennings and Hayes 1994). Suitable terrace habitat includes at least some dense overgrowth such as California sycamore (*Platanus racemosa*), Fremont cottonwood (*Populus fremontii*), and willows (*Salix* sp.) but the understory is usually barren except for layers of dead leaves (Sweet 1993). Adult and metamorphosed juvenile arroyo toads are known to forage for various invertebrates around the drip line of large oaks (*Quercus*) and also to forage extensively on ants (Sweet 1992, 1993). Little is known of arroyo toad winter hibernaculum requirements (USFWS 1999).

California Natural Diversity Database records for arroyo toad sightings include: 1) the Santa Clara River, directly east of Interstate-5, approximately two miles west of the project site; 2) Bear Canyon at the Santa Clara River, six miles upstream of Solemint (2001) which is about nine miles east of the project site; and 3) confluence of San Francisquito Creek and the Santa Clara River, approximately one mile west of the project site (Sandburg and Impact Sciences 2001). Neither of the museum database queries (CAS 2003; UC Berkeley 2003) yielded Santa Clara River watershed specimens of the arroyo toad.

The Biological Opinion (2002) issued by the United States Fish and Wildlife Service for the Natural River Management Plan (NRMP) stated that the implementation of NRMP improvements (including bank stabilization and bridge crossings) are unlikely to damage the Santa Clara River arroyo toad population. Critical Habitat designation for the arroyo toad has been set aside by judicial orders. No information is available on the revised Critical Habitat at this time. Thus, "Critical Habitat" for the species currently is undesignated.

California Red-legged Frog

California red-legged frog (*Rana aurora draytonii*) habitat components include spawning pools and their terrestrial borders, spring/summer refuges, and subterranean hibernation sites. These may be combined at single sites or they may be separated by aquatic or terrestrial "dispersal corridors" (Hayes & Jennings 1989; Jennings & Hayes 1994). Spawning pools are the ecologically central components of California red-legged frog habitat, because they support all elements of the species' reproductive biology and also provide forage for all red-legged frog life stages. Spawning pools are typically permanent or extended seasonal (through August) ponds or stream/spring pools of 0.7-1.2 meters in depth, with dense bordering, emergent, and surface vegetation. Such pools may be as small as one square meter in surface area, with no known upper area limit. Always present at spawning habitat is a large complex invertebrate fauna for juvenile forage, extensive submerged herbaceous and algal vegetation for tadpole forage, and small terrestrial mammals such as voles (*Microtus*) that are an important component of adult frog forage (Jennings & Hayes 1994). Most suitable ponds are also partially to fully sunlit with mud or silt substrata, environmental factors essential to promote dense floating and emergent vegetation. Large populations of exotic predators such as bullfrogs and exotic centrarchid fish are usually absent from California red-legged frog spawning pools.

Newly constructed or impounded ponds rarely support California red-legged frog populations—most spawning sites have existed in stable, relatively undisturbed form for decades (Barry unpbl; Hayes & Jennings 1989). Likewise, red-legged frog spawning habitat is usually absent from river bottomland, presumably because high springtime flows would disrupt spawning success by scouring spawning pools and discouraging long-term aquatic vegetative growth. California red-legged frogs are vulnerable to early season floods because they spawn in early to mid-winter.

Adult California red-legged frogs may move in late spring and summer to shaded pools along streams where undercut banks and exposed root masses offer secure refuges. However, an isolated summer refuge component appears not to be critical to population survival because many adult frogs may be found throughout the summer at spawning pools. Hibernaculum preferences probably include lentic substrata (pond bottoms) or any secure subterranean site near spawning or summer refuge habitat, such as rodent burrows, vegetation mats, and root channels.

California red-legged frog "dispersal habitat" refers usually to stream courses that do not offer spawning or summer habitat but could be dispersal corridors between populations (USFWS 2002). Such corridors probably pertain more to populations in xeric (arid) localities; preliminary data from Marin County, California populations indicate that in mesic regions few structures or habitats represent true dispersal barriers to California red-legged frogs (Gary Fellers USGS, personal communication). "Dispersal habitat" as discussed in this report refers to any habitat that could be occupied temporarily by California red-legged frogs; it does not necessarily imply that California red-legged frogs might use such habitat to disperse or move among spawning pool habitats.

There are no California Natural Diversity Database records for the California red-legged frog in the Santa Clara River watershed, Los Angeles and Ventura Counties. However, the Museum of Vertebrate Zoology (UC Berkeley 2003) lists 17, Soledad Canyon/Los Angeles County specimens in its collection, from as recently as 1953. The California Academy of Sciences (CAS 2003) also lists a Soledad Canyon specimen, from 1950. The nearest specific locality referenced in these records to the project site is approximately 15 miles upstream near the confluence with Agua Dulce Creek. Jennings and Hayes (1994) indicate that this species still occurs in the Santa Clara River watershed, in sites along San Francisquito Creek 5-10 miles northwest of the project site, and in tributaries to the Santa Clara River in Ventura County. The closest documented Ventura County occurrence is in Piru Creek 4.5 miles north of Piru, about 20 airline miles west of the project site (USFWS 2002). The project site is, therefore, placed within the distribution of the California Red-Legged Frog as it has been verified upstream and downstream of the project site.

Critical Habitat designation for the California red-legged frog has been set aside by judicial orders. No information is available on the revised Critical Habitat at this time. Thus, "Critical Habitat" for the species currently is undesignated.

1.3 STUDY SCOPE

The scope of this assessment focuses on addressing the potential effects of the Riverpark Project on the target aquatic species. The assessment is based on a review of technical and regulatory documentation provided by Newhall Land (Section 2.1), other technical documentation, research, databases related to the subject matter, and a field reconnaissance survey of the Project site. Additionally, the preparers of this assessment have extensive experience in this subject. No new surveys or analyses, other than that described herein, were conducted as part of this study.

1.4 ORGANIZATION OF DOCUMENT

The remainder of this report is organized as follows:

- Section 2 describes the methods used in the development of the assessment.
- Section 3 discusses the results of the assessment.
- Section 4 provides conclusions of the assessment.
- Section 5 cites literature and technical references used in the preparation of this assessment, all of which are incorporated herein by this reference.

2. METHODS

The methods used to conduct this assessment are based on review of technical and regulatory documentation provided by Newhall Land, and a field reconnaissance survey of the Project area. The methods are described in greater detail as follows.

2.1 REVIEW OF EXISTING PROJECT REPORTS AND DOCUMENTATION

The following technical reports and supporting documentation provided by Newhall Land were reviewed in assessing the potential effects of the Riverpark project on sensitive aquatic species inhabiting the Santa Clara River:

- *Final EIS/EIR: 404 Permit and 1603 Streambed Alteration Agreement for Portions of the Santa Clara River and its Tributaries, Los Angeles County.* Valencia Company, August 1998.
- *Natural River Management Plan: Permitted Projects and Activities.* Santa Clara River and tributaries. Valencia Company, November 1998.
- *Results of Focused Surveys for Arroyo Toad and Special-Status Aquatic Reptiles and Amphibians within the Natural River Management Plan Area, Valencia, California.* Impact Sciences, September 2001.
- *Aquatic Surveys Along the Santa Clara River Part I: Castaic Junction Project Area, Los Angeles County, California.* Aquatic Consulting Services, Inc., April 2002.
- *Biological Opinion for the Natural River Management Plan, Santa Clarita, Los Angeles County, California (1-8-02-F-4R) (File No. 940050400-BAH).* U.S. Fish and Wildlife Service, November 2002.
- *Results of Focused Unarmored Threespine Stickleback and Other Special-Status Fish Species, Newhall Ranch, Valencia California.* Impact Sciences, Inc., January 2003.
- *Amended 404 Permit (No. 940050400-BAH) for Natural River Management Plan.* U.S. Army Corps of Engineers, June 2003.
- *Revised Initial Study: Riverpark Project.* City of Santa Clarita, unpublished/undated.
- *Technical Flood Report for Riverpark.* PSOMAS, February 2004.

- *Riverpark Field Study References, Surveys and Appendices from Section 4.6 Biological Resources Draft Environmental Impact Report.* Impact Sciences, Inc (unpublished), February 2004.

2.2 REVIEW OF RECORDS AND LITERATURE

Information on the special-status wildlife of the proposed Riverpark Project Area was obtained through a search of the California Natural Diversity Database (CNDDB; CDFG 2003); the U.S. Fish and Wildlife Service (USFWS), Ventura Office, Endangered Species Division's species list (USFWS 2003), and other biological studies completed in the Project vicinity. Preliminary identification of potential habitat for aquatic species within the Project site was determined by reviewing aerial photography provided by Newhall Land. A subsequent site visit identified other potential aquatic habitat.

To evaluate the effects of the bank stabilization component of the Project on potential populations of UTS, arroyo toads, California red-legged frogs and other sensitive aquatic species, ENTRIX biologists queried the California Natural Diversity Database (CDFG 2003) and the collection databases of the Museum of Vertebrate Zoology, University of California, Berkeley (UC Berkeley 2003) and the California Academy of Sciences (CAS, 2003) to determine the historical distribution of these species in the project area. Various literature sources (especially Jennings and Hayes, 1994) were also used[1]. The ENTRIX biologists then examined maps, an aerial photograph dated January 22, 2003 and provided by Newhall Land, and ground photographs taken by ENTRIX biologists during the site visit on December 2, 2003 to locate potential aquatic habitat within and near the banks of the Santa Clara River within or directly adjacent to the site. Potential aquatic habitat suitability for any of the three species was determined by comparison with previously published assessments (e.g., Holland 1991; Jennings and Hayes 1994; USFWS 1999, 2002), as well as by the ENTRIX biologists' extensive experience with the three species in various parts of California, including the Santa Clara River region.

To assess the potential effects of the proposed project streambed stabilization on unarmored threespine stickleback, arroyo toad, and California red-legged frog, ENTRIX biologists consulted the USFWS Biological Opinion for the Natural River Management Plan (NRMP), Santa Clarita, Los Angeles County, California (1-8-02-F-4R), dated 15 November 2002, the Environmental Assessment 404(b)(1) Evaluation Public Interest Review for Permit Application Number 940050400-BAH (list in the references section), Valencia Company Natural River Management

1 Unless otherwise noted, neither the CNDDB nor the museum database records are verified independently. Experts usually identify museum specimens during accession, but taxonomic changes and misidentifications are always possible. Further, unless otherwise noted, the absence of CNDDB or museum species records from any site does not indicate that the species is absent from that site.

Plan, dated 18 June 2003, the Psomas/Impact Sciences Water Resources Technical Report for Riverpark (February 2004), references, surveys, appendices from the Draft Riverpark Biological EIR Section and various natural history accounts for these species (e.g., Jennings and Hayes 1994; Holland 1991; Sweet 1993; Swift et al. 1993; Stebbins 1951).

2.3 FIELD RECONNAISSANCE SURVEY

ENTRIX biologists, Dr. Camm Swift and Kathy Frye, conducted a reconnaissance-level field survey, focused on the following sensitive aquatic vertebrate species and their associated habitat within the Santa Clara River floodplain: 1) unarmored threespine stickleback; 2) southwestern arroyo toad; and 3) California red-legged frog. The purpose of field surveys was to analyze the potential effects of the Riverpark project on these species and their habitat.

The survey was conducted on December 2, 2003 in and along the Santa Clara River, within the boundaries of the Riverpark Project site. The Project site was examined for potential aquatic habitat, such as flowing or standing water, emergent vegetation, and associated aquatic species. The Santa Clara River channel, consistent with historical data, was entirely dry in the Project reach and free of standing or flowing water. There were several areas outside of the main channel adjacent to storm drain improvements where standing water was present. These areas of the project site were photographed. Water within these areas was sampled with random passes of a seine net in order to search for species present at the time of the December 2003 surveys. Figure 1 depicts the Project site and the areas where water was present. Species observed were recorded, along with water temperature, depth and width of wetted area. Field survey data is included in Appendix A.

Potential habitat for unarmored threespine stickleback, arroyo toad, and California red-legged frog, was noted, along with other features relevant to life history, such as the presence of prey or predators. Unarmored threespine stickleback habitat includes the presence of flowing water. Arroyo toad habitat factors include the presence of clear, standing water (required for egg deposition), sandy banks, and the presence of willows, cottonwood, and sycamore trees. California red-legged frogs habitat factors include relatively deep and vegetated sunlit pools.

3. RESULTS

This section presents the results of the focused assessment of potential effects of the Project on sensitive aquatic species.

3.1 AREAS OF STANDING WATER

The following summarizes the characteristics of the three sites within or adjacent to the project site containing standing water:

Site No. 1 – located directly east of the project site on the southern bank of the Santa Clara River (Figure 1). This site appears to be the result of nuisance flows from the adjacent industrial complex. The water is conveyed to the river by an improved concrete channel with ponding occurring near the river edge, outside of the main channel. This site (Site 1 photographs, Appendix A) lacked aquatic organisms, which indicates that the ponding in this area may not be permanent or this area only recently ponded. African clawed frogs were present at this location.

Site No. 2 – located adjacent to the Los Angeles Department of Water and Power aqueduct on the southern bank of the Santa Clara River (Figure 1). This site (Site 2 photographs, Appendix A) appears to be the result of nuisance flows from the adjacent mobile home park and properties south of Soledad Canyon Road. The water is conveyed to this site by an improved concrete channel and ponding again occurs at the edge of the river outside of the main channel. An incised natural channel from the pond extends westerly 300 feet downstream. This incised channel is located approximately 10 to 40 yards north of a berm bordering the mobile home park. This site lacked any vertebrate life.

Site No. 3 – located adjacent to Soledad Canyon Road, in the vicinity of Saugus Speedway, on the southern bank of the Santa Clara River. The site (Site 3 photographs, Appendix A) appears to be the result of nuisance flows from properties south of Soledad Canyon Road. The water is conveyed via an underground storm drain, with ponding occurring at the outlet to the river. Water empties from this stormdrain into a pile of boulders and drains 15 to 20 yards downstream. This area was choked with vegetation (cattails and watercress). This site, though the best from a potential habitat perspective, contained no vertebrate life.

No other potential aquatic habitat locations were identified during the reconnaissance survey of the project site.

3.2 UNARMORED THREESPINE STICKLEBACK

No indication of the presence of unarmored threespine stickleback could be detected during the visit. The four areas of standing water were sampled with dipnets or seines as appropriate. No fish, including UTS, were observed. This is consistent with the finding of recent surveys for the species conducted on the Riverpark site. Surface water is rarely present in this stretch of river for long periods of time, and it has never been designated as a location for the species to occur except as occasional winter straying from upstream locations during storm events.

As discussed previously, the nearest populations of stickleback are upstream approximately eight miles and somewhat closer downstream (approximately one mile). Newhall Land provided California Natural Diversity Data Base forms documenting the presence of 26 UTS on January 26, 27, and 28, and February 2, 1999 behind the Greenbrier Mobile Home Park, east of Bouquet Canyon Road Bridge over the Santa Clara River. The Greenbrier Mobile Home Park is located directly across from the River Park Project area. These UTS observations followed El Nino storms of 1998 that likely brought these fish downstream from the nearest upstream population. These observations do provide an indication that fish may become temporarily established on the project site as a result of high water flows.

Although Impact Sciences has identified jurisdictional drainages (not including the Santa Clara River) on the project site, we found no indication of water in any of these drainages. One of these drainages, located in the proposed park, was investigated in more detail during the site visit. Both ENTRIX biologists examined this drainage, which is partially developed. The only water seen was contained within a small artificial ornamental pool with a trickle of water as an outflow. No evidence of flow or riparian habitat was present and this drainage appears to be ephemeral, discharging water during storm events. Due to a lack of constant surface water and appropriate habitat characteristics, UTS are unlikely to utilize this and other drainages on-site.

The above findings support the conclusions that it is unlikely that UTS would inhabit the Project site on a permanent basis. UTS, could be expected to inhabit the site Project site temporarily, during wet years such as those associated with El Nino conditions.

The Psomas Technical Flood Impact Report prepared for the Riverpark project concludes that there would be no significant increase in water surface elevation, velocity or sedimentation downstream of the project site as a result of project improvements. Based upon this, no impacts to downstream UTS populations are expected.

3.3 ARROYO TOAD

The review of CNDDB records indicates that the arroyo toad still inhabits suitable habitat within the Santa Clara River upstream and downstream of the Project. However, no arroyo toads or arroyo toad habitat were observed at the Project site.

Long-term second-order confluence sand bar/overflow pool habitat of the type favored by arroyo toads for spawning or adult use is mostly absent within the project site, based on the listed reports and documents, site visit, and photographs reviewed for this assessment. The Impact Sciences (2001) report states that habitat capable of supporting arroyo toads is absent from the Santa Clara River from 450 meters east of Bouquet Canyon Road upstream to the eastern boundary of the Newhall Land and Farming property which includes most of the Riverpark Project site.

Areas of Standing Water Site No. 3 contained associated damp substrata with willow and cattail patches, but not vegetated sandbars and overflow pools parallel to the main channel. The other Areas of Standing Water sites and identified drainages are not large enough to provide the water or sediments necessary to form overflow pools and, therefore, are not considered habitat. In conclusion, in the absence of confluence overflow pool habitat, there is no spawning habitat for arroyo toads within the Project boundaries, and currently no information or evidence to suggest that adult arroyo toads occur within those boundaries.

The greatest potential concern regarding project impacts is that alterations in stream flow and sediment transport by the project bank stabilization, bridge abutments and bridge piers could damage arroyo toad spawning habitat downstream, whether by increased siltation, decreases in available sediments from upstream of the Project, seasonal alteration of water regimes, or excessive scouring by winter and spring floods. The EIR/EIS for the NRMP, of which the project is part, stated that the widening of the river channels within the areas of bank protection (i.e., bank stabilization) would not cause system-wide channel or bed erosion, or aggradation. USFWS in its 1998 and 2002 Biological Opinion on the NRMP (p. 30) supported that conclusion. The Psomas Technical Flood Report reaffirms the findings of the NRMP – that is no significant increase in velocity, water surface elevation or sedimentation as a result of project improvements (i.e., bank stabilization, bridge abutments, bridge piers, erosion protection).

The above findings support the conclusions that it is unlikely that arroyo toad would inhabit the Project site on a permanent basis. Based upon this, no impacts to downstream arroyo toad populations are expected.

3.4 CALIFORNIA RED-LEGGED FROG

The aerial photograph and field evaluation indicates that potential spawning or summer habitat for the California red-legged frog is absent from the main channel of the Santa Clara River within the project site. The floodplain and associated stream channel are clearly subject to episodic flooding and complete desiccation soon thereafter. Such instability does not allow California red-legged frog spawning habitat to develop.

No red-legged frogs were sighted during the site visit and none have been detected within the project site during any focused surveys. Site Nos. 1-3 (Areas of Standing Water) as well as the identified jurisdictional drianages offer little or no habitat capable of supporting aquatic frogs. Conversely, during the late winter and autumn, when California red-legged frogs may be most likely to move randomly (USFWS 2002), the main Santa Clara River channel within the project site could be considered "dispersal habitat," primarily because frogs can survive in the main channel during that season.

California red-legged frogs are probably not as vulnerable to floods because they usually do not spawn in river bottomlands. Local impacts (within the project site boundaries) to California red-legged frogs would probably result only from construction activity effects on the extremely unlikely presence of dispersing red-legged frogs during the construction process.

The above findings support the conclusions that it is unlikely that Red-Legged Frog would inhabit the Project site on a permanent basis.

The Psomas Technical Flood Impact Report prepared for the Riverpark project concludes that there would be no significant alteration in water surface elevation, velocity or sedimentation downstream of the project site as a result of project improvements. Based upon this, no impacts to downstream Red-Legged Frog habitat are expected.

The above conclusions may also apply to some other sensitive aquatic species such as the southwestern pond turtle (*Clemmys marmorata pallida*). Based on observations of the field assessment, including photographs, permanent water and terrestrial egg-laying sites required by these species are absent from the project site and immediately downstream.

4. SUMMARY OF FINDINGS

4.1 GENERAL FINDINGS

The historical record for the river indicates it has always been relatively dry in the Riverpark area and restoration to previous conditions should not be aimed at developing permanent water flows in this area. However, continued development in the drainage could result in more wastewater discharge that could increase the extent of surface flow and actually improve conditions for stickleback and other native aquatic forms.

4.2 UNARMORED THREESPINE STICKLEBACK

Occurrence of unarmored threespine stickleback on the Project site is predicted to be very sporadic and due to occasional strong storms or above average rainy seasons that may flush fish downstream from known established populations upstream. Site Nos. 1-3 (Areas of Standing Water) and proposed storm drain outlets provide possible areas that could maintain fish for temporary periods depending on the permanence of surface flow in the River and from these tributaries/storm drains. The implementation of project related improvements are unlikely to affect stickleback from using the Santa Clara River on the Project site.

The Psomas Flood Impact Report prepared for the Riverpark project concludes that there would be no significant alteration in water surface elevation, velocity or sedimentation downstream of the project site as a result of project improvements. Based upon this, no impacts to downstream populations of unarmored threespine stickleback are expected.

4.3 ARROYO TOAD

Occurrence of Arroyo Toad on the Project site is unlikely as the project site does not contain the habitat characteristics necessary for the permanent habitation of the species, primarily the lack of overflow pool habitat. Site No. 3 (Areas of Standing Water) contained associated damp substrata with willow and cattail patches but not vegetated sandbars and overflow pools parallel to the main channel. The other sites (Areas of Standing Water) and on-site drainages are not large enough to form overflow pools and therefore are not considered habitat.

The Psomas Flood Impact Report prepared for the Riverpark project concludes that there would be no significant alteration in water surface elevation, velocity or sedimentation downstream of the project site as a result of project improvements. Based upon this, no impacts to downstream populations of Arroyo Toad are expected.

4.4 CALIFORNIA RED-LEGGED FROG

California red-legged frogs occur rarely if at all in the Santa Clara River channel within or near the project site. The site lacks the appropriate spawning pools which are the ecologically central component of the California red-legged frog habitat.

5. REFERENCES

Aquatic Consulting Services, Inc. 2002. Aquatic Surveys Along the Santa Clara River Part I: Castaic Junction Project Area, Los Angeles County, California. Aquatic Consulting Services, Inc., April 2002.

Bury, R. B. 1986. Feeding ecology of the turtle *Clemmys marmorata*. Journal of Herpetology 20:515-521.

California Department of Fish and Game (CDFG). 2002. California Wildlife Habitat Relationships System. California Interagency Wildlife Task Group, Sacramento, California.

California Department of Fish and Game. 2003. RareFind3. California Natural Diversity Database.

CAS. 2003. California Academy of Sciences Department of Herpetology Collections Catalogue.

City of Santa Clarita, unpublished/undated. Revised Initial Study: Riverpark Project. City of Santa Clarita, unpublished/undated.

Hayes, M. P. & Jennings, M. R. 1989: Habitat correlates of distribution of the California red-legged frog (*Rana aurora draytonii*) and the foothill yellow-legged frog (*Rana boylii*): Implications for management. In: Management of amphibians, reptiles, and small mammals in North America, Proceedings of the symposium on the [July 19-21, 1988-Flagstaff, Arizona]. Vol. Technical Report RM - 166 (Szaro, R. E., Severson, Kieth E., Patton, David R. (technical coordinators) ed). USDA. pp. 1-458.

Holland, D. 1991. A synopsis of the ecology and status of the western pond turtle (*Clemmys marmorata*) in 1991. Report prepared for US Fish and Wildlife Service, National Ecology Research Center, San Simeon, California.

Impact Sciences, Inc. 2001. Results of Focused Surveys for Arroyo Toad and Special-Status Aquatic Reptiles and Amphibians within the Natural River Management Plan Area, Valencia, California. Impact Sciences, Inc., September 2001.

Impact Sciences, Inc. 2003. Results of Focused Unarmored Threespine Stickleback and Other Special-Status Fish Species, Newhall Ranch, Valencia California. Impact Sciences, Inc., January 2003.

Impact Sciences, Inc. and PSOMAS. 2003.Water Resources Technical Report for Riverpark. Impacts Sciences, Inc./PSOMAS, October 2003.

Impact Sciences, Inc. (unpublished) 2003.Riverpark Field Study References and Appendices from Section 4.6 Biological Resources Partial Screencheck Draft Environmental Impact Report. Impact Sciences, Inc (unpublished), November 2003.

Jennings, M R. and M. Hayes. 1994. Amphibian and Reptile Species of Special Concern in California. California Department of Fish and Game, Rancho Cordova, California.

PSOMAS. 2004. Technical Flood Report for Riverpark. Prepared for Impact Sciences, Inc., February 2004

Stebbins, R. C. 1951. Amphibians of Western North America. University of California Press, Berkeley, California.

Sweet, S. 1992. Ecology and status of the arroyo toad (*Bufo microscaphus californicus*) on the Los Padres National Forest of Southern California, with management recommendations. Contract Report to USDA Forest Service, Los Padres National Forest, Goleta, California.

Sweet, S. 1993. Second report on the biology and status of the arroyo toad (*Bufo microscaphus californicus*) on the Los Padres National Forest of Southern California. Contract Report to USDA Forest Service, Los Padres National Forest, Goleta, California.

Swift, C. C., T. R. Haglund, R. Fisher, and M. Ruiz. 1993. Status and distribution of the freshwater fishes of southern California. Bull. S. Calif Acad. Sci., 92(3):101-167.

UC Berkeley. 2003. Museum of Vertebrate Zoology online Data Access.

U.S. Army Corps of Engineers. 2003. Amended 404 Permit (No. 940050400-BAH) for Natural River Management Plan. U.S. Army Corps of Engineers, June 2003.

U.S. Fish and Wildlife Service, 1999. Recovery Plan for the Arroyo Southwestern Toad. U.S. Fish and Wildlife Service, Portland, Oregon.

U.S. Fish and Wildlife Service, 2002. Recovery Plan for the California Red-Legged Frog (*Rana aurora draytonii*). U.S. Fish and Wildlife Service, Portland, Oregon.

U.S. Fish and Wildlife Service. 2002. Biological Opinion for the Natural River Management Plan, Santa Clarita, Los Angeles County, California (1-8-02-F-4R) (File No. 940050400-BAH). U.S. Fish and Wildlife Service, November 2002.

Valencia Company. 1998. Final EIS/EIR: 404 Permit and 1603 Streambed Alteration Agreement for Portions of the Santa Clara River and its Tributaries, Los Angeles County. Valencia Company, August 1998.

Valencia Company. 1998 Natural River Management Plan: Permitted Projects and Activities. Santa Clara River and tributaries. Valencia Company, November 1998.

Zeiner, D. C., W.F Laudenslayer, Jr., K.E. Mayer, and M. White. 1990b. California's Wildlife: Volume III. Mammals. California Statewide Wildlife Habitat Relationship System. State of California, the Resources Agency, Department of Fish and Game, Sacramento, California.

6. LIST OF PREPARERS

ENTRIX, Inc.

- Matt Carpenter, Project Manager: coordination and management of ENTRIX technical staff through the background document review, field reconnaissance and document preparation phases,
- Camm Swift, Ph.D., Fisheries Scientist: conducted field reconnaissance survey and background document review; prepared technical discussion of issues related to stickleback and fish.
- Sean Barry, M.S. Herpetologist: reviewed background documents, site photos and field reconnaissance documentation; prepared technical discussion of issues related to amphibians and reptiles.
- Kathy Frye, Field Wildlife Biologist: conducted field reconnaissance survey evaluating habitat conditions for amphibians and reptiles.

Resumes for ENTRIX staff are included in Appendix B.

FIGURES

APPENDICES

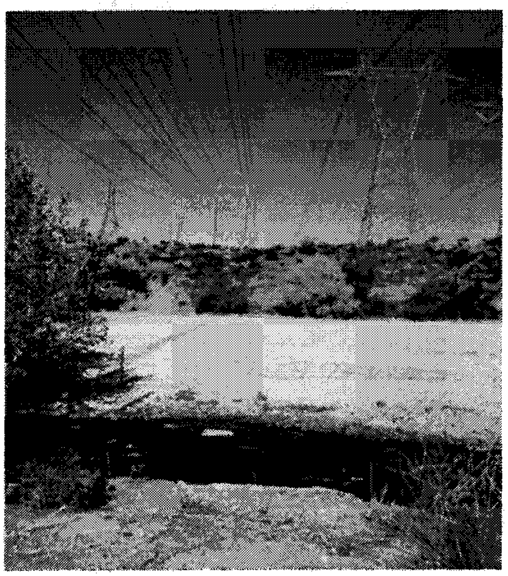
APPENDIX A

FIELD DATA & PHOTOGRAPHS

FIELD SURVEY DATA

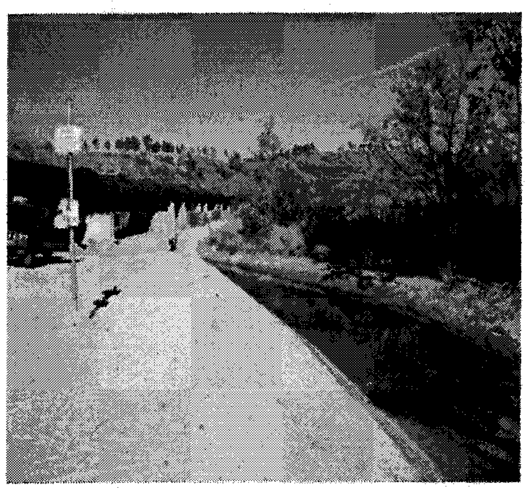
Site ID	Feature Locale	Physical Parameters	Biological Parameters
Site 1	Storm Channel Outlet upstream of Project	Water Depth: 2 ft. Max Water Temp: 10°C	Seined 31 African clawed frogs in 5 hauls; no fish observed
Site 2	Storm Channel Outlet near DPW Aqueduct Pipeline	Water Depth: 2-3 ft. Max Water Temp: 5°C	No fish or invertebrates observed
Site 3	Stromdrain Outlet from Commuter Way	Water Depth: 1 ft. Max No Water Temp	Dense cattails and willows in shallow standing water; no sampling conducted

FIELD PHOTOGRAPHS



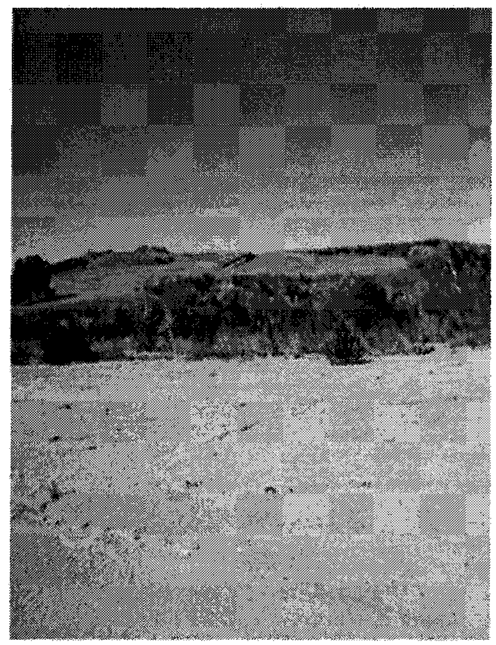
Site 1 - Sampling Site Located Upstream of Project at Outlet of Storm Channel on South Bank

Site 2 - Sampling Site at DWP Aqueduct Pipeline Crossing on South Bank

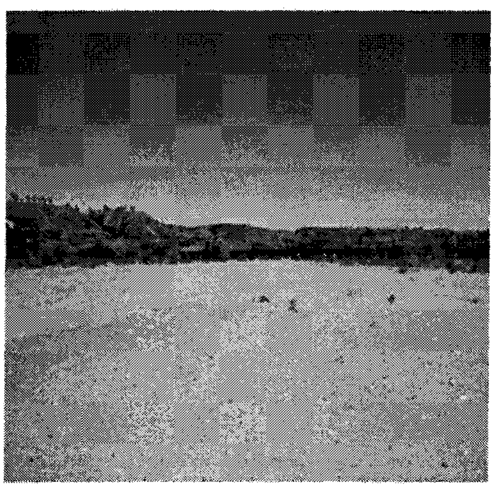


Site 2 - Sampling Site at DWP Aqueduct Pipeline Crossing on South Bank

View Downstream (West) from
Proposed Santa Clarita
Parkway Bridge Crossing



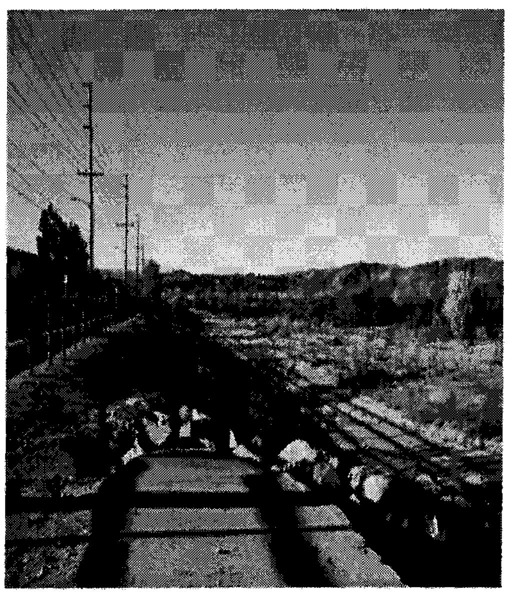
View to North Bank from
South, Downstream of DWP
Aqueduct Pipeline



View Upstream (East) to DWP
Aqueduct Pipeline

Site 3- View Downstream (West) at Dense Cattail/Willow Stand Along Southern Bank

Site 3- View Upstream (East) Along Southern Bank (note dense cattails and willows)



View Downstream (West) from Project Site Along Southern Bank Toward Bouquet Canyon Road

APPENDIX B

RESUMES

APPENDIX 4.21

Wastewater Data

DMS Wastewater Generation Calculations						
Without Riverpark Project						
Land Use	Units	Quantity	Generation Factor (gpd)	Generation (gpd)	Generation (mgd)	AFY
Residential						
Single Family	du	62,472.00	260.00	16,242,720.00	16.24	18,194.1832
Multi-Family	du	29,037.00	195.00	5,662,215.00	5.66	6,342.4954
Non-Residential						
Commercial Retail	tsf	9,545.01	100.00	954,500.90	0.95	1,069.1783
Restaurant	tsf	-	1,000.00	0.00	0.00	0.0000
Industrial	tsf	-	25.00	0.00	0.00	0.0000
Office	tsf	-	200.00	0.00	0.00	0.0000
School (2)	tsf	-	200.00	0.00	0.00	0.0000
Park	acre	110.00		0.00	0.00	0.0000
Recreation Center (3)	tsf	-	100.00	0.00	0.00	0.0000
			Sub Totals	**22,859,435.90**	**22.86**	**25,605.86**
With Riverpark Project						
Land Use	Units	Quantity	Generation Factor (gpd)	Generation (gpd)	Generation (mgd)	AFY
Residential						
Single Family	du	439	260.00	114,140.00	0.1141	127.8532
Multi-Family	du	744	195.00	145,080.00	0.1451	162.5105
Non-Residential						
Commercial Retail	tsf	40.00	100.00	4,000.00	0.0040	4.4806
Restaurant	tsf	-	1,000.00	0.00	0.0000	0.0000
Industrial	tsf	-	25.00	0.00	0.0000	0.0000
Office	tsf	-	200.00	0.00	0.0000	0.0000
School (2)	tsf	-	200.00	0.00	0.0000	0.0000
Park	acre	29.00		0.00	0.0000	0.0000
Recreation Center (3)	tsf	-	100.00	0.00	0.0000	0.0000
			Sub Totals	**263,220.00**	**0.263220**	**294.84**
			Totals	**23,122,655.90**	**23.12**	**25,900.70**
gpd = gallons per day; mgd = million gallons per day; du = dwelling unit; tsf = thousand sq. feet; AFY = acre-feet per year						
Source of wastewater generation factors is CSDLAC, Loadings for Each Class of Land Use obtained from October 2002 correspondance.						

SCV Cumulative Buildout

Land Use Types	Unit	Cumulative Buildout w/o Project	Generation Factor	Generation Value
Single Family	du	93,281	260.00	24,253,060.00
Multi-Family	du	48,013	195.00	9,362,535.00
Mobile Home	du	2,699	156.00	421,044.00
Commercial Retail	tsf	19,859,030	100.00	1,985,903.00
Hotel	rooms	2,071	125.00	258,875.00
Sit-Down Restaurant	tsf	283,790	1,000.00	283,790.00
Fast Food Restaurant	tsf	23,600	1,000.00	23,600.00
Movie Theater(1)	seats	29,700	125.00	3,712,500.00
Health Club(2)	tsf	54,000	125.00	6,750.00
Car Dealership	tsf	411,000	100.00	41,100.00
Elem./Middle School	students	279,340	20.00	5,586,800.00
High School	students	12,958	20.00	259,160.00
College	students	29,948	20.00	598,960.00
Hospital(3)	tsf	247,460	125.00	30,932.50
Library(4)	tsf	171,790	50.00	8,589.50
Church	tsf	501,190	50.00	25,059.50
Day Care(4)	tsf	785,000	50.00	39,250.00
Industrial Park	tsf	41,743,950	200.00	8,348,790.00
Business Park	tsf	8,424,330	200.00	1,684,866.00
Manufact./Warehouse	tsf	3,932,470	200.00	786,494.00
Utilities	tsf	1,150,240	25.00	28,756.00
Commercial Office	tsf	6,380,520	200.00	1,276,104.00
Medical Office	tsf	133,730	200.00	26,746.00
Golf Course	ac	1,209	-	-
Developed Parkland	ac	493	-	-
Undeveloped Parkland	ac	1,000	-	-
Special Generator(5)	sg	413	25.00	10.33
				59,049,674.83

59.05

gpd = gallons per day; mgd = million gallons per day; du = dwelling unit;
tsf = thousand square feet; sq. ft. = square feet; stdnts = students
Source of wastewater generation factors is CDSLAC, Loadings for Each Class of Land Use

(1) Assumes each seat occupies a 9 square foot area (a total of 3,300 seats)
(2) Uses same generation factor for health club as commercial retail
(3) Number of hospital beds is based on assumed 500 square feet per bed at 247,460 sq.ft.
(4) Uses same generation factor for library as used for church.
(5) Uses same generation factor as for industrial/manufacturing.

SCV Cumulative Buildout w/ Riverpark Project

Land Use Types	Unit	Cumulative Buildout w/o Project	Generation Factor	Generation Value
Single Family	du	93,720	260.00	24,367,200.00
Multi-Family	du	48,757	195.00	9,507,615.00
Mobile Home	du	2,699	156.00	421,044.00
Commercial Retail	tsf	19,899	100.00	1,989,900.00
Hotel	rooms	2,071	125.00	258,875.00
Sit-Down Restaurant	tsf	284	1,000.00	283,790.00
Fast Food Restaurant	tsf	24	1,000.00	23,600.00
Movie Theater(1)	seats	29,700	125.00	3,712,500.00
Health Club(2)	tsf	54	125.00	6,750.00
Car Dealership	tsf	411	100.00	41,100.00
Elem./Middle School	students	279,340	20.00	5,586,800.00
High School	students	12,958	20.00	259,160.00
College	students	29,948	20.00	598,960.00
Hospital(3)	tsf	0	125.00	61.88
Library(4)	tsf	172	50.00	8,589.50
Church	tsf	501	50.00	25,059.50
Day Care(4)	tsf	785	50.00	39,250.00
Industrial Park	tsf	41,744	200.00	8,348,790.00
Business Park	tsf	8,424	200.00	1,684,866.00
Manufact./Warehouse	tsf	3,932	200.00	786,494.00
Utilities	tsf	1,150	25.00	28,756.00
Commercial Office	tsf	6,381	200.00	1,276,104.00
Medical Office	tsf	134	200.00	26,746.00
Golf Course	ac	1,238	-	-
Developed Parkland	ac	493	-	-
Undeveloped Parkland	ac	1,000	-	-
Special Generator(5)	sg	413	25.00	10,325.00
				59,292,335.88

gpd = gallons per day; mgd = million gallons per day; du = dwelling unit;
tsf = thousand square feet; sq. ft. = square feet; stdnts = students
Source of wastewater generation factors is CDSLAC, Loadings for Each Class of Land Use

(1) Assumes each seat occupies a 9 square foot area (a total of 3,300 seats)
(2) Uses same generation factor for health club as commercial retail
(3) Number of hospital beds is based on assumed 500 square feet per bed at 247,460 sq.ft.
(4) Uses same generation factor for library as used for church.
(5) Uses same generation factor as for industrial/manufacturing.

APPENDIX 6.0

Alternatives Data

Table 1

TRIP GENERATION AND TRIP RATE SUMMARY
ALTERNATIVE SCENARIOS

LAND USE	UNITS	AM PEAK HOUR IN	AM PEAK HOUR OUT	AM PEAK HOUR TOTAL	PM PEAK HOUR IN	PM PEAK HOUR OUT	PM PEAK HOUR TOTAL	ADT
TRIP GENERATION								
Proposed Project		**201**	**602**	**803**	**755**	**492**	**1,247**	**13,274**
Alternative 2: Santa Clara River Alternative								
Area A1 - Single Family	*-54 DU*	*-10*	*-30*	*-40*	*-35*	*-19*	*-54*	*-535*
Area A2 - Single Family	*-21 DU*	*-4*	*-12*	*-16*	*-14*	*-8*	*-22*	*-208*
Retail Commercial	*-13 TSF*	*-12*	*-8*	*-19*	*-38*	*-41*	*-78*	*-845*
Developed Park	*-4 AC*	*0*	*0*	*0*	*0*	*0*	*0*	*-10*
Alternative 2 Total		**175**	**552**	**728**	**668**	**424**	**1,093**	**11,676**
Alternative 3: Ridgeline Protection								
Area B - Single Family	*-76 DU*	*-14*	*-43*	*-57*	*-49*	*-27*	*-76*	*-752*
Area C - Apartment	*-55 DU*	*-4*	*-24*	*-28*	*-23*	*-12*	*-35*	*-380*
Area D - Apartment	*-27 DU*	*-2*	*-12*	*-14*	*-11*	*-6*	*-17*	*-186*
Alternative 3 Total		**181**	**523**	**704**	**672**	**447**	**1,119**	**11,956**
Alternative 4: Compliance with Noise Ordinance								
Area A1 - Single Family	*-109 DU*	*-21*	*-61*	*-82*	*-71*	*-39*	*-110*	*-1,079*
Area A2 - Single Family	*-75 DU*	*-14*	*-42*	*-56*	*-49*	*-27*	*-76*	*-743*
Area B - Single Family	*-117 DU*	*-22*	*-66*	*-88*	*-76*	*-42*	*-118*	*-1,158*
Alternative 4 Total		**144**	**433**	**577**	**559**	**384**	**943**	**10,294**
Alternative 5: Deletion of Santa Clarita Parkway								
Area A2 - Single Family	*9 DU*	*2*	*5*	*7*	*6*	*3*	*9*	*89*
Alternative 5 Total		**203**	**607**	**810**	**761**	**495**	**1,256**	**13,363**
TRIP RATES								
Single Family Detached [1]	DU	0.19	0.56	0.75	0.65	0.36	1.01	9.9
Apartment [2]	DU	0.08	0.43	0.51	0.41	0.21	0.62	6.9
Developed Park [3]	ACRE	0	0	0	0.03	0.04	0.07	2.6
Retail Commercial [4]	TSF	ADT: LN(T) = 0.643*LN(X) + 5.866						
		AM: LN(T) = 0.596*LN(X) + 2.329 (61% IB/39% OB)						
		PM: LN(T) = 0.660*LN(X) + 3.403 (48% IB/52% OB)						

Notes:
[1] SCVCTM Category 3 (Single Family 6-10 DU/Acre)
[2] SCVCTM Category 5 (Apartment)
[3] SCVCTM Category 51 (Developed Park)
[4] Institute of Transportation Engineers (ITE) Category 820 (Shopping Center)

DU = Dwelling Unit
AC = ACRE
TSF = Thousand Square Feet

Table 2

TRIP GENERATION AND TRIP RATE SUMMARY
GENERAL PLAN SCENARIOS

LAND USE	UNITS		AM PEAK HOUR IN	AM PEAK HOUR OUT	AM PEAK HOUR TOTAL	PM PEAK HOUR IN	PM PEAK HOUR OUT	PM PEAK HOUR TOTAL	ADT
TRIP GENERATION									
Permitted Development									
Community Commercial	*23.946*	*TSF*	*42*	*27*	*68*	*117*	*127*	*244*	*2,719*
Community Commercial (PD)	*537.544*	*TSF*	*266*	*170*	*435*	*915*	*991*	*1,905*	*20,101*
Commercial Office (PD)	*2381.541*	*TSF*	*3,691*	*452*	*4,143*	*500*	*3,072*	*3,572*	*27,531*
Residential Medium	*2670*	*DU*	*507*	*1,495*	*2,002*	*1,736*	*961*	*2,697*	*26,433*
Mobile Home Park	*360*	*DU*	*29*	*115*	*144*	*126*	*76*	*202*	*2,484*
Industrial Commercial	*304.872*	*TSF*	*168*	*30*	*198*	*40*	*159*	*199*	*1,829*
Total			**4,702**	**2,288**	**6,990**	**3,434**	**5,386**	**8,820**	**81,098**
With Density Bonus									
Community Commercial	*583.704*	*TSF*	*279*	*178*	*457*	*966*	*1,046*	*2,012*	*21,195*
Community Commercial (PD)	*13102.848*	*TSF*	*1,781*	*1,139*	*2,920*	*7,527*	*8,154*	*15,681*	*156,689*
Commercial Office (PD)	*0*	*TSF*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Residential Medium	*13865*	*DU*	*2,634*	*7,764*	*10,398*	*9,012*	*4,991*	*14,003*	*137,264*
Mobile Home Park	*1870*	*DU*	*150*	*598*	*748*	*655*	*393*	*1,048*	*12,903*
Industrial Commercial	*0*	*TSF*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Total			**4,844**	**9,679**	**14,523**	**18,159**	**14,584**	**32,744**	**328,051**
TRIP RATES									
Residential Medium [1]	DU		0.19	0.56	0.75	0.65	0.36	1.01	9.90
Mobile Home [2]	DU		0.08	0.32	0.40	0.35	0.21	0.56	6.90
Commercial Office [3]	TSF		1.55	0.19	1.74	0.21	1.29	1.50	11.56
Industrial Commercial [4]	TSF		0.55	0.10	0.65	0.13	0.52	0.65	6.00
Retail Commercial [5]	TSF		ADT: LN(T) = 0.643*LN(X) + 5.866 AM: LN(T) = 0.596*LN(X) + 2.329 (61% IB/39% OB) PM: LN(T) = 0.660*LN(X) + 3.403 (48% IB/52% OB)						

Notes:
[1] SCVCTM Category 3 (Single Family 6-10 DU/Acre)
[2] SCVCTM Category 6 (Mobile Home)
[3] SCVCTM Category 40 (Commercial Office)
[4] SCVCTM Category 30 (Industrial Park)
[5] Institute of Transportation Engineers (ITE) Category 820 (Shopping Center)

DU = Dwelling Unit
TSF = Thousand Square Feet

Alternative 2
Santa Clarita Valley
Population and Employment Impact Analysis

Land Use	Unit	Quantity	Persons/ Household	Population	Employees/ Unit	Employees
Single Family Res'l	du	364	3.06	1,112	-	-
Multi-Family Res'l	du	744	3.06	2,274	-	-
Mobile Homes	du		2.55	0	-	-
Comm'l Retail	tsf	26.00	-	-	2.50	65
Hotel/Motel (1)	rooms		-	-	0.90	0
School/College	-		-	-	-	
Hospital	tsf		-	-	3.00	0
Library	tsf		-	-	1.00	0
Church	tsf		-	-	0.50	0
Business Park	tsf		-	-	3.00	0
Industrial/Mfg.	tsf		-	-	2.00	0
Utilities	tsf		-	-	0.70	0
Office	tsf		-	-	4.00	0
Golf Course/Park	acres	25.00	-	-	0.40	10
Special Generator (3)	tsf		-	-	0.70	0
			Totals	**3,386**	**-**	**75**

du = dwelling unit; tsf = thousand square feet

Build out analysis and school employment is derived from the Traffic Model.

(1) Based on 400 gross square feet per room and 0.9 employees per room (SCAG, 1990).

(3) Assumes same rate as Utilities.

Prepared by Impact Sciences, Inc.
S. Tebo
12/9/03

Alternative 2

River Park

Santa Clarita Valley
Library Impact Analysis

Land Use	Number of Units	Persons/ Household	Library (Sq. Feet)	Library Books
Single Family Res'l	364	3.01	383	2,191
Multi-Family Res'l	744	3.01	784	4,479
Mobile Homes		2.55	0	0
		Totals	**1,167**	**6,670**

L.A. County Public Library Standard: 0.35 s.f./capita
L.A. County Public Library Standard: 2.0 books/capita

Prepared by Impact Sciences, Inc.
S. Tebo
12/5/03

Santa Clarita Valley
Net Increase in
Student/Classroom/School Generation Using
Theoretical Student Generation Rates
River Park-Alternative 2

District	Housing Units by Type			Student Generation Rate			Class Size	School Size	Students	Classes	Schools
	Single Fam.	Multi-Fam.	Apartment	Single Fam.	Multi-Fam.	Apartment					
Saugus Union Elementary	364		744	0.431	0.0556	0.1326	30	770	256	8.52	0.33
Hart Junior High	364		744	0.104	0.037	0.038	32	930	66	2.07	0.07
Hart High School	364		744	0.179	0.064	0.054	32	2,764	105	3.29	0.04
								Totals	**427**	**13.88**	**0.44**

Prepared By Impact Sciences, Inc.
S.Tebo
12/5/03

Alternative 2
River Park
Parks and Recreation Impact Analysis
Using Household Size Numbers from Park Ordinance

Land Use	Number of Units	Persons/ Household	Population	Parkland Req'mt (acres)
Single Family Res'l	364	3.01	1,096	3.29
Multi-Family Res'l	744	3.01	2,239	6.72
Mobile Homes		2.55	0	0.00
		Totals	**3,335**	**10.01**

Based on Quimby requirement of 3.0 acres/1000 persons

Prepared by Impact Sciences, Inc.
S. Tebo
12/5/03

Alternative 2
Santa Clarita Valley
Solid Waste Generation
(No Recycling) Impact Analysis

			Generation Rate		Total Waste Generated	
Land Use	Quantity	Units	(tpy) (1)	(lbs./day)	(tpy)	(lbs./day)
Residential Units:						
Single Family Detached	364	du	2.0400	11.18	743	4,069
Multi-Family or Attached	744	du	1.1700	6.41	870	4,770
Mobile Home		du	1.1700	6.41	0	0
Commercial/Industrial						
General Retail	26,000	sq. ft.	0.0024	0.01	62	342
Eating/Drnkng Establ.		sq. ft.	0.0108	0.06	0	0
Food & Drug Stores		sq. ft.	0.0072	0.04	0	0
Auto Dlr/Service Sta.		sq. ft.	0.0051	0.03	0	0
Hotel & Motel		sq. ft.	0.0053	0.03	0	0
Warehouse		sq. ft.	0.0011	0.01	0	0
Medical Offices		sq. ft.	0.0027	0.01	0	0
Hospitals		sq. ft.	0.0055	0.03	0	0
Business Park		sq. ft.	0.0014	0.01	0	0
Office		sq. ft.	0.0014	0.01	0	0
Library (4)		sq. ft.	0.0014	0.01	0	0
Education & Schools		sq. ft.	0.0013	0.01	0	0
College		sq. ft.	0.0013	0.01	0	0
Trans., Comm., Utilities		sq. ft.	0.0079	0.04	0	0
Special Generator (6)		sq. ft.	0.0079	0.04	0	0
Golf Course/Park	25	acres	0.2000	1.10	5	27
Manufacturing		sq. ft.	0.0050	0.03	0	0
Church (4)		sq. ft.	0.0014	0.01	0	0
				Totals	**1,680**	**9,208**

du = dwelling unit; sq.ft. - square feet; tpy = tons per year; lbs. = pounds

(1) The solid waste daily generation rates in tons per year are derived from the Ventura County Solid Waste Management Department's Guidelines for Preparation of Environmental Assessments for Solid Waste Impacts. These figures do not reflect any recycling activities on the part of the generator.

(4) Assumes same generation rate as for office.

(6) Conservatively assumes same generation rate as utilities.

Prepared by Impact Sciences, Inc.
S. Tebo
12/5/03

Alternative 2
Santa Clarita Valley
Wastewater Generation Impact Analysis

Land Use	Units	Quantity	Generation Factor (gpd)	Generation (gpd)	Generation (mgd)
Residential					
Single Family	du	364	260.00	94,640.00	0.0946
Multi-Family	du	744	195.00	145,080.00	0.1451
Mobile Homes	du		195.00	0.00	0.0000
Non-Residential					
Commercial Retail	tsf	3	100.00	300.00	0.0003
Hotel	sq.ft.		na		
Hotel (1)	rooms		125.00	0.00	0.0000
School	tsf		200.00	0.00	0.0000
College	stdnts		20.00	0.00	0.0000
College	sq.ft.		na		
Hospital	sq.ft.		na		
Hospital (3)	beds		125.00	0.00	0.0000
Library (4)	tsf		50.00	0.00	0.0000
Church	tsf		50.00	0.00	0.0000
Business Park (7)	tsf		300.00	0.00	0.0000
Industrial/Manufacturing (5)	tsf		25.00	0.00	0.0000
Utilities	tsf		25.00	0.00	0.0000
Commercial/Medical Office	tsf		300.00	0.00	0.0000
Golf Course/Park	acres	25	0.00	0.00	0.0000
Golf Course/Park Imps	tsf		100.00	0.00	0.0000
Visitor Serving (8)	tsf		100.00	0.00	0.0000
Special Generator (9)	tsf		25.00	0.00	0.0000
			Totals	**240,020.00**	**0.2400**

gpd = gallons per day; mgd = million gallons per day; du = dwelling unit; tsf = thousand square feet; sq. ft. = square feet; stdnts = students

Source of wastewater generation factors is CDSLAC, Loadings for Each Class of Land Use (1992-93). This list is provided in Appendix 4.10.

(1) Number of hotel rooms is based upon an assumed 400 gross square feet per room.

(3) Number of hospital beds is based upon an assumed 500 gross square feet per bed.

(4) Uses same generation factor for library as used for church.

(5) Generation factor for industrial/manufacturing is based on dry manufacturing uses.

(7) Uses same generation factor as for professional building.

(8) Uses same generation factor as for commercial retail.

(9) Uses same generation factor as for industrial/manufacturing.

Prepared by Impact Sciences, Inc.
S. Tebo
12/5/03

Alternative 2-Santa Clara River Protection
Estimated Water Demand

Land Use Category	Amount	Water Duty Factor	Water Demand (AFY)
Single Family Units	364 units	0.55 af/unit	200.2
Apartments	744 units	0.19 af/unit	141.36
Park	4 acres	3 af per acre	12.0
Other Misc. Landscaping (irrigated common landscaping, pocket parks, etc.)	76 acres	3 af per acre	228.0
Commercial (26,000 sq. ft.)	2 acres	0.0289 af/100 sq. ft.	7.51
TOTAL			**589.07**

ALTERNATIVE 2 SUMMERTIME EMISSIONS

URBEMIS 2002 For Windows 7.4.2

File Name: C:\URBEMIS2002\Urbemis River Park\River Park Alternative 2.urb
Project Name: River Park Alternative 2
Project Location: South Coast Air Basin (Los Angeles area)
On-Road Motor Vehicle Emissions Based on EMFAC2002 version 2.2

SUMMARY REPORT
(Pounds/Day - Summer)

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	55.41	10.50	8.07	0.09	0.03
TOTALS (lbs/day, mitigated)	55.31	9.31	7.55	0.09	0.02

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	97.01	105.44	1,138.55	0.73	110.47
TOTALS (lbs/day, mitigated)	97.01	105.44	1,138.55	0.73	110.47

SUM OF AREA AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	152.42	115.94	1,146.62	0.82	110.50
TOTALS (lbs/day, mitigated)	152.32	114.75	1,146.10	0.82	110.50

URBEMIS 2002 For Windows 7.4.2

File Name: C:\URBEMIS2002\Urbemis River Park\River Park Alternative 2.urb
Project Name: River Park Alternative 2
Project Location: South Coast Air Basin (Los Angeles area)
On-Road Motor Vehicle Emissions Based on EMFAC2002 version 2.2

DETAIL REPORT
(Pounds/Day - Summer)

AREA SOURCE EMISSION ESTIMATES (Summer Pounds per Day, Unmitigated)

Source	ROG	NOx	CO	SO2	PM10
Natural Gas	0.80	10.43	4.43	-	0.02
Wood Stoves - No summer emissions					
Fireplaces - No summer emissions					
Landscaping	0.40	0.06	3.64	0.09	0.01
Consumer Prdcts	54.21	-	-	-	-
TOTALS(lbs/day,unmitigated)	55.41	10.50	8.07	0.09	0.03

AREA SOURCE EMISSION ESTIMATES

Source	ROG	NOx	CO	SO2	PM10
Natural Gas	0.70	9.24	3.92	-	0.02
Wood Stoves - No summer emissions					
Fireplaces - No summer emissions					
Landscaping	0.40	0.06	3.64	0.09	0.01
Consumer Prdcts	54.21	-	-	-	-
TOTALS (lbs/day, mitigated)	55.31	9.31	7.55	0.09	0.02

Area Source Mitigation Measures

UNMITIGATED OPERATIONAL EMISSIONS

	ROG	NOx	CO	SO2	PM10
Single family housing	32.09	34.78	379.75	0.24	36.59
Apartments low rise	49.31	49.54	540.99	0.34	52.13
City park	0.13	0.09	0.91	0.00	0.09
Strip mall	15.48	21.03	216.90	0.14	21.66
TOTAL EMISSIONS (lbs/day)	97.01	105.44	1,138.55	0.73	110.47

Does not include correction for passby trips.
Does not include double counting adjustment for internal trips.

OPERATIONAL (Vehicle) EMISSION ESTIMATES

Analysis Year: 2008 Temperature (F): 90 Season: Summer

EMFAC Version: EMFAC2002 (9/2002)

Summary of Land Uses:

Unit Type	Trip Rate	Size	Total Trips
Single family housing	9.90 trips / dwelling units	364.00	3,603.60
Apartments low rise	6.90 trips / dwelling units	744.00	5,133.60
City park	2.60 trips / acres	4.00	10.40
Strip mall	94.55 trips / 1000 sq. ft.	27.00	2,552.85

Vehicle Assumptions:

Fleet Mix:

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	55.00	1.60	98.00	0.40
Light Truck < 3,750 lbs	15.00	2.70	95.30	2.00
Light Truck 3,751- 5,750	16.20	1.20	97.50	1.30
Med Truck 5,751- 8,500	7.20	1.40	95.80	2.80
Lite-Heavy 8,501-10,000	1.10	0.00	81.80	18.20
Lite-Heavy 10,001-14,000	0.40	0.00	50.00	50.00
Med-Heavy 14,001-33,000	1.00	0.00	20.00	80.00
Heavy-Heavy 33,001-60,000	0.90	0.00	11.10	88.90
Line Haul > 60,000 lbs	0.00	0.00	0.00	100.00
Urban Bus	0.20	0.00	50.00	50.00
Motorcycle	1.70	76.50	23.50	0.00
School Bus	0.10	0.00	0.00	100.00
Motor Home	1.20	8.30	83.30	8.40

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Rural Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Trip Speeds (mph)	35.0	40.0	40.0	40.0	40.0	40.0
% of Trips - Residential	20.0	37.0	43.0			
% of Trips - Commercial (by land use)						
City park				5.0	2.5	92.5
Strip mall				2.0	1.0	97.0

MITIGATED OPERATIONAL EMISSIONS

	ROG	NOx	CO	SO2	PM10
Single family housing	32.09	34.78	379.75	0.24	36.59
Apartments low rise	49.31	49.54	540.99	0.34	52.13
City park	0.13	0.09	0.91	0.00	0.09
Strip mall	15.48	21.03	216.90	0.14	21.66
TOTAL EMISSIONS (lbs/day)	97.01	105.44	1,138.55	0.73	110.47

OPERATIONAL (Vehicle) EMISSION ESTIMATES

Analysis Year: 2008 Temperature (F): 90 Season: Summer

EMFAC Version: EMFAC2002 (9/2002)

Summary of Land Uses:

Unit Type	Trip Rate	Size	Total Trips
Single family housing	9.90 trips / dwelling units	364.00	3,603.60
Apartments low rise	6.90 trips / dwelling units	744.00	5,133.60
City park	2.60 trips / acres	4.00	10.40
Strip mall	94.55 trips / 1000 sq. ft.	27.00	2,552.85

Vehicle Assumptions:

Fleet Mix:

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	55.00	1.60	98.00	0.40
Light Truck < 3,750 lbs	15.00	2.70	95.30	2.00
Light Truck 3,751- 5,750	16.20	1.20	97.50	1.30
Med Truck 5,751- 8,500	7.20	1.40	95.80	2.80
Lite-Heavy 8,501-10,000	1.10	0.00	81.80	18.20
Lite-Heavy 10,001-14,000	0.40	0.00	50.00	50.00
Med-Heavy 14,001-33,000	1.00	0.00	20.00	80.00
Heavy-Heavy 33,001-60,000	0.90	0.00	11.10	88.90
Line Haul > 60,000 lbs	0.00	0.00	0.00	100.00
Urban Bus	0.20	0.00	50.00	50.00
Motorcycle	1.70	76.50	23.50	0.00
School Bus	0.10	0.00	0.00	100.00
Motor Home	1.20	8.30	83.30	8.40

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Rural Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Trip Speeds (mph)	35.0	40.0	40.0	40.0	40.0	40.0
% of Trips - Residential	20.0	37.0	43.0			
% of Trips - Commercial (by land use)						
City park				5.0	2.5	92.5
Strip mall				2.0	1.0	97.0

ENVIRONMENTAL FACTORS APPLICABLE TO THE PROJECT

Pedestrian Environment

0.0	Side Walks/Paths: No Sidewalks
0.0	Street Trees Provide Shade: No Coverage
0.0	Pedestrian Circulation Access: No Destinations
0.0	Visually Interesting Uses: No Uses Within Walking Distance
0.0	Street System Enhances Safety: No Streets
0.0	Pedestrian Safety from Crime: No Degree of Safety
0.0	Visually Interesting Walking Routes: No Visual Interest

0.0 <- Pedestrian Environmental Credit
0.0 /19 = 0.0 <- Pedestrian Effectiveness Factor

Transit Service

0.0	Transit Service: Dial-A-Ride or No Transit Service

0.0 <- Transit Effectiveness Credit
0.0 <- Pedestrian Factor
0.0 <-Total
0.0 /110 = 0.0 <-Transit Effectiveness Factor

Bicycle Environment

0.0	Interconnected Bikeways: No Bikeway Coverage
0.0	Bike Routes Provide Paved Shoulders: No Routes
0.0	Safe Vehicle Speed Limits: No Routes Provided
0.0	Safe School Routes: No Schools
0.0	Uses w/in Cycling Distance: No Uses w/in Cycling Distance
0.0	Bike Parking Ordinance: No Ordinance or Unenforceable

0.0 <- Bike Environmental Credit
0.0 /20 = 0.0 <- Bike Effectiveness Factor

MITIGATION MEASURES SELECTED FOR THIS PROJECT
(All mitigation measures are printed, even if
the selected land uses do not constitute a mixed use.)

Transit Infrastructure Measures

% Trips Reduced	Measure
15.0	Credit for Existing or Planned Community Transit Service
15.0	<- Totals

Pedestrian Enhancing Infrastructure Measures (Residential)

% Trips Reduced	Measure
2.0	Credit for Surrounding Pedestrian Environment
1.0	Provide Sidewalks and/or Pedestrian Paths
1.0	Provide Direct Pedestrian Connections
0.5	Provide Pedestrian Safety
0.5	Provide Street Lighting
0.5	Provide Pedestrian Signalization and Signage
5.5	<- Totals

Pedestrian Enhancing Infrastructure Measures (Non-Residential)

% Trips Reduced	Measure
2.0	Credit for Surrounding Pedestrian Environment
2.0	<- Totals

Bicycle Enhancing Infratructure Measures (Residential)

% Trips Reduced	Measure
7.0	Credit for Surrounding Bicycle Environment
2.0	Provide Bike Lanes/Paths Connecting to Bikeway System
9.0	<- Totals

Bike Enhancing Infrastructure Measures (Non-Residential)

% Trips Reduced	Measure
5.0	Credit for Surrounding Area Bike Environment
5.0	<- Totals

Operational Measures (Applying to Commute Trips)

% Trips Reduced	Measure
0.0	<- Totals

Operational Measures (Applying to Employee Non-Commute Trips)

% Trips Reduced	Measure
0.0	<- Totals

Operational Measures (Applying to Customer Trips)

% Trips Reduced	Measure
0.0	<- Totals

Measures Reducing VMT (Non-Residential)

VMT Reduced	Measure
0.0	Park and Ride Lots
0.0	<- Totals

Measures Reducing VMT (Residential)

VMT Reduced	Measure
0.0	<- Totals

Total Percentage Trip Reduction
with Environmental Factors and Mitigation Measures

Travel Mode	Home-Work Trips	Home-Shop Trips	Home-Other Trips
Pedestrian	0.00	0.00	0.00
Transit	0.00	0.00	0.00
Bicycle	0.00	0.00	0.00
Totals	0.00	0.00	0.00

Travel Mode	Work Trips	Employee Trips	Customer Trips
Pedestrian	0.00	0.00	0.00
Transit	0.00	0.00	0.00
Bicycle	0.00	0.00	0.00
Other	0.00	0.00	0.00
Totals	0.00	0.00	0.00

Changes made to the default values for Land Use Trip Percentages

Changes made to the default values for Area

The wood stove option switch changed from on to off.
The area souce mitigation measure option switch changed from off to on.
The landscape year changed from 2004 to 2008.
Mitigation measure Increase Insulation Beyond Title 24: Rsdntl Space Heat.
has been changed from off to on.
Mitigation measure Increase Insulation Beyond Title 24: Cmrcl Space Heat.
has been changed from off to on.

Changes made to the default values for Operations

The operational emission year changed from 2004 to 2008.
The double counting internal work trip limit changed from to 51.577.
The double counting shopping trip limit changed from to 25.7885.
The double counting other trip limit changed from to 2485.8845.
The travel mode environment settings changed from both to: both
Mitigation measure Provide Sidewalks and/or Pedestrian Paths:1
has been changed from off to on.
Mitigation measure Provide Direct Pedestrian Connections:1
has been changed from off to on.
Mitigation measure Provide Pedestrian Safety:0.5
has been changed from off to on.
Mitigation measure Provide Street Lighting:0.5
has been changed from off to on.
Mitigation measure Provide Pedestrian Signalization and Signage:0.5
has been changed from off to on.
Mitigation measure Provide Bike Lanes/Paths Connecting to Bikeway System:2
has been changed from off to on.

ALTERNATIVE 2 WINTERTIME EMISSIONS

URBEMIS 2002 For Windows 7.4.2

File Name: C:\URBEMIS2002\Urbemis River Park\River Park Alternative 2.urb
Project Name: River Park Alternative 2
Project Location: South Coast Air Basin (Los Angeles area)
On-Road Motor Vehicle Emissions Based on EMFAC2002 version 2.2

SUMMARY REPORT
(Pounds/Day - Winter)

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	1,296.07	24.52	1,373.39	2.17	187.53
TOTALS (lbs/day, mitigated)	1,295.97	23.33	1,372.88	2.17	187.53

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	89.92	152.45	1,082.56	0.60	110.47
TOTALS (lbs/day, mitigated)	89.92	152.45	1,082.56	0.60	110.47

SUM OF AREA AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	1,385.99	176.97	2,455.96	2.76	298.00
TOTALS (lbs/day, mitigated)	1,385.88	175.78	2,455.44	2.76	298.00

URBEMIS 2002 For Windows 7.4.2

File Name: C:\URBEMIS2002\Urbemis River Park\River Park Alternative 2.urb
Project Name: River Park Alternative 2
Project Location: South Coast Air Basin (Los Angeles area)
On-Road Motor Vehicle Emissions Based on EMFAC2002 version 2.2

DETAIL REPORT
(Pounds/Day - Winter)

AREA SOURCE EMISSION ESTIMATES (Winter Pounds per Day, Unmitigated)

Source	ROG	NOx	CO	SO2	PM10
Natural Gas	0.80	10.43	4.43	-	0.02
Wood Stoves	0.00	0.00	0.00	0.00	0.00
Fireplaces	1,241.06	14.09	1,368.96	2.17	187.51
Landscaping - No winter emissions					
Consumer Prdcts	54.21	-	-	-	-
TOTALS(lbs/day,unmitigated)	1,296.07	24.52	1,373.39	2.17	187.53

AREA SOURCE EMISSION ESTIMATES

Source	ROG	NOx	CO	SO2	PM10
Natural Gas	0.70	9.24	3.92	-	0.02
Wood Stoves	0.00	0.00	0.00	0.00	0.00
Fireplaces	1,241.06	14.09	1,368.96	2.17	187.51
Landscaping - No winter emissions					
Consumer Prdcts	54.21	-	-	-	-
TOTALS (lbs/day, mitigated)	1,295.97	23.33	1,372.88	2.17	187.53

Area Source Mitigation Measures

Increase Insulation Beyond Title 24: Rsdntl Space Heat.
Percent Reduction(ROG 14% NOx 13% CO 7.4% SO2 0% PM10 13%)
Increase Insulation Beyond Title 24: Cmrcl Space Heat.
Percent Reduction(ROG 10% NOx 9% CO 7% SO2 0% PM10 9.5%)

UNMITIGATED OPERATIONAL EMISSIONS

	ROG	NOx	CO	SO2	PM10
Single family housing	29.90	50.31	359.00	0.20	36.59
Apartments low rise	42.72	71.67	511.42	0.28	52.13
City park	0.07	0.13	0.88	0.00	0.09
Strip mall	17.22	30.33	211.27	0.11	21.66
TOTAL EMISSIONS (lbs/day)	89.92	152.45	1,082.56	0.60	110.47

Does not include correction for passby trips.
Does not include double counting adjustment for internal trips.

OPERATIONAL (Vehicle) EMISSION ESTIMATES

Analysis Year: 2008 Temperature (F): 50 Season: Winter

EMFAC Version: EMFAC2002 (9/2002)

Summary of Land Uses:

Unit Type	Trip Rate	Size	Total Trips
Single family housing	9.90 trips / dwelling units	364.00	3,603.60
Apartments low rise	6.90 trips / dwelling units	744.00	5,133.60
City park	2.60 trips / acres	4.00	10.40
Strip mall	94.55 trips / 1000 sq. ft.	27.00	2,552.85

Vehicle Assumptions:

Fleet Mix:

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	55.00	1.60	98.00	0.40
Light Truck < 3,750 lbs	15.00	2.70	95.30	2.00
Light Truck 3,751- 5,750	16.20	1.20	97.50	1.30
Med Truck 5,751- 8,500	7.20	1.40	95.80	2.80
Lite-Heavy 8,501-10,000	1.10	0.00	81.80	18.20
Lite-Heavy 10,001-14,000	0.40	0.00	50.00	50.00
Med-Heavy 14,001-33,000	1.00	0.00	20.00	80.00
Heavy-Heavy 33,001-60,000	0.90	0.00	11.10	88.90
Line Haul > 60,000 lbs	0.00	0.00	0.00	100.00
Urban Bus	0.20	0.00	50.00	50.00
Motorcycle	1.70	76.50	23.50	0.00
School Bus	0.10	0.00	0.00	100.00
Motor Home	1.20	8.30	83.30	8.40

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Rural Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Trip Speeds (mph)	35.0	40.0	40.0	40.0	40.0	40.0
% of Trips - Residential	20.0	37.0	43.0			
% of Trips - Commercial (by land use)						
City park				5.0	2.5	92.5
Strip mall				2.0	1.0	97.0

MITIGATED OPERATIONAL EMISSIONS

	ROG	NOx	CO	SO2	PM10
Single family housing	29.90	50.31	359.00	0.20	36.59
Apartments low rise	42.72	71.67	511.42	0.28	52.13
City park	0.07	0.13	0.88	0.00	0.09
Strip mall	17.22	30.33	211.27	0.11	21.66
TOTAL EMISSIONS (lbs/day)	89.92	152.45	1,082.56	0.60	110.47

OPERATIONAL (Vehicle) EMISSION ESTIMATES

Analysis Year: 2008 Temperature (F): 50 Season: Winter

EMFAC Version: EMFAC2002 (9/2002)

Summary of Land Uses:

Unit Type	Trip Rate	Size	Total Trips
Single family housing	9.90 trips / dwelling units	364.00	3,603.60
Apartments low rise	6.90 trips / dwelling units	744.00	5,133.60
City park	2.60 trips / acres	4.00	10.40
Strip mall	94.55 trips / 1000 sq. ft.	27.00	2,552.85

Vehicle Assumptions:

Fleet Mix:

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	55.00	1.60	98.00	0.40
Light Truck < 3,750 lbs	15.00	2.70	95.30	2.00
Light Truck 3,751- 5,750	16.20	1.20	97.50	1.30
Med Truck 5,751- 8,500	7.20	1.40	95.80	2.80
Lite-Heavy 8,501-10,000	1.10	0.00	81.80	18.20
Lite-Heavy 10,001-14,000	0.40	0.00	50.00	50.00
Med-Heavy 14,001-33,000	1.00	0.00	20.00	80.00
Heavy-Heavy 33,001-60,000	0.90	0.00	11.10	88.90
Line Haul > 60,000 lbs	0.00	0.00	0.00	100.00
Urban Bus	0.20	0.00	50.00	50.00
Motorcycle	1.70	76.50	23.50	0.00
School Bus	0.10	0.00	0.00	100.00
Motor Home	1.20	8.30	83.30	8.40

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Rural Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Trip Speeds (mph)	35.0	40.0	40.0	40.0	40.0	40.0
% of Trips - Residential	20.0	37.0	43.0			
% of Trips - Commercial (by land use)						
City park				5.0	2.5	92.5
Strip mall				2.0	1.0	97.0

ENVIRONMENTAL FACTORS APPLICABLE TO THE PROJECT

Pedestrian Environment

0.0 Side Walks/Paths: No Sidewalks
0.0 Street Trees Provide Shade: No Coverage
0.0 Pedestrian Circulation Access: No Destinations
0.0 Visually Interesting Uses: No Uses Within Walking Distance
0.0 Street System Enhances Safety: No Streets
0.0 Pedestrian Safety from Crime: No Degree of Safety
0.0 Visually Interesting Walking Routes: No Visual Interest

0.0 <- Pedestrian Environmental Credit
0.0 /19 = 0.0 <- Pedestrian Effectiveness Factor

Transit Service

0.0 Transit Service: Dial-A-Ride or No Transit Service

0.0 <- Transit Effectiveness Credit
0.0 <- Pedestrian Factor
0.0 <-Total
0.0 /110 = 0.0 <-Transit Effectiveness Factor

Bicycle Environment

0.0 Interconnected Bikeways: No Bikeway Coverage
0.0 Bike Routes Provide Paved Shoulders: No Routes
0.0 Safe Vehicle Speed Limits: No Routes Provided
0.0 Safe School Routes: No Schools
0.0 Uses w/in Cycling Distance: No Uses w/in Cycling Distance
0.0 Bike Parking Ordinance: No Ordinance or Unenforceable

0.0 <- Bike Environmental Credit
0.0 /20 = 0.0 <- Bike Effectiveness Factor

Changes made to the default values for Land Use Trip Percentages

Changes made to the default values for Area

The wood stove option switch changed from on to off.
The area souce mitigation measure option switch changed from off to on.
The landscape year changed from 2004 to 2008.
Mitigation measure Increase Insulation Beyond Title 24: Rsdntl Space Heat.
has been changed from off to on.
Mitigation measure Increase Insulation Beyond Title 24: Cmrcl Space Heat.
has been changed from off to on.

Changes made to the default values for Operations

The operational emission year changed from 2004 to 2008.
The double counting internal work trip limit changed from to 51.577.
The double counting shopping trip limit changed from to 25.7885.
The double counting other trip limit changed from to 2485.8845.
The travel mode environment settings changed from both to: both
Mitigation measure Provide Sidewalks and/or Pedestrian Paths:1
has been changed from off to on.
Mitigation measure Provide Direct Pedestrian Connections:1
has been changed from off to on.
Mitigation measure Provide Pedestrian Safety:0.5
has been changed from off to on.
Mitigation measure Provide Street Lighting:0.5
has been changed from off to on.
Mitigation measure Provide Pedestrian Signalization and Signage:0.5
has been changed from off to on.
Mitigation measure Provide Bike Lanes/Paths Connecting to Bikeway System:2
has been changed from off to on.

Santa Clarita Valley
Population and Employment Impact Analysis
River Park EIR
Alternative 3

Land Use	Unit	Quantity	Persons/ Household	Population	Employees/ Unit	Employees
Single Family Res'l	du	363	3.06	1,109	-	-
Multi-Family Res'l	du	662	3.06	2,023	-	-
Mobile Homes	du		2.55	0	-	-
Comm'l Retail	tsf	39.00	-	-	2.50	98
Hotel/Motel (1)	rooms		-	-	0.90	0
School/College	-		-	-	-	
Hospital	tsf		-	-	3.00	0
Library	tsf		-	-	1.00	0
Church	tsf		-	-	0.50	0
Business Park	tsf		-	-	3.00	0
Industrial/Mfg.	tsf		-	-	2.00	0
Utilities	tsf		-	-	0.70	0
Office	tsf		-	-	4.00	0
Golf Course/Park	acres	29.00	-	-	0.40	12
Special Generator (3)	tsf		-	-	0.70	0
			Totals	**3,132**	**-**	**109**

du = dwelling unit; tsf = thousand square feet
Build out analysis and school employment is derived from the Traffic Model.
(1) Based on 400 gross square feet per room and 0.9 employees per room (SCAG, 1990).
(3) Assumes same rate as Utilities.

Prepared by Impact Sciences, Inc.
S. Tebo
12/12/03

Santa Clarita Valley
Library Impact Analysis
River Park EIR
Alternative 3

Land Use	Number of Units	Persons/ Household	Library (Sq. Feet)	Library Books
Single Family Res'l	363	3.06	388	2,219
Multi-Family Res'l	662	3.06	708	4,046
Mobile Homes		2.55	0	0
		Totals	**1,096**	**6,265**

L.A. County Public Library Standard: 0.35 s.f./capita
L.A. County Public Library Standard: 2.0 books/capita

Prepared by Impact Sciences, Inc.
S. Tebo
12/12/03

Santa Clarita Valley
Net Increase in
Student/Classroom/School Generation Using
Theoretical Student Generation Rates
Alternative 3- River Park

District	Housing Units by Type			Student Generation Rate			Class Size	School Size	Students	Classes	Schools
	Single Fam.	Multi-Fam.	Apartment	Single Fam.	Multi-Fam.	Apartment					
Saugus Union Elementary	363		662	0.431	0.0556	0.1326	30	770	244	8.14	0.32
Hart Junior High	363		662	0.104	0.037	0.038	32	930	63	1.97	0.07
Hart High School	363		662	0.179	0.064	0.054	32	2,764	101	3.15	0.04
								Totals	**408**	**13.25**	**0.42**

Prepared By Impact Sciences, Inc.
S.Tebo
12/5/03

Santa Clarita Valley
Parks and Recreation Impact Analysis
River Park EIR
Alternative 3

Land Use	Number of Units	Persons/ Household	Population	Parkland Req'mt (acres)
Single Family Res'l	363	3.06	1,109	3.33
Multi-Family Res'l	662	3.06	2,023	6.07
Mobile Homes		2.55	0	0.00
		Totals	**3,132**	**9.40**

Based on Quimby requirement of 3.0 acres/1000 persons

Prepared by Impact Sciences, Inc.
S. Tebo
12/12/03

Santa Clarita Valley
Solid Waste Generation
(No Recycling) Impact Analysis
River Park EIR
Alternative 3

Land Use	Quantity	Units	Generation Rate		Total Waste Generated	
			(tpy) (1)	(lbs./day)	(tpy)	(lbs./day)
Residential Units:						
Single Family Detached	363	du	2.0400	11.18	741	4,058
Multi-Family or Attached	662	du	1.1700	6.41	775	4,244
Mobile Home		du	1.1700	6.41	0	0
Commercial/Industrial						
General Retail	39,000	sq. ft.	0.0024	0.01	94	513
Eating/Drnkng Establ.		sq. ft.	0.0108	0.06	0	0
Food & Drug Stores		sq. ft.	0.0072	0.04	0	0
Auto Dlr/Service Sta.		sq. ft.	0.0051	0.03	0	0
Hotel & Motel		sq. ft.	0.0053	0.03	0	0
Warehouse		sq. ft.	0.0011	0.01	0	0
Medical Offices		sq. ft.	0.0027	0.01	0	0
Hospitals		sq. ft.	0.0055	0.03	0	0
Business Park		sq. ft.	0.0014	0.01	0	0
Office		sq. ft.	0.0014	0.01	0	0
Library (4)		sq. ft.	0.0014	0.01	0	0
Education & Schools		sq. ft.	0.0013	0.01	0	0
College		sq. ft.	0.0013	0.01	0	0
Trans., Comm., Utilities		sq. ft.	0.0079	0.04	0	0
Special Generator (6)		sq. ft.	0.0079	0.04	0	0
Golf Course/Park	29	acres	0.2000	1.10	6	32
Manufacturing		sq. ft.	0.0050	0.03	0	0
Church (4)		sq. ft.	0.0014	0.01	0	0
				Totals	**1,614**	**8,846**

du = dwelling unit; sq.ft. - square feet; tpy = tons per year; lbs. = pounds

(1) The solid waste daily generation rates in tons per year are derived from the Ventura County Solid Waste Management Department's Guidelines for Preparation of Environmental Assessments for Solid Waste Impacts. These figures do not reflect any recycling activities on the part of the generator.

(4) Assumes same generation rate as for office.

(6) Conservatively assumes same generation rate as utilities.

Prepared by Impact Sciences, Inc.
S. Tebo
12/5/03

Santa Clarita Valley
Wastewater Generation Impact Analysis
River Park EIR
Alternative 3

Land Use	Units	Quantity	Generation Factor (gpd)	Generation (gpd)	Generation (mgd)
Residential					
Single Family	du	363	260.00	94,380.00	0.0944
Multi-Family	du	662	195.00	129,090.00	0.1291
Mobile Homes	du		195.00	0.00	0.0000
Non-Residential					
Commercial Retail	tsf	39	100.00	3,900.00	0.0039
Hotel	sq.ft.		na		
Hotel (1)	rooms		125.00	0.00	0.0000
School	tsf		200.00	0.00	0.0000
College	stdnts		20.00	0.00	0.0000
College	sq.ft.		na		
Hospital	sq.ft.		na		
Hospital (3)	beds		125.00	0.00	0.0000
Library (4)	tsf		50.00	0.00	0.0000
Church	tsf		50.00	0.00	0.0000
Business Park (7)	tsf		300.00	0.00	0.0000
Industrial/Manufacturing (5)	tsf		25.00	0.00	0.0000
Utilities	tsf		25.00	0.00	0.0000
Commercial/Medical Office	tsf		300.00	0.00	0.0000
Golf Course/Park	acres	29	0.00	0.00	0.0000
Golf Course/Park Imps	tsf		100.00	0.00	0.0000
Visitor Serving (8)	tsf		100.00	0.00	0.0000
Special Generator (9)	tsf		25.00	0.00	0.0000
			Totals	**227,370.00**	**0.2274**

gpd = gallons per day; mgd = million gallons per day; du = dwelling unit; tsf = thousand square feet; sq. ft. = square feet; stdnts = students

Source of wastewater generation factors is CDSLAC, Loadings for Each Class of Land Use (1992-93). This list is provided in Appendix 4.X.

(1) Number of hotel rooms is based upon an assumed 400 gross square feet per room.

(3) Number of hospital beds is based upon an assumed 500 gross square feet per bed.

(4) Uses same generation factor for library as used for church.

(5) Generation factor for industrial/manufacturing is based on dry manufacturing uses.

(7) Uses same generation factor as for professional building.

(8) Uses same generation factor as for commercial retail.

(9) Uses same generation factor as for industrial/manufacturing.

Prepared by Impact Sciences, Inc.
S. Tebo
12/5/03

Alternative 3-Secondary Ridgeline Protection
Estimated Water Demand

Land Use Category	Amount	Water Duty Factor	Water Demand (AFY)
Single Family Units	363 units	0.55 af/unit	199.65
Apartments	662 units	0.19 af/unit	125.78
Park	4 acres	3 af per acre	12.0
Other Misc. Landscaping (irrigated common landscaping, pocket parks, etc.)	80 acres	3 af per acre	240.0
Commercial (40,000 sq. ft.)	3 acres	0.0289 af/100 sq. ft.	11.56
TOTAL			**588.99**

ALTERNATIVE 3 SUMMERTIME EMISSIONS

URBEMIS 2002 For Windows 7.4.2

File Name: C:\URBEMIS2002\Urbemis River Park\River Park Alternative 3.urb
Project Name: River Park Alternative 3
Project Location: South Coast Air Basin (Los Angeles area)
On-Road Motor Vehicle Emissions Based on EMFAC2002 version 2.2

SUMMARY REPORT
(Pounds/Day - Summer)

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	51.31	9.99	7.84	0.09	0.02
TOTALS (lbs/day, mitigated)	51.21	8.88	7.35	0.09	0.02

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	98.95	110.02	1,182.38	0.76	115.06
TOTALS (lbs/day, mitigated)	98.95	110.02	1,182.38	0.76	115.06

SUM OF AREA AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	150.25	120.01	1,190.22	0.85	115.09
TOTALS (lbs/day, mitigated)	150.16	118.89	1,189.73	0.85	115.09

URBEMIS 2002 For Windows 7.4.2

File Name: C:\URBEMIS2002\Urbemis River Park\River Park Alternative 3.urb
Project Name: River Park Alternative 3
Project Location: South Coast Air Basin (Los Angeles area)
On-Road Motor Vehicle Emissions Based on EMFAC2002 version 2.2

DETAIL REPORT
(Pounds/Day - Summer)

AREA SOURCE EMISSION ESTIMATES (Summer Pounds per Day, Unmitigated)

Source	ROG	NOx	CO	SO2	PM10
Natural Gas	0.76	9.93	4.21	-	0.02
Wood Stoves - No summer emissions					
Fireplaces - No summer emissions					
Landscaping	0.40	0.06	3.63	0.09	0.01
Consumer Prdcts	50.15	-	-	-	-
TOTALS(lbs/day,unmitigated)	51.31	9.99	7.84	0.09	0.02

AREA SOURCE EMISSION ESTIMATES

Source	ROG	NOx	CO	SO2	PM10
Natural Gas	0.67	8.81	3.73	-	0.02
Wood Stoves - No summer emissions					
Fireplaces - No summer emissions					
Landscaping	0.40	0.06	3.63	0.09	0.01
Consumer Prdcts	50.15	-	-	-	-
TOTALS (lbs/day, mitigated)	51.21	8.88	7.35	0.09	0.02

Area Source Mitigation Measures

UNMITIGATED OPERATIONAL EMISSIONS

	ROG	NOx	CO	SO2	PM10
Single family housing	32.01	34.68	378.71	0.24	36.49
Apartments low rise	43.88	44.08	481.36	0.31	46.38
City park	0.13	0.09	0.96	0.00	0.10
Strip mall	22.93	31.16	321.34	0.21	32.10
TOTAL EMISSIONS (lbs/day)	98.95	110.02	1,182.38	0.76	115.06

Does not include correction for passby trips.
Does not include double counting adjustment for internal trips.

OPERATIONAL (Vehicle) EMISSION ESTIMATES

Analysis Year: 2008 Temperature (F): 90 Season: Summer

EMFAC Version: EMFAC2002 (9/2002)

Summary of Land Uses:

Unit Type	Trip Rate	Size	Total Trips
Single family housing	9.90 trips / dwelling units	363.00	3,593.70
Apartments low rise	6.90 trips / dwelling units	662.00	4,567.80
City park	2.60 trips / acres	4.25	11.05
Strip mall	94.55 trips / 1000 sq. ft.	40.00	3,782.00

Vehicle Assumptions:

Fleet Mix:

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	55.00	1.60	98.00	0.40
Light Truck < 3,750 lbs	15.00	2.70	95.30	2.00
Light Truck 3,751- 5,750	16.20	1.20	97.50	1.30
Med Truck 5,751- 8,500	7.20	1.40	95.80	2.80
Lite-Heavy 8,501-10,000	1.10	0.00	81.80	18.20
Lite-Heavy 10,001-14,000	0.40	0.00	50.00	50.00
Med-Heavy 14,001-33,000	1.00	0.00	20.00	80.00
Heavy-Heavy 33,001-60,000	0.90	0.00	11.10	88.90
Line Haul > 60,000 lbs	0.00	0.00	0.00	100.00
Urban Bus	0.20	0.00	50.00	50.00
Motorcycle	1.70	76.50	23.50	0.00
School Bus	0.10	0.00	0.00	100.00
Motor Home	1.20	8.30	83.30	8.40

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Rural Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Trip Speeds (mph)	35.0	40.0	40.0	40.0	40.0	40.0
% of Trips - Residential	20.0	37.0	43.0			
% of Trips - Commercial (by land use)						
City park				5.0	2.5	92.5
Strip mall				2.0	1.0	97.0

MITIGATED OPERATIONAL EMISSIONS

	ROG	NOx	CO	SO2	PM10
Single family housing	32.01	34.68	378.71	0.24	36.49
Apartments low rise	43.88	44.08	481.36	0.31	46.38
City park	0.13	0.09	0.96	0.00	0.10
Strip mall	22.93	31.16	321.34	0.21	32.10
TOTAL EMISSIONS (lbs/day)	98.95	110.02	1,182.38	0.76	115.06

OPERATIONAL (Vehicle) EMISSION ESTIMATES

Analysis Year: 2008 Temperature (F): 90 Season: Summer

EMFAC Version: EMFAC2002 (9/2002)

Summary of Land Uses:

Unit Type	Trip Rate	Size	Total Trips
Single family housing	9.90 trips / dwelling units	363.00	3,593.70
Apartments low rise	6.90 trips / dwelling units	662.00	4,567.80
City park	2.60 trips / acres	4.25	11.05
Strip mall	94.55 trips / 1000 sq. ft.	40.00	3,782.00

Vehicle Assumptions:

Fleet Mix:

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	55.00	1.60	98.00	0.40
Light Truck < 3,750 lbs	15.00	2.70	95.30	2.00
Light Truck 3,751- 5,750	16.20	1.20	97.50	1.30
Med Truck 5,751- 8,500	7.20	1.40	95.80	2.80
Lite-Heavy 8,501-10,000	1.10	0.00	81.80	18.20
Lite-Heavy 10,001-14,000	0.40	0.00	50.00	50.00
Med-Heavy 14,001-33,000	1.00	0.00	20.00	80.00
Heavy-Heavy 33,001-60,000	0.90	0.00	11.10	88.90
Line Haul > 60,000 lbs	0.00	0.00	0.00	100.00
Urban Bus	0.20	0.00	50.00	50.00
Motorcycle	1.70	76.50	23.50	0.00
School Bus	0.10	0.00	0.00	100.00
Motor Home	1.20	8.30	83.30	8.40

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Rural Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Trip Speeds (mph)	35.0	40.0	40.0	40.0	40.0	40.0
% of Trips - Residential	20.0	37.0	43.0			
% of Trips - Commercial (by land use)						
City park				5.0	2.5	92.5
Strip mall				2.0	1.0	97.0

ENVIRONMENTAL FACTORS APPLICABLE TO THE PROJECT

Pedestrian Environment

0.0 Side Walks/Paths: No Sidewalks
0.0 Street Trees Provide Shade: No Coverage
0.0 Pedestrian Circulation Access: No Destinations
0.0 Visually Interesting Uses: No Uses Within Walking Distance
0.0 Street System Enhances Safety: No Streets
0.0 Pedestrian Safety from Crime: No Degree of Safety
0.0 Visually Interesting Walking Routes: No Visual Interest

0.0 <- Pedestrian Environmental Credit
0.0 /19 = 0.0 <- Pedestrian Effectiveness Factor

Transit Service

0.0 Transit Service: Dial-A-Ride or No Transit Service

0.0 <- Transit Effectiveness Credit
0.0 <- Pedestrian Factor
0.0 <-Total
0.0 /110 = 0.0 <-Transit Effectiveness Factor

Bicycle Environment

0.0 Interconnected Bikeways: No Bikeway Coverage
0.0 Bike Routes Provide Paved Shoulders: No Routes
0.0 Safe Vehicle Speed Limits: No Routes Provided
0.0 Safe School Routes: No Schools
0.0 Uses w/in Cycling Distance: No Uses w/in Cycling Distance
0.0 Bike Parking Ordinance: No Ordinance or Unenforceable

0.0 <- Bike Environmental Credit
0.0 /20 = 0.0 <- Bike Effectiveness Factor

MITIGATION MEASURES SELECTED FOR THIS PROJECT
(All mitigation measures are printed, even if
the selected land uses do not constitute a mixed use.)

Transit Infrastructure Measures

% Trips Reduced	Measure
15.0	Credit for Existing or Planned Community Transit Service
15.0	<- Totals

Pedestrian Enhancing Infrastructure Measures (Residential)

% Trips Reduced	Measure
2.0	Credit for Surrounding Pedestrian Environment
1.0	Provide Sidewalks and/or Pedestrian Paths
1.0	Provide Direct Pedestrian Connections
0.5	Provide Pedestrian Safety
0.5	Provide Street Lighting
0.5	Provide Pedestrian Signalization and Signage
5.5	<- Totals

Pedestrian Enhancing Infrastructure Measures (Non-Residential)

% Trips Reduced	Measure
2.0	Credit for Surrounding Pedestrian Environment
2.0	<- Totals

Bicycle Enhancing Infratructure Measures (Residential)

% Trips Reduced	Measure
7.0	Credit for Surrounding Bicycle Environment
2.0	Provide Bike Lanes/Paths Connecting to Bikeway System
9.0	<- Totals

Bike Enhancing Infrastructure Measures (Non-Residential)

% Trips Reduced	Measure
5.0	Credit for Surrounding Area Bike Environment
5.0	<- Totals

Operational Measures (Applying to Commute Trips)

% Trips Reduced	Measure
0.0	<- Totals

Operational Measures (Applying to Employee Non-Commute Trips)

% Trips Reduced	Measure
0.0	<- Totals

Operational Measures (Applying to Customer Trips)

% Trips Reduced	Measure
0.0	<- Totals

Measures Reducing VMT (Non-Residential)

VMT Reduced	Measure
0.0	Park and Ride Lots
0.0	<- Totals

Measures Reducing VMT (Residential)

VMT Reduced	Measure
0.0	<- Totals

Total Percentage Trip Reduction
with Environmental Factors and Mitigation Measures

Travel Mode	Home-Work Trips	Home-Shop Trips	Home-Other Trips
Pedestrian	0.00	0.00	0.00
Transit	0.00	0.00	0.00
Bicycle	0.00	0.00	0.00
Totals	0.00	0.00	0.00

Travel Mode	Work Trips	Employee Trips	Customer Trips
Pedestrian	0.00	0.00	0.00
Transit	0.00	0.00	0.00
Bicycle	0.00	0.00	0.00
Other	0.00	0.00	0.00
Totals	0.00	0.00	0.00

Changes made to the default values for Land Use Trip Percentages

Changes made to the default values for Area

The wood stove option switch changed from on to off.
The area souce mitigation measure option switch changed from off to on.
The landscape year changed from 2004 to 2008.
Mitigation measure Increase Insulation Beyond Title 24: Rsdntl Space Heat.
has been changed from off to on.
Mitigation measure Increase Insulation Beyond Title 24: Cmrcl Space Heat.
has been changed from off to on.

Changes made to the default values for Operations

The operational emission year changed from 2004 to 2008.
The double counting internal work trip limit changed from to 76.1925.
The double counting shopping trip limit changed from to 38.09625.
The double counting other trip limit changed from to 3509.445.
The travel mode environment settings changed from both to: both
Mitigation measure Provide Sidewalks and/or Pedestrian Paths:1
has been changed from off to on.
Mitigation measure Provide Direct Pedestrian Connections:1
has been changed from off to on.
Mitigation measure Provide Pedestrian Safety:0.5
has been changed from off to on.
Mitigation measure Provide Street Lighting:0.5
has been changed from off to on.
Mitigation measure Provide Pedestrian Signalization and Signage:0.5
has been changed from off to on.
Mitigation measure Provide Bike Lanes/Paths Connecting to Bikeway System:2
has been changed from off to on.

ALTERNATIVE 3 WINTERTIME EMISSIONS

URBEMIS 2002 For Windows 7.4.2

File Name: C:\URBEMIS2002\Urbemis River Park\River Park Alternative 3.urb
Project Name: River Park Alternative 3
Project Location: South Coast Air Basin (Los Angeles area)
On-Road Motor Vehicle Emissions Based on EMFAC2002 version 2.2

SUMMARY REPORT
(Pounds/Day - Winter)

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	1,199.00	22.96	1,270.62	2.01	173.49
TOTALS (lbs/day, mitigated)	1,198.91	21.85	1,270.14	2.01	173.48

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	93.42	159.02	1,126.99	0.62	115.06
TOTALS (lbs/day, mitigated)	93.42	159.02	1,126.99	0.62	115.06

SUM OF AREA AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	1,292.42	181.98	2,397.61	2.62	288.55
TOTALS (lbs/day, mitigated)	1,292.33	180.87	2,397.12	2.62	288.55

URBEMIS 2002 For Windows 7.4.2

File Name: C:\URBEMIS2002\Urbemis River Park\River Park Alternative 3.urb
Project Name: River Park Alternative 3
Project Location: South Coast Air Basin (Los Angeles area)
On-Road Motor Vehicle Emissions Based on EMFAC2002 version 2.2

DETAIL REPORT
(Pounds/Day - Winter)

AREA SOURCE EMISSION ESTIMATES (Winter Pounds per Day, Unmitigated)

Source	ROG	NOx	CO	SO2	PM10
Natural Gas	0.76	9.93	4.21	-	0.02
Wood Stoves	0.00	0.00	0.00	0.00	0.00
Fireplaces	1,148.09	13.04	1,266.41	2.01	173.47
Landscaping - No winter emissions					
Consumer Prdcts	50.15	-	-	-	-
TOTALS(lbs/day,unmitigated)	1,199.00	22.96	1,270.62	2.01	173.49

AREA SOURCE EMISSION ESTIMATES

Source	ROG	NOx	CO	SO2	PM10
Natural Gas	0.67	8.81	3.73	-	0.02
Wood Stoves	0.00	0.00	0.00	0.00	0.00
Fireplaces	1,148.09	13.04	1,266.41	2.01	173.47
Landscaping - No winter emissions					
Consumer Prdcts	50.15	-	-	-	-
TOTALS (lbs/day, mitigated)	1,198.91	21.85	1,270.14	2.01	173.48

Area Source Mitigation Measures

Increase Insulation Beyond Title 24: Rsdntl Space Heat.
Percent Reduction(ROG 14% NOx 13% CO 7.4% SO2 0% PM10 13%)
Increase Insulation Beyond Title 24: Cmrcl Space Heat.
Percent Reduction(ROG 10% NOx 9% CO 7% SO2 0% PM10 9.5%)

UNMITIGATED OPERATIONAL EMISSIONS

	ROG	NOx	CO	SO2	PM10
Single family housing	29.82	50.17	358.01	0.20	36.49
Apartments low rise	38.01	63.77	455.05	0.25	46.38
City park	0.08	0.13	0.93	0.00	0.10
Strip mall	25.51	44.94	312.99	0.17	32.10
TOTAL EMISSIONS (lbs/day)	93.42	159.02	1,126.99	0.62	115.06

Does not include correction for passby trips.
Does not include double counting adjustment for internal trips.

OPERATIONAL (Vehicle) EMISSION ESTIMATES

Analysis Year: 2008 Temperature (F): 50 Season: Winter

EMFAC Version: EMFAC2002 (9/2002)

Summary of Land Uses:

Unit Type	Trip Rate	Size	Total Trips
Single family housing	9.90 trips / dwelling units	363.00	3,593.70
Apartments low rise	6.90 trips / dwelling units	662.00	4,567.80
City park	2.60 trips / acres	4.25	11.05
Strip mall	94.55 trips / 1000 sq. ft.	40.00	3,782.00

Vehicle Assumptions:

Fleet Mix:

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	55.00	1.60	98.00	0.40
Light Truck < 3,750 lbs	15.00	2.70	95.30	2.00
Light Truck 3,751- 5,750	16.20	1.20	97.50	1.30
Med Truck 5,751- 8,500	7.20	1.40	95.80	2.80
Lite-Heavy 8,501-10,000	1.10	0.00	81.80	18.20
Lite-Heavy 10,001-14,000	0.40	0.00	50.00	50.00
Med-Heavy 14,001-33,000	1.00	0.00	20.00	80.00
Heavy-Heavy 33,001-60,000	0.90	0.00	11.10	88.90
Line Haul > 60,000 lbs	0.00	0.00	0.00	100.00
Urban Bus	0.20	0.00	50.00	50.00
Motorcycle	1.70	76.50	23.50	0.00
School Bus	0.10	0.00	0.00	100.00
Motor Home	1.20	8.30	83.30	8.40

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Rural Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Trip Speeds (mph)	35.0	40.0	40.0	40.0	40.0	40.0
% of Trips - Residential	20.0	37.0	43.0			

% of Trips - Commercial (by land use)

	Commute	Non-Work	Customer
City park	5.0	2.5	92.5
Strip mall	2.0	1.0	97.0

MITIGATED OPERATIONAL EMISSIONS

	ROG	NOx	CO	SO2	PM10
Single family housing	29.82	50.17	358.01	0.20	36.49
Apartments low rise	38.01	63.77	455.05	0.25	46.38
City park	0.08	0.13	0.93	0.00	0.10
Strip mall	25.51	44.94	312.99	0.17	32.10
TOTAL EMISSIONS (lbs/day)	93.42	159.02	1,126.99	0.62	115.06

OPERATIONAL (Vehicle) EMISSION ESTIMATES

Analysis Year: 2008 Temperature (F): 50 Season: Winter

EMFAC Version: EMFAC2002 (9/2002)

Summary of Land Uses:

Unit Type	Trip Rate	Size	Total Trips
Single family housing	9.90 trips / dwelling units	363.00	3,593.70
Apartments low rise	6.90 trips / dwelling units	662.00	4,567.80
City park	2.60 trips / acres	4.25	11.05
Strip mall	94.55 trips / 1000 sq. ft.	40.00	3,782.00

Vehicle Assumptions:

Fleet Mix:

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	55.00	1.60	98.00	0.40
Light Truck < 3,750 lbs	15.00	2.70	95.30	2.00
Light Truck 3,751- 5,750	16.20	1.20	97.50	1.30
Med Truck 5,751- 8,500	7.20	1.40	95.80	2.80
Lite-Heavy 8,501-10,000	1.10	0.00	81.80	18.20
Lite-Heavy 10,001-14,000	0.40	0.00	50.00	50.00
Med-Heavy 14,001-33,000	1.00	0.00	20.00	80.00
Heavy-Heavy 33,001-60,000	0.90	0.00	11.10	88.90
Line Haul > 60,000 lbs	0.00	0.00	0.00	100.00
Urban Bus	0.20	0.00	50.00	50.00
Motorcycle	1.70	76.50	23.50	0.00
School Bus	0.10	0.00	0.00	100.00
Motor Home	1.20	8.30	83.30	8.40

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Rural Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Trip Speeds (mph)	35.0	40.0	40.0	40.0	40.0	40.0
% of Trips - Residential	20.0	37.0	43.0			
% of Trips - Commercial (by land use)						
City park				5.0	2.5	92.5
Strip mall				2.0	1.0	97.0

ENVIRONMENTAL FACTORS APPLICABLE TO THE PROJECT

Pedestrian Environment

0.0	Side Walks/Paths: No Sidewalks
0.0	Street Trees Provide Shade: No Coverage
0.0	Pedestrian Circulation Access: No Destinations
0.0	Visually Interesting Uses: No Uses Within Walking Distance
0.0	Street System Enhances Safety: No Streets
0.0	Pedestrian Safety from Crime: No Degree of Safety
0.0	Visually Interesting Walking Routes: No Visual Interest

0.0 <- Pedestrian Environmental Credit
0.0 /19 = 0.0 <- Pedestrian Effectiveness Factor

Transit Service

0.0 Transit Service: Dial-A-Ride or No Transit Service

0.0 <- Transit Effectiveness Credit
0.0 <- Pedestrian Factor
0.0 <-Total
0.0 /110 = 0.0 <-Transit Effectiveness Factor

Bicycle Environment

0.0	Interconnected Bikeways: No Bikeway Coverage
0.0	Bike Routes Provide Paved Shoulders: No Routes
0.0	Safe Vehicle Speed Limits: No Routes Provided
0.0	Safe School Routes: No Schools
0.0	Uses w/in Cycling Distance: No Uses w/in Cycling Distance
0.0	Bike Parking Ordinance: No Ordinance or Unenforceable

0.0 <- Bike Environmental Credit
0.0 /20 = 0.0 <- Bike Effectiveness Factor

MITIGATION MEASURES SELECTED FOR THIS PROJECT
(All mitigation measures are printed, even if the selected land uses do not constitute a mixed use.)

Transit Infrastructure Measures

% Trips Reduced	Measure
15.0	Credit for Existing or Planned Community Transit Service
15.0	<- Totals

Pedestrian Enhancing Infrastructure Measures (Residential)

% Trips Reduced	Measure
2.0	Credit for Surrounding Pedestrian Environment
1.0	Provide Sidewalks and/or Pedestrian Paths
1.0	Provide Direct Pedestrian Connections
0.5	Provide Pedestrian Safety
0.5	Provide Street Lighting
0.5	Provide Pedestrian Signalization and Signage
5.5	<- Totals

Pedestrian Enhancing Infrastructure Measures (Non-Residential)

% Trips Reduced	Measure
2.0	Credit for Surrounding Pedestrian Environment
2.0	<- Totals

Bicycle Enhancing Infratructure Measures (Residential)

% Trips Reduced	Measure
7.0	Credit for Surrounding Bicycle Environment
2.0	Provide Bike Lanes/Paths Connecting to Bikeway System
9.0	<- Totals

Bike Enhancing Infrastructure Measures (Non-Residential)

% Trips Reduced	Measure
5.0	Credit for Surrounding Area Bike Environment
5.0	<- Totals

Operational Measures (Applying to Commute Trips)

% Trips Reduced	Measure
0.0	<- Totals

Operational Measures (Applying to Employee Non-Commute Trips)

% Trips Reduced	Measure
0.0	<- Totals

Operational Measures (Applying to Customer Trips)

% Trips Reduced	Measure
0.0	<- Totals

Measures Reducing VMT (Non-Residential)

VMT Reduced	Measure
0.0	Park and Ride Lots
0.0	<- Totals

Measures Reducing VMT (Residential)

VMT Reduced	Measure
0.0	<- Totals

Total Percentage Trip Reduction
with Environmental Factors and Mitigation Measures

Travel Mode	Home-Work Trips	Home-Shop Trips	Home-Other Trips
Pedestrian	0.00	0.00	0.00
Transit	0.00	0.00	0.00
Bicycle	0.00	0.00	0.00
Totals	0.00	0.00	0.00
Travel Mode	Work Trips	Employee Trips	Customer Trips
Pedestrian	0.00	0.00	0.00
Transit	0.00	0.00	0.00
Bicycle	0.00	0.00	0.00
Other	0.00	0.00	0.00
Totals	0.00	0.00	0.00

Changes made to the default values for Land Use Trip Percentages

Changes made to the default values for Area

The wood stove option switch changed from on to off.
The area souce mitigation measure option switch changed from off to on.
The landscape year changed from 2004 to 2008.
Mitigation measure Increase Insulation Beyond Title 24: Rsdntl Space Heat.
     has been changed from off to on.
Mitigation measure Increase Insulation Beyond Title 24: Cmrcl Space Heat.
     has been changed from off to on.

Changes made to the default values for Operations

The operational emission year changed from 2004 to 2008.
The double counting internal work trip limit changed from to 76.1925.
The double counting shopping trip limit changed from to 38.09625.
The double counting other trip limit changed from to 3509.445.
The travel mode environment settings changed from both to: both
Mitigation measure Provide Sidewalks and/or Pedestrian Paths:1
     has been changed from off to on.
Mitigation measure Provide Direct Pedestrian Connections:1
     has been changed from off to on.
Mitigation measure Provide Pedestrian Safety:0.5
     has been changed from off to on.
Mitigation measure Provide Street Lighting:0.5
     has been changed from off to on.
Mitigation measure Provide Pedestrian Signalization and Signage:0.5
     has been changed from off to on.
Mitigation measure Provide Bike Lanes/Paths Connecting to Bikeway System:2
     has been changed from off to on.

Alternative 4
River Park EIR

Santa Clarita Valley
Population and Employment Impact Analysis

Land Use	Unit	Quantity	Persons/ Household	Population	Employees/ Unit	Employees
Single Family Res'l	du	138	3.06	422	-	-
Multi-Family Res'l	du	744	3.06	2,274	-	-
Mobile Homes	du		2.55	0	-	-
Comm'l Retail	tsf	39.00	-	-	2.50	98
Hotel/Motel (1)	rooms		-	-	0.90	0
School/College	-		-	-	-	
Hospital	tsf		-	-	3.00	0
Library	tsf		-	-	1.00	0
Church	tsf		-	-	0.50	0
Business Park	tsf		-	-	3.00	0
Industrial/Mfg.	tsf		-	-	2.00	0
Utilities	tsf		-	-	0.70	0
Office	tsf		-	-	4.00	0
Golf Course/Park	acres	29.00	-	-	0.40	12
Special Generator (3)	tsf		-	-	0.70	0
			Totals	**2,695**	**-**	**109**

du = dwelling unit; tsf = thousand square feet
Build out analysis and school employment is derived from the Traffic Model.
(1) Based on 400 gross square feet per room and 0.9 employees per room (SCAG, 1990).
(3) Assumes same rate as Utilities.

Prepared by Impact Sciences, Inc.
S. Tebo
12/15/03

Alternative 4
River Park EIR

Santa Clarita Valley
Library Impact Analysis

Land Use	Number of Units	Persons/ Household	Library (Sq. Feet)	Library Books
Single Family Res'l	138	3.06	148	843
Multi-Family Res'l	744	3.06	796	4,547
Mobile Homes		2.55	0	0
		Totals	**943**	**5,391**

L.A. County Public Library Standard: 0.35 s.f./capita
L.A. County Public Library Standard: 2.0 books/capita

Prepared by Impact Sciences, Inc.
S. Tebo
12/11/03

Santa Clarita Valley
Net Increase in
Student/Classroom/School Generation Using
Theoretical Student Generation Rates
River Park-Alternative 4

District	Housing Units by Type			Student Generation Rate			Class Size	School Size	Students	Classes	Schools
	Single Fam.	Multi-Fam.	Apartment	Single Fam.	Multi-Fam.	Apartment					
Saugus Union Elementary	138		744	0.431	0.0556	0.1326	30	770	158	5.27	0.21
Hart Junior High	138		744	0.104	0.037	0.038	32	930	43	1.33	0.05
Hart High School	138		744	0.179	0.064	0.054	32	2,764	65	2.03	0.02
								Totals	**266**	**8.63**	**0.27**

Prepared By Impact Sciences, Inc.
R. Mamaghani
12/5/03

Alternative 4
River Park EIR

Santa Clarita Valley
Parks and Recreation Impact Analysis
Using Household Size Numbers from Park Ordinance

Land Use	Number of Units	Persons/ Household	Population	Parkland Req'mt (acres)
Single Family Res'l	138	3.06	422	1.27
Multi-Family Res'l	744	3.06	2,274	6.82
Mobile Homes		2.55	0	0.00
		Totals	**2,695**	**8.09**

Based on Quimby requirement of 3.0 acres/1000 persons

Prepared by Impact Sciences, Inc.
S. Tebo
12/11/03

Alternative 4
Santa Clarita Valley
Solid Waste Generation
(No Recycling) Impact Analysis

Land Use	Quantity	Units	Generation Rate (tpy) (1)	Generation Rate (lbs./day)	Total Waste Generated (tpy)	Total Waste Generated (lbs./day)
Residential Units:						
Single Family Detached	138	du	2.0400	11.18	282	1,543
Multi-Family or Attached	744	du	1.1700	6.41	870	4,770
Mobile Home		du	1.1700	6.41	0	0
Commercial/Industrial						
General Retail	39,000	sq. ft.	0.0024	0.01	94	513
Eating/Drnkng Establ.		sq. ft.	0.0108	0.06	0	0
Food & Drug Stores		sq. ft.	0.0072	0.04	0	0
Auto Dlr/Service Sta.		sq. ft.	0.0051	0.03	0	0
Hotel & Motel		sq. ft.	0.0053	0.03	0	0
Warehouse		sq. ft.	0.0011	0.01	0	0
Medical Offices		sq. ft.	0.0027	0.01	0	0
Hospitals		sq. ft.	0.0055	0.03	0	0
Business Park		sq. ft.	0.0014	0.01	0	0
Office		sq. ft.	0.0014	0.01	0	0
Library (4)		sq. ft.	0.0014	0.01	0	0
Education & Schools		sq. ft.	0.0013	0.01	0	0
College		sq. ft.	0.0013	0.01	0	0
Trans., Comm., Utilities		sq. ft.	0.0079	0.04	0	0
Special Generator (6)		sq. ft.	0.0079	0.04	0	0
Golf Course/Park	29	acres	0.2000	1.10	6	32
Manufacturing		sq. ft.	0.0050	0.03	0	0
Church (4)		sq. ft.	0.0014	0.01	0	0
				Totals	**1,251**	**6,857**

du = dwelling unit; sq.ft. - square feet; tpy = tons per year; lbs. = pounds

(1) The solid waste daily generation rates in tons per year are derived from the Ventura County Solid Waste Management Department's Guidelines for Preparation of Environmental Assessments for Solid Waste Impacts. These figures do not reflect any recycling activities on the part of the generator.

(4) Assumes same generation rate as for office.

(6) Conservatively assumes same generation rate as utilities.

Prepared by Impact Sciences, Inc.
S. Tebo
12/5/03

Alternative 4
Santa Clarita Valley
Wastewater Generation Impact Analysis

Land Use	Units	Quantity	Generation Factor (gpd)	Generation (gpd)	Generation (mgd)
Residential					
Single Family	du	138	260.00	35,880.00	0.0359
Multi-Family	du	744	195.00	145,080.00	0.1451
Mobile Homes	du		195.00	0.00	0.0000
Non-Residential					
Commercial Retail	tsf	39	100.00	3,900.00	0.0039
Hotel	sq.ft.		na		
Hotel (1)	rooms		125.00	0.00	0.0000
School	tsf		200.00	0.00	0.0000
College	stdnts		20.00	0.00	0.0000
College	sq.ft.		na		
Hospital	sq.ft.		na		
Hospital (3)	beds		125.00	0.00	0.0000
Library (4)	tsf		50.00	0.00	0.0000
Church	tsf		50.00	0.00	0.0000
Business Park (7)	tsf		300.00	0.00	0.0000
Industrial/Manufacturing (5)	tsf		25.00	0.00	0.0000
Utilities	tsf		25.00	0.00	0.0000
Commercial/Medical Office	tsf		300.00	0.00	0.0000
Golf Course/Park	acres	29	0.00	0.00	0.0000
Golf Course/Park Imps	tsf		100.00	0.00	0.0000
Visitor Serving (8)	tsf		100.00	0.00	0.0000
Special Generator (9)	tsf		25.00	0.00	0.0000
			Totals	**184,860.00**	**0.1849**

gpd = gallons per day; mgd = million gallons per day; du = dwelling unit; tsf = thousand square feet;
sq. ft. = square feet; stdnts = students

Source of wastewater generation factors is CDSLAC, Loadings for Each Class of Land Use (1992-93).
This list is provided in Appendix 4.X.

(1) Number of hotel rooms is based upon an assumed 400 gross square feet per room.

(3) Number of hospital beds is based upon an assumed 500 gross square feet per bed.

(4) Uses same generation factor for library as used for church.

(5) Generation factor for industrial/manufacturing is based on dry manufacturing uses.

(7) Uses same generation factor as for professional building.

(8) Uses same generation factor as for commercial retail.

(9) Uses same generation factor as for industrial/manufacturing.

Prepared by Impact Sciences, Inc.
S. Tebo
12/5/03

Alternative 4-Compliance with the City of Santa Clarita Noise Ordinance
Estimated Water Demand

Land Use Category	Amount	Water Duty Factor	Water Demand (AFY)
Single Family Units	138 units	0.55 af/unit	75.9
Apartments	744 units	0.19 af/unit	141.36
Park	4 acres	3 af per acre	12.0
Other Misc. Landscaping (irrigated common landscaping, pocket parks, etc.)	29 acres	3 af per acre	87.0
Commercial (40,000 sq. ft.)	3 acres	0.0289 af/100 sq. ft.	11.56
TOTAL			**327.82**

ALTERNATIVE 4 SUMMERTIME EMISSIONS

URBEMIS 2002 For Windows 7.4.2

File Name: C:\URBEMIS2002\Urbemis River Park\River Park Alternative 4.urb
Project Name: River Park Alternative 4
Project Location: South Coast Air Basin (Los Angeles area)
On-Road Motor Vehicle Emissions Based on EMFAC2002 version 2.2

SUMMARY REPORT
(Pounds/Day - Summer)

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	43.96	7.76	5.13	0.04	0.02
TOTALS (lbs/day, mitigated)	43.88	6.90	4.75	0.04	0.02

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	84.54	93.98	1,007.26	0.65	98.19
TOTALS (lbs/day, mitigated)	84.54	93.98	1,007.26	0.65	98.19

SUM OF AREA AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	128.50	101.74	1,012.39	0.68	98.21
TOTALS (lbs/day, mitigated)	128.43	100.88	1,012.01	0.68	98.21

URBEMIS 2002 For Windows 7.4.2

File Name: C:\URBEMIS2002\Urbemis River Park\River Park Alternative 4.urb
Project Name: River Park Alternative 4
Project Location: South Coast Air Basin (Los Angeles area)
On-Road Motor Vehicle Emissions Based on EMFAC2002 version 2.2

DETAIL REPORT
(Pounds/Day - Summer)

AREA SOURCE EMISSION ESTIMATES (Summer Pounds per Day, Unmitigated)

Source	ROG	NOx	CO	SO2	PM10
Natural Gas	0.59	7.73	3.28	-	0.01
Wood Stoves - No summer emissions					
Fireplaces - No summer emissions					
Landscaping	0.21	0.03	1.85	0.04	0.00
Consumer Prdcts	43.15	-	-	-	-
TOTALS(lbs/day,unmitigated)	43.96	7.76	5.13	0.04	0.02

AREA SOURCE EMISSION ESTIMATES

Source	ROG	NOx	CO	SO2	PM10
Natural Gas	0.52	6.87	2.90	-	0.01
Wood Stoves - No summer emissions					
Fireplaces - No summer emissions					
Landscaping	0.21	0.03	1.85	0.04	0.00
Consumer Prdcts	43.15	-	-	-	-
TOTALS (lbs/day, mitigated)	43.88	6.90	4.75	0.04	0.02

Area Source Mitigation Measures

UNMITIGATED OPERATIONAL EMISSIONS

	ROG	NOx	CO	SO2	PM10
Single family housing	12.17	13.18	143.97	0.09	13.87
Apartments low rise	49.31	49.54	540.99	0.34	52.13
City park	0.13	0.09	0.96	0.00	0.10
Strip mall	22.93	31.16	321.34	0.21	32.10
TOTAL EMISSIONS (lbs/day)	84.54	93.98	1,007.26	0.65	98.19

Does not include correction for passby trips.
Does not include double counting adjustment for internal trips.

OPERATIONAL (Vehicle) EMISSION ESTIMATES

Analysis Year: 2008 Temperature (F): 90 Season: Summer

EMFAC Version: EMFAC2002 (9/2002)

Summary of Land Uses:

Unit Type	Trip Rate	Size	Total Trips
Single family housing	9.90 trips / dwelling units	138.00	1,366.20
Apartments low rise	6.90 trips / dwelling units	744.00	5,133.60
City park	2.60 trips / acres	4.25	11.05
Strip mall	94.55 trips / 1000 sq. ft.	40.00	3,782.00

Vehicle Assumptions:

Fleet Mix:

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	55.00	1.60	98.00	0.40
Light Truck < 3,750 lbs	15.00	2.70	95.30	2.00
Light Truck 3,751- 5,750	16.20	1.20	97.50	1.30
Med Truck 5,751- 8,500	7.20	1.40	95.80	2.80
Lite-Heavy 8,501-10,000	1.10	0.00	81.80	18.20
Lite-Heavy 10,001-14,000	0.40	0.00	50.00	50.00
Med-Heavy 14,001-33,000	1.00	0.00	20.00	80.00
Heavy-Heavy 33,001-60,000	0.90	0.00	11.10	88.90
Line Haul > 60,000 lbs	0.00	0.00	0.00	100.00
Urban Bus	0.20	0.00	50.00	50.00
Motorcycle	1.70	76.50	23.50	0.00
School Bus	0.10	0.00	0.00	100.00
Motor Home	1.20	8.30	83.30	8.40

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Rural Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Trip Speeds (mph)	35.0	40.0	40.0	40.0	40.0	40.0
% of Trips - Residential	20.0	37.0	43.0			
% of Trips - Commercial (by land use)						
City park				5.0	2.5	92.5
Strip mall				2.0	1.0	97.0

MITIGATED OPERATIONAL EMISSIONS

	ROG	NOx	CO	SO2	PM10
Single family housing	12.17	13.18	143.97	0.09	13.87
Apartments low rise	49.31	49.54	540.99	0.34	52.13
City park	0.13	0.09	0.96	0.00	0.10
Strip mall	22.93	31.16	321.34	0.21	32.10
TOTAL EMISSIONS (lbs/day)	84.54	93.98	1,007.26	0.65	98.19

OPERATIONAL (Vehicle) EMISSION ESTIMATES

Analysis Year: 2008 Temperature (F): 90 Season: Summer

EMFAC Version: EMFAC2002 (9/2002)

Summary of Land Uses:

Unit Type	Trip Rate	Size	Total Trips
Single family housing	9.90 trips / dwelling units	138.00	1,366.20
Apartments low rise	6.90 trips / dwelling units	744.00	5,133.60
City park	2.60 trips / acres	4.25	11.05
Strip mall	94.55 trips / 1000 sq. ft.	40.00	3,782.00

Vehicle Assumptions:

Fleet Mix:

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	55.00	1.60	98.00	0.40
Light Truck < 3,750 lbs	15.00	2.70	95.30	2.00
Light Truck 3,751- 5,750	16.20	1.20	97.50	1.30
Med Truck 5,751- 8,500	7.20	1.40	95.80	2.80
Lite-Heavy 8,501-10,000	1.10	0.00	81.80	18.20
Lite-Heavy 10,001-14,000	0.40	0.00	50.00	50.00
Med-Heavy 14,001-33,000	1.00	0.00	20.00	80.00
Heavy-Heavy 33,001-60,000	0.90	0.00	11.10	88.90
Line Haul > 60,000 lbs	0.00	0.00	0.00	100.00
Urban Bus	0.20	0.00	50.00	50.00
Motorcycle	1.70	76.50	23.50	0.00
School Bus	0.10	0.00	0.00	100.00
Motor Home	1.20	8.30	83.30	8.40

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Rural Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Trip Speeds (mph)	35.0	40.0	40.0	40.0	40.0	40.0
% of Trips - Residential	20.0	37.0	43.0			
% of Trips - Commercial (by land use)						
City park				5.0	2.5	92.5
Strip mall				2.0	1.0	97.0

ENVIRONMENTAL FACTORS APPLICABLE TO THE PROJECT

Pedestrian Environment

```
0.0          Side Walks/Paths: No Sidewalks
0.0          Street Trees Provide Shade: No Coverage
0.0          Pedestrian Circulation Access: No Destinations
0.0          Visually Interesting Uses: No Uses Within Walking Distance
0.0          Street System Enhances Safety: No Streets
0.0          Pedestrian Safety from Crime: No Degree of Safety
0.0          Visually Interesting Walking Routes: No Visual Interest

0.0    <- Pedestrian Environmental Credit
0.0   /19 =  0.0    <- Pedestrian Effectiveness Factor
```

Transit Service

```
0.0          Transit Service: Dial-A-Ride or No Transit Service

0.0    <- Transit Effectiveness Credit
0.0    <- Pedestrian Factor
0.0    <-Total
0.0    /110 =  0.0     <-Transit Effectiveness Factor
```

Bicycle Environment

```
0.0          Interconnected Bikeways: No Bikeway Coverage
0.0          Bike Routes Provide Paved Shoulders: No Routes
0.0          Safe Vehicle Speed Limits: No Routes Provided
0.0          Safe School Routes: No Schools
0.0          Uses w/in Cycling Distance: No Uses w/in Cycling Distance
0.0          Bike Parking Ordinance: No Ordinance or Unenforceable

0.0    <- Bike Environmental Credit
0.0  /20 =  0.0    <- Bike Effectiveness Factor
```

MITIGATION MEASURES SELECTED FOR THIS PROJECT
(All mitigation measures are printed, even if
the selected land uses do not constitute a mixed use.)

Transit Infrastructure Measures

% Trips Reduced	Measure
15.0	Credit for Existing or Planned Community Transit Service
15.0	<- Totals

Pedestrian Enhancing Infrastructure Measures (Residential)

% Trips Reduced	Measure
2.0	Credit for Surrounding Pedestrian Environment
1.0	Provide Sidewalks and/or Pedestrian Paths
1.0	Provide Direct Pedestrian Connections
0.5	Provide Pedestrian Safety
0.5	Provide Street Lighting
0.5	Provide Pedestrian Signalization and Signage
5.5	<- Totals

Pedestrian Enhancing Infrastructure Measures (Non-Residential)

% Trips Reduced	Measure
2.0	Credit for Surrounding Pedestrian Environment
2.0	<- Totals

Bicycle Enhancing Infratructure Measures (Residential)

% Trips Reduced	Measure
7.0	Credit for Surrounding Bicycle Environment
2.0	Provide Bike Lanes/Paths Connecting to Bikeway System
9.0	<- Totals

Bike Enhancing Infrastructure Measures (Non-Residential)

% Trips Reduced	Measure
5.0	Credit for Surrounding Area Bike Environment
5.0	<- Totals

Operational Measures (Applying to Commute Trips)

% Trips Reduced	Measure
0.0	<- Totals

Operational Measures (Applying to Employee Non-Commute Trips)

% Trips Reduced	Measure
0.0	<- Totals

Operational Measures (Applying to Customer Trips)

% Trips Reduced	Measure
0.0	<- Totals

Measures Reducing VMT (Non-Residential)

VMT Reduced	Measure
0.0	Park and Ride Lots
0.0	<- Totals

Measures Reducing VMT (Residential)

VMT Reduced	Measure
0.0	<- Totals

Total Percentage Trip Reduction
with Environmental Factors and Mitigation Measures

Travel Mode	Home-Work Trips	Home-Shop Trips	Home-Other Trips
Pedestrian	0.00	0.00	0.00
Transit	0.00	0.00	0.00
Bicycle	0.00	0.00	0.00
Totals	0.00	0.00	0.00

Travel Mode	Work Trips	Employee Trips	Customer Trips
Pedestrian	0.00	0.00	0.00
Transit	0.00	0.00	0.00
Bicycle	0.00	0.00	0.00
Other	0.00	0.00	0.00
Totals	0.00	0.00	0.00

Changes made to the default values for Land Use Trip Percentages

Changes made to the default values for Area

The wood stove option switch changed from on to off.
The area souce mitigation measure option switch changed from off to on.
The landscape year changed from 2004 to 2008.
Mitigation measure Increase Insulation Beyond Title 24: Rsdntl Space Heat.
    has been changed from off to on.
Mitigation measure Increase Insulation Beyond Title 24: Cmrcl Space Heat.
    has been changed from off to on.

Changes made to the default values for Operations

The operational emission year changed from 2004 to 2008.
The double counting internal work trip limit changed from to 76.1925.
The double counting shopping trip limit changed from to 38.09625.
The double counting other trip limit changed from to 2794.914.
The travel mode environment settings changed from both to: both
Mitigation measure Provide Sidewalks and/or Pedestrian Paths:1
    has been changed from off to on.
Mitigation measure Provide Direct Pedestrian Connections:1
    has been changed from off to on.
Mitigation measure Provide Pedestrian Safety:0.5
    has been changed from off to on.
Mitigation measure Provide Street Lighting:0.5
    has been changed from off to on.
Mitigation measure Provide Pedestrian Signalization and Signage:0.5
    has been changed from off to on.
Mitigation measure Provide Bike Lanes/Paths Connecting to Bikeway System:2
    has been changed from off to on.

ALTERNATIVE 4 WINTERTIME EMISSIONS

URBEMIS 2002 For Windows 7.4.2

File Name: C:\URBEMIS2002\Urbemis River Park\River Park Alternative 4.urb
Project Name: River Park Alternative 4
Project Location: South Coast Air Basin (Los Angeles area)
On-Road Motor Vehicle Emissions Based on EMFAC2002 version 2.2

SUMMARY REPORT
(Pounds/Day - Winter)

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	1,031.66	18.94	1,093.01	1.73	149.28
TOTALS (lbs/day, mitigated)	1,031.59	18.08	1,092.63	1.73	149.28

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	79.65	135.82	961.44	0.53	98.19
TOTALS (lbs/day, mitigated)	79.65	135.82	961.44	0.53	98.19

SUM OF AREA AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	1,111.31	154.76	2,054.45	2.25	247.47
TOTALS (lbs/day, mitigated)	1,111.24	153.91	2,054.07	2.25	247.47

URBEMIS 2002 For Windows 7.4.2

File Name: C:\URBEMIS2002\Urbemis River Park\River Park Alternative 4.urb
Project Name: River Park Alternative 4
Project Location: South Coast Air Basin (Los Angeles area)
On-Road Motor Vehicle Emissions Based on EMFAC2002 version 2.2

DETAIL REPORT
(Pounds/Day - Winter)

AREA SOURCE EMISSION ESTIMATES (Winter Pounds per Day, Unmitigated)

Source	ROG	NOx	CO	SO2	PM10
Natural Gas	0.59	7.73	3.28	-	0.01
Wood Stoves	0.00	0.00	0.00	0.00	0.00
Fireplaces	987.92	11.22	1,089.73	1.73	149.27
Landscaping - No winter emissions					
Consumer Prdcts	43.15	-	-	-	-
TOTALS(lbs/day,unmitigated)	1,031.66	18.94	1,093.01	1.73	149.28

AREA SOURCE EMISSION ESTIMATES

Source	ROG	NOx	CO	SO2	PM10
Natural Gas	0.52	6.87	2.90	-	0.01
Wood Stoves	0.00	0.00	0.00	0.00	0.00
Fireplaces	987.92	11.22	1,089.73	1.73	149.27
Landscaping - No winter emissions					
Consumer Prdcts	43.15	-	-	-	-
TOTALS (lbs/day, mitigated)	1,031.59	18.08	1,092.63	1.73	149.28

Area Source Mitigation Measures

Increase Insulation Beyond Title 24: Rsdntl Space Heat.
Percent Reduction(ROG 14% NOx 13% CO 7.4% SO2 0% PM10 13%)
Increase Insulation Beyond Title 24: Cmrcl Space Heat.
Percent Reduction(ROG 10% NOx 9% CO 7% SO2 0% PM10 9.5%)

UNMITIGATED OPERATIONAL EMISSIONS

	ROG	NOx	CO	SO2	PM10
Single family housing	11.34	19.07	136.10	0.08	13.87
Apartments low rise	42.72	71.67	511.42	0.28	52.13
City park	0.08	0.13	0.93	0.00	0.10
Strip mall	25.51	44.94	312.99	0.17	32.10
TOTAL EMISSIONS (lbs/day)	79.65	135.82	961.44	0.53	98.19

Does not include correction for passby trips.
Does not include double counting adjustment for internal trips.

OPERATIONAL (Vehicle) EMISSION ESTIMATES

Analysis Year: 2008 Temperature (F): 50 Season: Winter

EMFAC Version: EMFAC2002 (9/2002)

Summary of Land Uses:

Unit Type	Trip Rate	Size	Total Trips
Single family housing	9.90 trips / dwelling units	138.00	1,366.20
Apartments low rise	6.90 trips / dwelling units	744.00	5,133.60
City park	2.60 trips / acres	4.25	11.05
Strip mall	94.55 trips / 1000 sq. ft.	40.00	3,782.00

Vehicle Assumptions:

Fleet Mix:

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	55.00	1.60	98.00	0.40
Light Truck < 3,750 lbs	15.00	2.70	95.30	2.00
Light Truck 3,751- 5,750	16.20	1.20	97.50	1.30
Med Truck 5,751- 8,500	7.20	1.40	95.80	2.80
Lite-Heavy 8,501-10,000	1.10	0.00	81.80	18.20
Lite-Heavy 10,001-14,000	0.40	0.00	50.00	50.00
Med-Heavy 14,001-33,000	1.00	0.00	20.00	80.00
Heavy-Heavy 33,001-60,000	0.90	0.00	11.10	88.90
Line Haul > 60,000 lbs	0.00	0.00	0.00	100.00
Urban Bus	0.20	0.00	50.00	50.00
Motorcycle	1.70	76.50	23.50	0.00
School Bus	0.10	0.00	0.00	100.00
Motor Home	1.20	8.30	83.30	8.40

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Rural Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Trip Speeds (mph)	35.0	40.0	40.0	40.0	40.0	40.0
% of Trips - Residential	20.0	37.0	43.0			
% of Trips - Commercial (by land use)						
City park				5.0	2.5	92.5
Strip mall				2.0	1.0	97.0

MITIGATED OPERATIONAL EMISSIONS

	ROG	NOx	CO	SO2	PM10
Single family housing	11.34	19.07	136.10	0.08	13.87
Apartments low rise	42.72	71.67	511.42	0.28	52.13
City park	0.08	0.13	0.93	0.00	0.10
Strip mall	25.51	44.94	312.99	0.17	32.10
TOTAL EMISSIONS (lbs/day)	79.65	135.82	961.44	0.53	98.19

OPERATIONAL (Vehicle) EMISSION ESTIMATES

Analysis Year: 2008 Temperature (F): 50 Season: Winter

EMFAC Version: EMFAC2002 (9/2002)

Summary of Land Uses:

Unit Type	Trip Rate	Size	Total Trips
Single family housing	9.90 trips / dwelling units	138.00	1,366.20
Apartments low rise	6.90 trips / dwelling units	744.00	5,133.60
City park	2.60 trips / acres	4.25	11.05
Strip mall	94.55 trips / 1000 sq. ft.	40.00	3,782.00

Vehicle Assumptions:

Fleet Mix:

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	55.00	1.60	98.00	0.40
Light Truck < 3,750 lbs	15.00	2.70	95.30	2.00
Light Truck 3,751- 5,750	16.20	1.20	97.50	1.30
Med Truck 5,751- 8,500	7.20	1.40	95.80	2.80
Lite-Heavy 8,501-10,000	1.10	0.00	81.80	18.20
Lite-Heavy 10,001-14,000	0.40	0.00	50.00	50.00
Med-Heavy 14,001-33,000	1.00	0.00	20.00	80.00
Heavy-Heavy 33,001-60,000	0.90	0.00	11.10	88.90
Line Haul > 60,000 lbs	0.00	0.00	0.00	100.00
Urban Bus	0.20	0.00	50.00	50.00
Motorcycle	1.70	76.50	23.50	0.00
School Bus	0.10	0.00	0.00	100.00
Motor Home	1.20	8.30	83.30	8.40

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Rural Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Trip Speeds (mph)	35.0	40.0	40.0	40.0	40.0	40.0
% of Trips - Residential	20.0	37.0	43.0			
% of Trips - Commercial (by land use)						
City park				5.0	2.5	92.5
Strip mall				2.0	1.0	97.0

ENVIRONMENTAL FACTORS APPLICABLE TO THE PROJECT

Pedestrian Environment

0.0	Side Walks/Paths: No Sidewalks
0.0	Street Trees Provide Shade: No Coverage
0.0	Pedestrian Circulation Access: No Destinations
0.0	Visually Interesting Uses: No Uses Within Walking Distance
0.0	Street System Enhances Safety: No Streets
0.0	Pedestrian Safety from Crime: No Degree of Safety
0.0	Visually Interesting Walking Routes: No Visual Interest

0.0 <- Pedestrian Environmental Credit
0.0 /19 = 0.0 <- Pedestrian Effectiveness Factor

Transit Service

0.0 Transit Service: Dial-A-Ride or No Transit Service

0.0 <- Transit Effectiveness Credit
0.0 <- Pedestrian Factor
0.0 <-Total
0.0 /110 = 0.0 <-Transit Effectiveness Factor

Bicycle Environment

0.0	Interconnected Bikeways: No Bikeway Coverage
0.0	Bike Routes Provide Paved Shoulders: No Routes
0.0	Safe Vehicle Speed Limits: No Routes Provided
0.0	Safe School Routes: No Schools
0.0	Uses w/in Cycling Distance: No Uses w/in Cycling Distance
0.0	Bike Parking Ordinance: No Ordinance or Unenforceable

0.0 <- Bike Environmental Credit
0.0 /20 = 0.0 <- Bike Effectiveness Factor

MITIGATION MEASURES SELECTED FOR THIS PROJECT
(All mitigation measures are printed, even if
the selected land uses do not constitute a mixed use.)

Transit Infrastructure Measures

% Trips Reduced	Measure
15.0	Credit for Existing or Planned Community Transit Service
15.0	<- Totals

Pedestrian Enhancing Infrastructure Measures (Residential)

% Trips Reduced	Measure
2.0	Credit for Surrounding Pedestrian Environment
1.0	Provide Sidewalks and/or Pedestrian Paths
1.0	Provide Direct Pedestrian Connections
0.5	Provide Pedestrian Safety
0.5	Provide Street Lighting
0.5	Provide Pedestrian Signalization and Signage
5.5	<- Totals

Pedestrian Enhancing Infrastructure Measures (Non-Residential)

% Trips Reduced	Measure
2.0	Credit for Surrounding Pedestrian Environment
2.0	<- Totals

Bicycle Enhancing Infratructure Measures (Residential)

% Trips Reduced	Measure
7.0	Credit for Surrounding Bicycle Environment
2.0	Provide Bike Lanes/Paths Connecting to Bikeway System
9.0	<- Totals

Bike Enhancing Infrastructure Measures (Non-Residential)

% Trips Reduced	Measure
5.0	Credit for Surrounding Area Bike Environment
5.0	<- Totals

Operational Measures (Applying to Commute Trips)

% Trips Reduced	Measure
0.0	<- Totals

Operational Measures (Applying to Employee Non-Commute Trips)

% Trips Reduced	Measure
0.0	<- Totals

Operational Measures (Applying to Customer Trips)

% Trips Reduced	Measure
0.0	<- Totals

Measures Reducing VMT (Non-Residential)

VMT Reduced	Measure
0.0	Park and Ride Lots
0.0	<- Totals

Measures Reducing VMT (Residential)

VMT Reduced	Measure
0.0	<- Totals

Total Percentage Trip Reduction
with Environmental Factors and Mitigation Measures

Travel Mode	Home-Work Trips	Home-Shop Trips	Home-Other Trips
Pedestrian	0.00	0.00	0.00
Transit	0.00	0.00	0.00
Bicycle	0.00	0.00	0.00
Totals	0.00	0.00	0.00

Travel Mode	Work Trips	Employee Trips	Customer Trips
Pedestrian	0.00	0.00	0.00
Transit	0.00	0.00	0.00
Bicycle	0.00	0.00	0.00
Other	0.00	0.00	0.00
Totals	0.00	0.00	0.00

Changes made to the default values for Land Use Trip Percentages

Changes made to the default values for Area

The wood stove option switch changed from on to off.
The area souce mitigation measure option switch changed from off to on.
The landscape year changed from 2004 to 2008.
Mitigation measure Increase Insulation Beyond Title 24: Rsdntl Space Heat.
has been changed from off to on.
Mitigation measure Increase Insulation Beyond Title 24: Cmrcl Space Heat.
has been changed from off to on.

Changes made to the default values for Operations

The operational emission year changed from 2004 to 2008.
The double counting internal work trip limit changed from to 76.1925.
The double counting shopping trip limit changed from to 38.09625.
The double counting other trip limit changed from to 2794.914.
The travel mode environment settings changed from both to: both
Mitigation measure Provide Sidewalks and/or Pedestrian Paths:1
has been changed from off to on.
Mitigation measure Provide Direct Pedestrian Connections:1
has been changed from off to on.
Mitigation measure Provide Pedestrian Safety:0.5
has been changed from off to on.
Mitigation measure Provide Street Lighting:0.5
has been changed from off to on.
Mitigation measure Provide Pedestrian Signalization and Signage:0.5
has been changed from off to on.
Mitigation measure Provide Bike Lanes/Paths Connecting to Bikeway System:2
has been changed from off to on.

Alternative 5
Santa Clarita Valley
Population and Employment Impact Analysis
River Park EIR

Land Use	Unit	Quantity	Persons/ Household	Population	Employees/ Unit	Employees
Single Family Res'l	du	448	3.06	1,369	-	-
Multi-Family Res'l	du	744	3.06	2,274	-	-
Mobile Homes	du		2.55	0	-	-
Comm'l Retail	tsf	39.00	-	-	2.50	98
Hotel/Motel (1)	rooms		-	-	0.90	0
School/College	-		-	-	-	
Hospital	tsf		-	-	3.00	0
Library	tsf		-	-	1.00	0
Church	tsf		-	-	0.50	0
Business Park	tsf		-	-	3.00	0
Industrial/Mfg.	tsf		-	-	2.00	0
Utilities	tsf		-	-	0.70	0
Office	tsf		-	-	4.00	0
Golf Course/Park	acres	29.00	-	-	0.40	12
Special Generator (3)	tsf		-	-	0.70	0
			Totals	**3,643**	**-**	**109**

du = dwelling unit; tsf = thousand square feet

Build out analysis and school employment is derived from the Traffic Model.

(1) Based on 400 gross square feet per room and 0.9 employees per room (SCAG, 1990).

(3) Assumes same rate as Utilities.

Prepared by Impact Sciences, Inc.
S. Tebo
12/15/03

Alternative 5

River Park EIR

Santa Clarita Valley

Library Impact Analysis

Land Use	Number of Units	Persons/ Household	Library (Sq. Feet)	Library Books
Single Family Res'l	448	3.06	479	2,738
Multi-Family Res'l	744	3.06	796	4,547
Mobile Homes		2.55	0	0
		Totals	**1,275**	**7,286**

L.A. County Public Library Standard: 0.35 s.f./capita

L.A. County Public Library Standard: 2.0 books/capita

Prepared by Impact Sciences, Inc.
S. Tebo
12/15/03

Santa Clarita Valley
Net Increase in
Student/Classroom/School Generation Using
Theoretical Student Generation Rates
River Park EIR

District	Housing Units by Type			Student Generation Rate			Class Size	School Size	Students	Classes	Schools
	Single Fam.	Multi-Fam.	Apartment	Single Fam.	Multi-Fam.	Apartment					
Saugus Union Elementary	439		744	0.431	0.0556	0.1326	30	770	288	9.60	0.37
Hart Junior High	439		744	0.104	0.037	0.038	32	930	74	2.31	0.08
Hart High School	439		744	0.179	0.064	0.054	32	2,764	119	3.71	0.04
								Totals	**481**	**15.62**	**0.50**

Prepared By Impact Sciences, Inc.
S. Tebo
12/15/03

Alternative 5
Santa Clarita Valley
Parks and Recreation Impact Analysis
River Park EIR

Land Use	Number of Units	Persons/ Household	Population	Parkland Req'mt (acres)
Single Family Res'l	448	3.06	1,369	4.11
Multi-Family Res'l	744	3.06	2,274	6.82
Mobile Homes		2.55	0	0.00
		Totals	**3,643**	**10.93**

Based on Quimby requirement of 3.0 acres/1000 persons

Prepared by Impact Sciences, Inc.
S. Tebo
12/15/03

Alternative 5
Santa Clarita Valley
Solid Waste Generation
(No Recycling) Impact Analysis
River Park EIR

Land Use	Quantity	Units	Generation Rate (tpy) (1)	Generation Rate (lbs./day)	Total Waste Generated (tpy)	Total Waste Generated (lbs./day)
Residential Units:						
Single Family Detached	448	du	2.0400	11.18	914	5,008
Multi-Family or Attached	744	du	1.1700	6.41	870	4,770
Mobile Home		du	1.1700	6.41	0	0
Commercial/Industrial						
General Retail	39,000	sq. ft.	0.0024	0.01	94	513
Eating/Drnkng Establ.		sq. ft.	0.0108	0.06	0	0
Food & Drug Stores		sq. ft.	0.0072	0.04	0	0
Auto Dlr/Service Sta.		sq. ft.	0.0051	0.03	0	0
Hotel & Motel		sq. ft.	0.0053	0.03	0	0
Warehouse		sq. ft.	0.0011	0.01	0	0
Medical Offices		sq. ft.	0.0027	0.01	0	0
Hospitals		sq. ft.	0.0055	0.03	0	0
Business Park		sq. ft.	0.0014	0.01	0	0
Office		sq. ft.	0.0014	0.01	0	0
Library (4)		sq. ft.	0.0014	0.01	0	0
Education & Schools		sq. ft.	0.0013	0.01	0	0
College		sq. ft.	0.0013	0.01	0	0
Trans., Comm., Utilities		sq. ft.	0.0079	0.04	0	0
Special Generator (6)		sq. ft.	0.0079	0.04	0	0
Golf Course/Park	29	acres	0.2000	1.10	6	32
Manufacturing		sq. ft.	0.0050	0.03	0	0
Church (4)		sq. ft.	0.0014	0.01	0	0
				Totals	**1,884**	**10,322**

du = dwelling unit; sq.ft. - square feet; tpy = tons per year; lbs. = pounds
(1) The solid waste daily generation rates in tons per year are derived from the Ventura County Solid Waste Management Department's Guidelines for Preparation of Environmental Assessments for Solid Waste Impacts. These figures do not reflect any recycling activities on the part of the generator.
(4) Assumes same generation rate as for office.
(6) Conservatively assumes same generation rate as utilities.

Prepared by Impact Sciences, Inc.
S. Tebo
12/5/03

Alternative 5
Santa Clarita Valley
Wastewater Generation Impact Analysis
River Park EIR

Land Use	Units	Quantity	Generation Factor (gpd)	Generation (gpd)	Generation (mgd)
Residential					
Single Family	du	448	260.00	116,480.00	0.1165
Multi-Family	du	744	195.00	145,080.00	0.1451
Mobile Homes	du		195.00	0.00	0.0000
Non-Residential					
Commercial Retail	tsf	39	100.00	3,900.00	0.0039
Hotel	sq.ft.		na		
Hotel (1)	rooms		125.00	0.00	0.0000
School	tsf		200.00	0.00	0.0000
College	stdnts		20.00	0.00	0.0000
College	sq.ft.		na		
Hospital	sq.ft.		na		
Hospital (3)	beds		125.00	0.00	0.0000
Library (4)	tsf		50.00	0.00	0.0000
Church	tsf		50.00	0.00	0.0000
Business Park (7)	tsf		300.00	0.00	0.0000
Industrial/Manufacturing (5)	tsf		25.00	0.00	0.0000
Utilities	tsf		25.00	0.00	0.0000
Commercial/Medical Office	tsf		300.00	0.00	0.0000
Golf Course/Park	acres	29	0.00	0.00	0.0000
Golf Course/Park Imps	tsf		100.00	0.00	0.0000
Visitor Serving (8)	tsf		100.00	0.00	0.0000
Special Generator (9)	tsf		25.00	0.00	0.0000
			Totals	**265,460.00**	**0.2655**

gpd = gallons per day; mgd = million gallons per day; du = dwelling unit; tsf = thousand square feet; sq. ft. = square feet; stdnts = students

Source of wastewater generation factors is CDSLAC, Loadings for Each Class of Land Use (1992-93). This list is provided in Appendix 4.10.

(1) Number of hotel rooms is based upon an assumed 400 gross square feet per room.
(3) Number of hospital beds is based upon an assumed 500 gross square feet per bed.
(4) Uses same generation factor for library as used for church.
(5) Generation factor for industrial/manufacturing is based on dry manufacturing uses.
(7) Uses same generation factor as for professional building.
(8) Uses same generation factor as for commercial retail.
(9) Uses same generation factor as for industrial/manufacturing.

Prepared by Impact Sciences, Inc.
S. Tebo
12/5/03

Alternative 5- Deletion of Santa Clarita Parkway
Estimated Water Demand

Land Use Category	Amount	Water Duty Factor	Water Demand (AFY)
Single Family Units	448 units	0.55 af/unit	246.40
Apartments	744 units	0.19 af/unit	141.36
Park	4 acres	3 af per acre	12.0
Other Misc. Landscaping (irrigated common landscaping, pocket parks, etc.)	100 acres	3 af per acre	300.0
Commercial (40,000 sq. ft.)	3 acres	0.0289 af/100 sq. ft.	11.56
TOTAL			**711.32**

ALTERNATIVE 5 SUMMERTIME EMISSIONS

URBEMIS 2002 For Windows 7.4.2

File Name: C:\URBEMIS2002\Urbemis River Park\River Park Alternative 5.urb
Project Name: River Park Alternative 5
Project Location: South Coast Air Basin (Los Angeles area)
On-Road Motor Vehicle Emissions Based on EMFAC2002 version 2.2

SUMMARY REPORT
(Pounds/Day - Summer)

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	65.66	19.60	15.17	0.18	0.05
TOTALS (lbs/day, mitigated)	65.48	17.36	14.20	0.18	0.05

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	133.48	134.46	1,519.64	1.33	113.10
TOTALS (lbs/day, mitigated)	133.48	134.46	1,519.64	1.33	113.10

SUM OF AREA AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	199.14	154.06	1,534.81	1.51	113.16
TOTALS (lbs/day, mitigated)	198.95	151.82	1,533.84	1.51	113.15

URBEMIS 2002 For Windows 7.4.2

File Name: C:\URBEMIS2002\Urbemis River Park\River Park Alternative 5.urb
Project Name: River Park Alternative 5
Project Location: South Coast Air Basin (Los Angeles area)
On-Road Motor Vehicle Emissions Based on EMFAC2002 version 2.2

DETAIL REPORT
(Pounds/Day - Summer)

AREA SOURCE EMISSION ESTIMATES (Summer Pounds per Day, Unmitigated)

Source	ROG	NOx	CO	SO2	PM10
Natural Gas	1.51	19.51	8.29	-	0.04
Wood Stoves - No summer emissions					
Fireplaces - No summer emissions					
Landscaping	0.82	0.09	6.88	0.18	0.01
Consumer Prdcts	63.34	-	-	-	-
TOTALS(lbs/day,unmitigated)	65.66	19.60	15.17	0.18	0.05

UNMITIGATED OPERATIONAL EMISSIONS

	ROG	NOx	CO	SO2	PM10
Single family housing	54.76	55.98	636.72	0.55	47.16
Apartments low rise	65.03	62.03	705.49	0.61	52.26
City park	0.18	0.12	1.32	0.00	0.10
Strip mall	13.51	16.34	176.11	0.16	13.58
TOTAL EMISSIONS (lbs/day)	133.48	134.46	1,519.64	1.33	113.10

Does not include correction for passby trips.
Includes a double counting reduction for internal trips.

OPERATIONAL (Vehicle) EMISSION ESTIMATES

Analysis Year: 2004 Temperature (F): 90 Season: Summer

EMFAC Version: EMFAC2002 (9/2002)

Summary of Land Uses:

Unit Type	Trip Rate	Size	Total Trips
Single family housing	9.90 trips / dwelling units	468.00	4,633.20
Apartments low rise	6.90 trips / dwelling units	744.00	5,133.60
City park	2.60 trips / acres	4.50	11.70
Strip mall	40.00 trips / 1000 sq. ft.	40.00	1,600.00

Vehicle Assumptions:

Fleet Mix:

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	92.00	2.70	96.80	0.50
Light Truck < 3,750 lbs	0.00	4.60	92.70	2.70
Light Truck 3,751- 5,750	0.00	2.60	96.20	1.20
Med Truck 5,751- 8,500	2.00	2.90	94.20	2.90
Lite-Heavy 8,501-10,000	0.00	0.00	80.00	20.00
Lite-Heavy 10,001-14,000	1.00	0.00	66.70	33.30
Med-Heavy 14,001-33,000	0.00	10.00	20.00	70.00
Heavy-Heavy 33,001-60,000	2.00	0.00	12.50	87.50
Line Haul > 60,000 lbs	0.00	0.00	0.00	100.00
Urban Bus	0.10	0.00	0.00	100.00
Motorcycle	1.60	87.50	12.50	0.00
School Bus	0.00	0.00	0.00	100.00
Motor Home	1.30	15.40	76.90	7.70

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Rural Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Trip Speeds (mph)	35.0	40.0	40.0	40.0	40.0	40.0
% of Trips - Residential	20.0	37.0	43.0			
% of Trips - Commercial (by land use)						
City park				5.0	2.5	92.5
Strip mall				2.0	1.0	97.0

Changes made to the default values for Land Use Trip Percentages

Changes made to the default values for Area

The wood stove option switch changed from on to off.
The area souce mitigation measure option switch changed from off to on.
The natural gas residential percentage changed from 60 to 100.
The consumer product persons per residential unit changed from 2.861 to 3.056.
Mitigation measure Increase Insulation Beyond Title 24: Rsdntl Space Heat.
has been changed from off to on.
Mitigation measure Increase Insulation Beyond Title 24: Cmrcl Space Heat.
has been changed from off to on.

Changes made to the default values for Operations

The light auto percentage changed from 56.1 to 92.
The light truck < 3750 lbs percentage changed from 15.1 to 0.
The light truck 3751-5750 percentage changed from 15.6 to 0.
The med truck 5751-8500 percentage changed from 6.9 to 2.
The lite-heavy truck 8501-10000 percentage changed from 1.0 to 0.
The lite-heavy truck 10001-14000 percentage changed from 0.3 to 1.
The med-heavy truck 14001-33000 percentage changed from 1.0 to 0.
The heavy-heavy truck 33001-60000 percentage changed from 0.8 to 2.
The school bus percentage changed from 0.2 to 0.
The home based work selection item changed from 8 to 7.
The home based shopping selection item changed from 9 to 8.
The home based shopping urban trip length changed from 4.87 to 4.9.
The home based shopping rural trip length changed from 4.87 to 4.9.
The home based other selection item changed from 9 to 8.
The commercial based commute selection item changed from 9 to 8.
The commercial based non-work selection item changed from 9 to 8.
The commercial based customer selection item changed from 9 to 8.
The double counting internal work trip limit changed from to 32.585.
The double counting shopping trip limit changed from to 16.2925.
The double counting other trip limit changed from to 1562.8225.
The travel mode environment settings changed from both to: both
Mitigation measure Provide Sidewalks and/or Pedestrian Paths:1
has been changed from off to on.
Mitigation measure Provide Direct Pedestrian Connections:1
has been changed from off to on.
Mitigation measure Provide Pedestrian Safety:0.5
has been changed from off to on.
Mitigation measure Provide Street Lighting:0.5
has been changed from off to on.
Mitigation measure Provide Pedestrian Signalization and Signage:0.5
has been changed from off to on.
Mitigation measure Provide Bike Lanes/Paths Connecting to Bikeway System:2
has been changed from off to on.

ALTERNATIVE 5 WINTERTIME EMISSIONS

URBEMIS 2002 For Windows 7.4.2

File Name: C:\URBEMIS2002\Urbemis River Park\River Park Alternative 5.urb
Project Name: River Park Alternative 5
Project Location: South Coast Air Basin (Los Angeles area)
On-Road Motor Vehicle Emissions Based on EMFAC2002 version 2.2

SUMMARY REPORT
(Pounds/Day - Winter)

AREA SOURCE EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	1,422.39	34.93	1,505.75	2.37	205.15
TOTALS (lbs/day, mitigated)	1,422.20	32.69	1,504.78	2.37	205.15

OPERATIONAL (VEHICLE) EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	123.15	193.54	1,419.71	1.18	113.10
TOTALS (lbs/day, mitigated)	123.15	193.54	1,419.71	1.18	113.10

SUM OF AREA AND OPERATIONAL EMISSION ESTIMATES

	ROG	NOx	CO	SO2	PM10
TOTALS (lbs/day,unmitigated)	1,545.54	228.46	2,925.45	3.55	318.25
TOTALS (lbs/day, mitigated)	1,545.36	226.22	2,924.49	3.55	318.25

URBEMIS 2002 For Windows 7.4.2

File Name: C:\URBEMIS2002\Urbemis River Park\River Park Alternative 5.urb
Project Name: River Park Alternative 5
Project Location: South Coast Air Basin (Los Angeles area)
On-Road Motor Vehicle Emissions Based on EMFAC2002 version 2.2

DETAIL REPORT
(Pounds/Day - Winter)

AREA SOURCE EMISSION ESTIMATES (Winter Pounds per Day, Unmitigated)

Source	ROG	NOx	CO	SO2	PM10
Natural Gas	1.51	19.51	8.29	-	0.04
Wood Stoves	0.00	0.00	0.00	0.00	0.00
Fireplaces	1,357.55	15.41	1,497.45	2.37	205.11
Landscaping - No winter emissions					
Consumer Prdcts	63.34	-	-	-	-
TOTALS(lbs/day,unmitigated)	1,422.39	34.93	1,505.75	2.37	205.15

UNMITIGATED OPERATIONAL EMISSIONS

	ROG	NOx	CO	SO2	PM10
Single family housing	51.44	80.59	592.88	0.49	47.16
Apartments low rise	57.12	89.30	656.91	0.54	52.26
City park	0.11	0.18	1.26	0.00	0.10
Strip mall	14.48	23.47	168.66	0.14	13.58
TOTAL EMISSIONS (lbs/day)	123.15	193.54	1,419.71	1.18	113.10

Does not include correction for passby trips.
Includes a double counting reduction for internal trips.

OPERATIONAL (Vehicle) EMISSION ESTIMATES

Analysis Year: 2004 Temperature (F): 50 Season: Winter

EMFAC Version: EMFAC2002 (9/2002)

Summary of Land Uses:

Unit Type	Trip Rate	Size	Total Trips
Single family housing	9.90 trips / dwelling units	468.00	4,633.20
Apartments low rise	6.90 trips / dwelling units	744.00	5,133.60
City park	2.60 trips / acres	4.50	11.70
Strip mall	40.00 trips / 1000 sq. ft.	40.00	1,600.00

Vehicle Assumptions:

Fleet Mix:

Vehicle Type	Percent Type	Non-Catalyst	Catalyst	Diesel
Light Auto	92.00	2.70	96.80	0.50
Light Truck < 3,750 lbs	0.00	4.60	92.70	2.70
Light Truck 3,751- 5,750	0.00	2.60	96.20	1.20
Med Truck 5,751- 8,500	2.00	2.90	94.20	2.90
Lite-Heavy 8,501-10,000	0.00	0.00	80.00	20.00
Lite-Heavy 10,001-14,000	1.00	0.00	66.70	33.30
Med-Heavy 14,001-33,000	0.00	10.00	20.00	70.00
Heavy-Heavy 33,001-60,000	2.00	0.00	12.50	87.50
Line Haul > 60,000 lbs	0.00	0.00	0.00	100.00
Urban Bus	0.10	0.00	0.00	100.00
Motorcycle	1.60	87.50	12.50	0.00
School Bus	0.00	0.00	0.00	100.00
Motor Home	1.30	15.40	76.90	7.70

Travel Conditions

	Residential			Commercial		
	Home-Work	Home-Shop	Home-Other	Commute	Non-Work	Customer
Urban Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Rural Trip Length (miles)	11.5	4.9	6.0	10.3	5.5	5.5
Trip Speeds (mph)	35.0	40.0	40.0	40.0	40.0	40.0
% of Trips - Residential	20.0	37.0	43.0			
% of Trips - Commercial (by land use)						
City park				5.0	2.5	92.5
Strip mall				2.0	1.0	97.0

Changes made to the default values for Land Use Trip Percentages

Changes made to the default values for Area

The wood stove option switch changed from on to off.
The area souce mitigation measure option switch changed from off to on.
The natural gas residential percentage changed from 60 to 100.
The consumer product persons per residential unit changed from 2.861 to 3.056.
Mitigation measure Increase Insulation Beyond Title 24: Rsdntl Space Heat.
has been changed from off to on.
Mitigation measure Increase Insulation Beyond Title 24: Cmrcl Space Heat.
has been changed from off to on.

Changes made to the default values for Operations

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The light truck < 3750 lbs percentage changed from 15.1 to 0.
The light truck 3751-5750 percentage changed from 15.6 to 0.
The med truck 5751-8500 percentage changed from 6.9 to 2.
The lite-heavy truck 8501-10000 percentage changed from 1.0 to 0.
The lite-heavy truck 10001-14000 percentage changed from 0.3 to 1.
The med-heavy truck 14001-33000 percentage changed from 1.0 to 0.
The heavy-heavy truck 33001-60000 percentage changed from 0.8 to 2.
The school bus percentage changed from 0.2 to 0.
The home based work selection item changed from 8 to 7.
The home based shopping selection item changed from 9 to 8.
The home based shopping urban trip length changed from 4.87 to 4.9.
The home based shopping rural trip length changed from 4.87 to 4.9.
The home based other selection item changed from 9 to 8.
The commercial based commute selection item changed from 9 to 8.
The commercial based non-work selection item changed from 9 to 8.
The commercial based customer selection item changed from 9 to 8.
The double counting internal work trip limit changed from to 32.585.
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The double counting other trip limit changed from to 1562.8225.
The travel mode environment settings changed from both to: both
Mitigation measure Provide Sidewalks and/or Pedestrian Paths:1
has been changed from off to on.
Mitigation measure Provide Direct Pedestrian Connections:1
has been changed from off to on.
Mitigation measure Provide Pedestrian Safety:0.5
has been changed from off to on.
Mitigation measure Provide Street Lighting:0.5
has been changed from off to on.
Mitigation measure Provide Pedestrian Signalization and Signage:0.5
has been changed from off to on.
Mitigation measure Provide Bike Lanes/Paths Connecting to Bikeway System:2
has been changed from off to on.