Prepared for

Impact Sciences
803 Camarillo Springs Road, Suite A
Camarillo, California 93012

VISTA CANYON
WATER QUALITY TECHNICAL REPORT

Prepared by

Geosyntec consultants

engineers | scientists | innovators

475 14th Street, Suite 400
Oakland, California 94612

Project Number SR1006

May 2010

Vista Canyon
Water Quality Technical
Report

Prepared for
Impact Sciences
803 Camarillo Springs Road, Suite A
Camarillo, California 93012

Prepared by

Geosyntec Consultants
Oakland, California

May 2010

Table of Contents

Appendix D: "Assessment of Potential Impacts Resulting from Cumulative Hydromodification Effects, Selected Reaches of the Santa Clara River, Los Angeles County, California"

List of Tables

List of Figures

(all figures are provided at the end of this document)

Acronyms

ASCE:	American Society of Civil Engineers
AFY:	Acre Feet per Year
BAT:	Best Available Technology
BCT:	Best Conventional Technology
BMP:	Best Management Practice
BOD:	Biochemical Oxygen Demand
Cd:	Cadmium
$CACO_3$:	Calcium Carbonate
CASQA:	California Stormwater Quality Association
CCR:	California Code of Regulations
CDFG:	California Department of Fish and Game
CDPH:	California Department of Public Health
CEC:	Chemicals of Emerging Concern
CEQA:	California Environmental Quality Act

CLWA: Castaic Lake Water Agency
CTR: California Toxics Rule
Cu: Copper
CWA: Clean Water Act
CWP: Center For Watershed Protection
DCIA: Directly Connected Impervious Area
DDT: Dichlorodiphenyltrichloroethane
DLWC: Department of Land and Water Conservation
EIR: Environmental Impact Report
EMC: Event Mean Concentration
EPA: Environmental Protection Agency
ETo: Reference Evapotranspiration Rate
FIB: Fecal Indicator Bacteria
FT: Feet
HOA: Homeowners Association
In: Inch
IRWD: Irvine Ranch Water District
JPA: Joint Powers Authority
LACDPW: Los Angeles County Department of Public Works
LARWQCB: Los Angeles Regional Water Control Board
LID: Low Impact Development
LMD: Local Maintenance District
LSAA: Lake and Streambed Alteration Agreement
MBAS: Methylene Blue Activated Substances
MEP: Maximum Extent Practicable
MGD: Million Gallons per Day
mg/L: Milligrams per Liter
µg/L: Micrograms per Liter
MPN: Most Probable Number
MS4: Municipal Separate Storm Sewer System
NCDC: National Climatic Data Center
NPDES: National Pollutant Discharge Elimination System
NSWQ: National Stormwater Quality Database
O&M: Operations and Maintenance
PAH: Polycyclic Aromatic Hydrocarbons
Pb: Lead
PCB: Polychlorinated Biphenyl
PDF: Project Design Feature
PIPP: Public Information and Participation Program
POTW Publicly Owned Treatment Works
RWQCB: Regional Water Quality Control Board
SAR: Sodium Adsorption Ratio

SCR:	Santa Clara River
SEA:	Significant Ecological Area
SMA:	Special Management Area
SQMP:	Stormwater Quality Management Plan
SWMP:	Stormwater Mitigation Plan
SUSMP:	Standard Urban Stormwater Mitigation Plan
SWPPP:	Stormwater Pollution Prevention Plan
SWRCB:	State Water Resources Control Board
TDS:	Total Dissolved Solids
TKN:	Total Kjeldahl Nitrogen
TMDL:	Total Maximum Daily Load
TN:	Total Nitrogen
TP:	Total Phosphorus
TPH:	Total Petroleum Hydrocarbons
TSS:	Total Suspended Solids
USEPA:	United States Environmental Protection Agency
USGS:	United States Geological Survey
WEF:	Water Environment Federation
WDR:	Waste Discharge Requirements
WMA:	Watershed Management Area
WMC:	Watershed Management Committee
WRP:	Water Reclamation Plant
WQTR:	Water Quality Technical Report
Zn:	Zinc

1 INTRODUCTION

This report addresses the potential water quality impacts of the proposed Vista Canyon Project (the Project) on the Project's receiving waters, the Santa Clara River and groundwater. To evaluate impacts of the Project on water quality, pollutants of concern are identified based on regulatory and other considerations. Potential changes in water quality due to the Project are addressed for pollutants of concern based on runoff water quality modeling, literature information, and professional judgment. Impacts take into account Project Design Features (PDFs) which have been selected consistent with the Los Angeles County Municipal Separate Storm Sewer System (MS4) National Pollutant Discharge Elimination System (NPDES) Permit, including the Los Angeles County Standard Urban Stormwater Mitigation Plan (SUSMP) requirements. The level of significance of impacts is evaluated using a weight of evidence approach that considers significance criteria, including predicted runoff quality for proposed versus existing conditions, MS4 Permit and Construction General Permit requirements, and reference to receiving water quality benchmarks, including Total Maximum Daily Load (TMDL) waste load allocations and water quality standards from the Basin Plan and California Toxics Rule.

The report also assesses the potential for post-development changes to stormwater runoff discharge rates, velocities, and durations to cause accelerated stream erosion, and to impact stream habitat (hydromodification impacts), and includes PDFs to address these potential impacts.

The purpose of this report is to assess the Project's potential impacts on water quality and hydromodification, and to identify Project Design Features (PDFs) as part of the City of Santa Clarita's Draft Environmental Impact Report (DEIR) (Impact Sciences, 2010).

Potential hydrological impacts of the Project's proposed flood and erosion control facilities and bridge improvements (i.e., "floodplain modifications") to the Santa Clara River Corridor are analyzed in *Vista Canyon Project (TTM #69164) EIR Flood Technical Report - Santa Clara River* (PACE, 2009).

2 ENVIRONMENTAL SETTING

2.1 Physical Setting

The approximately 185-acre Project site is located immediately south of State Route 14 (SR-14), west of La Veda Avenue, north of the Metrolink rail line, and east of the Colony Townhome community in unincorporated Los Angeles County, directly adjacent to the City of Santa Clarita. (Figure 2-1). The Santa Clarita Valley is generally surrounded by the Los Padres and Angeles National Forest areas to the north; Agua Dulce and the Angeles National Forest to the east; the major ridgeline of the Santa Susana Mountains, which separates Santa Clarita Valley from the San Fernando and Simi Valleys to the south; and the County of Ventura to the west.

The Project site is bisected by the Santa Clara River. The majority of the Project site is located south of the Santa Clara River (Planning Areas 1, 2, and 3), with commercial development proposed north of the Santa Clara River on Mitchell Hill (Planning Area 4) (Figure 2-2). The Project site includes a portion of the Santa Clara River.

The Project site is mostly disturbed, vacant land, with the exception of 1.5 acres of light industrial land use (open storage) and an adjacent residential use in the southwest corner of the site. Although most of the Project site is not developed, it is surrounded by existing development. The site is also subject to repeated disturbance from utility construction and maintenance, illegal dumping, unauthorized off-road vehicle activity, flood management activities, and the natural fluvial processes characteristic of the Santa Clara River floodplain (PACE, 2009). Elevations across the property range from about 1,470 feet (ft) to about 1,580 ft above mean sea level (msl) (Dudek, 2009). There are eleven soil types on the Project site: riverwash (14.1%), sandy alluvial land (24.4%), Cortina sandy loam (22.7%), and Yolo loam (20.5%) comprise the majority of the Project site (NRCS, 2004).

Vegetation across the Project site reflects a confluence of topographic, hydrologic, climatic, and human disturbance factors (Forde, 2008). These factors, along with cumulative effects of activities that range from dumping to off-road vehicle activity and utility construction, have significantly disturbed the remaining vegetation communities and resulted in a mix of native and non-native species. Another notable feature of the vegetation is the mosaic of species reflecting a transitional climate between coast and desert, which is expected in the eastern portion of the Santa Clarita Valley.

Vegetation communities identified within the Project site include Fremont cottonwood-willow riparian forest, Fremont cottonwood-riparian scrub, coast live oak series, riparian scrub, alluvial scrub, mulefat series, rabbitbrush series, big sagebrush-buckwheat series, California sagebrush-buckwheat series, chamise series, scalebroom series, wild rye-saltbush scrub, saltgrass series, non-native annual grassland-ruderal, ruderal, rubble/dirt piles, and developed (Dudek, 2009).

2.1.1 Rainfall Analysis

The precipitation gage nearest to the Project site is the Newhall S FC32CE gage (NCDC #046162, LACDPW #32C). This gage is located approximately 5.5 miles southwest of the Project site at a similar elevation (1,243 ft msl at the gage compared to approximately 1,500 ft msl at the Project site). Based on estimates of average annual rainfall depths provided by the PRISM[1] model, the Newhall gage and the Project site receive comparable annual rainfall depths. The average annual precipitation at the Project site is approximately 18 inches.

A rainfall analysis was conducted to estimate the mean and 85th percentile storm events for the Project site from a variety of sources. Storm events were defined as both 24-hour total accumulations (computed from both hourly and daily gages) and variable-length storm events defined by a threshold rainfall depth and a minimum inter-event time. Variable-length events were computed using the SYNOP statistical rainfall analysis program (USEPA, 1989). The mean storm depth was estimated to be about 0.6 inches (in) and the 85th percentile, 24-hour storm event was estimated to be 1.4 in for the Project vicinity. Further detail on the rainfall analysis is provided in Appendix B.

2.1.2 Existing Drainage

The Project site consists of seven minor contributing drainage areas that independently drain via sheet flows and natural concentrated flows to the Santa Clara River.

2.2 <u>Project Area Land Uses</u>

2.2.1 Existing Land Uses

The Los Angeles County Land Use Map (initially adopted February 16, 1984 and as amended through May 13, 2003) designates the property as M (Industry) and W (Floodplain/Floodway). The property is currently zoned M-1.5 (Light Industrial), A-1-1 (Light Agriculture – One Acre minimum lot size), R-A-8,000 (Residential Agriculture – 8,000 square foot minimum lot size), and A-1-10,000 (Light Agriculture – 10,000 square foot minimum lot size).

The property was included in the Planning Area of the City of Santa Clarita General Plan. The City's adopted Land Use Plan (adopted June 26, 1991 and as amended through April 24, 2007) designates the property as BP (Business Park) with portion of the site covered by an SEA overlay. The City's General Plan Land Use Concept (Exhibit L-3 of the General Plan) identified the project as a major sub center with Business Park/Office Uses.

---

[1] PRISM (Parameter Regression on Independent Slope Model, Oregon State University, 2008) is a model used to spatially interpolate rainfall depths based on topography, relationship to water bodies, and other parameters. Average annual depths reported by PRISM provide a sound basis for estimating the relative difference in rainfall between discrete points that may not be represented by a rain gage.

Land uses surrounding the Project site include:

- Multi-family residential development, Colony Townhomes, directly west of the project site;
- SR-14, residential, and commercial development north of the project site;
- Single family residential units along both sides of La Veda Avenue, single family residential units along Lost Canyon Road, a public elementary school, and a private elementary school east of the project site;
- The Metrolink rail line and a commercial horse breeding facility property with accessory residential and barn structures south of the eastern portion of the project site; and
- Vacant land, the Metrolink rail line, and residential development (Fair Oaks Ranch) south of the western portion of the project site.

2.2.2 Proposed Project Land Uses

The proposed land uses shown on the tentative tract map include 1,117 dwelling units (96 single family residential lots and 1,021 multi-family residential units) and up to 950,000 square feet of commercial and medical office, retail, theater, restaurant, and hotel uses within four Planning Areas ("PA"). A residential overlay over the corporate office campus site within PA-2 would allow for a conversion of up to 250,000 square feet of office floor area to 233 attached residential units. If implemented, this conversion would permit a maximum of 1,350 residential units and 700,000 square feet of commercial floor area. The project includes various parks and recreation amenities, including the Oak Park, Town Green, Community Garden, and the River Education/Community Center; a Metrolink Station; Bus Transfer Station; private recreational facilities, and various trail and road improvements.

The Project also proposes a 395,411 gallon per day (gpd) on-site water reclamation plant ("WRP") (Dexter Wilson Engineering, 2010). The WRP and associated percolation ponds will be located in Planning Area 1, between the Santa Clara River Regional Trail and Lost Canyon Road.

The project applicant is proposing a Specific Plan (SP) designation for the project site. The Vista Canyon Specific Plan has been designed to deliver a mixed-use, transit-oriented neighborhood to the eastern Santa Clarita Valley. The following land use designation zones would be established by the Specific Plan, and applied to property within the Specific Plan area (Figure 2-2).

Residential (R)

The R land use designation zone is applied to areas appropriate for a variety of attached and detached residential units, including condominiums, apartments, residential flats, live/work units, attached residential over retail, and attached residential with parking structure. The designation also allows recreation and parking areas to support the residential areas.

Mixed-Use (MU)

The MU land use designation zone is applied to areas appropriate for a wide-range of land uses, and allows residential, offices, retail, general commercial uses, and office over retail, hotel/lodging, theater, cinema or performing arts, studios, health/fitness facilities, community assembly, and outdoor dining. Parking structures also are allowed in the MU zone, as well as subterranean parking. Further, this zone contemplates a variety of office uses, including areas appropriate for business, financial, professional, business support service, processing, administrative, bank, medical services, and other office and supporting uses. This zone also contemplates a variety of retail uses, including areas appropriate for restaurant, café, coffee shop, market, general retail, food service including drive-through facilities, and entertainment.

Open Space (OS)

The OS land use designation zone is applied to the Santa Clara River Corridor, including the buried bank stabilization areas within the Specific Plan boundary.

Other (O)

The O land use designation zone is applied to the on-site recreational areas, the WRP, bus-transfer station, and public streets.

Table 2-1 below summarizes the proposed Project land uses.

Table 2-1: Vista Canyon Proposed Land Uses

Land Use	**Area (acres)**
Residential	
Single-Family Detached	8.1
Multi-Family	25.2
Mixed-Use/Multi-Family	1.1
Commercial	
Mixed-Use - Commercial/Office	9.6
Office[1]	2.7
Commercial	3.4
Parking Structures	4.2
Water Reclamation Plant	1.5
Open Space	
Parks	7.8
Landscaping/Open Space/Recreation	23.2

Land Use	Area (acres)
River Bank Protection[2]	22.1
Santa Clara River	55
Roads	
Roads	21.4
TOTAL	185.3

1 - The Specific Plan allows a residential overlay within PA-2. This overlay allows for the conversion of up to 250,000 square feet of office uses to a maximum of 233 attached residential units.

2 - River Bank Protection encompasses maintenance access roads (2.8 acres), buried bank stabilization (6.8 acres), and areas of the river bed which will be temporarily impacted by construction (12.7 acres).

2.2.3 Drainage Improvements

Site preparation will include cut and fill grading with fill imported to the site from up to two borrow sites. The Project will also include buried bank stabilization (soil cement) on both the north and south sides of the Santa Clara River, and construction of the Vista Canyon Road Bridge, including bridge abutments and piers, across the River. These drainage improvements are described below (PACE, 2009).

Proposed Bank Protection

The proposed soil cement bank protection on the north bank of the Santa Clara River, which begins at the westerly edge of Planning Area 4 at Mitchell Hill, is designed to protect the bank against potential erosion and flooding. Mitchell Hill does not require river bank erosion protection due to its geologic characteristics, as it is composed of an exposed bedrock formation that rises approximately 40 feet above the elevation of the River. The proposed north bank protection will extend approximately 3,000 linear feet from Mitchell Hill downstream and terminate near the Project's northwest boundary. This buried bank stabilization would replace rip-rap flood control improvements located along a portion of this reach. The bank protection is also necessary to protect the Vista Canyon Road Bridge north abutment from erosion and flooding.

The proposed soil cement bank protection on the south bank of the Santa Clara River will be located between the easterly project boundary near existing La Veda Avenue and the westerly project boundary near the existing Colony Townhomes. The proposed south bank protection will be approximately 4,500 linear feet with the horizontal alignment extending from approximately 1,400 feet downstream of Sand Canyon Bridge to 1,100 feet upstream of SR-14 Bridge. The south bank protection is designed to protect the proposed Project and the southerly abutment of the Vista Canyon Road Bridge from potential erosion and flooding. The buried bank stabilization proposed by the project would also result in the removal of debris fencing located within the River corridor along the margins of the active channel.

The proposed bank protection will consist of an 8-foot wide soil cement section with a varied height (top and toe as required by the City/County) and a 1.5:1 slope (geotechnical analysis to verify slope). Once installed, the soil cement would be backfilled (buried) with native soils on a 3:1 or flatter slope. The excavation required to construct the bank protection would be backfilled and returned to existing grade, except as overlaid by the 3:1 or flatter fill slope. The final slope would be re-vegetated with native species and temporarily irrigated until the vegetation is established.

Proposed Storm Drain Outlets/Energy Dissipaters

Two storm drains are proposed to outlet through the south bank and two through the north bank. To reduce storm flow velocities and prevent erosion at stormwater discharge points into the River, energy dissipaters will be constructed, consisting of either rip-rap or other larger reinforced concrete impact-type energy dissipaters, at these outlets into the River.

Vista Canyon Road Bridge

The Project proposes to construct the Vista Canyon Road Bridge over the Santa Clara River. The bridge will be located in the center of the Project site, linking the southerly and northerly planning areas. The bridge length is estimated to be approximately 650 linear feet with abutments on each bank of the River and six support piers within the River.

Vista Canyon WRP

The proposed WRP, which would be owned and operated by the City of Santa Clarita, would recycle up to 395,411 gpd of wastewater, including the Project's estimated 214,265 gpd of wastewater (Dexter Wilson Engineering, 2010). The WRP would be designed as a scalping plant with no solids processing; any solids generated would be discharged to the existing sewer and treated at the existing Valencia Water Reclamation Plant.

The estimated on-site recycled water use would be 117,922 gpd (Dexter Wilson Engineering, 2010). This water would be utilized for irrigation purposes and for public restroom facilities in commercial buildings. The Castaic Lake Water Agency ("CLWA"), the regional water wholesaler, has expressed an interest in acquiring the excess recycled water, incorporating the supply into its future recycled water system, and using it for irrigation purposes for surrounding, existing development. Until CLWA's recycled system is operational, the proposed WRP would discharge excess recycled water to adjacent percolation ponds.

At this time, it is estimated that that 90 percent of the WRP's effluent would be recycled and utilized primarily for irrigation on- and off-site (i.e., through CLWA's recycled water system), with the remaining 10 percent discharged to the percolation ponds. During wetter years, the amount of water discharged to the percolation ponds would increase and, during dry years, the amount would decrease.

2.2.4 Off-Site Project Improvements

To facilitate development of the project, the following off-site improvements are proposed:

- Extension of Lost Canyon Road (approximately 800 feet), from its present terminus at the northerly abutment of the bridge over the Metrolink railroad tracks within Fair Oaks Ranch, north across adjacent properties to the south and west to the Specific Plan site. The right-of-way for this road will accommodate two vehicular lanes in each direction, a raised landscaped median, parkway, sidewalk and Class III bike lanes. Approximately 160,000 cubic yards of grading is necessary to complete this improvement.
- Extension of Lost Canyon Road to the south into the Cloyd property, along with the extension of the east-west "Y Street" into the Cloyd property from southern boundary of the Project.
- Extension of Jakes Way (approximately 250 feet) from its present terminus directly west of the Specific Plan site to the proposed roundabout at Lost Canyon Road and Jakes Way. The right-of-way for this road will accommodate one vehicular lane in each direction, parkway, sidewalk and Class III bike lanes. Approximately 2,000 cubic yards of grading is necessary to complete this improvement. Buried bank stabilization is necessary along this roadway extension, and will connect to the existing concrete-gunite flood protection located directly north of the existing Jakes Way.
- Grading on portions of the adjacent property to the south for slope and drainage purposes as shown on the tentative map.
- Santa Clara River Regional Trail extension easterly from the Specific Plan site along Lost Canyon Road to Sand Canyon Road. This 10-foot wide trail will consist of decomposed granite or a similar surface and include a pedestrian bridge crossing over the Sand Canyon Wash.
- Widening and completion of roadway improvements on Lost Canyon Road under SR-14, within the existing right-of-way. This roadway is presently partially improved and used for public access. Proposed improvements will include the addition of pavement, curb gutter, and sidewalk (east side).
- Import of up to 500,000 cubic yards of dirt from one or both of the following borrow sites: (a) the George Caravalho Santa Clarita Sports Complex, and (b) the Center Pointe Business Park. Development on both of the borrow sites has been previously approved.
- Construction of the platform and accessory station improvements within the Metrolink right-of-way as part of a new City/Metrolink transit center as shown on Tentative Tract Map No. 69164.
- Grading and various trail improvements within the Metrolink right-of-way adjacent to the project site as shown on Tentative Tract Map No. 69164.

Land use acreages associated with these improvements are summarized in Table 2-2 below.

Table 2-2: Summary of Off-site Impact Areas

Land Use	Area (acres)
Roadways[1]	7.2
Trails	0.4
Metrolink Platform	1.3
School[2]	16.5
Residential[2]	8.4
Grading in Metrolink ROW	1.6
TOTAL	**35.4**

1 - Roadway acreage includes pavement and non-paved areas within right-of-way
2 - Off-site school and residential land uses are not proposed to be improved as part of the project, but drainage will be routed to project BMPs

2.3 Receiving Surface Water Bodies and Beneficial Uses

2.3.1 Santa Clara River Watershed

The Project site is located within the Santa Clara River Hydrologic Basin and associated watershed, which is approximately 1,634 square miles in area. The Project will discharge from its storm drain and water quality control facilities directly to Santa Clara River Reach 7[2], which extends from Bouquet Canyon Road to the Lang gaging station (Figure 2-1). The portion of the Santa Clara River watershed that is located generally upstream or east of the Project is approximately 191 square miles in size (PACE, 2009). The watershed drains portions of the Angeles National Forest from the north, south, and southeast, which comprise approximately 40 percent of the watershed area at this location. The approximately 185-acre Project area represents 0.15 percent of the 191 square mile upstream watershed and 0.018 percent of the entire 1,634 square mile Santa Clara River watershed.

The Santa Clara River watershed drains an area in the Transverse mountain range of southern California. The River flows generally west from its headwaters near Acton to its terminus at the Pacific Ocean near the City of Ventura, approximately 60 miles downstream of the Project location. The River exhibits some perennial flow in its eastern-most stretches within the Angeles National Forest, then flows intermittently westward within Los Angeles County. The principal tributaries of the upper river watershed (upstream of the Los Angeles/Ventura County boundary,

[2] The SCR is divided into reaches for purposes of establishing beneficial uses and water quality objectives. However, there are two reach classifications, one established by the Los Angeles Regional Water Quality Control Board (LARWQCB) and one established by the United States Environmental Protection Agency (EPA). Both of these reach classifications are used by the LARWQCB and the EPA in various documents, which at times is a source of confusion. This report will use the LARWQCB reach numbers.

but all downstream of the Project location) are Castaic Creek, Bouquet Canyon Creek, San Francisquito Creek, and the South Fork of the Santa Clara River. Placerita Creek is a large tributary draining the western-most end of the San Gabriel Mountains; it joins the South Fork, which flows directly into the Santa Clara River. Castaic Creek is a south-trending creek that confluences with the Santa Clara River downstream of the City of Santa Clarita. Castaic Lake is a Department of Water Resources-owned reservoir located along the course of Castaic Creek. San Francisquito Canyon Creek is an intermittent stream in the watershed adjacent to Bouquet Canyon to the southeast. Elevations within the watershed range from sea level at the river mouth to 8,800 feet at the summit of Mount Pinos in the northwest corner of the watershed.

The Santa Clara River at the Project location is generally dry except after periods of heavy rainfall, generally occurring during the winter months (Dudek, 2009). The principal sources of water contributing to the base flow of the Santa Clara River, where regular surface flows are present (approximately eight miles downstream of the Project location), are: (a) groundwater from the Alluvial aquifer basin, which seeps into the riverbed near, and downstream of, Round Mountain (located just below the mouth of San Francisquito Creek); (b) tertiary-treated water discharged to the Santa Clara River from two existing Los Angeles County Sanitation District WRPs, the Saugus WRP, located near Bouquet Canyon Road bridge, and the Valencia WRP, located immediately downstream of I-5; and (c) in some years, DWR-released flood flows from Castaic Lake into Castaic Creek during winter and spring months (CH2M Hill, 2005). The Saugus Water Reclamation Plant, located near Bouquet Canyon Road bridge, has a permitted dry weather average design capacity of 6.5 million gallons per day (mgd), creating surface flows from the outfall to near McBean Parkway. The Valencia Water Reclamation Plant outfall is located immediately downstream of the Interstate 5 bridge, and has a permitted dry weather average design capacity of 21.6 mgd, creating surface flows extending into the far eastern portion of Ventura County (these flows generally terminate at the “Dry Gap” within Ventura County). The combined average treated discharge from both WRPs between January 2004 and June 2007 was approximately 20 mgd.

The following description of the physiography, climate, flows, and vegetation of the Santa Clara River are summarized primarily from the *Assessment of Potential Impacts Resulting from Cumulative Hydromodification Effects, Selected Reaches of the Santa Clara River, Los Angeles County, California* (Balance Hydrologics, provided in Appendix D) and the *California Rapid Assessment Methodology Report Vista Canyon Ranch Property* (Dudek, 2009).

Physiography

The Santa Clara River flows through a complex, tectonically-active trough. Slopes are very steep, often with local relief of 3,000 to 4,000 feet. These faults uplift harder, more resistant sedimentary rocks over softer and younger sedimentary formations, but all formations are fundamentally soft and erodible. On either side of the faults, sandstone and mudstones prevail. The northeastern and southeastern corners of the watershed are underlain by deeply-weathered granitic and schistose rocks, which produce sands that are coarser than those of other rock units when they weather and erode.

Geologic materials in the watershed decompose mainly to silts, clays, and sand, with some coarser materials. Most sediment moved by the Santa Clara River and its main tributaries is fine, with less than 5 percent of sediment being bedload-sized material (>0.25 mm, or about 0.01 inches in diameter). Some gravels and cobbles do occur within the beds of the stream and in their alluvium. Nonetheless, both the bed and the sediment transported by the river tend to be finer than in most Southern California watersheds.

Flows

As in most southern California rivers, flows in the Santa Clara River are highly episodic. For the gaged period between 1952 and 2005, annual mean flow at the Lang gage ranged between 0.04 and 52.3 cubic feet per second. These large episodic events have a significant impact on the geomorphic characteristics of the Santa Clara River mainstem. The annual mean runoff for this period is 5.68 cubic feet per second or 4,120 acre feet per year.

After studying the response of the river to several different anthropogenic and natural disturbances, Balance Hydrologics (2005) concluded that the Santa Clara River, as with many streams in semi-arid southern California, is highly episodic. Concepts of “normal” or “average” sediment-supply and flow conditions have limited value in this “flashy” environment, where episodic storm and wildfire events have enormous influence on sediment and storm flow conditions. In these streams, a large portion of the sediment movement events can occur in a matter of hours or days. Other perturbations, which can potentially affect channel geometry, appear to have transitory or minor manifestations. As a result, channel morphology, stability, and character of the Santa Clara River is almost entirely determined by the “reset” events that occur within the watershed.

Vegetation and Habitat Types

The portion of the Santa Clara River within the Project area exhibits an intermittent surface water hydrologic regime (Dudek, 2009). The River conveys runoff from precipitation in the upper watershed as well as urban runoff during storms from the developed portion of the watershed. The active channel of the River ranges in width on-site from approximately 28 to 64 feet. A majority of the River within the Project area is characterized by earthen banks that have been realigned over time due to storms, and a streambed that displays evidence of some aggradation and degradation.

The stretch of Santa Clara River within the Project area is characterized by a wide, meandering channel that supports vegetated and unvegetated islands of varying size, composition, and age that have developed both within and outside the bankfull channel (Dudek, 2009). The sparse, poorly-developed riparian scrub community is characterized by a limited assemblage of native and non-native species including willows and mulefat with an understory of annual bur-sage, California buckwheat, black mustard, rubber rabbitbrush, and Mediterranean grass. Stands of giant cane also occur, but comprise less than 15 percent species cover overall. The adjacent uplands support sparsely vegetated disturbed habitat and developed land.

2.3.2 Santa Clara River Beneficial Uses

The Water Quality Control Plan for the Los Angeles Region (Basin Plan) (LARWQCB, 1994, as amended) lists beneficial uses of major water bodies within this region (Table 2-3). Santa Clara River Reach 7 is listed and has specific beneficial uses assigned to it. As identified in Table 2-4, the existing beneficial uses of Santa Clara River Reach 7 include the following:

- MUN*: Conditional potential municipal and domestic water supply
- IND: Industrial activities that do not depend primarily on water quality
- PROC: Industrial activities that depend primarily on water quality
- AGR: Agricultural supply waters used for farming, horticulture, or ranching
- GWR: Groundwater recharge for natural or artificial recharge of groundwater
- FRSH: Natural or artificial maintenance of surface water quantity or quality
- REC1: Water contact recreation involving body contact with water and ingestion is reasonably possible
- REC2: Non-contact water recreation for activities in proximity to water, but not involving body contact
- WARM: Warm freshwater habitat to support warm water ecosystems
- WILD: Wildlife habitat waters that support wildlife habitats
- RARE: Waters that support rare, threatened, or endangered species and associated habitats
- WET: Wetland ecosystems

Table 2-3: Beneficial Uses of Surface Receiving Waters

Water Body	MUN	IND	PROC	AGR	GWR	FRSH	REC1	REC2	WARM	WILD	RARE	WET[1]
Santa Clara River (Hydrologic Unit 403.51)	P*	E	E	E	E	E	E	E	E	E	E	E

[1]Waterbodies designated as WET may have wetlands habitat associated with only a portion of the water body. Any regulatory action would require a detailed analysis of the area.
E – Existing beneficial use; P * – Asterixed MUN designations are conditional potential MUN designations[3].
Source: Water Quality Control Plan for the Los Angeles Region (Basin Plan) (LARWQCB, 1994, as amended)

2.3.3 Existing Receiving Water Quality

USGS Water Quality Monitoring Data

The U.S. Geological Survey (USGS) has collected stream flow and water quality data at a number of locations in the Santa Clara River watershed (http://waterdata.usgs.gov/nwis). USGS gaging stations have intermittently functioned at Lang (USGS 11107745) and Ravenna (USGS 342613118131601), approximately five miles and 13 miles upstream of the project site, respectively, and Bouquet Canyon (USGS 342526118322101) at the junction of the Santa Clara River and Bouquet Canyon Creek (Bouquet Junction), approximately six miles downstream of the project site (Figure 2-1). The USGS collected water quality data between August 1974 and March 1976 at Lang and Ravenna, and between August 1974 and June 1976 at Bouquet Junction. There are no current water quality data available at the Project location.

As discussed above, flows in the Santa Clara River are highly episodic in nature and this characteristic affects surface water quality considerably. Data collected by the USGS at the Santa Clara River Lang, Ravenna, and Bouquet Junction water quality monitoring sites summarized below provide historical perspective of water quality within the Santa Clara River upstream (Lang, Ravenna) and downstream (Bouquet Junction) of the Project boundary.

Data presentation

To facilitate interpretation, the wet weather water quality data were grouped into two categories depending on the depth of 2-day antecedent rainfall measured at the Newhall rain gauge:

---

[3] On December 5, 2001, the U.S. Federal District Court issued an order that effectively invalidated EPA's requirement that the asterisked MUN designated uses (MUN* uses) in the Los Angeles Basin Plan be immediately enforced. See Order granting plaintiffs' motion for summary judgment and remanding action to EPA, No. CV 00-08919 R(RZx), City of Los Angeles *et al.*. v. United States Environmental Protection Agency…, dated December 18, 2001. See also letter dated February 15, 2002, from Alexis Strauss, USEPA Region IX, to Celeste Cantu, Executive Director, California SWRCB: "…waters identified with an ("*") in Table 2-1 do not have an MUN as a designated use until such time as the State undertakes additional study and modifies its Basin Plan." EPA also stated that this conditional use designation has no legal effect.

1. *0 - 0.1 inches*;
2. *> 0.1 inch*.

Selected General Constituents

The selected general constituents examined were specific conductance as a surrogate for total dissolved solids (TDS), hardness, and chloride (see Section 4 for a discussion of pollutant selection). Specific Conductance (TDS) is a measure of the dissolved cations and anions, primarily inorganic salts (calcium, magnesium, potassium, sodium, chlorides and sulfates). TDS is an impairing pollutant in Reach 3 of the Santa Clara River as listed in the State's 2006 303(d) list of impaired water bodies. High TDS levels can impair agricultural, municipal supply, and groundwater recharge beneficial uses.

Hardness and chloride are important components of TDS. Hardness is a measure of the polyvalent cations, primarily calcium and magnesium. It is expressed as an equivalent concentration of calcium carbonate ($CaCO_3$). Hardness measurements are important because the toxicity of metals (and the associated water quality objectives) decreases as hardness increases. Chloride comprises a large proportion of the TDS. According to the RWQCB, high levels of chloride in Santa Clara River Reaches 3, 5, 6 and 7 are causing impairment of listed beneficial uses for agricultural irrigation. Irrigation of salt sensitive crops, such as avocados and strawberries, with water containing elevated levels of chloride could result in reduced crop yields.

Results for concentrations of specific conductance, chloride, and hardness for the three datasets are listed in Table 2-4. Rather than measuring TDS, the USGS station has recorded specific conductance (that is, the extent to which the sample conducts an electric current), which is related to TDS concentration. TDS concentration can be estimated as 0.55 to 0.9 times the specific conductance (Sawyer *et al.*, 1994).

Table 2-4: USGS Water Quality Data for Selected General Constituents in the Santa Clara River at the Lang, Ravenna, and Bouquet Junction Gages, 1974 – 1976

Constituent	Gage	2-day Antecedent Rainfall (inches)	No. of Samples	No. of Detects	Minimum	Maximum	Average
Specific Conductance (µS/cm)	Lang	< 0.1	12	12	720	820	765
		≥ 0.1	3	3	680	690	685
	Ravenna	< 0.1	7	7	578	650	609
		≥ 0.1	2	2	620	651	635.5
	Bouquet Junction	< 0.1	18	18	1110	1500	1338
		≥ 0.1	3	3	1290	1400	1333

Constituent	Gage	2-day Antecedent Rainfall (inches)	No. of Samples	No. of Detects	Minimum	Maximum	Average
Hardness (mg/L)	Lang	< 0.1	6	6	280	300	290
		≥ 0.1	3	3	270	300	273
	Bouquet Junction	< 0.1	14	14	280	360	320
		≥ 0.1	3	3	280	340	310
Chloride (mg/L)	Lang	< 0.1	5	5	36	45	42
		≥ 0.1	3	3	33	39	35
	Bouquet Junction	< 0.1	13	13	92	140	117
		≥ 0.1	3	3	100	120	110

Specific Conductance (TDS). The Basin Plan objective for TDS in Santa Clara River Reach 7 is 800 mg/L. Using an estimate of 0.64 times the specific conductance for the USGS data, the TDS concentrations at Lang station averaged 440 mg/L for storm flows. At Ravenna station, TDS concentrations averaged 400 mg/L and at Bouquet Junction, TDS concentrations averaged 850 mg/L.

Hardness. Hardness is a measure of the multivalent metallic cations in water, principally calcium, magnesium, strontium, iron, and manganese (Sawyer *et al.*, 1994). These cations are capable of reacting with soap to form precipitates and with certain anions to form scale. The hardness in water is derived largely from contact with soil and rock formations, and affects the CTR values for certain metals as discussed above. Waters with a hardness concentration from 150 mg/L to 300 mg/L as CaCO3 are considered hard; waters with a hardness concentration above 300 mg/L as CaCO3 are considered very hard. In the Santa Clara River, average hardness values were greater than 150, classifying as 'hard' at the Lang Gage and 'very hard' at Bouquet Junction for storm flows.

Chloride. Similar to TDS and hardness, chloride affects ion concentrations and contributes to TDS. Chloride in the Santa Clara River has a Basin Plan Water Quality Objective (WQO) of 100 mg/L. A recently completed Total Maximum Daily Load (TMDL) study by the Los Angeles RWQCB has presented a water resource plan that would allow higher chloride concentrations in Santa Clara River Reaches 4, 5, and 6. Reach 7 is still subject to the 100 mg/L limit for chloride. The historic data shows that chloride levels upstream of the site (Lang gage) are well below this WQO, while chloride levels at the Bouquet Junction station downstream of the site generally exceed this level.

Nutrients

Nutrient water quality data collected at the three USGS stations are summarized in Table 2-5 below. Phosphorus was measured as total phosphorus (TP). Dissolved phosphorus is the more bioavailable form of phosphorus compared to TP, which is often made up of a high proportion of particulate phosphorus. Nitrogen is measured variously as nitrate, nitrite, ammonia, and total Kjeldahl nitrogen (TKN). TKN is the measure of ammonia plus the organic forms of nitrogen. Nitrate, nitrite, and ammonia are the more bioavailable forms of nitrogen, and of these, nitrate (or nitrate + nitrite) has the higher concentration in natural waters and is more important than ammonia as a nutrient.

Table 2-5: USGS Water Quality Data for Selected Nutrients in the Santa Clara River at the Lang, Ravenna, and Bouquet Junction Gage, 1974 - 1976

Constituent	Gage	2-day Antecedent Rainfall (inches)	No. of Samples	No. of Detects	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)
Total Phosphorus	Lang	< 0.1	10	10	0.01	9.30	1.01
		≥ 0.1	3	3	0.07	0.12	0.09
	Ravenna	< 0.1	7	7	0.04	0.09	0.06
		≥ 0.1	2	2	0.06	0.08	0.07
	Bouquet Junction	< 0.1	18	18	0.31	17	8.68
		≥ 0.1	3	3	9.9	12	11.30
Ammonia as N	Lang	< 0.1	10	8	0.03	5.60	0.76
		≥ 0.1	3	2	0.05	0.06	0.06
	Ravenna	< 0.1	7	6	0.02	0.05	0.04
		≥ 0.1	2	2	0.03	0.09	0.06
	Bouquet Junction	< 0.1	18	18	0.08	29	8.01
		≥ 0.1	3	3	0.43	6.4	4.28
Nitrate + Nitrite as N	Lang	< 0.1	10	7	0.03	0.61	0.22
		≥ 0.1	3	1	0.09	0.09	0.09
	Ravenna	< 0.1	7	6	0.05	2.6	1.94
		≥ 0.1	2	1	2.4	2.4	2.4
	Bouquet Junction	< 0.1	18	15	0.02	10	3.49
		≥ 0.1	3	1	5.8	5.8	5.8
TKN as N	Lang	< 0.1	10	10	0.09	7.50	1.00
		≥ 0.1	3	3	0.09	0.26	0.17
	Ravenna	< 0.1	7	7	0.13	0.47	0.32
		≥ 0.1	2	2	0.16	0.35	0.26
	Bouquet Junction	< 0.1	18	18	0.37	26	9.73
		≥ 0.1	3	3	1.8	6.7	4.93

Constituent	Gage	2-day Antecedent Rainfall (inches)	No. of Samples	No. of Detects	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)
Total Nitrogen	Lang	< 0.1	10	10	0.14	7.50	1.15
		≥ 0.1	3	3	0.09	0.35	0.20
	Ravenna	< 0.1	7	6	0.16	3.1	2.32
		≥ 0.1	2	2	0.18	0.34	0.26
	Bouquet Junction	< 0.1	20	20	0.65	29	12.47
		≥ 0.1	3	3	1.8	12	6.7

Phosphorus. Historical average total phosphorus concentrations at the USGS stations upstream of the Project ranges from 0.06 mg/L to 1.01 mg/L and were independent of storm size. Total phosphorous measured downstream at the Bouquet Junction station averaged 8.7 mg/L for small storms (<0.1") and 11.3 mg/L for larger storms (≥0.1"). There are no numeric objectives for total phosphorus in the Basin Plan.

Nitrogen. The numeric target for nitrate plus nitrite-nitrogen in the Santa Clara River Nitrogen Compounds TMDL is 4.5 mg/L (30-day average) based on achieving the Basin Plan water quality objective of 5 mg/L. The average historical nitrate-N + nitrite-N concentrations at the USGS station were roughly similar, varying from 0.09 to 2.4 mg/L for storm flows upstream of the Project, and varying from 0.02 to 10 mg/L for all flows at Bouquet Junction, downstream of the Project. The higher concentrations for ammonia and nitrate in the historical data at the downstream USGS station Bouquet Junction may be attributed to farming and single family residential units that historically used onsite sewage treatment systems in Bouquet Canyon.

Selected Metals, Pesticides, and Cyanide

Metal and pesticide water quality data collected by the USGS at the three stations are summarized in Table 2-6. The heavy metals cadmium (Cd), copper (Cu), lead (Pb), and zinc (Zn) can be toxic at high concentrations. Trace metals occur naturally in soils and sediments, and are present in urban runoff. The organophosphorous pesticides chlorpyrifos and diazinon are two pesticides of concern due to their potential toxicity in receiving waters and, in the past, have been frequently detected downstream from urban and agricultural land uses. These pesticides are currently banned for residential use. Cyanide is a highly toxic substance and has a number of man-made and natural sources. The only data available from the USGS stations immediately upstream or downstream of the project site were for lead and diazinon.

Table 2-6: USGS Water Quality Data for Selected Metals and Pesticides in the Santa Clara River at the Lang Gage, 1974 to 1976

Constituent	Gage	2-day Antecedent Rainfall (inches)	No. of Samples	No. of Detects	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)
Total Lead	Lang	< 0.1	10	0	N/A	N/A	N/A
		≥ 0.1	3	0	N/A	N/A	N/A
	Ravenna	< 0.1	7	0	N/A	N/A	N/A
		≥ 0.1	2	0	N/A	N/A	N/A
	Bouquet Junction	< 0.1	18	0	N/A	N/A	N/A
		≥ 0.1	3	0	N/A	N/A	N/A
Diazinon	Lang	< 0.1	3	0	N/A	N/A	N/A
		≥ 0.1	2	0	N/A	N/A	N/A
	Bouquet Junction	< 0.1	5	5	0.01	0.13	0.05
		≥ 0.1	2	0	N/A	N/A	N/A

N/A – not applicable.

Metals. Metals data is only available for lead from the USGS site, and for a total of 43 samples there were no detects. The detection limit at the time of the monitoring was 200 μg/L.

Pesticides. Diazinon was detected in five dry weather samples at Bouquet Junction station. The CTR acute criterion for diazinon is 0.17 μg/L. The diazinon criterion derived by the California Department of Fish and Game is 0.08 μg/L (Marshack, 2003). The limited data available shows that the downstream station at Bouquet Junction ranged from 0.01 to 0.13 μg/L, with the higher end of the range exceeding the Fish and Game criterion.

2.4 Groundwater

2.4.1 Groundwater Basin

The Project site is located at the eastern end of the upper Santa Clara River hydrologic area, as defined by the California Department of Water Resources (DWR). The Santa Clara River Valley East Groundwater Subbasin lies within this hydrologic area and is the source of the local groundwater used for water supply in the Santa Clarita Valley. The local groundwater supplies are obtained from surficial alluvial deposits. The alluvium is underlain by bedrock units consisting of the Mint Canyon Formation in the Project area and other geologic units in the eastern and northern portions of the Santa Clarita Valley.

The alluvial sediments lie within the portion of the Valley occupied by the Santa Clara River and also are present in side canyons that contain tributaries to the River. The alluvium consists of extensively interlayered and interfingered mixtures of gravel and sand, with variable amounts of cobbles and boulders and minor amounts of silt and clay. Due to the unconsolidated to poorly consolidated condition of the alluvium, and its lack of cementation, the alluvium has relatively high permeability and porosity. The groundwater flow direction in the Alluvial aquifer follows the topography of the Valley and its tributaries. Groundwater recharge occurs in the eastern, northern, and southern portions of the Valley. Natural mechanisms for groundwater discharge occur at the west end of the Valley and consist of discharge to the Santa Clara River, subsurface outflow beneath the River, and evapotranspiration by deep-rooted vegetation.

The portion of the Project site where the WRP and percolation pond would be located is underlain by up to seven feet of fill, below which is a silt-sand-gravel alluvium that extends to at least 35 feet below ground surface, and locally greater than 50 feet below ground surface. At the time of investigation, groundwater levels were measured at approximately 40 feet below ground surface, but have been recorded in nearby production wells (which are located much closer to the active channel of the River) as shallow as 5 feet and as deep as 100 feet (RTFA, 2007a, 2007b).

2.4.2 Groundwater Beneficial Uses

The Project area is within the Basin Plan's Santa Clara – Mint Canyon subbasin of the Santa Clarita Valley Groundwater Basin, East Subbasin. Beneficial uses for groundwater for this subbasin are shown in Table 2-7.

Table 2-7: Beneficial Uses of Groundwaters

Groundwater Basin	MUN	IND	PROC	AGR
DWR 4-4.07 – Santa Clara – Mint Canyon	E	E	E	E

E-Existing Beneficial Use
MUN: Community, military, or individual water supply systems including, but not limited to, drinking water supply
Source: Water Quality Control Plan for the Los Angeles Region (Basin Plan) (LARWQCB, 1994 as amended)
IND: Industrial activities that do not depend primarily on water quality; PROC: Industrial activities that depend primarily on water quality; AGR: Agricultural supply waters used for farming, horticulture, or ranching

2.4.3 Existing Groundwater Quality

Groundwater in the alluvial aquifer beneath and adjacent to the Santa Clara River reflects direct interactions with Santa Clara River flows. This interaction is evidenced by declining groundwater levels over a period of several sequential dry precipitation years, followed by immediate and complete rebound of groundwater levels during a single wet year. This groundwater-surface water interaction can be viewed to a lesser extent in groundwater chloride values, which increase during dry precipitation cycles and then quickly decline during a wet year (CH2MHill/HGL, 2008). Few other water quality parameters are likely to mimic this increase and decrease caused by dry and wet precipitation cycles.

Data for water supply wells in the vicinity of the project site (Mitchell 5A, Mitchell 5B, Sand Canyon, and Lost Canyon 2, and Lost Canyon 2A) indicate that alluvial aquifer water quality is reasonably good, but has elevated boron and moderate sulfate and total dissolved solids (TDS) levels.

Table 2-8 summarizes average metals, general chemistry, and organic compounds data for five alluvial aquifer wells located in and near the Project area (Figure 2-3).

Table 2-8: Groundwater Monitoring Data from SCWD of CLWA

Parameter	Units	Basin Plan Objective / Maximum Contaminant Level	Average Concentration
Aluminum	µg/L	1,000[(2)]	<DLR
Arsenic	µg/L	50[(2)]	<DLR
Barium	mg/L	1[(2)]	0.103
Beryllium	µg/L	4[(2)]	<DLR
Cadmium	µg/L	5[(2)]	<DLR
Chromium	µg/L	50[(2)]	<DLR
Copper	µg/L	1,000[(3)]	<DLR
Iron	mg/L	0.3[(3)]	<DLR
Manganese	µg/L	50[(3)]	<DLR
Mercury, Total	µg/L	2[(2)]	<DLR
Nickel	µg/L	100[(2)]	<DLR
Selenium	µg/L	50[(2)]	<DLR
Silver	µg/L	100[(3)]	<DLR
Thallium	µg/L	2[(2)]	<DLR
Zinc	µg/L	5,000[(3)]	<DLR
Alkalinity as CaCO3	mg/L	--	289
Boron	mg/L	1.0[(1)]	**1.4**
Chloride	mg/L	150[(1)]	79
Color	Color unit	15[(3)]	<5
Cyanide, total	mg/L	0.15[(2)]	<DLR
Fluoride	mg/L	2.0[(2)]	0.3
Hardness as CaCO3	mg/L	--	391
MBAS	mg/L	0.5[(3)]	<0.050
Nitrate as NO3	mg/L	45[(1)]	17
Nitrite as N	mg/L	1[(1)]	<DLR
Nitrate+Nitrite as N	mg/L	10[(1)]	3.816
Odor	TON	3[(3)]	1
Specific Conductance	umhos/cm	900-1600[(3)]	1.059
Sulfate	mg/L	350[(1)]	123
TDS	mg/L	1,000[(1)]	670
Turbidity	NTU	5[(3)]	0.07

Parameter	Units	Basin Plan Objective / Maximum Contaminant Level	Average Concentration
Volatile Organic Chemicals (VOCs)	µg/L	variable	ND
Synthetic Organic Chemicals (SVOCs)	µg/L	variable	N/A
Key: **Bold Exceeds Standard**			

-- = no applicable Basin Plan objective or MCL
<DLR = Less than Detection Limit for Reporting Purposes
n/a = not analyzed
ND = not detected
[1]Los Angeles Basin Plan Regional Objectives for Groundwater (Table 3-10).
[2]California Department of Public Health Primary Drinking Water MCL (Title 22 CCR Table 64431-A and Table 64444-A).
[3]California Department of Public Health Secondary Drinking Water MCL (Title 22 CCR Table 64449-A and Table 64449-B).

3 REGULATORY SETTING

3.1 Clean Water Act

In 1972, the Federal Water Pollution Control Act [later referred to as the Clean Water Act (CWA)] was amended to require National Pollutant Discharge Elimination System (NPDES) permits for the discharge of pollutants to waters of the United States from any point source. In 1987, the CWA was amended to require that the United States Environmental Protection Agency (USEPA) establish regulations for permitting of municipal and industrial stormwater discharges under the NPDES permit program. The USEPA published final regulations regarding stormwater discharges on November 16, 1990. The regulations require that municipal separate storm sewer system (MS4) discharges to surface waters be regulated by a NPDES permit.

In addition, the CWA requires the States to adopt water quality standards for receiving water bodies and to have those standards approved by the USEPA. Water quality standards consist of designated beneficial uses for a particular receiving water body (e.g. wildlife habitat, agricultural supply, fishing etc.), along with water quality criteria necessary to support those uses. Water quality criteria are prescribed concentrations or levels of constituents – such as lead, suspended sediment, and fecal coliform bacteria – or narrative statements which represent the quality of water that support a particular use. Because California had not established a complete list of acceptable water quality criteria, USEPA established numeric water quality criteria for certain toxic constituents in receiving waters with human health or aquatic life designated uses in the form of the California Toxics Rule ("CTR") (40 CFR 131.38).

3.2 CWA Section 303(d) - TMDLs

When designated beneficial uses of a particular receiving water body are being compromised by water quality, 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 the impairing pollutant(s). 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 (with a "factor of safety" included). Once established, the TMDL allocates the loads among current and future pollutant sources to the water body.

The Project will discharge runoff to Santa Clara River Reach 7. Table 3-1 lists the water quality impairments for the Santa Clara River, at and downstream of the Project location, as reported in the 2006 CWA Section 303(d) List of Water Quality Limited Segments. States are required to submit the Section 303(d) list and TMDL priorities to the USEPA for approval. The 2006 Section 303(d) list was approved by USEPA on June 28, 2007. Reach 7 of the Santa Clara River is listed for coliform bacteria. Reach 6 (downstream of Bouquet Canyon Road) is listed for coliform bacteria, chlorpyrifos, diazinon, and toxicity. Reach 5 is listed for coliform bacteria and chloride. Downstream segments of the River, below the "Dry Gap" in Reach 4, are listed for total dissolved solids (TDS), toxicity, coliform bacteria, chlorinated legacy pesticides, and Toxaphene. Reach 3 is also listed for ammonia and chloride as "being addressed."

The RWQCB has adopted TMDLs for nitrogen compounds (nitrate plus nitrite-nitrogen and ammonia) and chloride into the Water Quality Control Plan for Los Angeles Region (Basin Plan). The waste load allocations for stormwater discharges into the Santa Clara River in the reaches downstream of the Project reach (Reaches 3, 5, and 6) are summarized in Table 3-2 The RWQCB has not yet adopted a TMDL for coliform in the Santa Clara River.

The Los Angeles Region 2008 Integrated Report and updated 303(d) list was approved by the Los Angeles RWQCB in July 2009. The Integrated Report, including the updated 303(d) list, was submitted to the State Water Resources Control Board (SWRCB) for approval along with the other Region's reports. The full State Integrated Report will then be submitted to the USEPA for approval and will then be final. The Santa Clara River impairments in the draft 2008 303(d) list are summarized in Table 3-3 below. There are no changes in the listed impairments for Reach 1 and Reach 7. New impairments are listed for nitrate in the estuary, toxicity in the estuary and Reach 3, iron in Reach 5 and Reach 6, benthic-macroinvertebrate bioassessment in Reach 6, and copper in Reach 6. Ammonia, nitrate and nitrite are proposed for delisting in Reach 5 and ammonia is proposed for delisting in Reach 6.

Table 3-1: 2006 CWA Section 303(d) List of Water Quality Limited Segments – Santa Clara River

SCR Reach[1]	Geographic Description & Distance from Project to Upstream End of Reach	Pollutants	TMDL Status/Proposed or USEPA Approved TMDL Completion Date	Potential Sources
7	Bouquet Canyon Rd to above Lang Gaging Station (Project is in Reach 7, located 4 miles downstream of upstream end)	1) Coliform Bacteria	1) Requires TMDL/2019	1) Nonpoint and Point Sources
6	West Pier Hwy 99 to Bouquet Cyn Rd (6.5 miles)	1) Coliform Bacteria 2) Chlorpyrifos 3) Diazinon 4) Toxicity 5) Ammonia 6) Chloride	1) Requires TMDL/2019 2) Requires TMDL/2019 3) Requires TMDL/2019 4) Requires TMDL/2019 5) Approved TMDL/2004 6) Approved TMDL/2005	1) Source Unknown 2) Nonpoint and Point Sources 3) Source Unknown 4) Source Unknown 5) Source Unknown 6) Nonpoint and Point Sources

SCR Reach[1]	Geographic Description & Distance from Project to Upstream End of Reach	Pollutants	TMDL Status/Proposed or USEPA Approved TMDL Completion Date	Potential Sources
5	Blue Cut Gaging Station to West Pier Hwy 99 (10 miles)	1) Coliform Bacteria 2) Ammonia 3) Chloride 4) Nitrate and Nitrite	1) Requires TMDL/2019 2) Approved TMDL/2004 3) Approved TMDL/2005 4) Approved TMDL/2004	1) Nonpoint and Point Sources 2) Source Unknown 3) Nonpoint and Point Sources 4) Source Unknown
3	Freeman diversion dam to "A" street [2] (30 miles)	1) Total Dissolved Solids 2) Ammonia 3) Chloride	1) Requires TMDL/2019 2) Approved TMDL/2004 3) Approved TMDL/2005	1) Nonpoint and Point Sources 2) Source Unknown 3) Nonpoint and Point Sources
1	Estuary to Highway 101 Bridge (50 miles)	1) Toxicity	1) Requires TMDL/2019	1) Source Unknown
--	Estuary (54 miles)	1) ChemA[3] 2) Coliform Bacteria 3) Toxaphene	1) Requires TMDL/2019 2) Requires TMDL/2019 3) Requires TMDL/2019	1) Source Unknown 2) Nonpoint Source 3) Nonpoint Source

[1]SCR reaches upstream of the Project area have not been included.
[2]Reach 3 is downstream of the Dry Gap in Reach 4.
[3]ChemA suite of chlorinated legacy pesticides include: Aldrin, chlordane, Dieldrin, Endosulfan I/II, Endrin, gamma-BHC, heptachlor, heptachlor epoxide, and Toxaphene.

Table 3-2: TMDL Waste Load Allocations for MS4 and Stormwater Sources to Santa Clara River Reaches 3, 5, and 6

Impairing Pollutant	Numeric Water Quality Objective	Waste Load Allocation
Chloride (Resolution No. 04-004)	100 mg/L.	Waste load allocations for point sources is **100 mg/L**. The load allocations for nonpoint sources is **100 mg/L**.
Nitrogen Compounds (Resolution No. 03-011)	The numeric target for NO_3-N + NO_2-N in the Nitrogen Compounds TMDL was based on achieving the existing water quality objective of 5 mg/L NO_3-N + NO_2-N. The numeric target that was used to calculate the waste load allocations included a 10% margin of safety; thus the numeric target is 4.5 mg/L NO_3-N + NO_2-N (30-day average).	Concentration-based waste loads are allocated to municipal, industrial, and construction stormwater sources regulated under NPDES permits. For stormwater Permittees discharging into Reach 7, the following waste load allocations apply: **30-day average nitrate plus nitrite = 6.8 mg/L (NO_3-N + NO_2-N)**

Table 3-3: Proposed 2008 CWA Section 303(d) List of Water Quality Limited Segments – Santa Clara River

SCR Reach[1]	Geographic Description	Pollutants	TMDL Status/Proposed or USEPA Approved TMDL Completion Date	Potential Sources
7	Bouquet Canyon Rd to above Lang Gaging Station	1) Coliform Bacteria	1) Requires TMDL/2019	1) Nonpoint and Point Sources
6	West Pier Hwy 99 to Bouquet Cyn Rd	1) Benthic-Macroinvertebrate Bioassessments 2) Chloride 3) Chlorpyrifos 4) Coliform Bacteria 5) Copper 6) Diazinon 7) Iron 8) Toxicity	1) Requires TMDL/2021 2) Approved TMDL/2005 3) Requires TMDL/2019 4) Requires TMDL/2019 5) Requires TMDL/2021 6) Requires TMDL/2019 7) Requires TMDL/2021 8) Requires TMDL/2021	1) Nonpoint and Point Sources 2) Nonpoint and Point Sources 3) Nonpoint and Point Sources 4) Source Unknown 5) Source Unknown 6) Source Unknown 7) Source Unknown 8) Source Unknown
5	Blue Cut Gaging Station to West Pier Hwy 99	1) Coliform Bacteria 2) Chloride 3) Iron	1) Requires TMDL/2019 2) Approved TMDL/2005 3) Requires TMDL/2021	1) Nonpoint and Point Sources 2) Nonpoint and Point Sources 3) Source Unknown
3	Freeman diversion dam to "A" street [2]	1) Total Dissolved Solids 2) Ammonia 3) Chloride 4) Toxicity	1) Requires TMDL/2023 2) Approved TMDL/2004 3) Approved TMDL/2005 4) Requires TMDL/2021	1) Nonpoint and Point Sources 2) Source Unknown 3) Nonpoint and Point Sources 4) Source Unknown
1	Estuary to Highway 101 Bridge	1) Toxicity	1) Requires TMDL/2019	1) Source Unknown
--	Estuary	1) ChemA[3] 2) Coliform Bacteria 3) Toxaphene 4) Nitrate 5) Toxicity	1) Requires TMDL/2019 2) Requires TMDL/2019 3) Requires TMDL/2019 4) Requires TMDL/2021 5) Requires TMDL/2021	1) Source Unknown 2) Nonpoint Source 3) Nonpoint Source 4) Source Unknown 5) Source Unknown

[1]SCR reaches upstream of the Project area have not been included.
[2]Reach 3 is downstream of the Dry Gap in Reach 4.
[3]ChemA suite of chlorinated legacy pesticides include: Aldrin, chlordane, Dieldrin, Endosulfan I/II, Endrin, gamma-BHC, heptachlor, heptachlor epoxide, and Toxaphene.

3.3 <u>California Toxics Rule</u>

The California Toxics Rule (40 C.F.R. §131.38) is a federal regulation issued by the USEPA that provides water quality criteria for toxic pollutants in waters with human health or aquatic life designated uses in California. Although CTR criteria do not apply directly to discharges of stormwater runoff, they can provide a useful benchmark to assess the potential impacts to the water quality of receiving waters from Project stormwater runoff discharges. Here, the freshwater aquatic life criteria are used as benchmarks to evaluate the potential impacts of stormwater runoff to the project's receiving waters. The CTR also contains human health criteria which are developed for drinking water sources and for fish consumption only. Since the human health criteria are less stringent than the aquatic life criteria for the pollutants of concern for the Project, the aquatic life criteria are used.

The CTR also establishes two types of aquatic life criteria: acute and chronic. Acute criteria represent the highest concentration of a pollutant to which aquatic life can be exposed for a short period of time without deleterious effects; chronic criteria equal the highest concentration to which aquatic life can be exposed for an extended period of time (four days) without deleterious effects. Due to the intermittent nature of stormwater runoff (especially in southern California), the acute criteria are considered to be more applicable to stormwater conditions than chronic criteria. For example, the average storm duration in the 40-year Newhall gage rainfall record is 7.6 hours. In this document, the acute CTR criteria are used as one type of benchmark to evaluate the potential ecological impacts of Project runoff on the receiving waters.

Freshwater aquatic life criteria for certain metals in the CTR are expressed as a function of hardness because hardness, and/or water quality characteristics that are usually correlated with hardness, can reduce the toxicities of some metals[4]. The minimum wet weather hardness value of 270 mg/L as $CaCO_3$ from USGS station at Lang (11107745) was used to approximate CTR criteria for metals. The hardness value of 270 mg/L is a conservative estimate of wet weather hardness values that should occur in the Project area; higher values are likely to occur.

3.4 California Porter-Cologne Act

The federal CWA places the primary responsibility for the control of surface water pollution and for planning the development and use of water resources with the states, although it does establish certain guidelines for the states to follow in developing their programs and allows USEPA to withdraw control from states with inadequate implementation mechanisms.

California‘s primary statute governing water quality and water pollution issues with respect to both surface waters and groundwater is the Porter-Cologne Water Quality Control Act of 1970 (Porter-Cologne Act). The Porter-Cologne Act grants the State Water Resource Control Board (SWRCB) and the Regional Water Quality Control Boards (RWQCBs) power to protect water quality and is the primary vehicle for implementation of California’s responsibilities under the federal Clean Water Act. The Porter-Cologne Act grants the SWRCB and the RWQCBs authority and responsibility to adopt plans and policies, to regulate discharges of waste to surface and groundwater, to regulate waste disposal sites and to require cleanup of discharges of

[4] The toxicity of a chemical to an aquatic organism may vary according to attributes of the organism, chemical composition, and exposure environment, so that the chemical is more or less "bioavailable." Many chemicals exist in a variety of forms (chemical species), and such chemical speciation affects bioavailability because relative uptake rates can differ among chemical species and the relative concentrations of chemical species can differ among exposure conditions. Usually, metal toxicity is reduced by increased water hardness, which is composed of cations (primarily calcium and magnesium). In some cases, the apparent effect of hardness on toxicity might be partly due to complexation of the metal by higher concentrations of hydroxide and/or carbonate (increased pH and alkalinity) commonly associated with higher hardness. (USEPA, 2007a)

hazardous materials and other pollutants. The Porter-Cologne Act also establishes reporting requirements for unintended discharges of any hazardous substance, sewage, or oil or petroleum product.

Each RWQCB must formulate and adopt a water quality control plan (Basin Plan) for its region. The Basin Plan must conform to the policies set forth in the Porter-Cologne Act and established by the SWRCB in its state water policy. To implement State and Federal law, the Basin Plan establishes beneficial uses for surface and groundwater in the region, and sets forth narrative and numeric water quality standards to protect those beneficial uses. The Porter-Cologne Act also provides that a RWQCB may include within its regional plan water discharge prohibitions applicable to particular conditions, areas, or types of waste.

3.5 Basin Plan

The applicable Basin Plan (LARWQCB, 1994, as amended) provides quantitative and narrative criteria for a range of water quality constituents applicable to certain receiving water bodies and groundwater basins within the Los Angeles Region. Specific criteria are provided for the larger designated water bodies within the region, as well as general criteria or guidelines for ocean waters, bays and estuaries, inland surface waters, and groundwater. In general, the narrative criteria require that degradation of water quality does not occur due to increases in pollutant loads that will adversely impact the designated beneficial uses of a water body. For example, the Los Angeles 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.” Water quality criteria apply within receiving waters as opposed to applying directly to runoff; therefore, water quality criteria from the Basin Plan are utilized as benchmarks as one method to evaluate the potential ecological impacts of Project runoff on the receiving waters of the proposed Project. Table 2-3 above lists the beneficial uses of applicable receiving surface waters.

The Basin Plan also contains water quality criteria for groundwater basins. For example, the Basin Plan requires that “Groundwaters shall not contain taste or odor producing substances in concentrations that cause nuisance or adversely affect beneficial uses.” Table 2-7 above lists the beneficial uses of the applicable groundwater basin.

3.6 MS4 Permit

In 2001, the Los Angeles Regional Water Quality Control Board (LARWQCB, 2001) issued an NPDES Permit and Waste Discharge Requirements (Order No. 01-182) under the CWA and the Porter-Cologne Act for discharges of urban runoff in public storm drains in Los Angeles County. The Permittees are the Los Angeles County cities and the County (collectively “the Co-Permittees”). This permit regulates stormwater discharges from MS4s in the Project area. The NPDES permit details requirements for new development and significant redevelopment, including specific sizing criteria for treatment BMPs and flow control requirements.

To implement the requirements of the NPDES permit, the Co-permittees have established development planning guidance and control measures that control and mitigate stormwater quality and quantity impacts to receiving waters as a result of new development and redevelopment. They are also required to implement other municipal source detection and elimination programs, as well as maintenance measures.

3.6.1 Stormwater Quality Management Program

The MS4 Permit contains the following provisions for implementation of the Stormwater Quality Management Program (SQMP) by the Co-permittees:

- General Requirement – Each Permittee is required to implement the SQMP to comply with applicable stormwater program requirements and implement additional controls where necessary to reduce the discharge of pollutants in stormwater to the "maximum extent practicable" (MEP).
- BMP Implementation – Permittees are required to implement the most effective combination of BMPs for stormwater/urban runoff pollution control.
- SQMP Revision – Permittees are required to revise the SQMP to comply with regional, watershed specific requirements, and/or waste load allocations for implementation of TMDLs for impaired waterbodies.
- Responsibilities of the Principal Permittee – The responsibilities of the Los Angeles County Department of Public Works (as the Principal Permittee) include, but are not limited to, coordinating activities necessary to comply with the NPDES permit, providing personnel and fiscal resources for SQMP updates and annual reports and summaries of reports required under the SQMP, and implementing and evaluating results of a County-wide Monitoring Program.
- Responsibilities of Permittees – Each Permittee is required to comply with the requirements of the SQMP applicable to the discharges within its boundaries.
- Watershed Management Committees (WMCs) – WMCs are comprised of a voting representative from each Permittee within the Watershed Management Areas (WMAs). WMCs are required to facilitate efforts and exchange of information between Permittees, establish additional goals for WMAs, prioritize pollution control efforts, monitor implementation of tasks designated for the WMA, and assess the effectiveness of and recommend revisions to the SQMP.
- Legal Authority – Permittees are granted the necessary legal authority to prohibit non-stormwater discharges to the storm drain system.

The objective of the SQMP is to reduce pollutants in urban stormwater discharges to the "maximum extent practicable" in order to attain water quality objectives and to protect the beneficial uses of receiving waters in Los Angeles County. Special provisions are provided in the MS4 permit to facilitate implementation of the SQMP. These provisions include:

- BMP substitution – Substitution of site-specific BMPs is allowed provided the alternative BMP will meet or exceed pollutant reduction of the original BMP, the fiscal burden of the original BMP is substantially greater than the proposed alternative, and the alternative BMP will be implemented within a similar time period.
- Public Information and Participation Program (PIPP) – This requires the Permittee to identify how public education needs were determined, who is responsible for developing and implementing the program, and the method used to determine its effectiveness.
- Industrial/Commercial Facilities Control Program – This requires the Permittee to develop a plan for managing stormwater runoff from industrial and commercial facilities. This program tracks, inspects, and ensures compliance at industrial and commercial facilities that are sources of pollutants in stormwater.
- Development Planning Program – This requires the Permittees to implement a development-planning program that requires new development and redevelopment projects to minimize impacts from stormwater and urban runoff.
- Development Construction Program – This requires the Permittee to implement a program to control runoff from construction activity to minimize erosion and transportation of sediment and prevent non-stormwater discharges from equipment and vehicle washing.
- Public Agency Activities Program – This requires municipalities to evaluate existing public agency activities that have an impact on stormwater quality (such as vehicle maintenance, landscape maintenance and weed control, and construction and maintenance of streets, roads, and flood control systems) and to develop a program to reduce stormwater impacts with a schedule for implementation.
- Illicit Connections and Illicit Discharges Elimination Program – This requires each Permittee to have a plan for finding and preventing illegal connections and discharges and a mechanism for enforcing against illegal connections and discharges.

3.6.2 Standard Urban Stormwater Mitigation Plan

On March 8, 2000, the development planning program requirements, including the Standard Urban Stormwater Mitigation Plan requirements (collectively, development planning program requirements, including Standard Urban Stormwater Mitigation Pan requirements, are referred to in this report as SUSMP requirements) were approved by the RWQCB as part of the MS4 program to address stormwater pollution from new construction and redevelopment. The SUSMP contains a list of minimum BMPs that must be employed to infiltrate or treat stormwater runoff, control peak flow discharge, and reduce the post-project discharge of pollutants from stormwater conveyance systems. The SUSMP defines, based upon land use type, the types of practices that must be included and issues that must be addressed as appropriate to the development type and size. Compliance with SUSMP requirements is used as one method to evaluate significance of project development impacts on surface water runoff.

Finalized in May 2000, the County of Los Angeles' "Manual for the Standard Urban Stormwater Mitigation Plan" details the requirements for new development and significant redevelopment BMPs (Los Angeles County, 2002) (the "SUSMP Manual"). The SUSMP Manual is a model guidance document for use by Permittees and individual project owners to select post-construction BMPs and otherwise comply with the SUSMP requirements. It addresses water quality and drainage issues by specifying design standards for structural or treatment control BMPs that infiltrate or treat stormwater runoff and control peak flow discharge. BMPs are defined in the SUSMP Manual and SUSMP requirements as any program, technology, process, sizing criteria, operational methods or measures, or engineered systems, which, when implemented, prevent, control, remove, or reduce pollution. Treatment BMP sizing criteria and design guidance are also contained in the MS4 Permit and in the SUSMP Manual.

One of the most important requirements within the SUSMP is the specific sizing criteria for stormwater treatment BMPs for new development and significant redevelopment projects. The SUSMP includes sizing criteria for both volume-based and flow-based BMPs. The sizing criteria options for volume-based BMPs are as follows:

1. The 85^{th} percentile 24-hour runoff event storm event determined as the maximized capture stormwater volume for the area, from the formula recommended in Urban Runoff Quality Management, Water Environment Federation (WEF) Manual of Practice No. 23/ASCE Manual of Practice No. 87 (WEF, 1998);

2. The volume of annual runoff based on unit basin storage volume, to achieve 80% or more volume treatment by the method recommended in California Stormwater Best Management Practices Handbook – Industrial/Commercial (SWQTF, 1993);

3. The volume of runoff produced from a 0.75 inch storm event, prior to its discharge to a stormwater 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 and flows as achieved by mitigation of the 85^{th} percentile, 24-hour runoff event.

Flow-based BMPs, such as vegetated swales, must be designed to infiltrate or treat the maximum flow rate generated from one of the following scenarios:

1. The flow of runoff produced from a rain event equal to at least 0.2 inches per hour intensity,

2. The flow of runoff produced from a rain event equal to at least two times the 85th 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.

Stormwater treatment facilities will be designed to meet or exceed the sizing standards contained in the SUSMP Manual. Facility sizing will be finalized by the project engineer with the final hydrology study prior to issuance of a grading permit, which will be prepared and approved to ensure consistency with this analysis.

Also, the SUSMP includes general design specifications for individual priority project categories. These include:

- Single-Family Hillside Home
- 100,000 square foot commercial developments
- Restaurants
- Retail gasoline outlets
- Automotive repair shops
- Parking lots

For example, commercial developments must have properly designed loading and unloading dock areas, repair and maintenance bays, and vehicle equipment wash areas. Restaurants need to have properly designed equipment and accessory wash areas. Parking lots have to be properly designed to limit oil contamination and have regular maintenance of parking lot stormwater treatment systems (e.g., storm drain filters and biofilters). This document preliminarily identifies appropriate BMPs for these categories.

The LARWQCB issued a letter in December 2006 that clarifies the Board's compliance expectations for the development planning requirements in Part 4.D of the MS4 Permit (LARWQCB, 2006a). Per the clarification letter, the three provisions in Part 4.D that are the essential requirements for compliance are to: (1) maximize the percentage of pervious surfaces to allow percolation of stormwater into the ground; (2) minimize the quantity of stormwater directed to impervious surfaces and the MS4; and (3) minimize pollution emanating from parking lots through the use of appropriate treatment control BMPs and good housekeeping practices.

The Project is required to incorporate appropriate SUSMP requirements into project plans as part of the development plan approval process for building and grading permits. This analysis will identify at a project level the design specifications related to treatment control BMPs and other project features associated with the Vista Canyon project. Prior to issuance of grading permits, final design of these BMPs, consistent with this analysis, will be completed by the project engineer.

3.6.3 Hydromodification and Peak Flow Control

Part 4, Section D.1. of the MS4 Permit notes that increased volume, velocity, and discharge duration of stormwater runoff from developed areas may potentially accelerate downstream erosion and impair habitat-related beneficial uses in Natural Drainage Systems. As a result, Section D.1. of the Permit stipulates that Permittees shall control post-development peak stormwater runoff discharge rates, velocities and durations in Natural Drainage Systems to prevent accelerated stream erosion and to protect stream habitat. Natural Drainage Systems are defined by the Permit to include the Santa Clara River.

Further, under Part 4, Section D.1 of the MS4 Permit, the County and its Co-permittees were required to develop and implement by February 1, 2005, numeric criteria for peak flow control in accordance with the findings of the Peak Discharge Impact Study analyzing the potential impacts on natural streams due to impervious development. The County of Los Angeles Department of Public Works and the Southern California Stormwater Monitoring Coalition had been conducting the study, but the study was not completed in time to meet the February 1st deadline. Therefore, on January 31, 2005, the County adopted and submitted to the LARWQCB an Interim Peak Flow Standard to be in effect until such time as a final standard can be adopted based on a completed study.

The adopted Los Angeles County Interim Peak Flow Standard was derived from a similar Interim Peak Flow Standard for Ventura County approved by the LARWQCB under the SUSMP requirements provisions of the MS4 Permit. The intent of the Interim Standard, as described by the County in the cover letter dated January 31, 2005, signed by Donald L. Wolfe transmitting the Interim Standard to Jonathan Bishop of the LARWQB, is to provide protection for natural streams to the extent supported by findings from the ongoing study, and consistent with practical construction practices.

The Interim Peak Flow Standard adopted by the County is:

> *The Peak Flow Standard shall require that all post-development runoff from a 2-year, 24-hour storm shall not exceed the predevelopment peak flow rate, burned, from a 2-year, 24-hour storm when the predevelopment peak flow rate equals or exceeds five cubic feet per second. Discharge flow rates shall be calculated using the County of Los Angeles Modified Rational Method. The Peak Flow Standard shall also require that post-development runoff from the 50-year capital storm shall not exceed the predevelopment peak flow rate, burned and bulked, from the 50-year capital storm.*

In its cover letter dated January 31, 2005, signed by Donald L. Wolfe, transmitting the Peak Flow Interim Standard to Jonathan Bishop of the LARWQB, the County notes that upon completion of the Peak Discharge Impact Study, new peak flow standards may be determined to be appropriate.

The Vista Canyon Project will be conditioned to require, as a project design feature, sizing and design of hydraulic features as necessary to control hydromodification impacts. See further discussion below.

3.7 Los Angeles County Low Impact Development Ordinance

3.7.1 Low Impact Development Ordinance and Manual

Chapter 12.84 of the Los Angeles County Municipal Code requires the use of low impact development ("LID") standards in development projects. Chapter 12.84 requires that applicable development projects:

- Mimic undeveloped stormwater and urban runoff rates and volumes in any storm event up to and including the "50-year capital design storm event," as defined by LACDPW;
- Prevent pollutants of concern from leaving the development site in stormwater as the result of storms, up to and including a water quality design storm event; and
- Minimize hydromodification impacts to natural drainage systems.

To meet these standards, development projects that consist of five or more residential units, or nonresidential development, shall comply with the following:

- The excess volume (ΔV, defined as the post-developed runoff volume minus the pre-developed runoff volume for the 85th percentile storm event) from each lot upon which such development is occurring shall be infiltrated at the lot level, or in the alternative, the excess volume from the entire development site, including streets and public right-of-way, shall be infiltrated in sub-regional facilities. The tributary area of a sub-regional facility shall be limited to five acres, but may be exceeded with approval of the Director of LACDPW. When infiltration of all excess volume is not technically feasible, on-site storage, reuse, or other water conservation uses of the excess volume is required and shall be implemented as authorized by the Director of LACDPW.

LACDPW has developed a LID Standards Manual that outlines stormwater runoff quantity and quality control development principles, technologies, and design standards for achieving the LID Standards of Chapter 12.84. The LID Standards Manual requires that large scale residential and nonresidential development projects prioritize the selection of BMPs to treat stormwater pollutants, reduce stormwater runoff volume, and promote groundwater infiltration and stormwater reuse in an integrated approach to protecting water quality and managing water resources. The Manual states that BMPs should be implemented in the following order of preference:

- BMPs that promote infiltration.
- BMPs that store and beneficially use stormwater runoff.
- BMPs that utilize the runoff for other water conservation uses including, but not limited to, BMPs that incorporate vegetation to promote pollutant removal and runoff volume reduction and integrate multiple uses, and BMPs that percolate runoff through engineered soil and allow it to discharge downstream slowly.

If compliance with the above LID requirements is technically infeasible, in whole or in part, the project must incorporate design features demonstrating compliance with the LID requirements to the maximum extent practicable. The LID goals of increasing groundwater recharge, enhancing water quality, and preventing degradation to downstream natural drainage courses will be considered by DPW in the determination of infeasibility.

The LID Standards Manual outlines site conditions where infiltration may not be possible:

- Locations where seasonal high groundwater is within 10 feet of the surface.
- Within 100 feet of a groundwater well used for drinking water.
- Brownfield development sites or other locations where pollutant mobilization is a documented concern.
- Locations with potential geotechnical hazards as outlined in a report prepared and stamped by a licensed geotechnical engineer.
- Locations with natural, undisturbed soil infiltration rates of less than 0.5 inches per hour that do not support infiltration-based BMPs.
- Locations where infiltration could cause adverse impacts to biological resources.
- Development projects in which the use of infiltration BMPs would conflict with local, State or Federal ordinances or building codes.
- Locations where infiltration would cause health and safety concerns.

The LID Standards Manual outlines where storage and reuse of the ΔV may not be possible:

- Projects that would not provide sufficient irrigation or (where permitted) domestic grey water demand for use of stored runoff due to limited landscaping or extensive use of low water use plant palettes in landscaped areas.
- Projects that are required to use reclaimed water for irrigation of landscaping.

- Development projects in which the storage and reuse of stormwater runoff would conflict with local, state or federal ordinances or building codes.
- Locations where storage facilities would cause potential geotechnical hazards as outlined in a report prepared and stamped by a licensed geotechnical engineer.
- Locations where storage facilities would cause health and safety concerns.

The LID Standards Manual also contains drainage analysis requirements for hydromodification impacts to off-site property. The LID Standards Manual provides for the following exemptions from conducting a full analysis for hydromodification impacts, although project applicants must still demonstrate that the project mitigates for hydromodification impacts to the satisfaction of the Director of Public Works:

- Projects that disturb less than one acre.
- Less than 10,000 square feet of new impervious area.
- Projects that do not increase impervious area or decrease the infiltration capacity of pervious areas compared to pre-project conditions.
- Projects that are replacement, maintenance, or repair of an existing permitted flood control facility.
- Projects within a watershed or subwatershed where a geomorphically-based watershed study has been prepared that establishes that the potential for hydromodification impacts is not present based on appropriate assessment and evaluation of relevant factors, including: runoff characteristics, soil conditions, watershed size and conditions, channel conditions, and proposed levels of development within the watershed.
- Projects that discharge directly or via a storm drain into concrete or significantly hardened channels, which in turn discharge into a sump area under tidal influence, or other receiving water that is not susceptible to hydromodification impacts.
- Projects that have hydrologic control measures that include sufficient subregional, regional, in-stream control measures, or a combination thereof such that hydromodification will not occur.

The project proposes annexation to the City of Santa Clarita. Consistent with this request, all discretionary applications were filed with the City of Santa Clarita prior to January 1, 2009. Therefore, the project is not required to adhere to the County's LID Ordinance. However, the project applicant has committed to adhere to these requirements to the maximum extent feasible.

3.8 <u>Construction Permits</u>

Pursuant to the CWA Section 402(p), requiring regulations for permitting certain stormwater discharges, the State Water Resources Control Board (SWRCB) issued a statewide general

NPDES Permit for stormwater discharges from construction sites [(NPDES No. CAR000002) Water Quality Order 2009-0009-DWQ, State Water Resources Control Board (SWRCB) National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges Associated with Construction Activity (adopted by the SWRCB on September 2, 2009)].

Under this Construction General Permit, discharges of stormwater from construction sites with a disturbed area of one or more acres (effective July 1, 2010) are required to either obtain individual NPDES permits for stormwater discharges or be covered by the Construction General Permit. Coverage under the Construction General Permit is accomplished by (i) completing a construction site risk assessment to determine the appropriate coverage level; (ii) preparing a Stormwater Pollution Prevention Plan (SWPPP), including site maps, a Construction Site Monitoring Program (CSMP), and sediment basin design calculations; (iii) for projects located outside of a Phase I or Phase II permit area, completing a post-construction water balance calculation for hydromodification controls; and (iv) completing a Notice of Intent. All of these documents must be electronically submitted to the SWRCB for General Permit coverage. The primary objective of the SWPPP is to identify and apply proper construction, implementation, and maintenance of BMPs to reduce or eliminate pollutants in stormwater discharges and authorized non-stormwater discharges from the construction site during construction. The SWPPP also outlines the monitoring and sampling program required for the construction site to verify compliance with discharge Numeric Action Levels (NALs) set by the Construction General Permit.

3.9 General Waste Discharge Requirements for Dischargers of Groundwater From Construction and Project Dewatering

The Los Angeles Regional Water Quality Control Board has issued a General NPDES Permit and General Waste Discharge Requirements (WDRs) (Order No. R4-2008-0032 (NPDES No. CAG994004), governing construction-related dewatering discharges within the Project development areas (the "General Dewatering Permit.")). This permit addresses discharges from temporary dewatering operations associated with construction and permanent dewatering operations associated with development. The discharge requirements include provisions mandating notification, sampling and analysis, and reporting of dewatering and testing-related discharges. The General Dewatering Permit authorizes such construction-related activities so long as all conditions of the permit are fulfilled. Compliance with the requirements of the General Dewatering Permit is used as one method to evaluate Project construction-related impacts on surface water quality.

3.10 Discharge of Fill or Dredge Materials

Hydrologic conditions of concern addressed in this report include instream changes in sediment transport, erosion, and sedimentation, and ultimately channel stability. There is a nexus between these concerns and the stream, habitat, and species protection programs administered by the

United States Army Corps of Engineers (ACOE), California Department of Fish and Game (CDFG) and the U.S. Fish and Wildlife Service.

Section 404 of the Clean Water Act is a program that regulates the discharge of dredged and fill material into waters of the United States, including wetlands. Activities in waters of the United States that are regulated under this program include fill for development (including physical alterations to drainages to accommodate storm drainage, stabilization, and flood control improvements), water resource projects (such as dams and levees), infrastructure development (such as highways and airports), and conversion of wetlands to uplands for farming and forestry. USEPA and the ACOE have issued Section 404(b)(1) Guidelines (40 CFR 230) that regulate dredge and fill activities, including water quality aspects of such activities. Subpart C at Sections 230.20 through 230.25 contains water quality regulations applicable to dredge and fill activities. Among other topics, these guidelines address discharges that alter substrate elevation or contours, suspended particulates, water clarity, nutrients and chemical content, current patterns and water circulation, water fluctuations (including those that alter erosion or sediment rates), and salinity gradients.

Section 401 of the Clean Water Act requires that any person applying for a federal permit or license that may result in a discharge of pollutants into waters of the United States must obtain a state water quality certification that the activity complies with all applicable water quality standards, limitations, and restrictions. Subject to certain limitations, no license or permit may be issued by a federal agency until certification required by Section 401 has been granted. Further, no license or permit may be issued if certification has been denied. CWA Section 404 permits and authorizations are subject to section 401 certification by the Regional Water Quality Control Boards (RWQCBs).

This report does not analyze the habitat and wildlife impacts associated with physical alterations to waters of the United States proposed in conjunction with the Project, such as dredge, fill, or bed, bank or channel improvements or stabilization measures affecting waters of the U.S. The impacts associated with these physical alterations are analyzed in the biota and floodplain modification sections of the Project EIR. As discussed below, this report analyzes the adverse impacts to natural drainage systems that may be caused by the Project's alteration of hydrologic conditions.

3.11 Lake or Streambed Alteration Agreement (LSAA)

The CDFG is responsible for conserving, protecting, and managing California's fish, wildlife, and native plant resources. To meet this responsibility, the law requires the proponent of a Project that may impact a river, stream, or lake to notify the CDFG before beginning the Project. This includes rivers or streams that flow at least periodically or permanently through a bed or channel with banks that support fish or other aquatic life and watercourses having a surface or subsurface flow that support or have supported riparian vegetation.

Section 1602 of the Fish and Game Code requires any person who proposes a Project that will substantially divert or obstruct the natural flow or substantially change the bed, channel, or bank of any river, stream, or lake or use materials from a streambed to notify the CDFG before beginning the Project. Similarly, under section 1602 of the Fish and Game Code, before any state or local governmental agency or public utility begins a construction Project that will: 1) divert, obstruct, or change the natural flow or the bed, channel, or bank of any river, stream, or lake; 2) use materials from a streambed; or 3) result in the disposal or deposition of debris, waste, or other material containing crumbled, flaked, or ground pavement where it can pass into any river, stream, or lake, it must first notify the CDFG of the proposed Project. If the CDFG determines that the Project may adversely affect existing fish and wildlife resources, a Lake or Streambed Alteration Agreement is required.

As discussed above, this report does not analyze the habitat and wildlife impacts associated with physical alterations to waters of the United States proposed in conjunction with the Project, such as dredge, fill, or bed, bank or channel improvements or stabilization measures affecting waters of the U.S. The impacts associated with these physical alterations are analyzed in the biota and floodplain modification sections of the Project EIR. As discussed below, this report analyzes the adverse impacts to natural drainage systems that may be caused by the Project's alteration of hydrologic conditions.

3.12 Recycled Water

3.12.1 Recycled Water Policy

The California State Water Resources Control Board adopted a Recycled Water Policy (the Policy) in 2009 by its Resolution No. 2009-0011. This policy requires increased usage of recycled water while addressing water quality concerns, and contains incentives for use of recycled water. The SWRCB states in this Policy that they expect to develop additional policies to encourage the use of stormwater, encourage water conservation, encourage the conjunctive use of surface and groundwater, and improve the use of local water supplies. The following goals are included in the Policy:

- Increase use of recycled water over 2002 levels by at least one million acre-feet per year (afy) by 2020 and at least two million afy by 2030.
- Increase the use of stormwater over use in 2007 by at least 500,000 afy by 2020 and at least one million afy by 2030.
- Increase the amount of water conserved in urban and industrial areas by comparison to 2007 by at least 20 percent by 2020.
- Substitute as much recycled water for potable water as possible by 2030.

The Recycled Water Policy provides direction to the Regional Water Quality Control Boards regarding appropriate criteria in issuing permits for recycled water projects that are intended to streamline permitting of the vast majority of recycled water projects, while also reserving sufficient authority and flexibility to address site-specific conditions. The Policy also addresses the benefits of recycled water and encourages other public agencies to presume there is a benefit from the use of recycled water in evaluating the impacts of recycled water projects on the environment, as required by CEQA. The Policy addresses a mandate for use of recycled water and indicates that the SWRCB will exercise their authority to the fullest extent possible to encourage the use of recycled water, consistent with state and federal water quality laws. The Policy addresses water quality concerns by requiring a number of key provisions.

To manage salts and nutrients, the Policy requires every groundwater basin or sub-basin in California to have a consistent salt/nutrient management plan. Each salt/nutrient plan must include a monitoring plan, which includes monitoring of emerging constituents/chemicals of emerging concern ("CECs") consistent with CDPH recommendations; be protective of water sources; and encourage recycling to meet the Policy's reuse goals.

The Policy requires that incidental runoff from landscape irrigation projects be controlled. Landscape irrigation projects that use recycled water must have a permit. Additionally, the Policy addresses groundwater recharge projects by requiring that all projects be reviewed and permitted on a site-specific basis. Note, the Project does not propose to recharge recycled water to groundwater.

The Policy also addresses control of emerging CECs. Due to the lack of knowledge on the full effects of these relatively new pollutants of concern, the Recycled Water Policy emphasizes the need for more scientific research in regards to CECs. The Policy states that the regulatory requirements for recycled water should be updated regularly based on the best available peer-reviewed science. Additionally, the Policy sets forth a research program, which includes a "blue-ribbon" advisory panel consisting of experts from all relevant fields of science. The panel is required to review all related scientific literature and to submit a report describing the current state of scientific knowledge and the actions that the State of California should take to improve current understanding of and human health protections against CECs.

3.12.2 Municipal Recycled Water Landscape Irrigation Use Permit

The General Waste Discharge Requirements for Landscape Irrigation Uses of Municipal Recycled Water (Water Quality Order No. 2009-0006-DWQ) (Landscape Irrigation General Permit) regulates landscape irrigation with recycled water. Specified uses of recycled water considered to be "landscape irrigation" include any of the following: (i) parks, greenbelts, and playgrounds; (ii) school yards; (iii) athletic fields; (iv) golf courses; (v) cemeteries; (vi) residential landscaping and common areas (not including individually owned residential areas); (vii) commercial landscaping, except eating areas; (viii) industrial landscaping, except eating areas; and (ix) freeway, highway, and street landscaping. Producers or distributors of recycled water must submit a Notice of Intent (NOI) for coverage under the Landscape Irrigation General Permit. This permit is not required for individual recycled water users and does not cover use of harvested stormwater for irrigation.

Producer and Distributor Responsibilities

Producers must produce disinfected tertiary recycled water as defined by CCR Title 22, sections 60301.230 and 60301.320, which address disinfection requirements and "filtered wastewater" requirements, respectively. Producers are responsible for ensuring that recycled water meets the quality standards for disinfected tertiary recycled water as described in Title 22 and any associated waste discharge requirement order for the water reclamation plant. Distributors are responsible for drafting and submitting an Operations and Maintenance (O&M) Plan to the State Water Board. The plan contents are contained in the permit, and include operation and maintenance/management of transport facilities and associated infrastructure necessary to convey and distribute recycled water from the point of production to the point of use. Additionally, distributors must designate a Recycled Water Use Supervisor for each use area. The permit also addresses best management practices, including general operations and maintenance, which producers and distributors must apply to manage recycled water and prevent water quality impacts.

Usage

The permit establishes terms and conditions of discharge to ensure that the discharge does not unreasonably affect beneficial uses of groundwater and surface water. This includes minimum setback distances, signage, application control, and use restrictions, along with other preventative measures, such as backflow prevention and cross-contamination programs.

3.12.3 California Department of Public Health Regulations

Title 17

Title 17 drinking water supply standards (Division 1, Chapter 5, Group 4, Articles 1 and 2) include requirements related to recycled water. The related standards concern the protection of potable water supply from recycled water due to cross-contamination. The water supplier is responsible for protecting the public water supply and for evaluating the degree of potential health hazard to the public water supply created as a result of conditions existing on a user's premises. The standards also call for backflow protection. Backflow protection must be provided by the water supplier and water user commensurate with the degree of hazard that exists on the consumer's premises.

Title 22

The requirements of Title 22, as revised in 1978, 1990 and 2001, establish the quality and/or treatment processes required for a recycled effluent to be used for a non-potable application. In addition to recycled water uses and treatment requirements, Title 22 addresses (1) sampling and analysis requirements at a treatment plant; (2) preparing an engineering report prior to production or use of recycled water; and (3) ensuring there are general treatment design requirements, reliability requirements, and alternative methods of treatment. Permits are issued to each water recycling project by one of the nine RWQCBs. The Los Angeles RWQCB would issue this permit for the Project site. These permits include water quality and public health protections, as detailed in Title 22.

4 POLLUTANTS OF CONCERN AND SIGNIFICANCE CRITERIA

4.1 Surface Water Pollutants of Concern

4.1.1 Pollutants of Concern

Pollutants of concern, as defined in the Los Angeles County SUSMP Manual, 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.

The surface water pollutants of concern for the water quality analysis are those that are anticipated or potentially could be generated by the Project at concentrations that exhibit these characteristics, based on water quality data collected in Los Angeles County from land uses that are the same as those proposed by the Project (LACDPW, 2000). Identification of the pollutants of concern also considered Basin Plan beneficial uses and water quality objectives, CTR criteria, and current Section 303(d) listings and TMDLs in the Santa Clara River, as well as pollutants that have the potential to cause toxicity or bioaccumulate in the receiving waters. Appendix A lists the pollutants of concern, the basis for their selection, and the significance criteria that will be applied for each.

The following pollutants were chosen as pollutants of concern for purposes of evaluating water quality based upon the above considerations:

Sediments (TSS and Turbidity)

Excessive erosion, transport, and deposition of sediment in surface waters are a significant form of pollution resulting in major water quality problems. Sediment imbalances impair waters' designated uses. Excessive sediment can impair aquatic life by filling interstitial spaces of spawning gravels, impairing fish food sources, filling rearing pools, and reducing beneficial habitat structure in stream channels. In addition, excessive sediment can cause taste and odor problems in drinking water supplies and block water intake structures.

Nutrients (Phosphorus and Nitrogen (Nitrate+Nitrite-N, Ammonia-N, and Total Nitrogen))

Nutrients of concern include the inorganic forms of nitrogen (nitrate, nitrite and ammonia) and phosphorus. Organic forms of nitrogen are associated with vegetative matter such as particulates from sticks and leaves. Inorganic forms of nitrogen include nitrate, nitrite and ammonia. Total

Nitrogen (TN) is a measure of all nitrogen present, including inorganic and particulate forms. Phosphorus can be measured as total phosphorus (TP) or as dissolved phosphorus. Dissolved phosphorus is the more bioavailable form of phosphorus, while TP is often composed mostly of soil-related particulate phosphorus. There are several sources of nutrients in urban areas, mainly fertilizers in runoff from lawns, pet wastes, failing septic systems, atmospheric deposition from industry and automobile emissions, and soil erosion. Nutrient over-enrichment is especially prevalent in agricultural areas where manure and fertilizer inputs to crops significantly contribute to nitrogen and phosphorus levels in streams and other receiving waters. Eutrophication due to excessive nutrient input can lead to changes in algae, benthic, and fish communities; extreme eutrophication can cause hypoxia or anoxia, resulting in fish kills. Surface algal scum, water discoloration, and the release of toxins from sediment can also occur.

Various downstream reaches of the Santa Clara River are identified as impaired by ammonia and nitrate- plus nitrite-nitrogen. Evidence of impairment includes low diversity of benthic macroinvertebrates and observations of excessive algae growth. A source analysis found that the majority of ammonia and nitrate/nitrite loads are from point sources; primarily downstream water reclamation plants (WRPs) (LARWQCB, 2003). Sources from municipal storm sewers are considered a minor source, but have a potential to cause significant local effects on water quality (LARWQCB, 2003). TMDLs have been developed and adopted into the Basin Plan for nitrogen compounds, including nitrate/nitrite and ammonia.

Trace Metals (Copper, Lead, and Zinc)

The primary sources of trace metals in stormwater are typically commercially available metals used in transportation (e.g. automobiles), buildings, and infrastructure. Metals are also found in fuels, adhesives, paints, and other coatings. Copper, lead, and zinc are the most prevalent metals typically found in urban runoff. Other trace metals, such as cadmium, chromium, and mercury, are typically either not detected in urban runoff or are detected at very low levels (LACDPW, 2000). Metals are of concern because of the potential for toxic effects on aquatic life and the potential for groundwater contamination. High metal concentrations can lead to bioaccumulation in fish and shellfish and affect the beneficial uses of receiving waters.

Chloride

According to the RWQCB, high levels of chloride in Santa Clara River Reaches 3, 5 and 6 are causing impairment of listed beneficial uses for agricultural irrigation, and irrigation of salt sensitive crops, such as avocados and strawberries, with water containing elevated levels of chloride could result in reduced crop yields. Chloride levels in some areas exceed water quality standards associated with groundwater recharge. Chloride TMDLs have been developed and adopted into the Basin Plan. The major sources of elevated chloride are discharges from downstream WRPs, contributing about 70% of the chloride load. Minor point sources are dewatering operations, and uncontrolled swimming pool and water ride discharges.

Pathogens (Bacteria, Viruses, and Protozoa)

Elevated levels of pathogens from domestic animal, wildlife, or human fecal wastes are typically associated with runoff from the watershed. Urban runoff can mobilize pathogens, including bacteria and viruses. Runoff from natural areas also contains pathogens (e.g., from wildlife). Sources of pathogens in urban areas include pets, septic systems, and leaky sanitary sewer pipes. The presence of pathogens in runoff can impair receiving waters and contaminate drinking water sources. Elevated pathogens are typically caused by the transport of animal or human fecal wastes from the watershed. Historically, an indicator organism such as fecal coliform has been used as a surrogate for the presence of pathogens due to the difficulty of monitoring for pathogens directly. More recently, the scientific community has questioned the use of indicator organisms, as scientific studies have shown no correlation between indictor bacteria and pathogen levels and therefore total and fecal coliform may not indicate a significant potential for causing human illness (Paulsen and List, 2005). Santa Clara River Reach 7 is listed as impaired by high coliform bacteria counts from point and nonpoint sources. Bacteria TMDLs have not yet been developed for the river.

Petroleum Hydrocarbons (Oil and Grease and PAHs)

The sources of oil, grease, and other petroleum hydrocarbons in urban areas include spillage of fuels and lubricants, discharge of domestic and industrial wastes, and atmospheric deposition in the case of PAHs. Runoff can be contaminated by leachate from asphalt roads, wearing of tires, and deposition from automobile exhaust. Direct contamination may be a byproduct of do-it-yourself auto mechanics that may illegally dump used oil and other automobile-related fluids directly into storm drains. Petroleum hydrocarbons, such as polycyclic aromatic hydrocarbons (PAHs), can bioaccumulate in aquatic organisms from contaminated water, sediments and food, and are toxic to aquatic life at low concentrations. Hydrocarbons can persist in sediments for long periods of time and result in adverse impacts on the diversity and abundance of benthic communities. Hydrocarbons can be measured as total petroleum hydrocarbons (TPH), oil and grease, or as individual groups of hydrocarbons, such as PAHs.

Pesticides

Pesticides (including herbicides, insecticides and fungicides) are chemical compounds commonly used to control insects, rodents, plant diseases, and weeds. Excessive application of a pesticide in connection with agriculture cultivation or landscaping may result in runoff containing toxic levels of the active ingredient. The historic evolution of pesticides proceeded from organochlorine pesticides to organophosphorous pesticides, topyrethroids. Organochlorine pesticides (e.g., DDT and other legacy pesticides) were found to be persistent and bioaccumulative and were banned in the 1970s. Such pesticides could have been used historically at the site for agriculture. Organophosphate pesticides include diazinon and chlorpyrifos whose urban uses are now also banned by EPA, and therefore will not be used at the Project site for landscape maintenance. The current pesticides of concern for water quality are pyrethrums; parathyroid’s (bifenthrin, cyfluthrin, cypermethrin, deltamethrin, esfenvalerate, and permethrin); carbaryl; malathion; and imidacloprid.

Trash & Debris

Trash (such as paper, plastic, polystyrene packing foam, and aluminum materials) and biodegradable organic debris (such as leaves, grass cuttings, and food waste) are general waste products on the landscape that can be entrained in urban runoff. The presence of trash and debris may have a significant impact on the recreational value of a water body and aquatic habitat. Excess organic matter can create a high biochemical oxygen demand in a water body and thereby lower its water quality. In areas where stagnant water exists, the presence of excess organic matter can promote septic conditions resulting in the growth of undesirable organisms and the release of odorous and hazardous compounds such as hydrogen sulfide.

Methylene Blue Activated Substances (MBAS)

MBAS are related to the presence of detergents in water. Positive results may indicate the presence of wastewater or be associated with urban runoff due to commercial and/or residential vehicle washing or other outdoor washing activities. Surfactants disturb the surface tension which negatively affects insects and can also harm the gills in aquatic life.

Cyanide

Cyanide has been identified by the Los Angeles County Department of Public Works as a constituent of concern for the Santa Clara River based on monitoring conducted at the downstream mass emission Station S29 (LACDPW, 2005). Cyanide is used in electroplating, metallurgy, and mining. It is also used to make synthetic fibers, plastics, dyes, pharmaceuticals, and pesticides, including fumigants. In addition, cyanide serves as a chemical intermediate in various production processes. Natural cyanides are produced by certain bacteria, fungi, and algae, and they are present in a number of plants and foods as cyanogenic glycosides. Man-made cyanides typically enter the environment from metal finishing and organic chemical industries. Other sources include iron and steel works, municipal waste burning, cyanide-containing pesticides, road deicers, and vehicle exhaust.

Bioaccumulation

Certain pollutants, such as pesticides, selenium and mercury, have a tendency to bioaccumulate. The Basin Plan and the CTR criteria set forth toxicity objectives for receiving water levels of substances that bioaccumulate in aquatic resources to prohibit concentrations of toxic substances that are harmful to human health and adversely affect beneficial uses.

4.1.2 Other Constituents

This section discusses other constituents that are listed in the Basin Plan, but for reasons explained below, are not pollutants of concern for the Project.

BOD (Biochemical Oxygen Demand) and Dissolved Oxygen

Adequate levels of dissolved oxygen are necessary to support aquatic life. High levels of oxygen demanding substances discharged to receiving waters can depress oxygen levels to levels of concern. Oxygen demanding substances are compounds that can be biologically degraded through aerobic processes. The presence of oxygen demanding substances can deplete oxygen supplies in waters. Nutrients in fertilizers and food wastes in trash are examples of likely oxygen demanding compounds to be present on the Project site. Other biodegradable organic materials include human and animal waste and vegetative matter. Biodegradable pollutants are largely subsumed by the nutrients and trash and debris categories above, and therefore will not be discussed as a separate category.

Chemical Constituents

Chemical constituents in excessive amounts in drinking water are harmful to human health. The Basin Plan objective for chemical constituents states: "Surface waters shall not contain concentrations of chemical constituents in amounts that adversely affect any designated beneficial use." As Santa Clara River Reach 7 is not designated with a municipal water supply designated use (see Section 2.5.1 above), chemical constituents are not a pollutant of concern for the Project.

Temperature

Increase in temperature can result in lower dissolved oxygen levels, impairing habitat and other beneficial uses of receiving waters. Discharges of wastewater can also cause unnatural and/or rapid changes in temperature of receiving waters, which can adversely affect aquatic life. Elevated temperatures are typically associated with discharges of process wastewaters or non-contact cooling waters. As the beneficial uses in the receiving waters for the Project include warm freshwater habitat to support warm water ecosystems, temperatures of stormwater runoff from the Project are not of concern.

Total Residual Chlorine

Total residual chlorine can be present in wastewater treatment plant discharges, or may be present in dry weather urban runoff from the emptying of swimming pools that have not been de-chlorinated. Chlorine is a strong oxidant and is therefore toxic to aquatic life. Municipal pools and private pools in areas served by a municipal sanitary system are required to be discharged into the sanitary system, and therefore, total residual chlorine will not be present in runoff from the Project.

Color, Taste, and Odor

The Basin Plan contains narrative objectives for color, taste, or odor that cause a nuisance or adversely affect beneficial uses. Undesirable tastes and odors in water may be a nuisance and may indicate the presence of a pollutant(s). Odor associated with water can result from decomposition of organic matter or the reduction of inorganic compounds, such as sulfate. Other potential sources of odor causing substances, such as industrial processes, will not occur as part of the Project. Color in water may arise naturally, such as from minerals, plant matter, or algae, or may be caused by industrial pollutants. As the Project will contain no industrial uses, color-, taste-, or odor-producing substances are not pollutants of concern for the Project.

Mineral Quality: TDS, Sulfate, Boron, and SAR

Mineral quality in natural waters is largely determined by the mineral assemblage of soils and rocks near the land surface. Elevated mineral concentrations could impact beneficial uses; however, the minerals listed in the Basin Plan, except chloride and nitrogen, are not believed to be constituents of concern due to the absence of River impairments and/or, as with TDS, anticipated post-development runoff concentrations well below the Basin Plan objectives (Table 4-1). Therefore, these constituents are not considered pollutants of concern for the Project.

Table 4-1: Comparison of Mineral Basin Plan Objectives with Mean Measured Values in Los Angeles County

Mineral	Los Angeles Basin Plan Water Quality Objective for Santa Clara River Reach 7 (mg/L)	Range of Mean Concentration in Urban Runoff[1] (mg/L)
Total Dissolved Solids	800	53 - 226
Sulfate	150	7 - 35
Boron	1.0	0.16 – 0.25
Sodium Absorption Ratio[2]	5	0.4 – 1.9

[1]Source: LACDPW, 2000. Land uses include SFR, MFR, commercial, education, transportation, light industrial, and mixed residential.

[2]Sodium adsorption ratio (SAR) predicts the degree to which irrigation water tends to enter into cation-exchange reactions in soil.

pH

The pH of rain water is usually slightly acidic due to the solubility of carbon dioxide from the atmosphere. Aquatic organisms can be highly sensitive to pH. The Basin Plan objective for pH is as follows:

> "The pH of inland surface waters 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."

Mean runoff concentrations in the Los Angeles County stormwater monitoring data ranged from 6.5 for mixed- and single-family residential land uses to 7.0 for commercial land use. Therefore, pH in the Santa Clara River is not expected to be affected by runoff discharges from the Project.

PCBs

PCBs are highly toxic persistent chemicals that have been historically released into the environment from industrial uses, such as transformers, but are no longer produced in the United States. Due to their persistence, PCBs can still be detected in urban runoff due to historic industrial sources of these chemicals. The Project area did not historically include PCB-producing land uses. Therefore, PCBs are not a pollutant of concern for the Project.

Radioactive Substances

Radioactive substances typically occur at very low concentrations in natural waters. Some activities such as mining or certain industrial activities (e.g., energy production, fuel reprocessing) can increase the amount of radioactive substances impairing beneficial uses. The Project will not have industrial or other activities that would be a source of any radioactive substances, and development will stabilize any naturally radioactive soils, though unlikely to be present in the Project area. Therefore, radioactive substances are not a pollutant of concern for the Project.

Toxicity

Certain pollutants in stormwater runoff have the potential to be highly toxic to aquatic organisms resulting in effects such as impaired reproduction or mortality. The Basin Plan water quality objective for toxicity is:

> "All surface waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life."

Toxicity in urban runoff could be caused by ammonia, trace metals, PAHs, or pesticides. These constituents are subsumed by the pollutant of concern categories above.

4.2 Groundwater Pollutants of Concern

The Project will allow for infiltration of urban runoff to groundwater after receiving pretreatment in the Project PDFs, as well as incidental recharge of recycled water. Research conducted on the effects on groundwater from stormwater infiltration by Pitt *et al.* (1994) indicate that the potential for contamination due to infiltration is dependent on a number of factors including the local hydrogeology and the chemical characteristics of the pollutants of concern.

Chemical characteristics that influence the potential for groundwater impacts include high mobility (low absorption potential), high solubility fractions, and abundance. As a class of constituents, trace metals tend to adsorb onto soil particles and are filtered out while infiltrating through soils. This has been confirmed by extensive data collected beneath stormwater infiltration basins in Fresno (conducted as part of the Nationwide Urban Runoff Program (Brown & Caldwell, 1984)) that showed that trace metals tended to be adsorbed in the upper few feet in the retention basin bottom sediments. Bacteria are also filtered out by soils. More mobile and soluble pollutants, such as salts (e.g., TDS and chloride) and nitrate, have a greater potential for impacting groundwater through infiltration.

Recent long term studies (2001-2005), as part of the Los Angeles Water Augmentation Study, carried out by the Los Angeles San Gabriel Rivers Watershed Council indicate that there are no discernable impacts on groundwater quality from infiltrating stormwater (LASGRWC, 2005).

4.2.1 Pollutants of Concern for Infiltration of Stormwater

The stormwater pollutants of concern for the groundwater quality analysis are those that are anticipated or potentially could be generated by the Project at concentrations, based on water quality data collected in Los Angeles County from land uses that are the same as those included in the Project, that exhibit these characteristics. Identification of the stormwater pollutants of concern for the Project considered proposed land uses as well as pollutants that have the potential to impair beneficial uses of the groundwater below the Project. The Los Angeles Basin Plan contains numerical objectives for bacteria, mineral quality, nitrogen, and various toxic chemical compounds, and contains qualitative objectives for taste and odor.

Nitrate- plus nitrite-N was chosen as the stormwater pollutant of concern for purposes of evaluating groundwater quality impacts based upon the above considerations. High nitrate levels in drinking water can cause health problems in humans. Infants can develop methemoglobinemia (blue-baby syndrome). Human activities and land use practices can influence nitrogen concentrations in groundwater. For example, irrigation water containing fertilizers can increase levels of nitrogen in groundwater.

4.2.2 Other Constituents in Stormwater

Bacteria

The Basin Plan contains numeric criteria for bacteria in drinking water sources. As bacteria are removed through filtration in soils (for example, as with septic tank discharges), incidental infiltration of stormwater runoff in the Project treatment PDFs is not expected to affect bacteria levels in groundwater.

Chemical Constituents and Radioactivity

Drinking water limits for inorganic and organic chemicals that can be toxic to human health in excessive amounts and radionuclides are contained in Title 22 of the California Code of Regulations. These chemicals and radionuclides are not expected to occur in the Project's stormwater runoff.

Taste and Odor

The Basin Plan contains a narrative objective for taste and odor that cause a nuisance or adversely affect beneficial uses. Undesirable tastes and odors in groundwater may be a nuisance and may indicate the presence of a pollutant(s). Odor associated with water can result from natural processes, such as the decomposition of organic matter or the reduction of inorganic compounds, such as sulfate. Pollutants causing taste and odor issues are not expected to occur in stormwater in amounts that would impact groundwater. Other potential sources of odor causing substances, such as industrial processes, will not occur as part of the Project. Therefore, taste and odor-producing substances are not stormwater pollutants of concern for the Project.

Mineral Quality: TDS, Sulfate, Chloride, and Boron

Mineral quality in groundwater is largely influenced by the mineral assemblage of soils and rocks that it comes into contact with. Elevated mineral concentrations could impact beneficial uses; however, the minerals listed in the Basin Plan are not believed to be pollutants of concern in stormwater due to the anticipated runoff concentrations, which are below the Basin Plan groundwater objectives (Table 4-2).

Table 4-2: Comparison of Basin Plan Mineral Groundwater Objectives with Mean Measured Stormwater Runoff Values in Los Angeles County

Mineral	Los Angeles Basin Plan Groundwater Quality Objective[1] (mg/L)	Range of Mean Concentrations in Urban Runoff [2] (mg/L)
Total Dissolved Solids	800	53 – 237
Sulfate	150	7 – 35
Chloride	150	4 – 50
Boron	1.0	0.2 – 0.3

[1]Upper Santa Clara-Mint Canyon
[2]Source: LACDPW, 2000. Includes all monitored land uses.

4.2.3 Recycled Water Pollutants of Concern

The recycled water pollutants of concern for the groundwater quality analysis include bacteria, chemical constituents and radioactivity, taste and odor, mineral quality, and nutrients.

Contaminants of emerging concern (CECs), described below, are also pollutants of concern for recycled water.

Contaminants of Emerging Concern (CECs)

Emerging contaminants are new chemicals or existing chemicals that were not previously considered pollutants of concern, but have more recently been found to have adverse effects on ecological systems. Many of these emerging contaminants arise from household use. They are not completely removed during wastewater treatment processes, thus can be released in wastewater treatment plant effluent. While there are hundreds of different CECs, they can be grouped into a number of general categories (Colker and Day, 2005; USGS, 2010)

Pharmaceuticals and Personal Care Products (PPCPs)

PPCPs encompass a broad array of chemicals, including antibiotics and other prescription drugs, pain relievers, fragrances, lotions, sunscreen agents, and a number of other products. These chemicals are commonly found in municipal wastewater plants, as they are typically excreted or washed off by consumers into the municipal sewer system. Wastewater treatment plants often cannot biodegrade these complex synthetic chemicals and they are discharged in effluent into the environment. Many of these chemicals are endocrine disrupters and can affect the reproductive cycle of aquatic organisms.

Industrial and Household Chemicals

Industrial and household CECs include cleaning agents, mechanical lubricants and solvents, and flame retardants. These synthetic chemicals are generally very toxic, and are often considered endocrine disrupters, adversely affecting aquatic organisms. These chemicals are difficult to treat and generally have low removal rates in traditional wastewater treatment systems.

Nanomaterials

Nanomaterials have recently been explored and used in industries from biotechnology to electronic circuitry. While nanomaterials are efficient and useful for these new applications, due to their size and reactivity, they could potentially negatively affect ecosystems and water bodies.

4.3 Hydrologic Conditions of Concern (Hydromodification)

Urbanization modifies natural watershed and stream hydrologic and geomorphic processes by introducing increased volumes and duration of flow via increased runoff from impervious surfaces and drainage infrastructure. Several studies have evaluated affects of increased runoff associated with the introduction of impervious surfaces and drainage facilities on geomorphic processes (SCCWRP, 2005a; Geosyntec, 2002; Bledsoe & Watson, 2001; Booth, 1990; Hollis, 1975; Hammer, 1972). Potential changes to the hydrologic regime may include increases in runoff volumes, frequency of runoff events, long-term cumulative duration, as well as increased peak flows. Urbanization may also introduce dry weather flows where only wet weather flows existed prior to development. These changes are referred to as “hydromodification”.

Hydromodification intensifies sediment transport and often leads to stream channel enlargement and loss of habitat and associated riparian species (SCCWRP, 2005a; Geosyntec, 2002; Bledsoe & Watson, 2001; MacRae, 1992; Booth, 1990). Under certain circumstances, development can also cause a reduction in the amount of sediment supplied to the stream system, which can lead to stream channel incision and widening. These changes also have the potential to impact downstream channels and habitat integrity. A project that increases runoff due to impervious surfaces and traps sediment from upland watershed sources creates compounding effects.

A change to the Project site’s hydrologic regime would be considered a condition of concern if the change could have a significant impact on downstream natural channels and habitat integrity, alone or in conjunction with impacts of other projects.

4.4 Significance Criteria and Thresholds for Significance

4.4.1 Surface Water Quality Significance Criteria

Appendix A provides the criteria for evaluating the significance of a potential impact for each surface water pollutant of concern. The application of the criteria to a decision regarding significance requires an integrated or “weight of evidence” approach, rather than a decision based on any one of the individual criterion.

Significance criteria for surface water quality impacts have been developed based on a review of the MS4 Permit and the CEQA Guidelines, Appendix G. Significant water quality impacts are presumed to occur if the proposed Project would:

- Create sizeable additional sources of polluted runoff to receiving waters that would result in exceedances of receiving water quality or substantially degrade water quality in receiving waters.
- Create sizeable additional sources of polluted runoff that would violate any water quality standards or waste discharge requirements for surface water runoff.
- Create sizeable additional sources of polluted construction site runoff (including polluted discharges associated with construction activities such as materials delivery, staging or storage, vehicle or equipment fueling, vehicle or equipment maintenance, waste handling, or hazardous materials handling or storage) that would violate any water quality standards or waste discharge requirements for surface water runoff or groundwater discharge.

This report analyzes whether sizeable additional sources of polluted runoff may result from the Project based on the results of water quality modeling and qualitative assessments that take into account water quality controls or BMPs that are considered Project Design Features (PDFs). Any increases in pollutant concentrations or loads in runoff resulting from the development of the Project site are considered an indication of a potentially significant adverse water quality impact. If loads and concentrations resulting from development are predicted to stay the same or to be reduced when compared with existing conditions, it is concluded that the Project will not cause a significant adverse impact to the ambient water quality of the receiving waters for that pollutant.

If pollutant loads or concentrations are expected to increase, for both the post-development and construction phases, potential impacts are assessed by evaluating compliance of the Project, including PDFs, with applicable regulatory requirements of the MS4 Permit, including SQMP and SUSMP requirements, the Construction General Permit, and the General Dewatering Permit. Further, post-development increases in pollutant loads and concentrations are evaluated by comparing the magnitude of the increase to relevant benchmarks, including receiving water TMDLs and receiving water quality objectives and criteria from the Basin Plan and CTR, as described below.

Receiving Water Benchmarks

Comparison of post-development water quality concentrations in the runoff discharge with benchmark TMDL waste load or load allocations for MS4 discharges establishes the likelihood that runoff would result in TMDL exceedances in receiving waters or would otherwise degrade receiving water quality.

Comparison of post-development water quality concentrations in the runoff discharge with benchmark numeric and narrative receiving water quality criteria as provided in the Basin Plan and the CTR facilitates analysis of the potential for runoff to result in exceedances of receiving water quality standards, adversely affect beneficial uses, or otherwise degrade receiving waters.

Water quality criteria are considered benchmarks for comparison purposes only; such criteria apply within receiving waters as opposed to applying directly to runoff discharges. Narrative and numeric water quality objectives contained in the Basin Plan apply to the Project's receiving waters. Water quality criteria contained in the CTR provide concentrations that are not to be exceeded in receiving waters more than once in a three year period for those waters designated with aquatic life or human health related uses. Projections of runoff water quality are compared to the acute form of the CTR criteria (as discussed above), as stormwater runoff is associated with episodic events of limited duration, whereas chronic criteria apply to 4-day exposures which do not describe typical storm events in the Project area, which last 8 hours on average. If pollutant levels in runoff are not predicted to exceed receiving water benchmarks, it is one indication that no significant impacts will result from project development.

MS4 Permit Requirements for New Development (SUSMP)

Satisfaction of MS4 Permit requirements for new development, including SUSMP requirements and SQMP requirements, and satisfaction of construction-related requirements of the Construction General Permit and General Dewatering Permit, establish compliance with water quality regulatory requirements applicable to stormwater runoff. In addition, satisfaction of the LID requirements of the County of Los Angeles' LID Ordinance and Manual are assessed as a benchmark for regulatory compliance. The LID criteria are considered benchmarks, as the Project will be located within the jurisdiction of the City of Santa Clarita and the City will act as the lead agency.

The MS4 Permit requires that the SQMP specify BMPs that will be implemented to reduce the discharge of pollutants in stormwater to the Maximum Extent Practicable (MEP). MS4 requirements are met when new development complies with the SUSMP requirements set forth in the MS4 Permit. Under the SUSMP requirements, the essential requirements for compliance are: (1) maximizing the percentage of pervious surfaces to allow percolation of stormwater into the ground; (2) minimizing the quantity of stormwater directed to impervious surfaces and the MS4; and (3) minimizing pollution emanating from parking lots through the use of appropriate treatment control BMPs and good housekeeping practices. The effectiveness of stormwater treatment controls are primarily based on two factors - the amount of runoff that is captured by the controls and the selection of BMPs to address identified pollutants of concern. Selection and numerical sizing criteria for new development treatment controls are included in the MS4 Permit and the County SUSMP Manual. If the Project PDFs meet MS4 requirements, including sizing for treatment controls and other source control and site design BMPs consistent with the SUSMP requirements, it indicates that no significant impacts will occur as the result of MS4 Permit compliance.

Construction General Permit and General Dewatering Permit

The Construction General Permit requires the development and implementation of a Stormwater Pollution Prevention Plan (SWPPP) that describes erosion and sediment control BMPs as well as material management/ non-stormwater BMPs that will be used during the construction phase of development. The General Dewatering Permit addresses discharges from permanent or temporary dewatering operations associated with construction and development and includes provisions mandating notification, sampling and analysis, and reporting of dewatering and testing-related discharges. To evaluate significance of construction phase Project water quality impacts, this Water Quality Technical Report evaluates whether water quality control is achieved by implementation of BMPs consistent with Best Available Technology Economically Achievable and Best Conventional Pollutant Control Technology (BAT/BCT), as required by the Construction General Permit and the General Dewatering Permit.

4.4.2 Significance Criteria for Hydrologic Conditions of Concern (Hydromodification Impacts)

Significance criteria for evaluating hydrologic impacts and conditions of concern have been developed based on a review of the MS4 Permit and the CEQA Guidelines, Appendix G. Significant impacts to natural drainage systems created by altered hydrologic conditions of concern are presumed to occur if the proposed Project would:

- Substantially alter the existing drainage pattern of a natural drainage, stream, or river causing substantial erosion, siltation, or channel instability in a manner that substantially adversely affects beneficial uses; or
- Substantially increase the rates, velocities, frequencies, duration and/or seasonality of flows causing channel instability and harming sensitive habitats or species in natural drainages in a manner that substantially adversely affects beneficial uses.

4.4.3 Cumulative Impacts

CEQA requires the analysis of cumulative impacts of a project when the project's incremental effects may be significant when assessed along with the effects of past projects, other current projects, and probable future projects. The discussion of cumulative impacts must reflect the potential severity of the impacts and their likelihood of occurrence, but the discussion and analysis need not provide as great a detail as is provided for the direct effects attributable to the Project alone. This report, therefore, analyzes the potential for cumulative water quality impacts, cumulative groundwater quality impacts, and cumulative hydrologic impacts in accordance with the thresholds for direct impacts discussed in Sections 4.4.1 and 4.4.2 above, and Section 4.4.4 below. See Sections 7.7, 7.8, and 7.9 below.

The cumulative analysis of all surface water quality and hydrologic impacts in this report is based primarily on "adopted plans and projections" found in the LADPW adopted and approved Hydrology Manual, which have been verified by reference to approved plans, including the City of Santa Clarita and County of Los Angeles adopted General Plans, as well as available empirical data for the Santa Clara River. As required by CEQA, the focus of the cumulative impacts analysis for this Project will be on the Project's incremental contribution to significant adverse water quality and hydrologic impacts to the Santa Clara River, taking into account the reasonably foreseeable water quality and hydrologic impacts of other projects that may develop impervious surfaces and urban land uses within the Santa Clara River watershed in accordance with adopted general plans and related projections. The cumulative impacts analysis will consider the Project's incremental contribution to significant cumulative water quality and hydrologic impacts to the Santa Clara River in light of the water quality and hydrology impact mitigation achieved by certain of the PDFs. The analysis will also consider whether the Project, including PDFs, and future projects will comply with specific requirements in a previously approved ordinance, plan, or mitigation program (such as the Basin Plan, the CTR, the MS4

Permit, the Construction General Permit and the General Dewatering Permit) that have been adopted for the purpose of avoiding or substantially lessening the cumulative water quality and hydrologic impact problems within the geographic area in which the Project is located.

4.4.4 Groundwater Quality Impacts

Significance criteria for evaluating the Project's hydrologic and water quality impacts on groundwater have been developed based on CEQA Appendix G thresholds. Significant impacts to groundwater are presumed to occur if the proposed Project would:

- Substantially deplete groundwater supplies or interfere with groundwater recharge so as to cause a net deficit in aquifer volume or a lowering of the local groundwater table.
- Through changes in surface water runoff quality and quantity (including Project treatment PDFs), and changes in groundwater recharge, result in a violation of any groundwater quality standards or waste discharge requirements or otherwise substantially degrade water quality.

Groundwater quality is addressed in Section 7.9. Groundwater quality benchmarks were compared with post-development runoff water and recycled water quality to establish the likelihood that runoff and recycled water discharge could result in a degradation of groundwater quality. Groundwater recharge is addressed in Section 7.9.4.

5 POST DEVELOPMENT WATER QUALITY AND HYDROMODIFICATION CONTROL PROJECT DESIGN FEATURES

PDFs for water quality and hydrologic impacts include site design/low impact development (LID), source control, treatment control, and hydromodification control BMPs that will be incorporated into the Project and are considered a part of the Project for impact analysis. Effective management of wet and dry weather runoff water quality begins with limiting increases in runoff pollutants and flows at the source. Site design/LID and source control BMPs are practices designed to minimize surface runoff and the introduction of pollutants into runoff. Treatment control BMPs are designed to remove pollutants once they have been mobilized by rainfall and runoff. Hydromodification control BMPs are designed to control increases in post-development runoff flows and/or volumes. This section describes the post-development site design/LID, source control, treatment control, and hydromodification control PDFs for the Project.

5.1 SUSMP Requirements and Project Design Features

Table 5-1 summarizes the SUSMP requirements and the corresponding proposed PDFs that will be incorporated into the Project.

Table 5-1: SUSMP Requirements and Corresponding Project Design Features

SUSMP Requirement	Criteria/ Description	Corresponding Vista Canyon PDFs
1. Runoff Flow Control	• Control post-development peak stormwater runoff discharge rates, velocities, and duration in Natural Drainage Systems to prevent accelerated downstream erosion and to protect habitat related beneficial uses.[5] • All post-development runoff from a 2-year, 24-hour storm shall not exceed the predevelopment peak flow rate, burned, from a 2-year, 24-hour storm when the predevelopment peak flow rate equals or exceeds five cfs. Discharge flow rates shall be calculated using the County of Los Angeles Modified Rational Method. • Post-development runoff from the 50-year capital storm shall not exceed the predevelopment peak flow rate, burned and bulked, from the 50-year capital	• Controls proposed to reduce runoff volumes include routing runoff to LID and treatment control BMPs that promote evapotranspiration and/or infiltration including bioretention, bioretention swales, planter boxes, vegetated swales, filter strips, infiltration facilities, and/or rainwater capture and use systems. • 50-year capital storm peak flow rate analysis is contained in the *Vista Canyon Project (TTM #69164) EIR Flood Technical Report - Santa Clara River* (PACE, 2009).

[5] This requirement is from Part 4, § D.1 of the MS4 Permit.

SUSMP Requirement	Criteria/ Description	Corresponding Vista Canyon PDFs
	storm. • Control peak flow discharge to provide stream channel and over bank flood protection, based on flow design criteria selected by the local agency.	
2. Conserve Natural Areas	• Concentrate or cluster development on portions of a site while leaving the remaining land in a natural undisturbed condition • Limit clearing and grading of native vegetation at a site to the minimum amount needed to build lots, allow access, and provide fire protection • Maximize trees and other vegetation at each site, planting additional vegetation, clustering tree areas, and promoting the use of native and/or drought tolerant plants • Promote natural vegetation by using parking lot islands and other landscaped areas • Preserve riparian areas and wetlands	• Approximately 32 acres (16%) of the approximately 185-acre project area will remain as parks, landscaping, open spaces (non-River related), and water quality treatment BMPs. • Approximately 74.5 acres (40%) of the approximately 185-acre project area will consist of buried bank stabilization, the Santa Clara River Regional Trail, and the Santa Clara River Corridor. • Site clearing and grading will be limited as necessary to allow development, allow access, and provide fire protection. • Native and/or non-native/non-invasive vegetation will be utilized within the development. • The final Project stormwater system will include the use of the LID and vegetated treatment BMPs placed in common area landscaping in commercial and multi-family residential areas and parking lot islands (where applicable). • The excavation required to construct the bank protection will be backfilled and returned to existing grade, except as overlaid by the 3:1 or flatter fill slope. The final slope will be re-vegetated with native species.
3. Minimize Stormwater Pollutants of Concern	• Minimize, to the maximum extent practicable, the introduction of pollutants of concern that may result in significant impacts generated from site runoff of directly connected impervious areas (DCIA) to the stormwater conveyance system as approved by the building official.	• LID, source control, and treatment control BMPs will be selected to address the pollutants of concern for the Project (see Section 5.3 below). These BMPs are designed to minimize introduction of pollutants to the Maximum Extent Practicable (MEP). • The Project will include numerous source controls, including education programs, animal waste bag stations, street sweeping and catch basin cleaning. • An education program will be implemented that includes both the education of residents and commercial businesses regarding water quality issues. Topics will include services that could affect water quality, such as

SUSMP Requirement	Criteria/ Description	Corresponding Vista Canyon PDFs
		carpet cleaners and others that may not properly dispose of cleaning wastes; community car washes; and residential car washing. The education program will emphasize animal waste management, such as the importance of cleaning up after pets and not feeding pigeons, seagulls, ducks, and geese. • LID and treatment control BMPs will promote the infiltration of treated stormwater.
4. Protect Slopes and Channels	Project plans must include BMPs consistent with local codes and ordinances and the SUSMP requirements to decrease the potential of slopes and/or channels from eroding and impacting stormwater runoff: • Convey runoff safely from the tops of slopes and stabilize disturbed slopes • Stabilize permanent channel crossings • Vegetate slopes with native or drought tolerant vegetation • Install energy dissipaters, such as riprap, at the outlets of new storm drains, culverts, conduits, or channels that enter unlined channels in accordance with applicable specifications to minimize erosion with the approval of all agencies with jurisdiction, e.g., the U.S. Army Corps of Engineers and the California Department of Fish and Game.	• There are no significant slopes or natural drainage channels within the developed portion of the Project in the post-developed condition. • Natural slopes and native vegetation on slopes adjacent to the Santa Clara River will be preserved and/or, if impacted during construction, they will be restored and enhanced. Native plants will be used in all plant palettes placed on restored slopes. • Project PDFs (hydrologic source controls), will reduce flows to the Santa Clara River through infiltration and evapotranspiration. • The banks of the Santa Clara River at portions of this site will be stabilized using buried bank stabilization. After implementation of these measures and other flow control and volume reduction PDFs, the Santa Clara River will be capable of handling the expected flow volumes, velocities, and durations with little or no erosion. For a description of bank stabilization see Section 5.4.2. • All outlet points to the Santa Clara River will include energy dissipaters. For a description of energy dissipation see Section 5.4.2.

SUSMP Requirement	Criteria/ Description	Corresponding Vista Canyon PDFs
5. Provide Storm Drain System Stenciling and Signage	• All storm drain inlets and catch basins within the Project area must be stenciled with prohibitive language and/or graphical icons to discourage illegal dumping. • Signs and prohibitive language and/or graphical icons, which prohibit illegal dumping, must be posted at public access points along channels and creeks within the Project area. • Legibility of stencils and signs must be maintained.	• All storm drain inlets and water quality inlets will be stenciled or labeled. • Signs will be posted in areas where dumping could occur. • The City, a Landscape or Local Maintenance District (LMD), Homeowners Association (HOA), or other maintenance entity will maintain stencils and signs.
6. Properly Design Outdoor Material Storage Areas	• Where proposed Project plans include outdoor areas for storage of materials that may contribute pollutants to the stormwater conveyance system measures to mitigate impacts must be included.	• Pesticides, fertilizers, paints, and other hazardous materials used for maintenance of common areas, parks, commercial areas, and multifamily residential common areas will be kept in enclosed storage areas.
7. Properly Design Trash Storage Areas	All trash containers must meet the following structural or treatment control BMP requirements: • Trash container areas must have drainage from adjoining roofs and pavement diverter around the areas. • Trash container areas must be screened or walled to prevent offsite transport of trash.	• All outdoor trash storage areas will be covered and isolated from stormwater runoff.
8. Provide Proof of Ongoing BMP Maintenance	• Applicant required to provide verification of maintenance provisions through such means as may be appropriate, including, but not limited to legal agreements, covenants, and/or Conditional Use Permits.	• Depending on the type and location of the BMP, either the City, a Landscape or Local Maintenance District (LMD), or Homeowners Association (HOA) will be responsible for maintenance. • The Homeowners/Property Owners Associations or residential, commercial/ business owners will be responsible for operation and maintenance of site-based BMPs (such as BMPs placed in common area landscaping in multi-family residential areas and commercial areas). • The City of Santa Clarita will be responsible for maintenance of BMPs located in public right-of-way or in larger open space parcels.

SUSMP Requirement	Criteria/ Description	Corresponding Vista Canyon PDFs
9. Design Standards for Structural or Treatment Control BMPs	• Post-construction Structural or Treatment Control BMPs shall be designed to mitigate (infiltrate or treat) stormwater runoff using either volumetric treatment control BMPs or flow-based treatment control BMPs sized per listed criteria (see section 3.6.2 above).	• Stormwater treatment facilities will be designed to meet or exceed the sizing standards in the SUSMP requirements. • The size of the facilities will be finalized during the design stage by the project engineer with the final hydrology study, which will be prepared and approved to ensure consistency with this analysis prior to issuance of a final grading permit. • Types of treatment control BMPs that may be employed include planter boxes, bioretention, bioretention swales, vegetated swales, filter strips, permeable pavement, infiltration trenches and galleries, dry wells, storage and reuse systems, proprietary filtration BMPs, and combinations thereof.
10.B.1 Properly Design Loading/ Unloading Dock Areas (100,000 ft^2 Commercial Developments)	• Cover loading dock areas or design drainage to minimize run-on and runoff of stormwater • Direct connections to storm drains from depressed loading docks (truck wells) are prohibited	• Loading dock areas will be covered or designed to preclude run-on and runoff. • Direct connections to storm drains from depressed loading docks (truck wells) will be prohibited. • Below grade loading docks for fresh food items will drain through a treatment control BMP applicable to the use, such as a catch basin insert. • Loading docks will be kept in a clean and orderly condition through weekly sweeping and litter control, at a minimum and immediate cleanup of spills and broken containers without the use of water.
10B.2. Properly Design Repair/ Maintenance Bays (100,000 ft^2 Commercial Developments)	• Repair/ maintenance bays must be indoors or designed in such a way that does not allow stormwater run-on or contact with stormwater runoff. • Design a repair/maintenance bay drainage system to capture all wash water, leaks, and spills. Connect drains to a sump for collection and disposal. Direct connection of the repair/ maintenance bays to the storm drain system is prohibited. If required by local jurisdiction, obtain an Industrial Waste Discharge Permit.	• Commercial areas will not have repair/maintenance bays or the bays will comply with design requirements.

SUSMP Requirement	Criteria/ Description	Corresponding Vista Canyon PDFs
10B.3. Properly Design Vehicle/ Equipment Wash Areas (100,000 ft^2 Commercial Developments)	• Self-contained and /or covered, equipped with a clarifier, or other pretreatment facility, and properly connected to a sanitary sewer.	• Areas for washing/steam cleaning of vehicles will be self-contained or covered with a roof or overhang; will be equipped with a wash racks and with the prior approval of the sewering agency; will be equipped with a clarifier or other pretreatment facility: and will be properly connected to a sanitary sewer.
10.C. Properly Design Equipment/ Accessory Wash Areas (Restaurants)	• Self-contained, equipped with a grease trap, and properly connected to a sanitary sewer. • If the wash area is to be located outdoors, it must be covered, paved, have secondary containment, and be connected to the sanitary sewer.	• Food preparation areas shall have either contained areas or sinks, each with sanitary sewer connections for disposal of wash waters containing kitchen and food wastes. • If located outside, the containment areas or sinks shall also be structurally covered to prevent entry of stormwater. Adequate signs shall be provided and appropriately placed stating the prohibition of discharging washwater to the storm drain system.
10.D. Properly design fueling area (Retail Gasoline Outlets)	• The fuel dispensing area must be covered with an overhanging roof structure or canopy. The cover's minimum dimensions must be equal to or greater than the area within the grade break. The cover must not drain onto the fuel dispensing area and the downspouts must be routed to prevent drainage across the fueling area. • The fuel dispensing area must be paved with Portland cement concrete (or equivalent smooth impervious surface). The use of asphalt concrete shall be prohibited. • The fuel dispensing areas must have a 2% to 4% slope to prevent ponding, and must be separated from the rest of the site by a grade break that prevents run-on of urban runoff. • At a minimum, the concrete fuel dispensing area must extend 6.5 feet (2.0 meters) from the corner of each fuel dispenser, or the length at which the hose and nozzle assembly may be operated plus 1 foot (0.3 meter), whichever is less.	• None are proposed. However, retail gasoline outlets will comply with design requirements.

SUSMP Requirement	Criteria/ Description	Corresponding Vista Canyon PDFs
10.E.1. Properly design fueling area (Automotive Repair Shops)	• See requirement 10.D. above.	• Automotive repair shop fueling areas will comply with design requirements.
10.E.2. Properly design repair/ maintenance bays (Automotive Repair Shops)	• See requirement 10.B.2 above.	• None are proposed. However, automotive repair shop repair/maintenance bays will comply with design requirements.
10.E.3. Properly design vehicle/equipment wash areas (Automotive Repair Shops)	• Self-contained and/or covered, equipped with a clarifier, or other pretreatment facility, and properly connected to a sanitary sewer or to a permitted disposal facility.	• None proposed. However, automotive repair shop vehicle/equipment wash areas will comply with design requirements.
10.E.4. Properly design loading/unloading dock areas (Automotive Repair Shops)	• See requirement 10.B.1. above.	• None proposed. However, automotive repair shop loading/unloading dock areas will comply with design requirements.
10.F.1. Properly Design Parking Area (Parking Lots)	• Reduce impervious land coverage of parking areas • Infiltrate runoff before it reaches the storm drain system • Treat runoff before it reaches storm drain system	• Surface parking lots may incorporate BMPs in selected islands to promote filtration and infiltration of runoff as part of the overall suite of treatment control PDFs. • Stormwater runoff from parking lots will be directed to treatment control BMPs in compliance with SUSMP requirements.
10.F.2 Properly Design to Limit Oil Contamination and Perform Maintenance (Parking Lots)	• Treat to remove oil and petroleum hydrocarbons at parking lots that are heavily used. • Ensure adequate operation and maintenance of treatment systems particularly sludge and oil removal	• See above. • Treatment of runoff in BMPs capable of addressing oil and petroleum hydrocarbons will be used for high-use parking lots. • The HOA/Property Owners Associations or Business Owners will be responsible for operation and maintenance of treatment control BMPs that serve private parking lots.

SUSMP Requirement	Criteria/ Description	Corresponding Vista Canyon PDFs
13. Limitation of Use of Infiltration BMPs	• Infiltration is limited based on design of BMP, pollutant characteristics, land use, soil conditions, and traffic. • Appropriate conditions (groundwater >10 ft from grade) must exist to utilize infiltration to treat and reduce stormwater runoff for the Project.	• Per the LARWQCB Clarification Letter (LARWQCB, 2006a), generally, the common pollutants in stormwater are filtered or adsorbed by soil, and unlike hydrophobic solvents and salts, do not cause groundwater contamination. In addition, the Water Augmentation Study by the Los Angeles and San Gabriel River Watershed Council determined no impacts to groundwater from infiltration of stormwater at several sites studied over a number of years. Seasonal high groundwater levels are greater than 10 feet below the proposed finished grade under infiltration-based BMPs. • BMPs that infiltrate directly into sub-grade soil, such as infiltration galleries and dry wells, will be preceded upstream where necessary by pretreatment BMPs and include design features allowing isolation of the BMP in case of a spill in the watershed.

5.2 Site Design/Low Impact Development BMPs

The purpose of site design/low impact development (LID) BMPs is, to the extent feasible, to mimic the pre-developed hydrologic regime. The primary goals of site design/LID BMPs are to maintain a landscape functionally equivalent to predevelopment hydrologic conditions, and to minimize the generation of pollutants of concern.

Site design/LID principles include:

Minimize Impervious Area/Maximize Permeability – Principles include preserving natural open space, reducing impervious surfaces such as roads, using more permeable paving materials, reducing street widths, using minimal disturbance techniques during development to avoid soil compaction, reducing the land coverage of buildings by building taller and narrower footprints, minimizing the use of impervious materials such as decorative concrete in landscape design, and incorporating detention or infiltration into landscape design.

Minimize Directly Connected Impervious Areas (DCIAs) – Minimizing DCIA can be achieved by directing runoff from impervious areas to vegetated areas (e.g., landscaped areas or vegetated treatment control BMPs) or to infiltration BMPs.

Conserve Natural Areas – Conserving and protecting native soils, vegetation, and stream corridors helps to mimic the site's pre-development hydrologic regime. This may be accomplished by clustering development within portions of the site to conserve as much natural open space as possible, planting additional vegetation, using native and/or non-native/non-invasive vegetation in parking lot islands and other landscape areas, and preserving and/or restoring riparian areas and wetlands.

***Select Appropriate Building Materials* –** Use of appropriate building materials reduces the generation and discharge of pollutants of concern in runoff (and is therefore also a source control BMP). For example, restricting the use of architectural copper on the outside of buildings and reducing the use of galvanized materials will reduce the impact of copper and zinc to stormwater runoff.

***Protect Slopes and Channels* –** Protecting slopes and channels reduces the potential for erosion and preserves natural sediment supply.

5.2.1 Consideration of Spatial Scale

Site design/LID BMP implementation for the Project occurs at different spatial scales of development. These spatial scales are listed below, from larger to smaller scale:

- Project scale – the Vista Canyon Project;
- Land use scale – single family residential, multi-family residential, commercial, parks/recreation, and roadways within the Project, and
- Lot or parcel scale – individual lots or parcels within the Project.

5.2.2 Vista Canyon Site design/Low Impact Development BMPs

Project design features include site design/LID BMPs, as described above and summarized in Table 5-2 below. These PDFs will reduce stormwater runoff volume and promote groundwater recharge in an integrated approach to protecting water quality and managing water resources in accordance with the Los Angeles County LID Ordinance requirements as established in the LID Standards Manual.

Table 5-2: Vista Canyon Site Design/Low Impact Development BMPs

LID Manual Requirement	Corresponding Vista Canyon LID Practice
1. Large scale residential and nonresidential development projects shall prioritize the selection of BMPs to treat stormwater pollutants, reduce stormwater runoff volume, and promote groundwater infiltration and stormwater reuse in an integrated approach to protecting water quality and managing water resources.	• The types of treatment control BMPs that may be employed include planter boxes, bioretention, bioretention swales, vegetated swales, filter strips, permeable pavement, infiltration trenches and galleries, dry wells, storage and reuse systems, proprietary filtration BMPs, and combinations thereof.
2. BMPs shall be implemented in the following order of preference: 1. BMPs that promote infiltration. 2. BMPs that store and beneficially use stormwater runoff. 3. BMPs that utilize the runoff for other water conservation uses including, but not limited to, BMPs that incorporate vegetation to promote pollutant removal and runoff volume reduction and integrate multiple uses, and BMPs that percolate runoff through engineered soil and allow it to discharge downstream slowly. 4. If the Director of Public Works determines that compliance with the above (No. 3) LID requirements is technically infeasible, in whole or in part, in response to an applicant's submittal, the Director shall require the applicant to submit a proposal for approval by the Director that incorporates design features demonstrating compliance with the LID requirements to the maximum extent practicable.	• The types of treatment control BMPs that may be employed include: 1. BMPs that promote infiltration (e.g., bioretention, bioretention swales, vegetated swales, filter strips, permeable pavement, infiltration trenches and galleries, and dry wells) 2. BMPs that store and beneficially use stormwater runoff (e.g., stormwater harvesting systems). 3. BMPs that utilize the runoff for other water conservation uses including, but not limited to, BMPs that incorporate vegetation to promote pollutant removal and runoff volume reduction and integrate multiple uses, and BMPs that percolate runoff through engineered soil and allow it to discharge downstream slowly (e.g., bioretention, bioretention swales, vegetated swales, filter strips, planter boxes, proprietary filtration BMPs). 4. Technically feasible determination will be finalized by the project engineer as part of the final hydrology study.
3. The LID goals of increasing groundwater recharge, enhancing water quality, and preventing degradation to downstream natural drainage courses shall be used in the evaluation, approval, and implementation of LID BMPs, as well as any determination of infeasibility.	• The types of treatment control BMPs included as PDFs for the Project promote the LID goals of increasing groundwater recharge, enhancing water quality, and preventing degradation to downstream natural drainage courses.
4. The excess volume (ΔV) shall be infiltrated, stored and used, or captured and treated in vegetated BMPs throughout the project site whenever possible. This can be accomplished on a lot-by-lot or on a subregional scale provided that equivalent benefit can be demonstrated.	• The excess volume (ΔV) will be infiltrated, stored and used, or captured and treated in vegetated BMPs throughout the project site whenever possible based on the feasibility analysis finalized by the project engineer as part of the final hydrology study.

5.3 Treatment and Volume Control Project Design Features

The SUSMP requirements mandate that treatment controls address the pollutants of concern from all developed areas of a project. The Los Angeles County LID Manual stipulates that LID

BMPs address increases in runoff volume as a result of a project. This section describes the treatment control and volume control PDFs that are proposed for the Project. Note that a single project design feature may provide both treatment and volume control benefits, thus, these classes of PDFs are described together in this section.

5.3.1 Treatment and Volume Control Performance Standard

Stormwater runoff from all urban areas within the Project will be routed to treatment control and volume control PDFs consistent with the following criteria:

1. Treatment of runoff will be provided for all developed areas by BMPs sized for the entire water quality volume or flowrate as defined by SUSMP:

    a) ***Water Quality Volume*****.** The runoff volume resulting from the 85th percentile, 24-hour storm event at the Newhall rainfall gage (1.4 inches) based on 48-hour drawdown of stored water, or an equivalent combination of design storm and drawdown time; or

    b) ***Water Quality Flowrate*****.** The runoff flowrate resulting from 0.2 inch per hour uniform rainfall intensity based on a 30 minute time of concentration, adjusted per SUSMP Appendix A, Table A-1 for shorter times of concentration.

2. Infiltration or capture and use of the difference between pre-development and post-development runoff volume from the water quality storm event (i.e. the “delta volume”) will be provided by Project PDFs except where infeasible or where exempted based on land use or ownership.

    a) ***Where infeasible*****:** infiltrate or capture and use the maximum amount feasible and capture, treat, and discharge the remaining volume in a vegetated BMP.

    b) ***Where exempted*****:** detain, treat, and discharge the delta volume in a vegetated BMP.

Infiltration may be deemed infeasible where soils to do not have sufficient infiltration rate or where natural features, such as shallow bedrock, limit infiltration. Infiltration may be prohibited where groundwater is less than 10 feet below the ground surface, within 100 feet of a drinking water well, in locations where infiltration could cause geotechnical instability, or in locations where infiltration may mobilize soil or groundwater contamination. Capture and reuse is not appropriate on projects that use reclaimed water for irrigation, as sufficient irrigation demand must exist for stormwater capture and use systems to control pollutant loads properly, and the demand for reclaimed water conflicts with the demand for stormwater on such projects. Public road and flood control infrastructure projects are not subject to the County’s LID Ordinance and Manual.

5.3.2 Spatial Application of Performance Standard

The spatial application of the Performance Standard is influenced by soil and groundwater conditions and land use as described above.

Geotechnical investigations of the project site (RTFA, 2006, 2008) permit a planning-level assessment of areas where infiltration may be infeasible based on physical factors (low infiltration rates, shallow bedrock, etc.). It was assumed that areas of the project site underlain by bedrock would not be able to meet infiltration goals on site due to low infiltration rates, thus would be exempt from the requirement to infiltrate the “delta volume.” While it may be feasible to route runoff from these areas to adjacent areas for infiltration, this planning-level assumption is consistent with the current level of design detail and serves to bracket the lower bound on the portion of the site that will be able to achieve the “delta volume” criterion.

Two production wells are present within the Project in the River corridor, but are not within 100 feet of proposed development. Based on current grading plans and water level records in production wells (Personal Communication, RTFA), seasonal high groundwater is greater than 10 feet below proposed ground surface everywhere on the proposed project site with the exception of the River corridor where development is not proposed. Finally, the site does not contain known pollutant plumes. Therefore, none of these factors limit the areas over which infiltration can occur.

BMPs accepting drainage from public roads, Metrolink infrastructure, and off-site land uses not constructed by the project (but comingled with untreated project runoff) are required to provide treatment for the full water quality volume or flowrate but are exempt from volume control requirements.

The Project will use reclaimed water for irrigation, thus is exempt from the requirement to preferentially incorporate capture and reuse systems over BMPs that detain, treat and discharge where infiltration is not feasible. One capture and reuse system is proposed for the project. This system is located within an area suitable for infiltration and will meet the delta volume criterion through a combination of storage and irrigation use in a community garden and storage and infiltration in an infiltration gallery.

Table 5-3 below provides an estimate of the Project area that will comply with the treatment and volume control performance standard (SUSMP and Delta V), the treatment control standard (SUSMP), and self-mitigating areas (such as vegetated slopes).

Table 5-3: Spatial Application of Treatment and Volume Control Performance Standards

	Total Area (Acre)	Area Achieving Performance Standard (Acre)		
		SUSMP and Delta V	SUSMP	Self-Mitigating
PA-1	12.0	12.0	-	-
PA-2	30.4	20.6	9.8	-
PA-3	44.0	43.0	1.0	-
PA-4	12.8	6.7	6.1	-
Public Roads (outside of PA)	8.8	-	8.8	-
River Bank Protection[1]	22.3	-	2.8	19.5
On-site Total	130.3	82.3	28.5	19.5
Off-site Areas	33.0	0.0	32.6	0.4
Project Total	163.3	82.3	61.1	19.9

[1]The River Bank Protection area encompasses maintenance access roads (2.8 acres), buried bank stabilization (6.8 acres), and areas of the river bed that will be temporarily impacted by construction (12.7 acres), but does not include river corridor which will not be developed.

5.3.3 Structural Treatment and Volume Control BMPs

The SUSMP and LID requirements mandate that BMPs be selected to address the pollutants of concern. Pollutants of concern for the Project include:

- Sediments (TSS and Turbidity)
- Nutrients (Total Phosphorus, Nitrate-N + Nitrite-N, Ammonia-N, and Total Nitrogen)
- Trace Metals (Copper, Lead, and Zinc)
- Pathogens (Bacteria, Viruses, and Protozoa)
- Petroleum Hydrocarbons (Oil and Grease and PAHs)
- Pesticides
- Trash & Debris
- Chloride
- Methylene Blue Activated Substances (MBAS)
- Cyanide

Treatment BMPs to be used for the Project are listed in Table 5-4, along with the pollutants of concern addressed by each.

Table 5-4: Treatment Control BMP Selection Matrix

Pollutant of Concern[1]	Treatment Control BMP Categories				
	Vegetated Swale	Bioretention	Infiltration BMPs[3]	Retention/ Irrigation	Media Filters[4]
Sediment	M	H	H	H	M
Nutrients	L	M	H	H	L
Trace Metals	M	H	H	H	M
Bacteria	L	H	H	H	L
Organics[2]	M	H	H	H	M
Trash	L	H	H	H	H

Source: California Stormwater Best Management Practices Handbook for New Development and Redevelopment (CASQA, 2003)

Note: H, M, L, indicates high, medium, and low removal efficiency.

[1]Chloride and MBAS are addressed with source control BMPs, as they are not treatable in typical stormwater treatment BMPs aside through infiltration.

[2]Includes pesticides and petroleum hydrocarbons.

[3]Same rankings apply to all infiltration BMPs (permeable pavement, bioretention without underdrains, infiltration trenches, dry wells, underground infiltration galleries)

[4]Treatment effectiveness for this category is estimated based on best professional judgment, as effectiveness results are not reported for proprietary treatment technologies in the CASQA BMP Handbook.

LID requirements focus on infiltration of stormwater as close to the source as feasible, followed by sub-regional infiltration BMPs. This focus is intended to control both changes in stormwater quantity, caused by increase in impervious area, and changes in stormwater quality, caused by changes in land use. BMPs that have underdrains or treated surface discharge outlets generally do not retain and infiltrate sufficient volumes of water to meet volumetric reduction criteria where it is required. Table 5-5 below summarizes the ability of the potential treatment control BMPs to provide SUSMP treatment and volume reduction.

Table 5-5: Treatment Control BMP Selection Matrix

BMP	Provides SUSMP Treatment and Incidental Volume Reduction	Provides SUSMP and Delta Volume Reduction
Bioretention with Underdrains	♦	
Bioretention without Underdrains		♦
Planter Boxes	♦	
Vegetated Swale	♦	
Combo Bioretention Swale		♦
Filter Strip	♦	
Permeable Pavement		♦
Underground Infiltration Gallery		♦
Infiltration Trench		♦
Dry Well		♦
Storage and Use		♦
Proprietary Filters	♦	

In order to meet both SUSMP and LID requirements, stormwater runoff from all developed areas within the Project will be routed to BMPs meeting the Project Performance Standard. The proposed spatial application of this standard is illustrated in Figure 5-1 and summarized in Table 5-3. The preliminary sizing of the treatment control facilities is provided in the Vista Canyon Ranch Drainage Concept Report (Alliance, 2010). Facility sizing will be finalized by the project engineer based upon the final hydrology study and will be consistent with the conclusions of this analysis.

Treatment BMPs to be used for the Project are described below. The effectiveness of the selected treatment BMPs is described in detail in Appendix B, Section B.2.5. The effectiveness of treatment BMPs is evaluated without taking source control BMPs into account. Therefore, the analysis is conservative in that it understates water quality controls.

Bioretention

Bioretention areas are vegetated (i.e., landscaped) shallow depressions that provide storage, infiltration, and evapotranspiration. Bioretention areas also remove pollutants by filtering stormwater through plants adapted to the local climate and soil moisture conditions and an engineered soil mix. In bioretention areas, pore spaces, microbes, and organic material in the engineered soils help to retain water in the form of soil moisture and to promote the adsorption of pollutants (e.g., dissolved metals and petroleum hydrocarbons) into the soil matrix. Plants utilize soil moisture and promote the drying of the soil through transpiration. If no underdrain is provided, exfiltration of the stored water in the bioretention area engineered soil into the underlying soils occurs over a period of days. A conceptual illustration of a bioretention area is shown in Figure 5-2.

Planter Boxes

Planter boxes are much like bioretention, with a soil media layer, a gravel drainage layer, and vegetation. Like bioretention, planter boxes provide storage, filtration, and evapotranspiration, and remove pollutants via filtration. However, unlike many bioretention, planter boxes are typically underlain by an impervious layer and not designed to infiltrate water. This allows planter boxes to be placed in areas where infiltration is prohibited. It also prevents them from achieving the LID volume reduction criteria. Planter boxes may be designed without a bottom where infiltration is permissible. A conceptual illustration of a planter box is shown in Figure 5-3.

Vegetated Swales

Vegetated swales treat stormwater runoff through both vegetative treatment and infiltration. Swales treat the water quality design flow as the runoff sheet-flows through grassy vegetation on the swale surface, removing pollutants by filtering stormwater through plants adapted to the local climate and soil moisture conditions. Incidental infiltration occurs into native soil when water is present. Plants utilize soil moisture and promote the drying of the soil through transpiration thereby promoting volume reduction. A conceptual illustration of a vegetated swale is shown in Figure 5-4.

Combination Bioretention Swales

Combination bioretention swales have attributes of both bioretention areas and swales described above and are intended specifically to meet the Project Performance Standard. Bioretention swales have all the attributes of a bioretention area, but do not include an underdrain. Runoff is stored in the pores of the amended soil and in shallow surface ponding and exfiltrates into native soil over a period of days. The facilities are designed to retain a specified volume of water and have no surface discharge for this volume. When this volume fills during a storm, the facility begins to overflow but continues to treat water that flows through by filtering water through the plants, as occurs in a swale. Bioretention swales are linear in shape, have dense vegetation that protrudes above the maximum water surface elevation, and are configured with the inlet and outlet at opposite ends to promote flow through the length of the facility. Outlet controls above the retained volume promote sufficient residence time. A conceptual illustration of a bioretention swale is shown in Figure 5-5.

Filter Strip

Filter strips treat stormwater runoff through both vegetative treatment and infiltration. Runoff from impervious surfaces sheet flows in a very shallow layer through grassy vegetation, removing pollutants by filtering stormwater through plants adapted to the local climate and soil moisture conditions. Incidental infiltration occurs into native soil when water is present. Plants utilize soil moisture and promote the drying of the soil through transpiration thereby promoting volume reduction. A conceptual illustration of a filter strip is shown in Figure 5-6.

Permeable Pavement

Permeable pavements contain small voids that allow water to pass through to a stone base. They come in a variety of forms; they may be a modular paving system (concrete pavers, grass-pave, or gravel-pave) or poured in place solutions (porous concrete, permeable asphalt). All permeable pavements include an aggregate reservoir to retain and infiltrate water. An overflow pipe is generally installed near the top of this aggregate layer to ensure that water does not pond on the surface of the pavement. While conventional pavement result in increased rates and volumes of surface runoff, permeable pavements, when properly constructed and maintained, allow some of the stormwater to percolate through the pavement and enter the soil below. A conceptual illustration of a permeable pavement installation is shown in Figure 5-7.

Underground Infiltration Gallery

Underground retention and infiltration galleries operate by storing and infiltrating water below roadways or other surfaces. These may consist of a thick layer of aggregate providing storage volume in pore space. Alternatively, underground retention products are available that provide storage capacity and promote infiltration, often more efficiently than aggregate reservoirs. Pretreatment is required for underground retention BMPs in order to reduce the sediment load entering the facility and maintain the infiltration rate of the facility. For best long term performance and minimal maintenance, pretreatment should be provided by a filtration BMP with the capability of addressing fine particulates. A conceptual illustration of an underground infiltration gallery is shown in Figure 5-8.

Infiltration Trench

Infiltration trenches are rock-filled trenches design specifically to store stormwater during a storm and exfiltrate it into surrounding soils over a period of days. Infiltration trenches are used in areas with high infiltration rates and limited space. Pretreatment is required for infiltration trenches in order to reduce the sediment load entering the facility and maintain the infiltration rate of the facility. A conceptual illustration of an infiltration trench is shown in Figure 5-9.

Dry Well

Dry wells are much like infiltration trenches but may be installed deeper in the soil profile to specifically promote infiltration into highly infiltrative soil layers. Pretreatment is required for dry wells in order to reduce the sediment load entering the facility and maintain the infiltration rate of the facility. For best long term performance and minimal maintenance, pretreatment should be provided by a filtration BMP with the capability of addressing fine particulates. A conceptual illustration of a dry well is shown in Figure 5-10.

Storage and Use

Storage and use systems may take a variety of forms, most typically consisting of cisterns or rain barrels connected to a roof gutter system. Roof runoff is captured and stored for non-potable use. The collection of stormwater reduces runoff and can make water available for non-potable uses such as irrigation, thus reducing overall water usage. To comply with the Project Performance Standard, cisterns must be designed for the entire water quality volume and must draw down a portion of this volume quickly enough to make room for subsequent storms. A conceptual illustration of a storage and reuse system is shown in Figure 5-11.

Proprietary Devices

Proprietary devices are commercial products that typically aim to provide stormwater treatment in space-limited applications, often using patented innovative technologies. The most commonly encountered classes of proprietary stormwater management controls include hydrodynamic separation, catch basin insert technologies, cartridge media filters, and proprietary biotreatment devices. These devices are briefly explained below. Generally, proprietary devices that do not incorporate vegetation are discouraged by regulatory agencies, and are not capable of meeting LID Ordinance and Manual standard. These may be effective for pretreatment upstream of underground infiltration facilities, for capture of trash, or for small parts of the development that cannot otherwise be treated. Typical proprietary devices include:

- Hydrodynamic separation devices (alternatively, swirl concentrators) are devices that are installed in a gutter or manhole and remove trash, debris, and coarse sediment from incoming flows using screening, gravity settling, and centrifugal forces generated by forcing the influent into a circular motion.
- Catch basin inserts are manufactured filters or fabric placed in a drop inlet to remove sediment and debris and may include sorbent media to remove floating oils and grease. There are a multitude of inserts of various shapes and configurations, typically falling into one of three groups: socks, boxes, and trays.
- Cartridge filters typically consist of a cartridges packed with filter media contained in a vault or catch basin that provide treatment through filtration and sedimentation. The vault may be divided into multiple chambers where the first chamber acts as a pre-settling basin for removal of coarse sediment while another chamber acts as the filter bay and houses the filter cartridges.
- Proprietary biotreatment devices are devices that are manufactured to mimic natural systems such as soil columns and wetlands by incorporating plants, soil, and microbes engineered to provide treatment at higher flow rates or higher volumes and with smaller footprints than their natural counterparts. Incoming flows are typically filtered through natural media (mulch, compost, soil, plants, microbes, etc) and either infiltrated or collected by an underdrain and delivered to the storm system. Tributary areas for biotreatment devices tend to be limited to 0.5 to 1.0 acres.

Conceptual illustrations of selected proprietary BMPs are shown in Figure 5-12.

5.4 Hydromodification Control PDFs

A series of progressive hydromodification control measures will be used in the Project to prevent and control hydromodification impacts to the Santa Clara River:

- Avoid, to the extent feasible, the need to mitigate for hydromodification impacts by preserving natural hydrologic conditions and protecting sensitive hydrologic features, sediment sources, and sensitive habitats within the River corridor.
- Minimize the effects of development through low impact/site design practices (e.g., reducing connected impervious surfaces) and implementation of stormwater volume-reducing BMPs (project-based hydrologic source control).
- Mitigate hydromodification impacts using geomorphically-based channel design.

5.4.1 Hydrologic Source Control

Disconnecting impervious areas from the drainage network and adjacent impervious areas is a key approach to protecting channel stability. Several hydrologic source controls will be included in the Project that will limit impervious area and disconnect imperviousness to avoid and minimize hydromodification impacts.

Site Design/Low Impact Development BMPs

Site design/LID BMPs that help to reduce the increase in runoff volume include leaving areas of undeveloped open space, routing of stormwater runoff to vegetated areas and/or vegetated BMPs, permeable pavement and infiltration galleries, use of native or non-native/non-invasive plants in landscaped areas, and the use of efficient irrigation systems in common area landscaped areas.

Treatment Controls

The Project's treatment control BMPs will also serve as hydromodification source control BMPs. Vegetated swales, bioretention areas, permeable pavement and infiltration galleries will provide significant wet weather volume reduction through infiltration and evaporation. In addition these facilities will also receive and eliminate dry weather flows.

5.4.2 Geomorphically-Referenced Channel Design

The hydromodification management approach for the Santa Clara River will incorporate "geomorphically-referenced" channel design as described in SCCWRP Technical Report 450 (SCCWRP, 2005a). The goal of this approach is to preserve the natural stream channel function to the maximum extent practicable while limiting instability in stream channel morphology.

The Project's development footprint will allow for the greatest freedom possible for "natural stream channel" activity. This includes establishing upland areas and maintaining setbacks to allow for channel movement and adjustment to changes in energy associated with runoff.

The engineered structural elements that will be implemented where needed for Santa Clara River stability include energy dissipation and geomorphically-referenced bank stabilization.

Energy Dissipation

Energy dissipation at storm drain outfalls provides erosion protection in areas where discharges have the potential to cause localized stream erosion. Erosion protection will be provided at all storm drain outlets to the Santa Clara River.

Bank Stabilization

The Project will include buried bank stabilization (soil cement) along the Santa Clara River. The proposed bank protection would consist of buried soil cement to provide scour and freeboard flood control protection. Soil cement is a flood control technique used to protect against erosion while maintaining natural vegetation and soft banks. Soil cement will be buried below the existing banks of the Santa Clara River. Disturbed areas will then re-vegetated with native plant species, maintaining or improving the natural habitat presently found along the River.

5.5 Operation and Maintenance

Depending on the type and location of the BMP, the City, a Landscape Maintenance District (LMD), Drainage Benefit Assessment Area (DBAA), Homeowners or Property Owners Association (HOA or POA), or other similar government or quasi-government agency will be responsible for maintenance. LMD(s), DBAA(s), or other similar government or quasi-government agency would be formed prior to both turnover of stormwater facilities and the first home sale. Maintenance and inspection agreements will be established as the treatment facilities are approved and built. HOA or POA maintenance agreements will incorporate a list of responsibilities. The LMD(s), DBAA (s), or other similar government or quasi-government agency will have a mechanism and staffing to monitor, maintain, and enforce BMP maintenance. The City will have the right to inspect and maintain the BMPs that are maintained by the HOA/POA, LMD, DBAA, or other similar agency at the expense of the HOA, LMD, DBAA, or other similar agency, if they are not being properly maintained. BMP maintenance will be conducted in compliance with maintenance requirements established in the Los Angeles County Stormwater BMP Design and Maintenance Manual (LACDPW, 2009).

5.6 WRP

The WRP design is described in *Engineering Report for the Vista Canyon Water Factory* (Dexter Wilson Engineering Inc., 2010). The WRP will be designed to produce disinfected tertiary recycled water meeting the requirements of Section 60304(a) of Title 22, including the reliability requirements of Title 22. No solids will be treated on site. The WRP will be a scalping plant with waste activated sludge processed at the Santa Clarita Valley Sanitation District facilities downstream.

The treatment process will be a variation of the extended aeration activated sludge process; the treatment process variation will be selected during final design of the WRP. One of three processes will be used for secondary and tertiary treatment: 1) conventional extended aeration activated sludge with sand filters, 2) sequencing batch reactors with sand filters, or 3) membrane bioreactors. All of these technologies would produce disinfected tertiary recycled water meeting the requirements listed above.

The headworks will be designed to pump flow to the start of the treatment process and provide screening to protect downstream equipment. If a conventional system or sequencing batch reactor system is used, course screening or a comminutor will be installed upstream of the influent pump station and will provide protection for downstream processes. If the membrane bioreactor process is used, then a fine screen and screening compacter will be needed.

After the headworks and prior to the treatment process, a flow equalization basin may be installed. The purpose of this basin would be to balance out incoming flow variations such that a constant flow rate is conveyed through the treatment process portion of the plant. This equalization would only be needed if the peak flow cannot be accommodated in the secondary or tertiary process. A bypass line will be provided to allow the flow equalization tank to be taken off-line without shutting down the plant.

Disinfection will be accomplished through a combination of ultraviolet (UV) and chlorination. UV will be the primary disinfectant. UV is utilized to reduce the amount of chlorine being added to the system to reduce effluent chlorine levels. In order to provide continuous disinfection in the piping system, a small amount of chlorine will be added after the UV disinfection.

Excess recycled water and off-quality effluent will be percolated in percolation ponds at the WRP. Effluent that is directed to the percolation ponds will not be chlorinated to prevent chlorinated byproducts from being infiltrated. Additionally, stormwater may be diverted to the percolation ponds to dilute the recycled water. Pretreatment would be provided to the stormwater diverted to the percolation ponds to remove suspended sediment to prevent clogging.

6 WATER QUALITY ANALYSIS APPROACH

6.1 Stormwater Assessment Methodology

6.1.1 Stormwater Modeling

A water quality model was used to estimate pollutant loads and concentrations in Project stormwater runoff for certain pollutants of concern for pre-development conditions and post-development conditions with PDFs. The water quality model is one of the few models that accounts for the observed variability in stormwater hydrology and water quality. This is accomplished by characterizing the probability distribution of observed rainfall event depths, stormwater event mean concentrations, and the number of storm events per year. These distributions are then sampled randomly using a Monte Carlo Approach to develop estimates of mean annual loads and concentrations.

A detailed description of the stormwater quality model is presented in Appendix B. The following summarizes major features of the model:

- *Rainfall Data*: The water quality model estimates the volume of runoff from storm events. The storm events were determined from 40 years (1969 - 2008) of hourly rainfall data measured at the National Climatic Data Center (NCDC) Newhall rain gage that incorporates a wide range of storm events. The rainfall analysis that is incorporated in the water quality model requires rainfall measurements at one hour intervals and a period of record that is at least 20 to 30 years in length.

- *Land Use Runoff Water Quality*: The water quality model estimates the concentration of pollutants in runoff from storm events based on existing and proposed land uses. The pollutant concentrations for various land uses, in the form of Event Mean Concentrations (EMCs), were estimated from data collected in Los Angeles County (LACDPW, 2000). The Los Angeles County database was chosen for use in the model because: (1) it is an extensive database that is quite comprehensive, (2) it contains monitoring data from land use specific drainage areas, and (3) the data is representative of the semi-arid conditions in southern California.

- *Pollutant Load*: The pollutant load associated with each storm is estimated as the product of the storm event runoff times the event mean concentration. For each year in the simulation, the individual storm event loads are summed to estimate the annual load. The mean annual load is then the average of all the annual loads.

- *PDFs Modeled*: The modeling only considers the structural treatment PDFs (vegetated swales, and bioretention areas, infiltration, cisterns) and does not take into account source control PDFs (e.g., street sweeping and catch basin inserts) that would also improve water quality. In this respect, the modeling results are conservative (i.e., tend to overestimate pollutant loads and concentrations).

- *Treatment Effectiveness*: The water quality model estimates mean pollutant concentrations and loads in stormwater following treatment. The amount of stormwater runoff that is captured by the treatment BMPs was calculated for each storm event, taking into consideration the intensity of rainfall, duration of the storm, and duration between storm events. The mean effluent water quality for treatment BMPs was based on the International Stormwater BMP Database (ASCE/EPA, 2003). The International Stormwater BMP Database was used because it is a peer reviewed database that contains a wide range of BMP effectiveness studies that are reflective of diverse land uses. An analysis of the monitored inflow and outflow data contained in the International Stormwater BMP Database showed a volume reduction on the order of 38 percent for biofilters (Strecker *et al.*, 2004). Based on this analysis, a conservative estimate of 25 percent of the inflow to the vegetated swales and bioretention with underdrains was assumed to infiltrate and/or evapotranspire in the water quality model. These assumptions regarding volumetric losses were also used to assess the quantity of dry weather flows that would be captured in the treatment BMPs (see Section 7.8.2).

- *Bypass Flows*: The water quality model takes into account conditions when the treatment facility is full and flows are bypassed.

- *Representativeness to Local Conditions*: The water quality model utilizes runoff water quality data obtained from tributary areas that have a predominant land use, and are measured prior to discharge into a receiving water body. Currently, such data are *available from stormwater programs in Los Angeles County, San Diego County, and* Ventura County, although the amount of data available from San Diego County and Ventura County is small in comparison with the Los Angeles County database. Such data is often referred to as "end-of-pipe" data to distinguish it from data obtained in urban streams, for example.

- *Infiltration*: Existing conditions infiltration parameters were assumed based on soil hydrologic group, soil texture class, and the NRCS Soil Survey of the Project area. The majority of the development area will be impacted by cut/fill operations; therefore, post-development soil compaction impacts were modeled for post-development open and landscaped areas assuming a 25 percent reduction in saturated hydraulic conductivity, or infiltration rate, from the pre-developed to post-developed condition. Impervious surfaces were modeled assuming no infiltration.

6.1.2 Pollutants Modeled

The appropriate form of data used to address water quality are flow composite storm event samples, which are a measure of the average water quality during the event. To obtain such data usually requires automatic samplers that collect data at a frequency that is proportionate to flow rate. The pollutants of concern for which there are sufficient flow composite sampling data in the Los Angeles County database are:

- Total Suspended Solids (sediment)
- Total Phosphorus
- Nitrate-Nitrogen, Nitrite-Nitrogen, Ammonia-Nitrogen, and Total Nitrogen
- Dissolved Copper
- Total Lead
- Dissolved Zinc
- Chloride

The other pollutants of concern, such as pathogens, hydrocarbons, pesticides, and trash and debris, are not amenable to this type of sampling either because of short holding times (e.g., pathogens), difficulties in obtaining a representative sample (e.g., hydrocarbons), or low detection levels (e.g., pesticides). Due to the lack of statistically reliable monitoring data for these pollutants, they were addressed qualitatively using literature information and best professional judgment (see Section 6.1.3 below).

6.1.3 Qualitative Impact Analysis

Post-development stormwater runoff water quality impacts associated with the following pollutants of concern were addressed based on literature information and professional judgment because available data were not deemed sufficient for modeling:

- Turbidity
- Pathogens (Bacteria, Viruses, and Protozoa)
- Hydrocarbons (Oil and Grease, Polycyclic Aromatic Hydrocarbons)
- Pesticides
- Trash and Debris
- Methylene Blue Activated Substances (MBAS)
- Cyanide

Human pathogens are usually not directly measured in stormwater monitoring programs because of the difficulty and expense involved; rather, indicator bacteria such as fecal coliform or certain strains of *E. Coli* are measured. Unfortunately, these indicators are not very reliable measures of the presence of pathogens in stormwater, in part because stormwater tends to mobilize pollutants from many sources, some of which contain non-pathogenic bacteria. For this reason, and because holding times for bacterial samples are necessarily short, most stormwater programs do not collect flow-weighted composite samples that potentially could produce more reliable statistical estimates of concentrations. Fecal coliform or *E. Coli* are typically measured with grab samples, making it difficult to develop reliable EMCs. Total coliform and fecal bacteria (fecal coliform, fecal streptococcus, and fecal enterococci) were detected in stormwater samples tested in Los Angeles County at highly variable densities (or most probable number, MPN) ranging between several hundred to several million cells per 100 ml (LACDPW, 2000).

Hydrocarbons are difficult to measure because of laboratory interference effects and sample collection issues (hydrocarbons tend to coat sample bottles). Hydrocarbons are typically measured with single grab samples, making it difficult to develop reliable EMCs.

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 available on pesticides in urban runoff. Pesticides were not detected in Los Angeles County monitoring data for land use-based samples, except for diazinon and glyphosate which were detected in less than 15 percent and 7 percent of samples, respectively (LACDPW, 2000).

Turbidity, trash and debris, MBAS, and cyanide are not typically included in routine urban stormwater monitoring programs. Turbidity is not typically included in post-construction treatment control BMP effectiveness studies. Several studies conducted in the Los Angeles River basin have attempted to quantify trash generated from discrete areas, but the data represent relatively small areas or relatively short periods, or both. MBAS was included in the land use-based monitoring data, but not enough data is available for modeling purposes. Cyanide was not included in the Los Angeles County land use-based monitoring program.

Also addressed qualitatively are potential water quality impacts from runoff and dewatering discharges, if any, during construction (Section 7.4), potential water quality impacts due to pollutant bioaccumulation (Section 7.5), dry weather runoff water quality impacts (Section 7.6), and groundwater quality impacts (Section 7.8).

6.2 WRP Analysis

Potential impacts to groundwater from percolating WRP effluent were qualitatively assessed based on the estimated recycled water quality. Potential impacts to downstream drinking water supply wells were assessed based on water quality, volume of pumping, and the likely volume of the alluvial aquifer that the water supply wells draw from. The WRP will not discharge to the Santa Clara River, so surface water quality impacts were not analyzed.

7 IMPACT ASSESSMENT

The modeled pollutant impact assessment is presented in Section 7.1 and the qualitative analyses of the remaining pollutants of concern follow in Section 7.2. Analyses of dry weather impacts and compliance with NPDES Permit requirements, LID Ordinance requirements, and construction-related requirements of the Construction General Permit and Dewatering General Permit follow the pollutant-by-pollutant impact assessment. Also included is a discussion of other considerations, including operation and maintenance, vector control, bioaccumulation, and hydrologic impacts. An analysis of potential impacts to groundwater from recycled water is provided, as well as an analysis of cumulative impacts to surface water, groundwater, and hydromodification. A weight of evidence approach is employed using the various significance criteria and thresholds discussed in Section 4.4

7.1 Post Development Stormwater Runoff Impact Assessment for Modeled Pollutants of Concern

In this section, model results for each pollutant are evaluated in relation to the following significance criteria: (1) comparison of post-development versus pre-development stormwater quality concentrations and loads; (2) comparison with MS4 Permit, Construction General Permit, and General Dewatering Permit requirements for new development; and (3) evaluation in light of receiving water benchmarks. Pursuant to the third criterion, predicted runoff pollutant concentrations in the post-development condition, with runoff treatment PDFs, are compared with benchmark receiving water quality criteria as provided in the Basin Plan and the CTR, and with TMDL waste load allocations. The water quality criteria and waste load allocations are considered benchmarks for comparison purposes only, since they do not apply directly to runoff from the Project, but the comparison provides useful information to evaluate potential impacts. A weight of evidence approach is employed in this analysis considering the various significance criteria.

Results from the water quality model for significance criterion 1 are reported in Tables 7-1 and 7-2, organized by constituent, showing predicted mean annual pollutant loads (lbs/yr) and mean annual concentrations. Projections are made for two conditions: (1) existing condition; and (2) developed condition with PDFs. Table 7-1 shows the predicted changes in stormwater runoff mean annual volumes and mean annual pollutant loadings from on-site, off-site and combined Project areas. Table 7-2 shows the predicted changes in mean annual pollutant concentration in stormwater runoff from on-site, off-site and combined Project areas. Specific pollutants and comparison to benchmarks are discussed in the sections that follow.

Table 7-1: Predicted Average Annual Stormwater Runoff Volumes and Pollutant Loads

		On-site Impacts			Off-site Impacts			Total Project		
Parameter	**Units**	**Existing Conditions**	**Developed Conditions w/ PDFs**	**Change**	**Existing Conditions**	**Developed Conditions w/ PDFs**	**Change**	**Existing Conditions**	**Developed Conditions w/ PDFs**	**Change**
Volume	acre-ft	9	69	60	28	30	2	37	99	62
TSS	tons/yr	2.7	7.6	4.9	4.2	2.4	-1.8	6.9	10.1	3.2
Total Phosphorous	lbs/yr	3	62	59	29	35	6	33	97	64
Nitrate-N + Nitrite-N	lbs/yr	29	185	156	61	64	2	90	249	159
Ammonia-N	lbs/yr	4	77	73	32	22	-10	35	99	64
Total Nitrogen - N	lbs/yr	57	525	469	221	203	-18	278	728	450
Dissolved Copper	lbs/yr	0.1	1.6	1.5	1.1	0.9	-0.2	1.1	2.4	1.3
Total Lead	lbs/yr	0.1	1.1	1.0	0.5	0.5	0	0.6	1.6	1.0
Dissolved Zinc	lbs/yr	2	13	11	6	4	-2	8	17	9
Chloride	tons/yr	0.1	2.3	2.2	0.6	0.6	0.0	0.7	2.8	2.1

Table 7-2: Predicted Average Annual Stormwater Pollutant Concentration

		On-site Impacts			Off-site Impacts			Total Project		
Parameter	**Units**	**Existing Conditions**	**Developed Conditions w/ PDFs**	**Change**	**Existing Conditions**	**Developed Conditions w/ PDFs**	**Change**	**Existing Conditions**	**Developed Conditions w/ PDFs**	**Change**
TSS	mg/L	218	79	-139	108	57	-51	130	72	-58
Total Phosphorous	mg/L	0.16	0.34	0.18	0.38	0.43	0.05	0.34	0.37	0.03
Nitrate-N + Nitrite-N	mg/L	1.16	0.98	-0.18	0.80	0.78	-0.02	0.87	0.92	0.05
Ammonia-N	mg/L	0.03	0.10	0.07	0.09	0.09	0.00	0.08	0.10	0.02
Total Nitrogen - N	mg/L	2.4	2.8	0.4	2.9	2.5	-0.4	2.8	2.7	-0.1
Dissolved Copper	mg/L	2.9	8.0	5.1	13.9	10.3	-3.6	11.6	8.7	-2.9
Total Lead	mg/L	5.2	5.9	0.7	6.8	5.7	-1.1	6.4	5.9	-0.5
Dissolved Zinc	mg/L	91	64	-27	80	50	-30	79	60	-19
Chloride	mg/L	8	24	16	16	14	-2	14	21	7

7.1.1 Stormwater Runoff Volume

Mean annual runoff volumes are expected to increase with development. The increase can be explained by the increase in imperviousness associated with development of the site, as well as by the decrease in infiltration capacity of existing site soils associated with the compaction of site soils during construction. For modeling purposes, the existing open space land use was assumed to have an imperviousness of 1 percent. In contrast, single family residential land use is assumed to have an average imperviousness of 60 to 70 percent, multi-family residential land use is assumed to have an average imperviousness of 85 percent, and commercial land use and roads are assumed to have an average imperviousness of 90 percent.

Project design features include site design, source control, and treatment control BMPs in compliance with the SUSMP and LID Ordinance requirements. The site design PDFs, especially the provision of approximately 32 acres of trails, parks, and landscaping/open space/recreation areas within the Project, reduce the impacts of the proposed development on increases in stormwater runoff volume. In addition to water quality improvements, the treatment and volume control BMPs will also provide significant runoff volume reduction; these BMPs are predicted to reduce the post-developed runoff volume by at least 46 acre-feet per year on average.

7.1.2 Total Suspended Solids (TSS)

Comparison of Pre- and Post-Project Conditions

TSS load is predicted to increase with development due to increase in runoff volume. TSS concentration is predicted to decrease as a result of the Project. This decrease can be attributed to higher EMCs observed in monitoring data from open space land uses (the existing condition for the site) compared with urban land uses (representative of post-development conditions).

Comparison with Water Quality Criteria

The predicted average annual TSS concentration in stormwater runoff is compared with receiving water objectives in Table 7-3 below. It is generally expected that TSS concentrations in alluvial streams can be greatly elevated during storm runoff because of the combination of high sediment supply and a high capacity for instream transport and erosion. As concluded by Balance Hydrologics (2005), concepts of “normal” or “average” sediment-supply and flow conditions have limited value in this “flashy” environment, where episodic storm and wildfire events have enormous influence on sediment and storm flow conditions. In the Santa Clara River, a large portion of sediment movement events can occur in a matter of hours or days under large storm flow conditions.

Table 7-3: Comparison of Predicted TSS Concentrations with Water Quality Criteria

Total Project Predicted Average Annual TSS Concentration (mg/L)	Los Angeles Basin Plan Water Quality Objectives	California Toxics Rule Criteria
72	Water shall not contain suspended or settleable material in concentrations that cause nuisance or adversely affect beneficial uses	NA

NA – not applicable

Based on the comprehensive site design/LID, source control, and treatment control strategy, and comparison with the Basin Plan benchmark objectives, potential impacts associated with total suspended solids are predicted to be less than significant.

7.1.3 Total Phosphorus

Comparison of Pre- and Post-Project Conditions

Total phosphorous loads are predicted to increase due to increased runoff volume. Total phosphorous concentration is predicted to increase slightly post-development.

Comparison with Water Quality Criteria

There are no numeric objectives for total phosphorus in the Basin Plan. A narrative objective for biostimulatory substances in the Basin Plan states: "waters shall not contain biostimulatory substances in concentrations that promote aquatic growth to the extent that such growth causes nuisance or adversely affects beneficial uses." The low predicted total phosphorus concentrations in Project stormwater discharges are not expected to promote (i.e., increase) algal growth and therefore comply with the narrative objective for biostimulatory substances in the Basin Plan. As shown in Table 7-4 below, the predicted total phosphorus concentration is at the low end of the range of the historical concentrations observed in Santa Clara River Reach 7.

Table 7-4: Comparison of Predicted Total Phosphorus Concentration with Water Quality Criteria and Observed Concentrations in Santa Clara River Reach 7

Predicted Average Annual Total Phosphorus Concentration (mg/L)	Los Angeles Basin Plan Water Quality Objectives	California Toxics Rule Criteria	Range of Observed[1] Concentrations in Santa Clara River Reach 7 (mg/L)
0.37	Waters shall not contain biostimulatory substances in concentrations that promote aquatic growth to the extent that such growth causes nuisance or adversely affects beneficial uses	NA	0.01 - 17

[1] Range of concentrations observed in the Santa Clara River during wet weather (Lang, Ravenna, Bouquet Junction Stations, see Section 2.7). NA – not applicable

Based on the comprehensive site design/LID, source control, and treatment control strategy and the comparison with available in-stream monitoring data and Basin Plan benchmark objectives, potential impacts associated with total phosphorus are predicted to be less than significant.

7.1.4 Nitrogen Compounds

Comparison of Pre- and Post-Project Conditions

Loads of nitrate- plus nitrite-nitrogen, ammonia, and total nitrogen for the total Project are predicted to increase due to increased runoff volumes. Average concentrations of nitrate- plus nitrite-nitrogen and total nitrogen are predicted to decrease, while concentrations of ammonia-nitrogen are predicted to increase. The decrease in nitrate- plus nitrite-nitrogen and total nitrogen concentrations can be attributed to higher nitrogen compound EMCs observed in monitoring data from open/vacant land use versus urbanized land uses, along with nitrogen reductions in the treatment control PDFs.

Comparison with Water Quality Criteria

Predicted nitrogen compound concentrations are compared to Basin Plan objectives and observed concentrations in Table 7-5 below. The average annual stormwater concentration of ammonia is predicted to be considerably less than the concentration-based waste load allocation for Santa Clara River Reach 6 and the Basin Plan objective, and within the range of observed concentrations. Likewise, the average annual stormwater concentration of nitrate- plus nitrite-nitrogen is predicted to be considerably less than the TMDL waste load allocation and the Basin Plan water quality objective and within the range of historically-observed concentrations for this reach of the Santa Clara River.

There are no numeric objectives for total nitrogen in the Basin Plan. A narrative objective for biostimulatory substances in the Basin Plan states: “waters shall not contain biostimulatory substances in concentrations that promote aquatic growth to the extent that such growth causes nuisance or adversely affects beneficial uses.” The low predicted total nitrogen concentrations in project stormwater discharges will not promote (i.e., increase) aquatic growth and therefore will comply with the narrative objective for biostimulatory substances in the Basin Plan. As shown in Table 7-5, the predicted total nitrogen concentration is within the range of historically-observed concentrations in Santa Clara River Reach 7.

Table 7-5: Comparison of Predicted Nitrogen Compound Concentrations with Water Quality Objectives, TMDLs, and Observed Concentrations in Santa Clara River Reach 7

Nutrient	Predicted Average Annual Concentration (mg/L)	Basin Plan Water Quality Objectives[1] (mg/L)	Waste Load Allocations for MS4 Discharges into the Santa Clara River Reach 7 (mg/L)	Range of Observed[2] Concentrations in Santa Clara River Reach 7 (mg/L)
Nitrate-N + Nitrite-N	0.92	5	6.8[3]	0.2 - 3.5
Ammonia-N	0.10	2.2	1.75	0.04 - 4.3
Total Nitrogen	2.7	Waters shall not contain biostimulatory substances in concentrations that promote aquatic growth to the extent that such growth causes nuisance or adversely affects beneficial uses	NA	0.2 - 12.5

[1] There are no CTR criteria for nitrogen compounds.
[2] Range of concentrations observed in the Santa Clara River during wet weather (Lang, Ravenna, Bouquet Junction Stations, see Section 2.3.1).
[3] 30-day average.

Nitrate-N plus nitrite-N and ammonia-nitrogen concentrations in post-development runoff from the off-site project components are predicted to decrease compared to open space/vacant land use concentrations, although loads are predicted to increase due to the increase in runoff volume.

Based on the comprehensive site design, source control, and treatment control strategy, and the comparison with historical in-stream monitoring data and benchmark Basin Plan objectives and waste load allocations, potential impacts associated with nitrogen compounds are predicted to be less than significant.

7.1.5 Metals

Comparison of Pre- and Post-Project Conditions

Except for lead, the projections are for the dissolved form of the metal, as it is the dissolved form to which the CTR criteria apply. Due to consistently low concentrations of dissolved lead in the available stormwater runoff data, it was not possible to develop reliable EMC parameters for most land uses for modeling the dissolved fraction of lead. This constituent was therefore modeled as the total recoverable metal. Copper, lead, and zinc are the most prevalent metals typically found in urban runoff. Other trace metals, such as cadmium, chromium, and mercury, are typically not detected in urban runoff or are detected at very low levels (LACDPW, 2000).

Post-development dissolved copper, total lead, and dissolved zinc concentrations are projected to decrease compared to pre-development conditions. Total loads for dissolved copper, dissolved zinc, and total lead are predicted to increase compared to pre-development conditions due to increased runoff volumes. These results can be explained by the difference in EMC values observed in representative monitoring data from the pre-developed open/vacant space condition and the post-developed urban condition (see Appendix B, Table B-12).

Project design features include site design/LID, source control, and treatment control BMPs in compliance with the SUSMP requirements. Specific site design PDFs that will be implemented to minimize increases in trace metals include the selection of building material for roof gutters and downspouts that do not include copper or zinc. Source control PDFs that target metals include education for property owners, BMP maintenance, and street sweeping private streets and parking lots. The treatment control BMPs will also reduce trace metals in the runoff from the proposed development.

Comparison with Water Quality Criteria

A narrative objective for toxic substances in the Basin Plan states: "all waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life."

The CTR criteria are the applicable water quality objectives for protection of aquatic life. The CTR criteria are expressed for acute and chronic (4-day average) conditions; however, only acute conditions were considered to be applicable for stormwater discharges because the duration of stormwater discharge is consistently less than four days. The CTR criteria are calculated on the basis of the hardness of the receiving waters. Lower hardness concentrations result in lower, more stringent CTR criteria. The minimum hardness value (270 mg/L as $CaCO_3$) observed in the Santa Clara River at the USGS Station 11107745 during wet weather was used as a conservative estimate.

Comparison of the predicted runoff metal concentrations and the acute CTR criteria for dissolved copper, total lead, and dissolved zinc are shown in Table 7-6 below. The comparison of the post-developed with PDFs condition to the benchmark CTR values shows that all of the trace metal concentrations are below the benchmark water quality criteria.

Table 7-6: Comparison of Predicted Trace Metal Concentrations with Water Quality Criteria

Metal	Predicted Average Annual Concentration (µg/L)	California Toxics Rule Criteria[1] (µg/L)
Dissolved Copper	8.7	34
Total Lead	5.9	290
Dissolved Zinc	60	270

[1] Hardness = 270 mg/L, based on minimum observed value at USGS Station 11107745. Lead criteria is for total recoverable lead.

Based on the comprehensive site design/LID, source control, and treatment strategy and the comparison with benchmark water quality criteria, the Project will not have significant impacts resulting from trace metals.

7.1.6 Chloride

Comparison of Pre- and Post-Project Conditions

Due to the conversion from open/vacant to urban land-uses and the associated EMCs, annual chloride load and concentration are predicted to increase when compared to the existing conditions. The concentration increase is minimal and the load increase is caused by the predicted increase in runoff volume.

Comparison with Water Quality Criteria

The predicted chloride concentration in post-development Project runoff is compared to the Basin Plan water quality objective and the range of historically-observed concentrations in Santa Clara River Reach 7 in Table 7-7 below. The predicted average annual chloride concentration in stormwater runoff from the Project area is well below the Santa Clara River Reach 7 Basin Plan water quality objective and the TMDL waste load allocation for Santa Clara River Reach 5 (100 mg/L for both).

Table 7-7: Comparison of Predicted Chloride Concentrations with Water Quality Criteria and Observed Concentrations in Santa Clara River Reach 7

Pollutant	Predicted Average Annual Concentration (mg/L)	Santa Clara River Reach 7 TMDL Waste Load Allocation & Basin Plan Water Quality Objective[1] (mg/L)	Range of Observed[2] Concentrations in Santa Clara River Reach 7 (mg/L)
Chloride	21	100	35 - 117

[1] There are no CTR criteria for chloride.
[2] Range of concentrations observed in the Santa Clara River during wet weather (Lang, Ravenna, Bouquet Junction; see Section 2.7).

Based on the comprehensive site design/LID, source control, and treatment control strategy, and comparison with benchmark receiving water criteria and instream monitoring data, the Project is not expected to have significant water quality impacts resulting from chloride.

7.2 Post Development Stormwater Impact Assessment for Pollutants and Basin Plan Criteria Addressed Without Modeling

7.2.1 Turbidity

Turbidity is a measure of suspended matter that interferes with the passage of light through the water or in which visual depth is restricted (Sawyer *et al.*, 1994). Turbidity may be caused by a wide variety of suspended materials, which range in size from colloidal to coarse dispersions, depending upon the degree of turbulence. In lakes or other waters existing under relatively quiescent conditions, most of the turbidity will be due to colloidal and extremely fine dispersions. In rivers under flood conditions, most of the turbidity will be due to relatively coarse dispersions. During high energy storm events erosion of clay and silt soils may contribute to in-stream turbidity (see discussion of hydromodification impacts in Section 7.9 below). Organic materials reaching rivers serve as food for bacteria, and the resulting bacterial growth and growth of microorganisms that feed upon the bacteria produce additional turbidity. Nutrients in runoff may stimulate the growth of algae, which also contributes to turbidity.

Discharges of turbid runoff are primarily of concern during the construction phase of development. Construction-related impacts are addressed in Section 7.4 below. The Construction Stormwater Pollution Prevention Plan must contain sediment and erosion control BMPs pursuant to the Construction General Permit, and those BMPs must effectively control erosion and discharge of sediment, along with other pollutants, per the Best Available Technology Economically Achievable and Best Conventional Pollutant Control Technology (BAT/BCT) standards[6]. Additionally, fertilizer control, non-visible pollutant monitoring, and trash control BMPs in the SWPPP will combine to help control turbidity during the construction phase.

---

[6] BAT/BCT are Clean Water Act technology-based standards that are applicable to construction site stormwater discharges. Federal law specifies factors relating to the assessment of BAT including: age of the equipment and facilities involved; the process employed; the engineering aspects of the application of various types of control techniques; process changes; the cost of achieving effluent reduction; non-water quality environmental impacts (including energy requirements); and other factors as the Administrator deems appropriate. Clean Water Act §304(b)(2)(B). Factors relating to the assessment of BCT include: reasonableness of the relationship between the costs of attaining a reduction in effluent and the effluent reduction benefits derived; comparison of the cost and level of reduction of such pollutants from the discharge from publicly owned treatment works to the cost and level of reduction of such pollutants from a class or category of industrial sources; the age of the equipment and facilities involved; the process employed; the engineering aspects of the application of various types of control techniques; process changes; non-water quality environmental impact (including energy requirements); and other factors as the Administrator deems appropriate. Clean Water Act §304(b)(4)(B). The Administrator of U.S. EPA has not issued regulations specifying BAT or BCT for construction site discharges.

In the post-development condition, placement of impervious surfaces will serve to stabilize soils and to reduce the amount of erosion that may occur from the Project area during storm events, and will therefore decrease turbidity in the runoff (see also hydromodification impacts discussed in section 7.9 below). Project design features, including source controls (such as common area landscape management and common area litter control) and treatment control BMPs in compliance with the SUSMP requirements, will prevent or reduce the release of organic materials and nutrients (which might contribute to algal blooms) to receiving waters. As shown in Section 7.1 above, post-development nutrients in runoff are not expected to cause significant water quality impacts. Based on implementation of the PDFs and the construction-related controls outlined in Section 7.4, runoff discharges from the Project will not cause increases in turbidity which would result in adverse affects to beneficial uses in the receiving waters. Based on these considerations, the water quality impacts of the Project on turbidity are considered less than significant.

7.2.2 Pathogens

Pathogens are viruses, bacteria, and protozoa that can cause gastrointestinal and other illnesses in humans through body contact exposure. Identifying pathogens in water is difficult as the number of pathogens is fairly small, requiring sampling and filtering large volumes of water to obtain a reliable result. Traditionally, regulators have used fecal indicator bacteria (FIB), such as total and fecal coliform, enterococci, and *E. coli*, as indirect measures of the presence of pathogens, and by association, human illness risk. Early epidemiological studies (i.e., studies that investigate human illness occurrence versus environmental factors such as water quality) that linked swimming-associated gastrointestinal symptoms to *E. coli* or enterococci in swimming waters for sewage-dominated receiving waters led to the development of the current recreational water quality criteria (USEPA, 1986). In contrast to receiving waters subject to sanitary discharges, only a few epidemiological studies have evaluated the health effects of exposure to water bodies subject to discharges from storm drains and these studies focused on the effects of dry weather urban flows on recreational exposure (e.g., Haile et al, 1999 and Colford et al, 2005).

Factors That Affect FIB Concentrations

There are various confounding factors that affect the reliability of FIB as pathogen indicators. One primary factor is that there are numerous natural or non-anthropogenic (or “zoonotic”) sources of FIB in developed watersheds and their receiving water bodies, including birds and other wildlife, soils, and plant matter. Anthropogenic sources may include domesticated animals and pets, poorly functioning septic systems, sewer system overflows or spills, cross-connections between sewer and storm drains, and the utilization of outdoor areas or storm drains for human waste disposal by people without access to indoor sanitary facilities. All of these sources can contribute to the concentrations of FIB, but not all the sources may pose a comparable human health risk (USEPA, 2009).

A second confounding factor is that FIB can multiply in the field if the substrate, temperature, moisture, and nutrient conditions are suitable (MEC, 2004). This is one potential reason that FIB concentrations do not always correlate with pathogens. For example, in a field study conducted by Schroeder *et al.* (2002), pathogens (in the form of viruses, bacteria, or protozoa) were found to occur in 12 of 97 soil samples, but the samples that contained pathogens did not correlate with the samples containing concentrations of FIB. Numerous other researchers have reported that bacteria presence and even regrowth was observed in various substrates such as beach sands, wrack line (accumulation of kelp in the inter-tidal area of beaches), inter/sub-tidal sediments, and material deposited in storm drains (MEC, 2004). FIB monitoring in the Santa Ana River indicate that the ubiquity of sources and potential regrowth far exceed the human sources of fecal bacteria generated by the entire population in the watershed (Surbeck et al, 2008). Regrowth of bacteria downstream of a package treatment plant utilizing ultraviolet (UV) radiation to disinfect dry weather flows in Aliso Creek was considered a prime factor in the rapid rebound of FIB concentrations downstream of the plant (Andersen, 2005).

A third confounding factor is that the persistence of FIB may differ from those of various pathogenic viruses, bacteria, protozoa. Viruses, for instance, are small, low in number, and difficult to inactivate, while protozoa may form protective cysts that are resistant to destruction and render them dormant but capable of reactivating in the future. Therefore, while some indicator bacteria may die off in the water column due to ultraviolet disinfection or other unfavorable environmental conditions (including predation and antagonism), pathogens occasionally may persist longer (Haile et. al., 1999). So while the previously two described factors may result in indicator bacteria resulting in false positive indications of public health risk, there may also be instances when indicator bacteria result in false negative indications.

Current Research Efforts to Improve Recreational Water Quality Criteria

Given the concern about the adequacy of the current recreational water quality criteria, the USEPA is undergoing a comprehensive evaluation and revision of their current FIB-based recreational water quality criteria, with completion scheduled for 2012. To help initiate this effort, EPA gathered 43 experts to identify research priorities needed to refine the existing criteria and transition to new methods (USEPA, 2007b). The experts identified seven topics for research, including “scientifically defensible for applications in a wide variety of geographical locations and water types” and “protective of individuals exposed to recreational waters impacted by all sorts of pathogen sources including animal feces, stormwater, and sewage” (Boehm et al, 2009).

In a similar effort focused on inland waters, the Water Environment Research Federation (WERF) convened an expert panel to recommend a research program that would also support EPA’s intended revision of the water quality criteria (WERF, 2009).

Epidemiological Studies

Until recently, few epidemiological studies have tested the health effects of exposure to the receiving waters of direct and recent stormwater runoff, and these studies have found it difficult to link illness with stormwater sources. For instance, the Mission Bay epidemiological study (Colford *et al.*, 2005) found that "only skin rash and diarrhea were consistently elevated in swimmers versus non swimmers, the risk of illness was uncorrelated with levels of traditional water quality indicators, and State water quality thresholds were not predictive of swimming-related illnesses." Various other researchers, as part of EPA's pathogen research program, are now conducting epidemiological studies nationwide at fresh and salt water beaches that receive wastewater and/or stormwater discharges. In southern California, the Southern California Coastal Water Research Project (SCCWRP) has been conducting a multi-year study of public health risks at marine beaches, with a final report that is scheduled for late 2010. Until these various studies are completed, however, there is no reliable documentation of the health effects caused by exposure to stormwater based on epidemiological studies.

Effects of Land Use and Runoff on FIB Concentrations

Dry weather, non-storm stream flows from undeveloped watersheds tend to have lower concentrations of FIB than dry weather urban flows, although water quality standard exceedances still occur. For instance, a recent study by SCCWRP which monitored 15 unimpaired natural southern California streams weekly during dry weather for a year showed that about 18% of the samples exceeded daily and monthly bacterial indicator thresholds, although concentrations from these unimpaired streams were one to two orders of magnitude lower than levels found in developed watersheds (Tiefenthaler, *et al.*, 2009). The study reported an average of the geometric means for *E. coli* in dry weather flows in each stream of 41 MPN/100 mL. In comparison, the Basin Plan objective is geometric mean *E. coli* density shall not exceed 126 MPN/100 mL.

During wet weather, stormwater runoff can mobilize indicator bacteria from a number of watershed and instream sources, and, therefore, indicator bacteria concentrations tend to increase. For example, median stormwater runoff monitoring results for the open space land use category, as summarized by Stein et. al. (2007), include *E. Coli* concentrations of about 5,400 MPN/100 mL from the 2001-2005 Los Angeles River Watershed Wet Weather Study, and 7,200 MPN/100 mL from the National Stormwater Quality Database (Pitt *et al.*, 2003). Similarly, median open space land use stormwater runoff monitoring results include *E. coli* concentrations of 5,400 MPN/100 mL from the Stein *et al.* (2007) study based on two flow-weighted average results, and 500 MPN/100 mL for fecal coliform from a 1994-2000 Los Angeles County (2000) study based on 21 grab samples.

Land use type and condition also affect runoff concentrations, and most studies show higher FIB concentrations in urban runoff than in open space runoff. Runoff from residential land uses from the Los Angeles River Watershed Wet Weather Study had a median *E. coli* concentration of about 6,300 MPN/100 mL and about 8,300 from the National Stormwater Quality Database (Table 5-2, Stein et. al, 2007). The median value of four flow-weighted average results from the Stein et. al. (2007) study was about 6,100 MPN/100mL for *E. coli* for the low density residential land use site. These data represent urban areas that in general do not have source and treatment controls, and therefore are not indicative of runoff from the proposed Project.

Runoff from agricultural watersheds involving horticulture and row cropping is known to similarly contain relatively high concentrations of FIB. Data from a stormwater drain serving an agricultural watershed with predominantly row crops in Ventura County showed median fecal coliform levels (approximately 7,000 MPN/100 mL) similar to that found for general urban runoff (Ventura County, 2005). Agricultural land and open space areas likely share some of the same wildlife sources, but livestock may be present as well. These data indicate that wildlife, livestock, plants and/or soils can be a very important source of pathogens and/or FIB.

Project Design Features that Address Pathogen Indicators

The primary sources of pathogen indicators from the Project development would likely be sediment, pet wastes, wildlife, and regrowth in the storm drain itself. Other sources of pathogens and pathogen indicators, such as cross connections between sanitary and storm sewers, are unlikely given modern sanitary sewer installation methods and inspection and maintenance practices.

The levels of bacteria in runoff from the Project would be reduced by source controls and treatment controls. The most effective means of controlling specific bacteria sources, such as pet and other animal wastes, is through source control, specifically education of pet owners, education regarding feeding (and therefore attracting) of waterfowl near waterbodies, and providing products and disposal containers that encourage and facilitate cleaning up after pets. These BMPs are specified as project source controls in Table 5-1.

Although there are limited data on the effectiveness of different types of stormwater treatment to manage pathogen indicators, treatment processes that help reduce pathogen indicators include sunlight (ultraviolet light) degradation, sedimentation, and filtration.

Bioretention facilities that incorporate an amended soil media for filtration is an example of a type of stormwater treatment effective in addressing FIB. The City of Austin, Texas conducted a number of studies on the effectiveness of sedimentation/filtration treatment systems for treating stormwater runoff (City of Austin, 1990; CWP, 1996). Most of the structures were designed to treat one-half inch of runoff. Data from four sand filters indicated a range of removals from 37 percent to 83 percent for fecal coliform, and 25 percent to 81 percent for fecal streptococci. Research on the use of filtration to remove bacteria also has been conducted in Florida by the Southwest Florida Water Management District (Kurz, 1999). Significant reductions in total and fecal coliform bacteria and the other indicators were observed between inflow and outflow samples for sand filtration. Percent reductions were measured using flow-weighted sampling techniques. Total coliform bacteria removals were less than 70 percent, and fecal coliform bacteria reduction varied from 65 percent to 100 percent.

Similarly, where soil conditions are conducive to infiltration, LID practices and stormwater treatment facilities that allow for infiltration can reduce runoff volume and treat FIB by infiltration, which in turn reduces FIB loads. In a literature summary, EPA reported typical pathogen removal for infiltration facilities as 65 to 100 percent (USEPA, 1993). These types of BMPs are specified for incorporation into the Project where feasible to meet the LID design standards specified in Section 5 of this report, which are based on achieving equivalent pollutant control and hydrologic control as specified the LID Ordinance and Manual and in the MS4 Permit/ SUSMP Manual requirements for treatment of volume or flow of stormwater.

In summary, stormwater discharges from the Project could potentially exceed the Basin Plan standard for FIB and therefore impacts from FIB may be significant prior to mitigation. However, the FIB concentrations in runoff from the Project would be reduced through the implementation of source and treatment control PDFs. The Project will incorporate a number of source controls specific to managing FIB, including education of pet owners, education regarding feeding (and therefore attracting) of waterfowl near waterbodies, and providing products and disposal containers that encourage and facilitate cleaning up after pets. The Project will not include septic systems and the sewer system will be designed to current standards which minimizes the potential for leaks. The Project development, consistent with the MS4 permit requirements, includes a comprehensive set of source, site design/LID, and treatment control PDFs, including treatment BMPs (i.e., infiltration facilities and bioretention), selected to manage pollutants of concern, including pathogen indicators. With these PDFs, the Project would not result in substantial changes in pathogen levels causing a violation of the water quality standards or waste discharge requirements, would not create runoff that would provide substantial additional sources of bacteria, or otherwise substantially degrade water quality in the receiving waters. Water quality impacts related to pathogens would be reduced to less-than-significant.

7.2.3 Hydrocarbons

Various forms of hydrocarbons (oil and grease) are common constituents associated with 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 PAH compounds associated with transportation-related sources.

Although the concentration of hydrocarbons in runoff is expected to increase slightly under post-development conditions due to the increase in roadways, driveways, parking areas, and vehicle use, the PDFs are expected to prevent appreciable increases in hydrocarbon concentrations from leaving the Project site. Source control PDFs that address petroleum hydrocarbons include educational materials on used oil programs, carpooling, and public transportation alternatives to driving; BMP maintenance; and street sweeping private streets. Lastly, the parking lot site design, source controls, treatment BMPs and vegetation and soils within the treatment control PDFs will adsorb the low levels of emulsified oils in stormwater runoff, preventing discharge of hydrocarbons and visible film in the discharge or the coating of objects in the receiving water.

The majority of PAHs in stormwater adsorb to the organic carbon fraction of particulates in the runoff, including soot carbon generated from vehicle exhaust (Ribes *et al.*, 2003). For example, a stormwater runoff study by Marsalek et al. (1997) found that the dissolved-phase PAHs represented less than 11 percent of the total concentration of PAHs. Consequently bioretention areas, and vegetated swales proposed as PDFs, which are designed to treat pollutants through settling, filtration, and infiltration, will be effective at treating PAHs.

Los Angeles County conducted PAH analyses on 27 stormwater samples from a variety of land uses in the period 1994-2000 (LACDPW, 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 PDFs should result in a reduction in hydrocarbon concentrations inclusive of PAHs. This makes it very unlikely that impacts will occur to the receiving water due to hydrocarbon loads or concentrations. On this basis, the effect of the Project on petroleum hydrocarbon levels in the receiving waters post-development is considered less than significant.

During the construction phase of the Project, hydrocarbons in site runoff could result from construction equipment/vehicle fueling or spills. Construction related impacts are addressed in Section 7.4 below. However, pursuant to the Construction General Permit, the Construction Stormwater Pollution Prevention Plan must include BMPs that address proper handling of petroleum products on the construction site, such as proper petroleum product storage and spill response practices, and those BMPs must effectively prevent the release of hydrocarbons to runoff per the Best Available Technology Economically Achievable and Best Conventional Pollutant Control Technology standards. PAH that are adsorbed to sediment during the construction phase would be effectively controlled via the erosion and sediment control BMPs. For these reasons, construction-related water quality impacts related to hydrocarbons are considered less than significant.

7.2.4 Pesticides

Pesticides can be of concern where past farming practices involved the application of persistent organochlorine pesticides. Legacy pesticides Chlordane, Dieldrin, DDT, and Toxaphene are of particular concern, as TMDLs have been established for these pesticides in the Santa Clara River estuary. Historical pesticides should no longer be discharged in the watershed except in association with erosion of sediments to which these pollutants may have adhered in the past.

In the post-developed condition, pesticides will be applied to common landscaped areas and residential lawns and gardens. Pesticides that have been commonly found in urban streams include the organophosphate pesticides chlorpyrifos and diazinon (Katznelson and Mumley, 1997). However, only 0 to 13% of the samples in the Los Angeles County database had detectable levels of diazinon (depending on the land use) while levels of chlorpyrifos were below detection limits for all land uses in all samples taken between 1994 and 2000 (LACDPW, 2000). Other pesticides presented in the database were seldom measured above detection limits. Furthermore, these data represent flows from areas without treatment controls, unlike the proposed Project, which does incorporate treatment control PDFs.

Diazinon and chlorpyrifos are two pesticides of concern due to their potential toxicity in receiving waters. The USEPA banned all indoor uses of diazinon in 2002 and stopped sales for all outdoor non-agricultural use in 2003 (USEPA, June, 2002)[7]. With no agricultural uses planned for the proposed Project, diazinon would not be used at the proposed Project site. The USEPA has also phased out most indoor and outdoor residential uses of chlorpyrifos and has stopped all non-residential uses where children may be exposed. Use of chlorpyrifos in the proposed Project area is not expected.

Diazinon had long been one of the most commonly used pesticides on the market (SFBRWQCB, 2005) before its use was phased-out. Although the U.S. Environmental Protection Agency's actions eliminated most urban diazinon uses by the end of 2004, phasing out diazinon likely has increased post-2004 reliance on alternative pesticides and encouraged new pesticides to enter the marketplace.

[7] 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 were phased out by December 31, 2004. Therefore it is likely that the USEPA agreement will eliminate most of the use of diazinon within the Project area. The use of diazinon for many agricultural crops has been eliminated (USEPA 2001), while some use of this chemical will continue to be permitted for some agricultural activities.

The San Francisco Regional Water Quality Control Board commissioned a study, Insecticide Market Trends and Potential Water Quality Implications, to evaluate pesticide use trends as they relate to water quality. In 2003, on the basis of current and projected pesticide use and possible water quality risks, the report considered the pesticide alternatives of potential concern for water quality to be pyrethrums; parathyroid's (bifenthrin, cyfluthrin, cypermethrin, deltamethrin, esfenvalerate, and permethrin); carbaryl; malathion; and imidacloprid (SFBRWQCB, 2003). A more recent study also identified lambda cyhalothrin (a pyrethroid) and fipronil among pesticides of interest (SFEP, 2005).

The water quality risks posed by a pesticide relate to the quantity of the pesticide used, its runoff characteristics, and its relative toxicity in water and sediment. As urban diazinon applications are phased out, the use of some alternatives may inadvertently pose new water quality risks. Given what is known about alternative pesticide use trends, pyrethroids may be the alternatives that pose the greatest concerns for water quality. Although pyrethroids tend to be toxic to Ceriodaphnia dubia test organisms at concentrations in water comparable to diazinon, pyrethroids do not dissolve well in water but instead adhere well to surfaces, including particles in the environment. At equilibrium, pyrethroid concentrations in sediment are reported to be about 3,000 times greater than dissolved concentrations in water (SFBRWQCB, 2005). Thus, BMPs targeting reductions and removal of sediment loads will be effective to reduce and remove pyrethroids as well.

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 controlling the pesticides that will be used post-development. Structural treatment controls are less practical because of the variety of pesticides and wide range of chemical properties that affect their ability to treat these compounds. However, most pesticides, including historical pesticides that may be present at the site, are relatively insoluble in water and therefore tend to adsorb to the surfaces of sediment, which will be stabilized with development, or if eroded, will be settled or filtered out of the water column in the water quality treatment PDFs. Thus, treatment in the bioretention, and vegetated swales should achieve some removal of pesticides from stormwater as TSS is reduced.

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 byproducts, 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 pesticide use is likely to occur due to maintenance of landscaped areas, particularly in the residential portions of the development, careful selection, storage and application of these chemicals for use in common areas will help prevent adverse water quality impacts from occurring. Additionally, as discussed above, removal of sediments in the PDFs will also remove sediment-adsorbed pesticides.

Based on the incorporation of site design, source control, and treatment control BMPs pursuant to SUSMP and LID requirements, the Project's potential post-development impacts associated with pesticides are considered less than significant.

Transport of legacy pesticides adsorbed to existing site sediments may be a concern during the construction phase of development. Construction-related impacts are addressed in Section 7.4 below. The Construction Stormwater Pollution Prevention Plan must contain sediment and erosion control BMPs pursuant to the Construction General Permit, and those BMPs must effectively control erosion and the discharge of sediment along with other pollutants per the BAT/BCT standards. Based on these sediment controls, construction-related impacts associated with pesticides are considered less than significant.

7.2.5 Trash and Debris

Urban development tends to generate significant amounts of trash and debris. Trash refers to any human-derived materials including paper, plastics, metals, glass and cloth. Debris is defined as any organic material transported by stormwater, including leaves, twigs, and grass clippings (DLWC, 1996). Debris can be associated with the natural condition. Trash and debris can be characterized as material retained on a 5-mm mesh screen. It contributes to the degradation of receiving waters by imposing an oxygen demand, attracting pests, disturbing physical habitats, clogging storm drains and conveyance culverts and mobilizing nutrients, pathogens, metals, and other pollutants that may be attached to the surface. Sources of trash in developed areas can be both accidental and intentional. During wet weather events, gross debris deposited on paved surfaces can be transported to storm drains, where it eventually can be discharged to receiving waters. Trash and debris can also be mobilized by wind and transported directly into waterways, imposing an oxygen demand on the water body as organic matter decomposes.

Urbanization could significantly increase trash and debris loads if left unchecked. However, the PDFs, including source control and treatment BMPs, will minimize the adverse impacts of trash and debris. Source controls such as street sweeping, public education, fines for littering, and storm drain stenciling can be effective in reducing the amount of trash and debris that is available for mobilization during wet and dry weather events. Common area litter control will include a litter patrol, covered trash receptacles, emptying of trash receptacles in a timely fashion, and noting trash violations by tenants/homeowners or businesses and reporting the violations to the owner/HOA/POA for investigation. The PDFs will remove or prevent the release of floating materials, including solids, liquids, foam, or scum, from runoff discharges and will prevent impacts on dissolved oxygen in the receiving water due to decomposing debris. Based on these considerations, post-development trash and debris is not expected to significantly impact the receiving waters of the Project.

During the construction phase, there is potential for an increase in trash and debris loads due to lack of proper contractor good housekeeping practices at the construction site. Per the

Construction General Permit, the SWPPP for the site will include BMPs for trash control (catch basin inserts, good housekeeping practices, etc.). Compliance with the Permit Requirements and inclusion of these BMPs, meeting BAT/BCT, included in the SWPPP will reduce impacts from trash and debris to less than significant. See Section 7.4 below for a full discussion of Construction Related Impacts.

7.2.6 Methylene Blue Activated Substances (MBAS)

MBAS, which is related to the presence of detergents in runoff, may be incidentally associated with urban development due to commercial and/or residential vehicle washing or other outdoor washing activities. Surfactants disturb the surface tension which affects insects and can affect gills in aquatic life.

The presence of soap in Project runoff will be controlled through the source control PDFs, including a public education program on residential and charity car washing, and the provision of a car wash pad connected to sanitary sewer in the multi-family residential areas. Other sources of MBAS, such as cross connections between sanitary and storm sewers, are unlikely given modern sanitary sewer installation methods and inspection and maintenance practices. Therefore, MBAS are not expected to significantly impact the receiving waters of the Project.

7.2.7 Cyanide

The information on cyanide levels in urban stormwater is relatively sparse. The incidence of detection of cyanide in urban stormwater is relatively low, except in some special cases. In the Nationwide Urban Runoff Project (NURP), cyanide was detected in runoff from four cities out of a total of 15 cities that participated in the monitoring program (USEPA 1983). Overall, cyanide was detected in 23 percent of the urban runoff samples collected (16 out of a total of 71 samples), at concentrations ranging from 2 to 33 µg/L (Cole *et al.* 1984). Of the 71 samples, only 3 percent (i.e., 2) exceeded the freshwater acute guideline of 22 µg/L (USEPA 1983). The predominant sources of cyanides found in urban runoff samples were reported to be products of gasoline combustion and anti-caking ingredients in road salts (Cole *et al.* 1984).

A review of highway runoff (Colman 2001) suggested that deicing salts are the main source of cyanide in highway runoff. It has been estimated that approximately two million pounds of sodium ferrocyanide, which is used as an anticaking agent in road salts during the winter in the northeastern United States, are washed off from roads into streams and storm sewers (USEPA 1981; Gaffney *et al.* 1987). Information on the quality of snow packs and snow melt support the premise that deicing salts are the major source of cyanide in stormwater. For example, concentrations of cyanide in snow packs ranged up to 314 µg/L in Milwaukee and Syracuse (Novotny *et al.* 1999). An urban stream receiving snow melt in Milwaukee had an average cyanide concentration of 31 µg/L (<2 – 45 µg/L). Two urban streams in Syracuse had average cyanide concentrations of 8 µg/L (<2 – 27 µg/L) and 48 µg/L (<2 – 167 µg/L), respectively. Reconsidering the NURP findings, three of the four cities which detected cyanide are within the snowbelt, and may have used deicing salts containing anti-caking agents. One (Austin, Texas) presumably does not.

In contrast to these relatively high concentrations associated with deicing salts, runoff from cities which do not use deicing salts or from northern cities outside the snow season has lower concentrations of cyanides. The City of Fresno NURP study (Brown & Caldwell, 1984) found undetectable cyanide (< 10 µg/L) in 19 grab samples of stormwater runoff from four watersheds with different land uses. Highway runoff from three urban sites in Michigan had average cyanide concentrations ranging from 5.8 – 9.3 µg/L. Samples were collected from June through October, which was outside the season where deicing salts might be used. Traffic volumes were high and ranged from 40,000 to 120,000 vehicles per day.

It is highly probable that the reported concentrations which exceed the freshwater acute guideline in urban stormwater are associated with the use of deicing salts containing the de-caking agent ferrocyanide. In situations where deicing salts are not being used, and where vehicle exhaust may be the dominant source, concentrations are much less (e.g., typically < 10 µg/L), even with high traffic volumes. Anti-caking agents will not be a source of cyanide in urban stormwater in the Project, and the forgoing discussion suggests that concentrations in stormwater runoff from the Project may reach concentrations of magnitude of approximately 10 µg/L, but are highly unlikely to exceed the acute CTR criteria of 22 µg/L.

A potential source is cyanide from burnt catchments. For example, cyanide concentrations in run-off obtained from an area that had been burned in a wildfire that occurred in Tennessee and North Carolina averaged 49 µg/L (Barber *et al.* 2003). Higher cyanide concentrations were reported in runoff from a wild fire that occurred in New Mexico, with an average value of 80 µg/L.

In addition to the expected relatively low level of cyanide in untreated stormwater, cyanide in runoff from the Project would be readily removed by biological uptake, degradation by microorganisms, and by volatilization in the treatment PDF. Therefore, cyanide is not expected to significantly impact the receiving waters of the Project.

7.3 MS4 Permit Requirements for New Development as Defined in the SUSMP

Project Design Features (PDFs) include site design/LID, source control, and treatment control BMPs in compliance with the SUSMP and LID requirements, as described in Section 5.1 and 5.2, and summarized in Table 5-1 and Table 5-2. Treatment control PDFs will treat runoff from the entire urban portion of the Project. Sizing criteria contained in the MS4 Permit and the SUSMP requirements will be met for all treatment control BMPs.

In summary, the proposed site design/LID, source control, and treatment control PDFs have been selected based on:

- Effectiveness for addressing pollutants of concern in Project runoff, resulting in insignificant water quality impacts;
- Sizing and outlet design consistent with the MS4 Permit and SUSMP requirements;
- Additional design guidance consistent with the California BMP Handbook: New Development and Redevelopment, other literature, and best professional judgment;
- Hydrologic and water quality modeling to verify performance;
- Meeting LID requirements minimizing changes in stormwater volumes; and
- Providing specific O&M requirements to inspect and maintain the facilities.

On this basis, the proposed PDFs meet the MS4 Permit requirements for new development.

7.4 Los Angeles County Low Impact Development Requirements for New Development as Defined in the Los Angeles County LID Ordinance and LID Standards Manual

Chapter 12.84 of the *Los Angeles County Code* requires the use of low impact development (LID) standards in development Projects. The proposed Project's PDFs will mimic undeveloped stormwater runoff rates and volumes, prevent pollutants of concern from leaving the Project site, and prevent hydromodification impacts to natural drainage systems. These PDFs would provide a stormwater management system that is highly sustainable because of the use of natural systems to control runoff rates and promote groundwater recharge. The following hydrologic source controls, included as PDFs, will limit impervious area and disconnect imperviousness to avoid and minimize water quality and hydromodification impacts:

- Site Design/Low Impact Development BMPs. Site design/LID PDFs that promote infiltration and help to reduce runoff volumes include the routing of impervious area runoff to vegetated areas, use of permeable pavements, use of native and/or non-native/non-invasive vegetation in landscaped areas, and the use of efficient irrigation systems in common area landscaped areas.
- Treatment Controls. The project's treatment control PDFs have been selected to promote infiltration and evapotranspiration. The treatment control PDFs, described in Section 5.3 above, will incorporate vegetation and amended soil to promote pollutant removal and runoff volume reduction through infiltration and evapotranspiration. Treatment controls will be designed in accordance with the Los Angeles County LID Ordinance and Standards Manual to the maximum extent feasible in conformance with the Project Performance Standard described in Section 5.3. Collectively, these treatment facilities are expected to provide significant reduction in wet weather runoff volume and to eliminate dry weather flows.

The PDFs to be included during build-out would meet to the maximum extent feasible the Los Angeles County LID requirements for new development as defined in the Los Angeles County LID Ordinance and LID Standards Manual.

7.5 Construction-Related Impacts

The potential impacts of construction activities, construction materials, and non-stormwater runoff on water quality during the construction phase are primarily due to sediment (TSS and turbidity) and certain non-sediment related pollutants. Construction-related activities that are primarily responsible for sediment releases are related to exposing previously stabilized soils to potential mobilization by rainfall/runoff and wind. Such activities include removal of vegetation from the site, grading of the site, and trenching for infrastructure improvements. Environmental factors that affect erosion include topographic, soil, and rainfall characteristics. Non sediment-related pollutants that are also of concern during construction relate to construction materials and non-stormwater flows and include construction materials (e.g., paint, stucco, etc); chemicals, liquid products, and petroleum products used in building construction or the maintenance of heavy equipment; and concrete-related pollutants.

Construction impacts due to Project development will be minimized through compliance with the Construction General Permit. This permit requires the discharger to perform a risk assessment for the proposed development (with differing requirements based upon the determined level) and to prepare and implement a Storm Water Pollution Prevention Plan (SWPPP), which must include erosion and sediment control BMPs that will meet or exceed measures required by the determined risk level of the Construction General Permit, as well as BMPs that control the other potential construction-related pollutants. A Construction Site Monitoring Program that identifies monitoring and sampling requirements during construction is a required component of the SWPPP. Preliminary analysis indicates that the Project will most likely be categorized as a Risk Level 2. BMPs required by the Construction General Permit will be incorporated assuming this level of risk; if final design analysis indicates that the Project will fall under Risk Level 3, the additional Level 3 permit requirements will be implemented as necessary.

7.5.1 Erosion and Sediment Control BMPs to be Implemented during Construction

Erosion control BMPs are designed to prevent erosion, whereas sediment controls are designed to trap or filter sediment once it has been mobilized. A SWPPP will be developed as required by, and in compliance with, the Construction General Permit and the City of Santa Clarita Standard Conditions. The General Permit requires the SWPPP to include BMPs to be selected and implemented based on the determine project risk level to effectively control erosion and sediment to the BAT/BCT. The following types of BMPs will be implemented as needed during construction:

Erosion Control

- Physical stabilization through hydraulic mulch, soil binders, straw mulch, bonded and stabilized fiber matrices, compost blankets, and erosion control blankets (i.e., rolled erosion control products).
- Limiting the area and duration (<14 days) of exposure of disturbed soils.

- Soil roughening of graded areas (through track walking, scarifying, sheepsfoot rolling, or imprinting) to slow runoff, enhance infiltration, and reduce erosion.
- Vegetative stabilization through temporary seeding and mulching to establish interim vegetation.
- Wind erosion (dust) control through the application of water or other dust palliatives as necessary to prevent and alleviate dust nuisance.

Sediment Control

- Perimeter protection to prevent sediment discharges (silt fences, fiber rolls, gravel bag berms, sand bag barriers, and compost socks).
- Storm drain inlet protection.
- Sediment capture and drainage control through sediment traps and sediment basins.
- Velocity reduction through check dams, sediment basins, and outlet protection/velocity dissipation devices.
- Reduction in off-site sediment tracking through stabilized construction entrance/exit, construction road stabilization, and entrance /exit tire wash.
- Slope interruption at permit-prescribed intervals (fiber rolls, gravel bag berms, sand bag berms, compost socks, biofilter bags).

Waste and Materials Management

- Management of the following types of materials, products, and wastes: solid, liquid, sanitary, concrete, hazardous and equipment-related wastes. Management measures include covered storage and secondary containment for material storage areas, secondary containment for portable toilets, covered dumpsters, dedicated and lined concrete washout/waste areas, proper application of chemicals, and proper disposal of all manners of wastes.
- Protection of soil, landscaping and construction material stockpiles through covers, the application of water or soil binders, and perimeter control measures.
- A spill response and prevention program will be incorporated as part of the SWPPP and spill response materials will be available and conspicuously located at all times on-site.

Non-Stormwater Management

- BMPs or good housekeeping practices to reduce or limit pollutants at their source before they are exposed to stormwater, including such measures as: water conservation practices, vehicle and equipment cleaning and fueling practices, and street sweeping. All such measures will be recorded and maintained as part of the project SWPPP.

- If construction dewatering or discharges from other specific construction activities such as water line testing, and sprinkler system testing are required, comply with the requirements of the Los Angeles RWQCB's General Waste Discharge Requirements (WDRs) under Order No. R4-2008-0032 (NPDES No. CAG994004) governing construction-related dewatering discharges.

Training and Education

- Inclusion of General Permit defined "Qualified SWPPP Developers" (QSD) and "Qualified SWPPP Practitioners" (QSP). QSDs and QSPs shall have required certifications and shall attend SWRCB sponsored training.
- Training of individuals responsible for SWPPP implementation and permit compliance, including contractors and subcontractors.
- Signage (bilingual, if appropriate) to address SWPPP-related issues (such as site cleanup policies, BMP protection, washout locations, etc).

Inspections, Maintenance, Monitoring, and Sampling

- Performing routine site inspections and inspections before, during (for storm events > 0.5 inches), and after storm events.
- Preparing and implementing Rain Event Action Plans (REAPs) prior to any storm event with 50% probability of producing 0.5 inches of rainfall, including performing required preparatory procedures and site inspections.
- Implementing maintenance and repairs of BMPs as indicated by routine, storm-event, and REAP inspections.
- Implementation of the Construction Site Monitoring Plan for non-visible pollutants, if a leak or spill is detected.
- Sampling of discharge points for turbidity and pH, at minimum, three times per qualifying storm event and recording and retention of results.

7.5.2 Construction BMP Implementation

During Project construction, BMPs will be implemented in compliance with the Construction General Permit and the general waste discharge requirements in the Dewatering General WDRs. The Project will reduce or prevent erosion and sediment transport and transport of other potential pollutants from the project site during the construction phase through implementation of BMPs meeting BAT/BCT in order to prevent or minimize environmental impacts and to ensure that discharges during the project construction phase will not cause or contribute to any exceedance of water quality standards in the receiving waters. All discharges from qualifying storm events will be sampled for turbidity and pH and results will be compared to Numeric Action Levels (250 NTU and 6.5-8.5, respectively) to ensure that BMPs are functioning as intended. If discharge sample results fall outside of these action levels, a review of causative agents and the existing site BMPs will be undertaken, and maintenance and repair on existing BMPs will be performed and/or additional BMPs will be provided to ensure that future discharges meet these criteria.

The construction-phase BMPs will assure effective control of not only sediment discharge, but also of pollutants associated with sediments, such as nutrients, heavy metals, and certain pesticides, including legacy pesticides. In addition, compliance with BAT/BCT requires that BMPs used to control construction water quality are updated over time as new water quality control technologies are developed and become available for use. Therefore, compliance with the BAT/BCT performance standard ensures mitigation of construction water quality impacts over time.

7.5.3 Compliance with Construction Permit and Construction Impacts

Prior to the issuance of preliminary or precise grading permits, the landowner or subsequent project applicant will provide the City Engineer with evidence that a Notice of Intent (NOI) has been filed with the State Water Resources Control Board. Such evidence will consist of a copy of the NOI stamped by the State Water Resources Control Board or Regional Water Quality Control Board, or a letter from either agency stating that the NOI has been filed and a copy of the site's applicable Waste Discharge identification (WDID) number.

Construction on the Project site may require dewatering. For example, dewatering may be needed if water has been standing on site and needs to be removed for construction, vector control, or other reasons. Further, dewatering may be necessary if groundwater is encountered during grading, or to allow discharges associated with testing of water lines, sprinkler systems and other facilities. In general, the Construction General Permit authorizes construction dewatering activities and other construction-related non-stormwater discharges as long as they (a) comply with Section III.C of the General Permit; (b) do not cause or contribute to violation of any water quality standards, (c) do not violate any other provisions of the General Permit, (d) do not require a non-stormwater permit as issued by some RWQCBs, and (e) are not prohibited by a Basin Plan provision.

An additional Project Design Feature will be implemented to protect receiving waters from dewatering and construction related non-stormwater discharges. Such discharges will be implemented in compliance with the Los Angeles RWQCB's General Waste Discharge Requirements (WDRs) under Order No. R4-2008-0032 (NPDES No. CAG994004) governing construction-related dewatering discharges within the Project development areas. Typical BMPs for construction dewatering include infiltration of clean groundwater; on-site treatment using suitable treatment technologies; on-site or transport offsite for sanitary sewer discharge with local sewer district approval; or use of a sedimentation bag for small volumes of localized dewatering. Compliance with these WDRs constitutes a PDF, further assuring that the impacts of these discharges are not significant.

On this basis, the impact of Project construction-related runoff is considered less than significant.

7.6 Pollutant Bioaccumulation

Certain pollutants have the potential to accumulate in treatment BMP vegetation and soils, potentially increasing the risk of exposure to wildlife and the food chain. Factors that could affect the extent of potential bioaccumulation include:

- The bioavailability of the pollutant;
- Conditions in the soils (e.g., pH, acid-volatile sulfide concentration, organic content) that affect the form and bioavailability of the pollutant;
- The efficiency by which pollutants in the soils enter the plant community, the storage of these pollutants in plant tissues that are edible, and the utilization of the plants as a food source by animals;
- The type of habitats, organisms attracted to these habitats, and their feeding habits; and
- System design and maintenance.

The primary pollutants of concern with regard to bioaccumulation are mercury and selenium. However, based on the water quality monitoring conducted by Los Angeles County at the downstream Santa Clara River mass emission station S29 (LACDPW, 2005), selenium and mercury are not naturally present at levels of concern in this watershed. Since these pollutants would not be introduced by the Project, bioaccumulation of selenium and mercury is not expected.

The potential for bioaccumulation impacts from the Project's treatment control facilities would be minimal. Since the tributary areas to the BMPs are largely impervious, very little coarse solids and associated pollutants are expected to be generated. The vegetation in the facilities would trap sediments and pollutants in the soils, which contain bacteria that metabolize and transform trace metals, thereby reducing the potential for these pollutants to enter the food chain. The facilities do not provide open water areas and are not likely to attract waterfowl.

Bioaccumulation of pollutants in the Santa Clara River would not be significant due to the low predicted concentrations of pollutants such as trace metals, which are predicted to be below the benchmark CTR criteria in the treated runoff. Also, sediments in the Santa Clara River are transported downstream in the wet season by storm flows, and, therefore, do not accumulate. On this basis, the potential for bioaccumulation and adverse effects on waterfowl and other species is considered less than significant.

7.7 Dry Weather Runoff

While there are no specific requirements in the MS4 Permit and the SUSMP requirements to treat dry-weather discharges from the Project area, pollutants in dry weather flows could also be of concern because dry weather flow conditions occur throughout a large majority of the year, and because some of the TMDLs in downstream reaches of the Santa Clara River are applicable for dry weather conditions (e.g., nutrients and chloride).

Dry weather flows are typically low in sediment because the flows are relatively low and coarse suspended sediment tends to settle out or is filtered out by vegetation. As a consequence, pollutants that tend to be associated with suspended solids (e.g., phosphorus, some bacteria, some trace metals, and some pesticides) are typically found in very low concentrations in dry weather flows. The focus of the following discussion is therefore on constituents that tend to be dissolved, e.g., nitrate and trace metals, or constituents that are so small as to be effectively transported, e.g., pathogens and oil and grease.

In order to minimize the potential generation and transport of dissolved constituents, landscaping in public and common areas will utilize drought tolerant vegetation that requires little watering and chemical application. Landscape watering in common areas, commercial areas, multiple family residential areas, and in parks will use efficient irrigation technology utilizing evapotranspiration sensors to minimize excess watering.

In addition, educational programs and distribution of materials (source controls) will emphasize appropriate car washing locations (at commercial car washing facilities or the car wash pad in the multi-family residential areas) and techniques (minimizing usage of soap and water), encourage low impact landscaping and appropriate watering techniques, appropriate swimming pool dechlorination and discharge procedures, and discourage driveway and sidewalk washing. Illegal dumping will be discouraged by stenciling storm drain inlets and posting signs that illustrate the connection between the storm drain system and the receiving waters and natural systems downstream.

The bioretention areas, vegetated swales, permeable pavement and infiltration will provide treatment for and infiltrate dry weather flows and small storm events. Water cleansing is a natural function of vegetation, offering a range of treatment mechanisms. Sedimentation of particulates is the major removal mechanism. However the performance is enhanced as plant materials allow pollutants to come in contact with vegetation and soils containing bacteria that metabolize and transform pollutants, especially nutrients and trace metals. Plants also take up nutrients in their root system. Some pathogens would be removed through ultraviolet light degradation. Any oil and grease will be effectively adsorbed by the vegetation and soil within the low flow wetland vegetation. Dry weather flows and small storm flows will infiltrate.

The treatment control PDFs will infiltrate or evapotranspire all expected dry weather runoff (see Section 7.9.2 below). It is expected that no dry weather discharge will occur to the Santa Clara River from the Project. Based on source control PDFs reducing the amount of dry weather runoff and treatment control PDFs capturing and treating the dry weather runoff that does occur, the impact from dry weather flows is considered less than significant.

7.8 Summary of Surface Water Quality Impacts

7.8.1 Direct Impacts

Concentrations of TSS, total nitrogen, dissolved copper, total lead, and dissolved zinc are predicted to decrease, while concentrations of total phosphorous, nitrate-N plus nitrite-N, ammonia, and chloride are predicted to increase under the proposed conditions compared with existing conditions. Runoff volume and loads of all modeled constituents are predicted to increase under proposed conditions when compared to existing conditions. Pollutant concentrations in runoff from developed areas with PDFs are predicted to be below all benchmark water quality objectives and criteria and TMDL waste load allocations for the Santa Clara River and are addressed by a comprehensive site design/LID, source control, and treatment control strategy in compliance with MS4 Permit, LID Ordinance, Construction General Permit, and General De-Watering Permit requirements.

Concentrations of hydrocarbons are expected to increase, while concentrations of pathogens, pesticides, and trash and debris may or may not increase under proposed conditions when compared to existing conditions. None of the qualitatively assessed constituents are expected to significantly impact receiving waters due to the implementation of a comprehensive site design/LID, source control, and treatment control strategy in compliance with the MS4 Permit, LID Ordinance, Construction General Permit, and General De-Watering Permit requirements. Therefore, potential impacts from the Project on receiving water quality are not significant.

7.8.2 Cumulative Impacts

This section defines the geographic area of potential impact for the cumulative impacts analysis, and evaluates impacts from probable future projects together with the incremental effects of the proposed Project to determine effects on water quality and hydromodification within this geographic area. The model results presented below are used in addition to consideration of the other projects reflected in adopted plans and projections for areas tributary to Santa Clara River Reach 7 in order to provide an overall assessment of cumulative water quality effects on the Santa Clara River.

As discussed above, the anticipated quality of effluent expected from the Vista Canyon PDFs will not contribute concentrations of pollutants of concern that would be expected to cause or contribute to a violation of the water quality standards in the Project's receiving waters.

Therefore, the Project's incremental effects on surface water quality are not considered significant.

The Vista Canyon Project's surface runoff water quality, after PDFs, both during construction and post-development, is predicted to comply with adopted regulatory requirements that are designed by the LARWQCB to assure that regional development does not adversely affect water quality, including MS4 Permit and SUSMP requirements; Construction General Permit and General Dewatering Permit requirements; and benchmark Basin Plan water quality objectives, CTR criteria, and TMDLs. Any future urban development occurring in the Santa Clara River watershed must also comply with these requirements. By extrapolating the results of the direct and cumulative impact analysis modeling done for this Water Quality Technical Report, it can be predicted that analysis of other proposed development combined with existing conditions would have similar water quality results. Therefore, cumulative impacts on surface water quality of receiving waters from the Project and future urban development in the Santa Clara Watershed are addressed through compliance with the MS4 Permit and SUSMP requirements; Construction General Permit and General Dewatering Permit requirements; and benchmark Basin Plan water quality objectives, CTR criteria, and TMDLs, which are intended to be protective of beneficial uses of the receiving waters. Based on compliance with these requirements designed to protect beneficial uses, cumulative water quality impacts are considered less than significant.

7.9 <u>Groundwater Impacts</u>

Discharge from the Project's developed areas to groundwater will occur in four ways: (1) through infiltration of urban runoff in the proposed treatment control PDFs after pretreatment; (2) through infiltration of urban runoff, after treatment in the Project PDFs, in the Santa Clara River, which is the primary recharge zone for groundwater in the Santa Clara Valley; (3) through general infiltration of irrigation water; and (4) through percolation of excess recycled water at the WRP.

7.9.1 Direct Groundwater Quality Impacts from Stormwater Infiltration

Groundwater quality will be fully protected through implementation of the Project's site design/LID, source control, and treatment control PDFs prior to discharge of Project runoff to groundwater.

Per the LARWQCB Clarification Letter (LARWQCB, 2006a), generally, the common pollutants in stormwater are filtered or adsorbed by soil, and unlike hydrophobic solvents and salts, do not cause groundwater contamination. In any case, infiltration of one to two inches of rainfall in semi-arid areas like Southern California where there is a high rate of evapotranspiration presents minimal risks.

The stormwater pollutant of concern with respect to groundwater is nitrate-N plus nitrite-N. The Basin Plan groundwater quality objective for nitrate-nitrogen plus nitrite-nitrogen is 10 mg/L.

The predicted nitrate-nitrogen plus nitrite-nitrogen concentration in runoff after treatment in the PDFs is 0.92 mg/L, which is well below the groundwater quality objective. Therefore, infiltration of stormwater to groundwater will not result in a violation of any groundwater quality standards or otherwise substantially degrade water quality.

7.9.2 Direct Groundwater Quality Impacts from Percolation of Recycled Water

The proposed Vista Canyon WRP will collect and treat municipal wastewater from the Project and adjacent development. The treated effluent will be distributed to the Project for non-potable interior uses, such as toilet flushing, in commercial areas, and exterior uses, such as landscape irrigation. Treated effluent likely will be made available to the Castaic Lake Water Agency (CLWA) to fulfill off-site demand for recycled water. Treated effluent that is not reused on-site or made available to CLWA will be discharged to on-site percolation ponds. Water balance calculations predict that in the absence of CLWA demand, excess reclaimed water will be generated (Dexter Wilson Engineering, 2010).

Impacts to CLWA Water Supply Wells

The Santa Clarita Water Division of CLWA operates drinking water wells in the vicinity of the Project (Figure 2-3). The purpose of this section is to evaluate potential impacts to groundwater quality at these downgradient production wells. Potential wells of interest include the Mitchell wells (Mitchell 5A and 5B), the Sierra well, and the North Oaks wells (East, Central, and West wells). The Mitchell wells are located approximately 0.3 miles upgradient from the proposed percolation ponds and, as they are upgradient, are not likely to be affected by the percolation ponds. The Sierra well is located approximately one mile downgradient of the percolation ponds. The North Oaks wells are located approximately 1.5 miles downgradient of the proposed percolation ponds. Based on proximity, the Sierra well has been selected as the "critical well" for this analysis.

Analysis Approach

Potential impacts to downgradient water supply wells were evaluated using a simplified approach. The analysis assumed that the total mass of pollutants discharged to the aquifer from the percolation ponds would be extracted at the well. The analysis approach combined the estimated pollutant concentration and discharge rates from the percolation ponds and the production rate and existing water quality at the critical well to predict the post-project groundwater quality at the well. The entire quantity of percolated water was assumed to replace an equal quantity of groundwater during extraction. Average production rates were assumed to remain unchanged and the total mass of pollutants in the percolated recycled water was assumed to be withdrawn from the well. This approach conservatively over-estimates the amount of pollutants that could be withdrawn at the critical well. The analysis approach has been applied on an average annual basis, consistent with the temporal resolution of the surface water quality impact analysis.

Analysis Inputs
Table 7-8 provides estimated production of excess reclaimed water (RW) on a monthly basis in the absence of CLWA demand (Dexter Wilson Engineering, 2010). Table 7-9 provides the estimated quality of excess reclaimed water that would be percolated (Dexter Wilson Engineering, 2010).

Table 7-8: Estimated Excess Reclaimed Water without CLWA Demand

Month	RW Available, MG	On-site RW Demand, MG	Excess RW, MG
January	12.1	1.6	10.5
February	10.9	2.4	8.5
March	12.1	2.9	9.2
April	11.7	2.3	9.3
May	12.1	3.1	9
June	11.7	3.7	8
July	12.1	4.9	7.2
August	12.1	5.4	6.8
September	11.7	4.1	7.6
October	12.1	4.3	7.8
November	11.7	2.5	9.2
December	12.1	2.3	9.8
Annual Total, MG	142.4	39.5	102.9

Source: Dexter Wilson Engineering, 2009.

Table 7-9: Estimated WRP Effluent Concentration

Parameter	Estimated WRP Effluent Concentration, mg/L
Total Dissolved Solids, TDS	935
Chloride	116
Sulfate	146
NO_3-N + NO_2-N	<10
Boron	1.415
Aluminum	<1
Fluoride	1.3
Manganese	0.3

Source: Dexter Wilson Engineering, 2010.

Water quality data provided by the Santa Clarita Water Division of CLWA for the Sierra well is summarized in Table 7-10.

Table 7-10: Average Groundwater Quality of the Sierra Well

Parameter	Average Concentration from Sierra Well[1], mg/L
Total Dissolved Solids, TDS	763
Chloride	80
Sulfate	173
NO_3-N + NO_2-N	7.1
Boron	1.0
Aluminum	<DLR (0.05)
Fluoride	0.31
Manganese	<DLR (0.02)

[1]Based on arithmetic average of samples collected in 2001, 2004 and 2007. Data provided by CLWA.
DLR – Detection Levels for Purposes of Reporting (detection limit)

A summary of groundwater production for the Sierra well is provided in Table 7-11. Years without any production were removed for the purpose of computing average annual pumping for this analysis.

Table 7-11: Summary of Production Rates at Sierra Well

Year	Annual Production	
	ac-ft/yr	MG/yr
1980	2780	906
1981	2089	681
1982	1202	392
1983	1255	409
1984	1780	580
1985	1834	598
1986	856	279
1987	220	72
1988	459	150
1989	730	238
1990	772	252
1991	719	234
1992	1050	342
1993	1413	460
1994	1,433	467
1995	1,092	356
1996	1,034	337
1997	597	195
1998	814	265
1999	1,158	377
2000	640	209
2001	846	276
2002	87	28
2003	0	0
2004	0	0
2005	1,384	451
2006	1,671	544
2007	1,652	538
2008	1,381	450
2009	446	145
Average 1980-2009 (excluding zero production years)	**1,121**	**365**

Source: data provided by CLWA.

Based on the monthly production records, production tends to be somewhat higher during summer months, correlating to increased irrigation demand.

Analysis Results

Estimates of pollutant concentrations in the Sierra production well in the existing and proposed conditions are provided in Table 7-12. Table 7-12 also provides a comparison of the estimated proposed condition concentration in the Sierra production well to applicable water quality benchmarks.

Table 7-12: Comparison to Water Quality Benchmarks for Water Supply

		Estimated Average Concentration in Sierra Well		Water Quality Benchmarks	
Parameter	**Units**	**Existing Condition [1]**	**Proposed Condition**	**Primary MCL**	**Secondary MCL, mg/L [2]**
TDS	mg/L	763	812	-	500/1000
Chloride	mg/L	80	91	-	250/500
Sulfate	mg/L	173	165	-	250/500
NO_3-N + NO_2-N	mg/L	7.1	<7.9	10	-
Boron	mg/L	1.0	1.1	-	-
Aluminum	mg/L	<DLR (0.05)	<0.32	1	-
Fluoride	mg/L	0.31	0.60	2	-
Manganese	mg/L	<DLR (0.02)	<0.10	-	0.05

[1] Based on arithmetic average of samples collected in 2001, 2004 and 2007.

[2] Recommended concentration/maximum concentration

DLR – Detection Levels for Purposes of Reporting (detection limit)

In the proposed condition, the concentrations of TDS, chloride, boron, and fluoride are predicted to increase; nitrate-N plus nitrite-N, aluminum, and manganese may increase, although there is some uncertainty due to the uncertainty in the predicted WRP effluent concentration. All predicted concentrations are below the benchmark water quality objectives.

As stated above, the analysis assumed that the entire volume of recycled water that is percolated, and the associated pollutant loading, will be withdrawn at the Sierra well. This assumes that none of the constituent loading will bypass the wells and no natural attenuation of pollutants would occur in the aquifer. Consequently, the analysis methodology is highly conservative and the estimated proposed condition concentrations are likely to be much lower than those listed in Table 7-12.

Significant mixing of percolated water with native groundwater would be expected to occur between the percolation ponds and critical production wells. Based on the framework used in the Groundwater Surface Water Interaction Model (CH2MHill and HGL, 2008, Figure 3-26), the aquifer is approximately 1,200 feet wide and 100 feet thick over the 5,500 foot reach between the percolation ponds and the Sierra well. With an assumed porosity of 0.25, the total volume of water in this reach of the aquifer can be estimated to be approximately 1,200 MG. In comparison, the estimated volume of percolated water, assuming no demand for excess recycled water, is approximately 103 MG/yr. The actual volume of percolated recycled water would likely be much less than 103 MG/yr.

Significant bypass of percolated water around the critical well would also be expected to occur. Levels recorded in production wells show that high groundwater levels (which can be used as a surrogate for trends in groundwater flux) tend to occur during the wet season. These periods tend to have the lowest production rates. It is during these periods that it is more likely that constituent load associated with percolated recycled water would mix with the larger volume of the aquifer and bypass the production wells.

In conclusion, based on the comparison of the predicted groundwater quality at the critical production well to the water quality objectives for water supply, the Project would not adversely impact the water quality of downstream water supply wells.

Impacts to Groundwater Pollutants of Concern

In addition to the percolated recycled water, stormwater percolation will occur in infiltration-based stormwater management PDFs, as described in Section 5 above. Percolated stormwater would have lower concentrations of the groundwater pollutants of concern than the recycled water, thus would improve the overall quality of percolated water from the Project. Table 7-13 provides a summary of the volume and concentration of nitrate-N plus nitrite-N and minerals for the reclaimed water, stormwater, and the combined percolated water for the Project.

Nutrients

The Basin Plan groundwater quality objective for nitrate-nitrogen plus nitrite-nitrogen is 10 mg/L. The expected nitrate-nitrogen plus nitrite-nitrogen concentration in combined percolated recycled water and stormwater is less than 8.9 mg/L (Table 7-13). Therefore, percolation of recycled water and stormwater would not result in a violation of the groundwater quality standards for nitrate-nitrogen plus nitrite-nitrogen.

Mineral Quality: TDS, Chloride, Sulfate, and Boron

The predicted average annual concentrations of TDS and boron in combined percolated water (140 mg/L and 1.3 mg/L, respectively) are greater than the Basin Plan standards (800 mg/L and 1.0 mg/L, respectively). The predicted average annual concentrations of chloride and sulfate are less than the Basin Plan groundwater quality objective (Table 7-13).

7-13: Estimated Average Annual Volume and Concentration of Percolated Water

Parameter	Units	Recycled Water [1]	Stormwater[2]	Combined Percolated Water (RW + SW)	Basin Plan Groundwater Quality Objective[3] (mg/L)	Average Concentration from 5 SCWD Wells[4] (mg/L)
Volume	ac-ft	315	43	358	--	--
NO3-N + NO2-N	mg/L	<10	0.9	<8.9	10	3.8
TDS	mg/L	935	144	840	800	670
Chloride	mg/L	116	21	105	150	79
Sulfate	mg/L	146	5	129	150	123
Boron	mg/L	1.4	0.2	1.3	1.0	1.4

[1] Source: Dexter Wilson Engineering, 2010.

[2] Average annual water quality simulated in runoff from Project (including off-site impacts) in proposed condition with BMPs, except sulfate and boron. Source for sulfate and boron is LACDPW, 2000 (based on median values for mixed residential land use).

[3] Upper Santa Clara-Mint Canyon

[4] Includes Mitchell 5A, Mitchell 5B, Sand Canyon, Lost Canyon 2A and Lost Canyon 2. Values provided by CLWA.

The RWQCB first adopted a TMDL for chloride in the Upper Santa Clara River (Reaches 3, 5, and 6) in October 2002 (Resolution No. 2002-018). On May 6, 2004, the RWQCB amended the Upper Santa Clara River chloride TMDL to revise the interim wasteload allocations and implementation schedule (Resolution 04-004). The amended TMDL became effective in May 2005. At the time the TMDL was adopted and approved, there were key scientific uncertainties regarding the sensitivity of crops to chloride and the complex interactions between surface water and groundwater in the Upper Santa Clara River watershed. The TMDL recognized the possibility of revised chloride water quality objectives and included mandatory reconsiderations by the RWQCB to consider Site Specific Objectives (SSOs). The TMDL required the Santa Clarita Valley Sanitation District to implement special studies and actions to reduce chloride loadings from the Saugus and Valencia WRPs. The TMDL included the development of the Groundwater and Surface Water Interaction Study (GSWI) to determine chloride transport and fate from surface waters to groundwater basins underlying the Upper Santa Clara River. Additional measures included the development of conceptual compliance measures and costs based on different hypothetical water quality objectives and final wasteload allocation scenarios and the consideration of site-specific objectives for chloride based on the results of an agricultural chloride threshold study and the GSWI.

TMDL special studies were conducted in a facilitated stakeholder process in which stakeholders participated in scoping and reviewing the studies. This process has lead stakeholders to develop an alternative TMDL implementation plan that addresses chloride impairment of surface waters and degradation of groundwater. The alternative, termed Alternative Water Resources Management (AWRM), was first set forth by Upper Basin water purveyors and United Water

Conservation District, the management agency for groundwater resources in the Ventura County portions of Upper Santa Clara River watershed. The GSWI linkage analysis conducted for the AWRM demonstrated that beneficial uses can be protected through a combination of SSOs for surface water and groundwater and reduction of chloride levels from the Valencia WRP effluent through advanced treatment (LARWQCB, 2008). The AWRM program will be implemented through NPDES permits for the existing WRPs.

To manage salts and nutrients, the Recycled Water Policy requires every groundwater basin or sub-basin in California to have a consistent salt/nutrient management plan. Each salt/nutrient plan must include a monitoring plan, which includes monitoring of emerging constituents/ chemicals of emerging concern (CECs) consistent with CDPH recommendations; be protective of water sources; and encourage recycling to meet the Policy's reuse goals.

Although not specifically adopted as a formal salt/nutrient management plan for the Santa Clara River watershed, the AWRM program does serve as a basis for a future plan. First, the AWRM program elements have many similarities to the required salt/nutrient management plan elements. Second, the AWRM program was developed using the GSWI model, which assessed the fate and transport of chloride from all sources in the surface waters and groundwater in the Santa Clara River watershed. While the GSWI was developed specifically to assess the fate and transport of chloride, the evaluations and assessments largely apply to other salts in the region, which behave similarly to chloride. Third, the GSWI model also assessed water quality impacts associated with the planned recycled water uses in the future. The Vista Canyon WRP, although not specifically included in the GSWI model, would constitute a portion of the planned growth that would have occurred at the Valencia WRP. Fourth, the facilities that would be implemented through the AWRM (i.e., advanced treatment of wastewater, salt export facilities) would also remove and manage other salts. More specifically, the AWRM program provides for (1) watershed-wide monitoring; (2) determination of all sources, loading, fate and transport of salts; (3) salt management measures and implementation; (4) an anti-degradation analysis; and (5) water recycling goals and objectives (LARWQCB, 2008). The specific salt management measures, as well as the implementation and funding of the specific facilities needed, have not been completed. However, the overarching purpose of the AWRM is effective and efficient salt/nutrient management; therefore, the necessary measures will be adopted and provided. The Vista Canyon project would participate in the AWRM by contributing, based upon its fair share, to the cost of implementation.

In conclusion, participation in the AWRM (through annexation of the project site into the Santa Clarita Valley Sanitation District), percolation of recycled water and stormwater from the Project would not result in a violation of the groundwater quality standards for minerals (TDS, chloride, sulfate, and boron).

Bacteria

The Basin Plan contains numeric criteria for bacteria in drinking water sources. Title 22 of the California Code of Regulations (Title 22) specifies California's Wastewater Reclamation Criteria (WRC) and all recycled water in California must meet or exceed these criteria to assure protection of receiving water quality. These criteria apply to the treatment processes; treatment performance standards, such as removal efficiencies and effluent water quality; process monitoring programs, including type and frequency of monitoring; facility operation plans; and necessary reliability features. Title 22 specifies bacteria treatment standards for recycled water. The WRP will incorporate disinfection with a combination of ultraviolet (UV) and chlorination to remove bacteria in compliance with the WRC. In addition, bacteria that may be present in the stormwater would be removed through filtration in soils (for example, as with septic tank discharges). Therefore, percolation of recycled water and stormwater from the Project would not result in a violation of the groundwater quality standards for bacteria.

Chemical Constituents and Radioactivity

Drinking water limits for inorganic and organic chemicals that can be toxic to human health in excessive amounts and radionuclides are contained in Title 22 of the California Code of Regulations. These chemicals and radionuclides will be fully controlled in compliance with Title 22 and the Waste Discharge Requirements adopted by the RWQCB for the WRP. Therefore, percolation of recycled water and stormwater from the Project would not result in a violation of the groundwater quality standards for Title 22 chemical constituents and radioactivity.

Taste and Odor

The Basin Plan contains a narrative objective for taste and odor that cause a nuisance or adversely affect beneficial uses. Undesirable tastes and odors in groundwater may be a nuisance and may indicate the presence of a pollutant(s). Pollutants causing taste and odor issues will be controlled by the proposed WRP treatment processes in compliance with Title 22 and the Water Discharge Requirement adopted by the RWQCB for the WRP. Therefore, percolation of recycled water and stormwater from the Project would not result in a violation of the groundwater quality standards for taste and odor.

Contaminants of Emerging Concern (CECs)

Studies have shown good removal efficiencies of some CECs by wastewater treatment plants operating with conventional activated sludge processes, as much as 95% removal, although removal by conventional activated sludge processes has been found to be inconsistent for other CECs (Reemtsma, 2006; Gobel, 2007). Several studies have noted the importance of hydraulic retention time in the removal of CECs in activated sludge processes (Phillips, 2005; Reemtsma, 2006). The molecular complexity of emerging contaminants causes microbial degradation to occur over longer periods of time, thus increasing retention time may increase removal rates of many CECs. Additionally, the CECs with the highest removal rates tend to be those which biodegrade fastest (Snyder et al, 2007).

One of the alternative treatment processes proposed for the WRP employs a membrane bioreactor (MBR) process. This process includes conventional activated sludge followed by a membrane tank, which acts as secondary treatment (sedimentation), and tertiary treatment (filtration), providing solid/liquid separation. Studies generally indicate that MBRs provide good removal for a number of CECs, including estrogenic compounds, anionic detergents, herbicides, and others (Lyko, 2005; Melin, 2006; Kim 2007; Snyder 2007). Additionally, since MBR treatment results in fewer particles in effluent, greater removal rates are generally expected (Lyko, 2006). However, similar to conventional activated sludge performance, removal efficiencies by MBRs vary widely. A literature review by Onesios, 2009, showed that studies on lab and pilot scale MBRs had varying removal efficiencies for a wide range of CECs. High removal efficiencies were seen for a number of antibiotics and common over-the-counter drugs, including acetaminophen, ibuprofen, and caffeine, though low removal efficiencies were also seen, particularly for a variety of pharmaceuticals.

A combination of UV and chlorine residual is proposed for disinfection purposes. UV is effective in aiding removal of at least one class of CECs, nitrosamines. Notably, nitrosamines, including N-nitrosodimethlyamine (NDMA) are found in chlorinated water as a byproduct of the chlorination process, particularly when chlorination is conducted with chloramines. Additionally, nitrosamines are found in a number of industrial wastes and consumer products, including food and beverages. While chlorination can lead to harmful byproducts such as NDMA and other chlorinated compounds, it is effective in treating some CECs, as well as conventional wastewater pollutants, especially bacteria.

The Recycled Water Policy addresses control of CECs. Due to the lack of knowledge on the full effects of these relatively new pollutants of concern, the Recycled Water Policy emphasizes the need for more scientific research in regards to CECs. The Policy states that the regulatory requirements for recycled water should be updated regularly based on the best available peer-reviewed science. Additionally, the Policy sets forth a research program which includes a "blue-ribbon" advisory panel consisting of experts from all relevant fields of science. The panel is required to review all related scientific literature and to submit a report describing the current state of scientific knowledge and the actions that the State of California should take to improve current understanding of and human health protections against CECs.

In conclusion, based on the incorporation of best practicable treatment and control measures in the WRP treatment processes, which will be regularly maintained and optimally operated, and as supported by the research program set forth by the Recycled Water Policy, percolation of recycled water and stormwater from the Project would not result in water quality impacts to CECs.

Conclusion
The WRP's percolated water quality will have to comply with Waste Discharge Requirements (WDRs) that would be obtained from the LARWQCB. As required by the Porter-Cologne Act

and the Basin Plan, this permit will include effluent limitations for percolated water that will be protective of groundwater quality and designated beneficial uses.

Based on the above analysis for the pollutants of concern in groundwater, the Project will not result in a violation of any groundwater quality standards or waste discharge requirements or otherwise substantially degrade water quality. On this basis, the Project's direct impact on groundwater quality is considered less than significant.

7.9.3 Cumulative Groundwater Quality Impacts

As discussed above, the anticipated quality of runoff discharges from the Project's developed areas and recycled water percolation will not contribute loads or concentrations of pollutants of concern that would be expected to cause or contribute to a violation of the groundwater quality standards. By extrapolating these results to existing and proposed development throughout the watershed and based on a review of adapted plans and projections, it is concluded that no adverse cumulative effects would occur to groundwater. Therefore, the Project's incremental effects on groundwater quality are not expected to be significant.

The Project's discharges to groundwater, after PDFs, both during construction and post-development, is predicted to comply with adopted regulatory requirements that are designed by the LARWQCB to assure that regional development does not adversely affect water quality, including MS4 Permit and SUSMP requirements; Construction General Permit and General Dewatering Permit requirements; future water reclamation plant Waste Discharge Requirements; and benchmark Basin Plan groundwater quality objectives. Any future urban development occurring in the Santa Clara River watershed must also comply with these requirements. Therefore, cumulative impacts on groundwater quality from the proposed Project and future urban development in the Santa Clara Watershed are addressed through compliance with the MS4 Permit and SUSMP requirements, Construction General Permit requirements, General Dewatering Permit requirements, future water reclamation plant Waste Discharge Requirements, and benchmark Basin Plan groundwater quality objectives, which are intended to be protective of beneficial uses of the groundwater. Based on compliance with these requirements designed to protect beneficial uses, cumulative groundwater quality impacts are considered less than significant.

7.9.4 Groundwater Recharge Impacts

Direct Project Impacts

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. A memorandum prepared by CH2M Hill (2004) entitled, "Effect of Urbanization on Aquifer Recharge in the Santa Clarita Valley" (Appendix C), discusses the general effects of urbanization on groundwater recharge and the specific effects in the Santa Clarita Valley. In summary, the CH2MHill memorandum concludes that the majority of groundwater recharge in the Santa Clarita Valley occurs within the Santa Clara River and its major tributaries.

Currently, the site is open/vacant land. As a result, in the existing condition recharge occurs within the Project site from precipitation. On one hand, development of the site will introduce impervious surfaces over approximately 48 percent of the Project site, which will reduce recharge. On the other hand, development of the site will increase runoff volume discharged after treatment to the Santa Clara River, whose channel is predominantly natural and consists of vegetation and coarse-grained sediments (rather than concrete). The porous nature of the sands and gravels forming the streambed will allow for significant infiltration to occur to the underlying groundwater. Also, the Project will introduce landscaping, irrigation, and PDFs designed to infiltrate runoff and excess recycled water. Therefore, the Project is not expected to result in a significant change in groundwater recharge in the project vicinity. Based on the above discussion, the Project's impact on groundwater recharge is considered less than significant.

Cumulative Impacts

Increased urbanization in the Santa Clarita 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 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 (CH2M Hill, 2004). This long-term stability of groundwater levels is attributed in part to the significant volume of natural recharge that occurs in the Santa Clara River and its tributaries. 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 groundwater was used primarily for agriculture. Also, the importation of 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 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.

Based on the above discussion, the cumulative impact on groundwater recharge is considered less than significant.

7.10 Hydromodification Impacts

Development typically increases impervious surfaces on formerly undeveloped (or less developed) landscapes, reducing the capture and infiltration of rainfall. The result is that, as a watershed develops, a larger percentage of rainfall becomes runoff during any given storm. In addition, runoff reaches the stream channel more efficiently due to the development of storm drain systems, so that, if no controls are implemented, the peak discharge rates for rainfall events and floods are higher for an equivalent event than they were prior to development. Further, the introduction of irrigation and other dry weather flows can change the seasonality of runoff reaching natural receiving waters. These changes, in turn, affect the stability and habitat of natural drainages, including the physical and biological character of these drainages. This process, termed "hydromodification" (SCCWRP, 2005a) is addressed in this section.

Significant hydromodification impacts are presumed to occur if the proposed Project would:

- Substantially alter the existing drainage pattern of a natural drainage, stream, or river causing substantial erosion, siltation, or channel instability; or
- Substantially increase the rates, velocities, frequencies, duration and/or seasonality of flows causing channel instability and harming sensitive habitats or species in natural drainages in a manner that substantially adversely affects beneficial uses.

All flows from those areas of the Project that will be developed with impervious surface with potential for altering drainage patterns will be discharged directly to the Santa Clara River. Therefore, this analysis addresses the potential for hydromodification impacts to the Santa Clara River as a result of the proposed Project.

The physical alteration of natural drainages, such as buried bank stabilization, energy dissipaters, and bridge abutments, are not impacts created by changes in runoff seasonality, volume, duration, or flow associated with development. Instead, these types of alterations are physical alterations to the stream bed and bank, with associated effects on channel morphology, stream habitat and species. These types of effects are analyzed in the *Vista Canyon Project (TTM #69164) EIR Flood Technical Report - Santa Clara River* (PACE, 2009) and the Biological Resources section of the Draft EIR for the Project.

7.10.1 Wet Weather Flows

Direct Impacts to the Santa Clara River

The Project proposes development of approximately 41 percent (77 acres) of the approximately 185-acre Project site; with the remaining 108 acres used for trails, parks, and vegetated slopes and water quality BMPs, or consisting of the Santa Clara River. The size of the Project in comparison to both the approximate 191 square mile total watershed area at the Project location (0.15% of the watershed area) and the expected total impervious area in the watershed in the existing conditions (7 square miles) and at build-out (15 square miles) is small. It is estimated, based on the land use data provided by LACDPW, that the proposed Project will comprise 1.8 percent of the total impervious area in the watershed encompassing the Project location at ultimate planned build-out for the watershed. See Section 4.4.3 above for information regarding adopted plans and projection used to derive build-out assumptions for the watershed.

A series of progressive hydromodification control measures will be used in the Project to prevent and control hydromodification impacts to the Santa Clara River:

- Avoid, to the extent possible, the need to mitigate for hydromodification impacts by preserving natural hydrologic conditions and protecting sensitive hydrologic features, sediment sources, and sensitive habitats.

- Minimize the effects of development through site design practices (e.g., reducing connected impervious surfaces) and implementation of stormwater volume-reducing BMPs (project-based hydrologic source control).

- Mitigate hydromodification impacts in-stream using a geomorphically-based approach (e.g., buried soil cement bank stabilization).

Project-based Hydrologic Source Control. Disconnecting impervious areas from the drainage network and adjacent impervious areas is a key approach to protecting channel stability. Several hydrologic source controls will be included in the Project that will limit impervious area and disconnect imperviousness:

<u>Low Impact/Site Design</u>**.** Low impact/site design PDFs will help to reduce the increase in runoff volume. These PDFs include the preservation of open space, consisting of about 108 acres (58 percent of the Project site) within the River corridor, trails, slopes, and vegetated water quality treatment BMPs; routing of impervious area runoff to vegetated areas; use of native and/or non-native, non-invasive mostly drought tolerate plants in landscaped areas; and the use of efficient irrigation systems in common area landscaped areas. The reduction in runoff volume attributable to some of these low impact/site design PDFs were not quantified in the runoff modeling, so these PDFs will further reduce the predicted increase in runoff volumes discussed below. These

measures will help to protect the stability of the Santa Clara River and to avoid and minimize direct impacts to the River.

Treatment Controls. The Project's treatment control BMPs will also serve as hydromodification source control BMPs. Vegetated swales, and bioretention areas can provide volume reduction on the order of 38 percent (Strecker et al., 2004). Collectively, these vegetated treatment facilities are expected to provide significant reduction in wet weather runoff. The increase in impervious surface within the project area is predicted to increase the average annual stormwater runoff volume from the project area by approximately 94 acre-feet per year, after accounting for the estimated volume reductions in the proposed treatment control PDFs (see Section 7.1 above). Using conservative values for volume reduction, the treatment control PDFs are estimated to reduce the increase in average annual stormwater runoff volume by approximately 46 acre-feet per year, which is a 67 percent reduction of the predicted average post-development stormwater runoff volume without the treatment control PDFs. In addition, these facilities will also receive and eliminate dry weather flows.

Geomorphically-Referenced Channel Design. The hydromodification management approach for the Santa Clara River will incorporate "geomorphically-referenced river engineering" as described in SCCWRP Technical Report 450 (SCCWRP, 2005a). The goal of this approach is to preserve the appearance of the natural stream channel to the maximum extent practicable while maintaining stability in stream channel morphology. The Project's development footprint will allow for the greatest freedom possible for "natural stream channel" activity. This includes establishing buffer zones and maintaining setbacks to allow for channel movement and adjustment to changes in energy associated with runoff. The engineered structural elements that will be implemented where needed for the Santa Clara River include energy dissipation and bank stabilization.

The proposed drainage improvements would utilize innovative techniques to meet the requirements of flood control while maintaining the natural resources within the Santa Clara River (PACE, 2009). Traditional flood control techniques in use in Los Angeles County rely on reinforced concrete or grouted rock rip-rap to minimize erosion while maximizing the volume of flood flows carried by the drainage. While exceedingly efficient as a flood control technique, this approach retains none of the natural resource value. The Vista Canyon Drainage Plan utilizes several criteria that are to be implemented, including:

- Flood corridor must allow for the passage of Los Angeles County Capital Flood discharge without the permanent removal (maintenance) of natural River vegetation (except at bridge crossings);

- The banks of the River will generally be established outside of the "waters of the United States" as defined by federal laws and regulations and as determined by the delineation completed by the ACOE in August 1993;

- Where the ACOE delineation width is insufficient to contain the Capital Flood flow, the flood corridor will be widened by an amount sufficient to carry the Capital Flood flow without the necessity of permanently removing vegetation or significantly increasing velocity; and

- Soil cement and other bank protection would occur only where necessary to protect against erosion adjacent to the proposed development. Where bluffs are determined to be stable and there is no adjacent proposed development, no bank protection will be constructed.

Conclusion. In summary, although Project runoff volumes, flow rates, and durations will increase, potential impacts of hydromodification (i.e., the potential to cause erosion, siltation, or channel instability) will be minimized by the Project PDFs. The Project's site design and treatment controls PDFs will minimize increases in runoff volume from the development area, the preferred method for controlling hydromodification impacts from new development (SCCWRP, 2005a). Potential instream impacts of increased volumes, rates, and flow durations will be managed and mitigated with energy dissipaters at the discharge points to the Santa Clara River and the River banks will be protected with vegetated buried bank stabilization. For these reasons, the wet weather direct hydromodification impacts of the Project with PDFs on the Santa Clara River are considered less than significant.

Cumulative Impacts

As identified in the MS4 Permit, increased volume, velocity, and discharge duration of stormwater runoff from the cumulative existing and future developed areas in watersheds of natural drainages, including the Santa Clara River, has the potential to accelerate downstream erosion and impair stream habitat. Given the large size of the Santa Clara River watershed, the contribution of the Project to cumulative hydromodification impacts to the Santa Clara River is difficult to assess quantitatively. Therefore, a qualitative assessment that references total predicted development per adopted General Plans and projections for the Santa Clara River watershed is provided below.

Effect of Watershed Impervious Area. The limited hydromodification impact research to date has focused on empirical evidence of channel failures in relationship to directly connected impervious area (DCIA) or total impervious area. However, more recent research has established the importance of size of watershed, channel slope and materials, and climatic and precipitation patterns (SCCWRP 2005a, Balance Hydrologics 2005 (provided in Appendix D)). Impervious area that drains directly to a storm drain system and then to the receiving water is considered "directly connected," whereas impervious area that drains through vegetation or to infiltration facilities is considered "disconnected."

Booth and Jackson (1997) reported finding a correlation between loss of channel stability and increases in DCIA. In Washington State, streams were found to display the onset of degradation when the DCIA increases to ten percent or more, and a lower imperviousness of five percent was found to cause significant degradation in sensitive watersheds (Booth and Jackson, 1997). The Center for Watershed Protection (Schuler and Holland, 2000) described the impacts of urbanization on stream channels and established thresholds based on total imperviousness within the tributary drainage area. It states "a threshold for urban stream stability exists at about 10 percent imperviousness." It further states that a "sharp threshold in habitat quality exists at approximately 10 percent to 15 percent imperviousness." These studies, however, addressed changes in a very different climatic region than Southern California.

Geosyntec's work in the San Francisco Bay area's Santa Clara Valley (Geosyntec 2004) also evaluated the relationship between imperviousness and stream channel degradation in an area that had predominately directly connected impervious areas. Geosyntec found similar results to those published by Booth and Schuler, where channel erosion was observed at approximately six to nine percent imperviousness for two separate watershed systems. More recent studies conducted by Geosyntec in this same watershed area showed that levels as low as two to three percent total imperviousness could lead to stream channel degradation, depending on channel characteristics. This region also has different climatic characteristics than Southern California.

Although physical degradation of stream channels in semi-arid climates of California may be detectable when watershed imperviousness is between three and five percent, not all streams will respond in the same manner (SCCWRP, 2005b). Management strategies need to account for differences in stream type, stage of channel adjustment, current and expected amount of basin imperviousness, and existing or planned hydromodification control strategies.

The absolute measure of watershed imperviousness that could cause stream instability in the Santa Clara River depends on many factors, including watershed area, land cover, and soil type; development impervious area and connectedness; reduced sediment yield; longitudinal slope of the river; channel geometry; and local boundary materials, such as bed and bank material properties and vegetation characteristics. Based on land use data provided by the County of Los Angeles (see Section 4.4.3 above), the estimated cumulative level of percent impervious area at in the Santa Clara River watershed upstream from the Project area is currently about four percent and is projected to be about eight percent at build-out.

Effect of Catchment Drainage Area. The Southern California Coastal Water Research Project (SCCWRP) found signs of hydromodification impacts in Southern California streams when watershed percent imperviousness was around two to three percent for streams with a catchment drainage area of less than five square miles (mi^2) (SCCWRP, 2005a). Recognizing that their findings were based on the type and size of catchments that were measured, the researchers in the SCCWRP study attempted to develop a framework by which their results could be extended to other stream types. They developed a classification system based on watershed characteristics, stream channel characteristics (including level of vegetative development), and stream channel resistance, and suggested these features could be important in selecting management strategies and approaches to control hydromodification impacts. The Level 1 classification is based on watershed characteristics that include the size, shape, and topography of the watershed.

The catchment drainage area (CDA) is stated to be the most obvious differentiator among watersheds, as this is likely to have the greatest effect on runoff. The SCCWRP study focused on small watersheds (< 5 square miles), whereas the CDA of the Santa Clara River at the project area is 191 square miles. Based on the differences in CDA, the SCCWRP findings with respect to CDA would not be applicable to the Santa Clara River. Information in the SCCWRP report, based in part on the work of Zielinski (2002), suggests that smaller watersheds are more responsive and sensitive to changes in land use, whereas larger watersheds (> 30 square miles) were said to be less responsive to land use changes. Geosyntec's work in the San Francisco Bay area found significant hydromodification impacts on streams of watersheds that were 40 square miles in size; however, this is still substantially smaller than the Santa Clara River watershed at the Project Site. Given the large CDA for the Santa Clara River, the river is likely less responsive to potential hydromodification effects, but channel morphology must still be examined to determine the level and potential significance of Santa Clara River response.

Application to the Santa Clara River. Balance Hydrologics assessed the potential effects of the planned cumulative urbanization within the Santa Clara River upstream of the County line (the upper watershed) on channel morphology by examining historical changes in the Santa Clara River channel pattern in response to different types of major disturbance using historical rainfall and other relevant records and aerial channel photography (Balance Hydrologics, 2005 (provided in Appendix D)). The findings of this analysis are summarized below.

The Santa Clara River is a dynamic, episodic system. Understanding the magnitude of geomorphic change over the course of recent history in response to natural and human disturbances in the watershed is a key factor in assessing the potential response to future urbanization within the watershed.

After studying the response of the river to several different anthropogenic and natural disturbances, the report concludes that the Santa Clara River, as with many streams in semi-arid southern California, is highly episodic. Concepts of "normal" or "average" sediment-supply and flow conditions have limited value in this "flashy" environment, where episodic storm and wildfire events have enormous influence on sediment and storm flow conditions. In these streams, a large portion of the sediment movement events can occur in a matter of hours or days. Other perturbations which can potentially affect channel geometry appear to have transitory or minor manifestations. For example, effects on the channel width due to the 1980s levee construction were barely discernible by the first few years of the 21st century, probably mostly due to morphologic compensation associated with the storm events in the mid- to late-1990s. As a result, channel morphology, stability, and character of the Santa Clara River is almost entirely determined by the "reset" events that occur within the watershed.

Conclusion. As discussed above, the Project will include a number of hydrologic source control PDFs that will substantially lessen any potential contribution to cumulative hydromodification impacts to the Santa Clara River. In addition, it is presumed that all future development within the watershed will be reflected in adopted plans and projections will implement hydromodification controls to meet flow criteria that will be adopted by the LACDPW under Part 4, § D.1 of the MS4 Permit. These measures are designed to mitigate and prevent direct and cumulative hydromodification impacts.

Within the Santa Clara River watershed, major perturbations (urbanization, dam construction, levee construction, decadal changes in climate, and increases in woody vegetation) do not appear to have had a significant impact on the geomorphic expression of the Santa Clara River. Large "re-set" events (those which are typically not as affected by increases in impervious area) have episodically completely altered the form of the Santa Clara River channel. These events, occurring on average once every ten years, are a dominant force in defining channel characteristics. The geomorphic dominance of "re-set" events determines the geomorphic character of the Santa Clara River and the Santa Clara River's response to anthropogenic perturbations, including hydromodification impacts associated with development, is expected to be minimal in light of the "re-set" driven nature of the Santa Clara River channel. Due to these episodic "re-sets," "unraveling" of the Santa Clara River mainstem due to hydromodification associated with cumulative urban development within the watershed, as is seen in many smaller southern California watersheds, is not expected to occur. The "re-set" events appear to adequately buffer changes that may occur in short-term sediment transport between re-set events.

Based upon the above discussion, that the Project includes hydromodification controls as Project Design Features, that future development projects within the watershed will control flow in compliance with the regional program, and that large-scale changes naturally occur in the Santa Clara River in response to major episodic events, the Project's contribution to cumulative hydromodification impacts to the Santa Clara River will be less than significant and consistent with the requirements of the MS4 permit.

7.10.2 Dry Weather Runoff

Direct Impacts

The quantity of dry weather flows from urban sources is variable and not easily quantified. Information available from the Irvine Ranch Water District suggests an average dry weather flow from urban areas of 2.9×10^{-4} cfs per urbanized acre (IRWD, 2003). Dry weather flow estimates in Santa Monica, used to design a dry weather flow recycling facility, indicate a range of dry weather flows between 8.3×10^{-5} to 1.8×10^{-4} cfs per urbanized acre (Antich *et al.*, 2003). For purposes of conservatively estimating the impacts of dry weather flows, a dry weather discharge of 3.0×10^{-4} cfs per urbanized acre was used in this report.

While the exact suite of BMPs to be used on the project is not currently know, the Performance Standard established in this document can be used to estimate area of vegetated BMPs available to evapotranspire and infiltrate dry weather flows. A worst case evaluation was made by considering vegetated swales designed only for SUSMP water quality treatment (i.e. no volume reduction required) accepting runoff from a portion of the project dominated by single family residential (lowest imperviousness ratio, therefore smallest BMP footprint per developed area). Based on design storm and swale sizing calculations, it is anticipated that the minimum swale footprint will be approximately 0.5% of the developed area footprint. Based on design storm calculations and accepted rules of thumb, bioretention areas would tend to be larger in area than vegetated swales.

To consider this worst case scenario, the total project area expected to contribute dry weather flows was used to generate monthly dry weather runoff volumes, and 0.5% of this area was considered to be available to evapotranspire and infiltrate this volume. Evapotranspiration rates were assumed to be 60% of reference rates from the California Irrigation Management Information System (CIMIS) Zone 14, in which the Project is located. This assumption is believed to be conservative in representing a plant palate in continually moist conditions. An infiltration rate of 0.15 inches per hour was assumed consistent with post-development assumptions made for the Project site in water quality modeling efforts (See Appendix B). It was assumed that open space in the Project area would result in no dry weather runoff.

It is predicted that all dry weather flows will be removed by evapotranspiration or infiltrated in the treatment control PDFs, which also provide hydrologic source control. As a result, no change in seasonality of flows from the Project is anticipated.

Based on the comprehensive site planning, source control, and treatment control strategy the impact of the Project on dry weather water quality and seasonality of flow in the Santa Clara River is considered less than significant.

8 CONCLUSIONS

This section summarizes the potential effects, if any, of the proposed Vista Canyon Project on water quality and hydromodification in Santa Clara River Reach 7.

8.1 Water Quality Impacts

The following are the conclusions regarding the significance of impacts for the pollutants of concern under wet and dry weather conditions:

- ***Sediments*****:** MS4 Permit, LID Ordinance/Manual, Construction General Permit, Dewatering General Permit, and SUSMP-compliant BMPs will be incorporated into the Project to address sediment in both the construction phase and post-development. Mean total suspended solids concentration is predicted to be less in the post-development condition than in the existing conditions and TSS load is predicted to increase. Turbidity in stormwater runoff will be controlled through implementation of a Construction SWPPP and will be permanently reduced through the stabilization of erodible soils with development. On this basis, the impact of the Project on sediments is considered less than significant.
- ***Nutrients (Phosphorus and Nitrogen (Nitrate-N + Nitrite-N, Ammonia-N, and Total Nitrogen))***: MS4 Permit, LID Ordinance/Manual, Construction General Permit, Dewatering General Permit, and SUSMP-compliant BMPs will be incorporated into the Project to address nutrients in both the construction phase and post-development. Total phosphorus load and concentration; nitrate- plus nitrite-nitrogen, ammonia, and total nitrogen loads and ammonia concentration are predicted to increase; and nitrate- plus nitrite-nitrogen, and total nitrogen concentrations are predicted to decrease in the post-developed condition. Nitrate-N plus nitrite-N and ammonia-N concentrations are predicted to be below Basin Plan objectives and TMDL waste load allocations. The predicted total nutrient concentrations are not expected to cause increased algal growth. On this basis, the impact of the Project on nutrients is considered less than significant.
- ***Trace Metals*****:** MS4 Permit, LID Ordinance/Manual, Construction General Permit, General Dewatering Permit, and SUSMP-compliant BMPs will be incorporated into the Project to address trace metals in both the construction phase and post-development. The mean loads of dissolved copper, total lead, and dissolved zinc and the concentration of total lead are predicted to increase with Project development, while concentrations of dissolved copper and dissolved zinc are predicted to decrease. Mean concentrations of dissolved copper, total lead, and dissolved zinc are predicted to be below benchmark Basin Plan objectives and CTR criteria. Cadmium is not expected to be present at significant levels in Project runoff. On this basis, the impact of the Project on trace metals is considered less than significant.

- ***Chloride*****:** MS4 Permit, LID Ordinance/Manual, Construction General Permit, Dewatering General Permit, and SUSMP-compliant BMPs will be incorporated into the Project to address chloride loads (via volume reduction) in both the construction phase and post-development. The mean concentration and load of chloride is predicted to increase with development. The predicted concentration is well below the Los Angeles Basin Plan objective and is within the range of observed values in Santa Clara River Reach 7. On this basis, the impact of the Project on chloride is considered less than significant.

- ***Pesticides*****:** Pesticides in runoff may or may not increase in the post-development phase as a result of landscape applications. Proposed pesticide management practices, including source control, removal with sediments in treatment control PDFs, and advanced irrigation controls, in compliance with the requirements of the MS4 Permit and the SUSMP Manual, will minimize the presence of pesticides in runoff. During the construction phase of the Project, erosion and sediment control BMPs implemented per General Construction Permit and General De-Watering Permit requirements will prevent pesticides associated with sediment from being discharged. Final site stabilization will limit mobility of legacy pesticides that may be present in pre-development conditions. On this basis, the impact of the Project on pesticides is considered less than significant.

- ***Pathogens*****:** Post-development pathogen sources include both natural and anthropogenic sources. The natural sources include bird and mammal excrement. Anthropogenic sources include leaking septic and sewer systems and pet wastes. The Project will not include septic systems and the sewer system will be designed to current standards which minimizes the potential for leaks. Thus pet wastes are the primary source of concern. The PDFs will include source controls and treatment controls which in combination should help to reduce pathogen indicator levels in post-construction stormwater runoff. Pathogens are not expected to occur at elevated levels during the construction-phase of the Project. On this basis, the Projects impact on pathogen and pathogen indicators is considered less than significant.

- ***Hydrocarbons*****:** Hydrocarbon concentrations will likely increase in post-development because of vehicular emissions and leaks. In stormwater runoff, hydrocarbons are often associated with soot particles that can combine with other solids in the runoff. Such materials are subject to treatment in the proposed bioretention areas, and vegetated swales. Source control BMPs incorporated in compliance with the MS4 Permit and the SUSMP requirements will also minimize the presence of hydrocarbons in runoff. During the construction phase of the Project, pursuant to the Construction General Permit, the Construction Stormwater Pollution Prevention Plan must include BMPs that address proper handling of petroleum products on the construction site, such as proper petroleum product storage and spill response practices, and those BMPs must effectively prevent the release of hydrocarbons to runoff per the Best Available Technology Economically Achievable and Best Conventional Pollutant Control Technology standards. On this basis, the impact of the Project on hydrocarbons is considered less than significant.

- ***Trash and debris*****:** Trash and debris in runoff are likely to increase in post-development if left unchecked. However, the Project PDFs, including source control and treatment BMPs incorporated in compliance with the MS4 Permit and the SUSMP requirements, will minimize the adverse impacts of trash and debris. Source controls such as street sweeping, public education, fines for littering, covered trash receptacles, and storm drain stenciling are effective in reducing the amount of trash and debris that is available for mobilization during wet weather. During the construction phase of the Project, PDFs implemented per Construction General Permit and General De-Watering Permit requirements will remove trash and debris through the use of BMPs such as catch basin inserts and by general good housekeeping practices. Trash and debris are not expected to significantly impact receiving waters due to the implementation of the Project PDFs.

- ***Methylene Blue Activated Substances (MBAS):*** In the post-development phase, the presence of soap in runoff from the Project will be controlled through the source control PDFs, including a public education program on residential and charity car washing and the provision of a centralized car wash area directed to sanitary sewer in the multi-family residential areas. Other sources of MBAS, such as cross connections between sanitary and storm sewers, are unlikely given modern sanitary sewer installation methods and inspection and maintenance practices. During the construction phase of the Project, equipment and vehicle washing will not use soaps or any other MBAS sources. Therefore, MBAS are not expected to significantly impact the receiving waters of the proposed Project.

- ***Cyanide:*** In addition to the expected relatively low level of cyanide in untreated stormwater, cyanide in runoff from the Project would be readily removed by biological uptake, degradation by microorganisms, and by volatilization in the treatment PDFs. Therefore cyanide is not expected to significantly impact the receiving waters of the Project.

- ***Bioaccumulation*****:** In the literature, the primary pollutants that are of concern with regard to bioaccumulation are mercury and selenium. However, selenium and mercury are not of concern in the Project's watershed, so bioaccumulation of selenium and mercury is also not expected to result either during the construction or post-development Project phases. On this basis, the potential for bioaccumulation in the Project PDFs or in the Santa Clara River and adverse effects on waterfowl and other species is considered less than significant.

- ***Construction Impacts:*** Construction impacts on water quality are generally caused by soil disturbance and subsequent suspended solids discharge. These impacts will be minimized through implementation of construction BMPs that will meet or exceed measures required by the Construction General Permit, as well as BMPs that control the other potential construction-related pollutants (e.g., petroleum hydrocarbons and metals). A SWPPP specifying BMPs for the site that meet or exceed Best Available Technology economically achievable/Best Conventional Pollutant Control Technology standards will be developed as required by, and in compliance with, the Construction General Permit and Los Angeles County Standard Conditions. Erosion control BMPs, including but not limited to hydro-mulch, erosion control blankets, stockpile stabilization, and other physical soil stabilization techniques will be implemented to prevent erosion, whereas sediment controls, including but not limited to silt fencing, sedimentation ponds, and secondary containment on stockpiles will be implemented to trap sediment and prevent discharge. Non-stormwater and construction waste and materials management BMPs, such as vehicle and equipment fueling and washing BMPs; nonvisible pollutant monitoring; and BMPs to manage materials, products, and solid, sanitary, concrete, hazardous, and hydrocarbon wastes will also be deployed to protect construction site runoff quality. On this basis, the construction-related impact of the project on water quality is considered less than significant.

- ***Regulatory Requirements:*** The proposed Project satisfies MS4 Permit requirements for new development, including SUSMP and SQMP requirements, satisfies construction-related requirements of the Construction General Permit and General Dewatering Permit, and complies with the requirements of the County's LID Ordinance, and, therefore, complies with water quality regulatory requirements applicable to stormwater runoff.

8.2 Groundwater Impacts

- ***Groundwater Quality Impacts (Stormwater)***: MS4 Permit, LID Ordinance, Construction General Permit, Dewatering General Permit, and SUSMP-compliant BMPs will be incorporated into the Project to address nutrients in both the construction phase and post-development. Nitrate- plus nitrite-nitrogen concentrations are predicted to decrease in the post-developed condition. The predicted nitrate-nitrogen plus nitrite-nitrogen concentration in stormwater runoff after treatment in the Project PDFs and in irrigation water is well below the groundwater quality objective. On this basis, the potential for stormwater infiltration to adversely affect groundwater quality is considered less than significant.
- ***Groundwater Quality Impacts (Recycled Water)***: The WRP treatment processes will incorporate best practicable treatment and control measures which will be regularly maintained and optimally operated. Comparison of predicted groundwater quality at the critical downgradient production well to the water quality objectives for water supply showed that the Project would not adversely impact the water quality of downstream water supply wells. The expected nitrate-nitrogen plus nitrite-nitrogen concentration in combined percolated recycled water and stormwater is less than the Basin Plan standard, thus would not result in a violation of the groundwater quality standards for nitrate-nitrogen plus nitrite-nitrogen. Through participation in the AWRM (through inclusion of the project site within the Santa Clarita Valley Sanitation District), percolation of recycled water from the Project would not result in a violation of the groundwater quality standards for minerals (TDS, chloride, sulfate, and boron). Impacts to all other groundwater pollutants of concern will be prevented by the incorporation of best

practicable treatment and control measures in the WRP treatment processes. Based on the analysis for the pollutants of concern in groundwater, the Project will not result in a violation of any groundwater quality standards or waste discharge requirements or otherwise substantially degrade water quality. On this basis, the Project's direct impact on groundwater quality is considered less than significant.

- ***Groundwater Recharge Impacts***: Project stormwater runoff will be discharged to the Santa Clara River after treatment, whose channel is predominantly natural and consists of vegetation and coarse-grained sediments (rather than concrete). The porous nature of the sands and gravels forming the streambed will allow for significant infiltration to occur to the underlying groundwater. Also, irrigation water is predicted to be fully infiltrated during dry weather, which will increase groundwater recharge from the Project. On this basis, the Project’s impact on groundwater recharge is considered less than significant

8.3 Hydromodification Impacts

The following are the conclusions regarding the significance of impacts for hydromodification impacts under wet- and dry-weather conditions:

- ***Wet Weather Project Impacts***: Although the Project’s runoff volumes, flow rates, and durations will increase, potential impacts of hydromodification (i.e., the potential to cause erosion, siltation, or channel instability) will be avoided, minimized, and mitigated by the Project PDFs in the following ways:
    - Project site design and on-site treatment PDFs, especially open space retention, efficient irrigation, and treatment control PDFs will avoid and/or minimize increases in runoff volume from the development area, the preferred method for controlling hydromodification impacts from new development (SCCWRP, 2005a).
    - Concentrated flows will be mitigated with energy dissipaters at the discharge points to the Santa Clara River and the Santa Clara River banks will be protected by geomorphically-referenced engineering techniques, primarily with vegetated buried bank stabilization. This type of stabilization technique is the preferred approach for bank stabilization (SCCWRP, 2005a).

  For these reasons, direct hydromodification impacts of the Project on the Santa Clara River is considered less than significant.

- ***Cumulative Hydromodification Impacts***: The Project contributes only 1.8 percent of the total potential impervious surface at build out within the watershed, the Project includes hydromodification controls as Project Design Features, future development projects within the watershed will control flow in compliance with the sub-regional program, and large-scale changes naturally occur in the Santa Clara River in response to major episodic events, therefore, the Project’s contribution to cumulative hydromodification impacts to the Santa Clara River will be less than significant and consistent with the requirements of the MS4 permit.

- ***Dry Weather Hydromodification Impacts***: It is predicted that all dry weather flows will be removed in the treatment control PDFs, which also provide hydrologic source control. As a result, no appreciable change in seasonality of flows is anticipated to result from development. Based on the comprehensive site planning, source control, and treatment control strategy and that no dry weather flows are predicted to be discharged to the Santa Clara River, the impact of the Project on dry weather water quality and seasonality of flow in the Santa Clara River is considered less than significant.

9 REFERENCES

Alliance Land Planning and Engineering, Inc., 2010. Drainage Concept/SUSMP Study, Vista Canyon, Tentative Tract No. 69164. Prepared for JSB Development by Alliance Land Planning and Engineering, Inc. December 2009.

American Society of Civil Engineers (ASCE), 1998. Urban Runoff Quality Management. ASCE Manual and Report on Engineering Practice No. 87; 259 pages.

American Society of Civil Engineers Urban Water Resources Research Council and United States Environmental Protection Agency (ASCE/EPA), 2003, International Stormwater Best Management Practices Database. http://www.bmpdatabase.org/index.htm.

Anderson, MA, 2005. Aliso Beach Clean Beaches Initiative, J01P28 Interim Water Quality Improvement Package Plant Best Management Practice, County of Orange Resources and Development Management Department, Watershed and Coastal Resources, January.

Antich, Anthony, Harvey R. Gobas, and Jag Salgaonkar. The Santa Monica Urban Runoff Recycling Facility and the Sustainable Environment. Stormwater Journal. Available at: http://www.forester.net/sw_0207_santa.html.

Balance Hydrologics, 2005. Assessment of Potential Impacts Resulting from Cumulative Hydromodification Effects, Selected Reaches of the Santa Clara River, Los Angeles County, California. Prepared by Balance Hydrologics Inc. for Newhall Land. October 2005.

Barber, T.R., Lutes, C.C., Doorn, M.R.J., Fuchsman, P.C., Timmenga, H.J., and R.L. Crouch, 2003. Aquatic Ecological Risks Due to Cyanide Releases from Biomass Burning. Chemosphere 50:33, 343-348, January 2003.

Bledsoe, Brian P. and Chester C. Watson. 2001. Effects of Urbanization on Channel Instability. Journal of the American Water Resources Association, vol. 37 (2). 255-270.

Boehm, AB, NJ Ashbolt, JM Colford Jr., LE Dunbar, LE Fleming, MA Gold, JA Hansel, PR Hunter, AM Ichida, CD McGee, JA Soller, SB Weisberg, A Sea Change Ahead for Recreational Water Quality Criteria, Journal of Water and Health, 07.1 (9-20).

Booth, Derek, 1990. Stream-channel incision following drainage-basin urbanization. Water Resources Bulletin, vol 26, pg 407-417.

Booth, D.B. and Jackson C.R. 1997 Urbanization of Aquatic Systems: Degradation Thresholds, Stormwater Detection, and the Limits of Mitigation. Journal of the American Water Resources Association, vol 33 (5), pg 1077-1090.

Brown & Caldwell, 1984. Fresno Nationwide Urban Runoff Program Project. Report for the Fresno Metropolitan Flood Control Board, May 1984.

California Stormwater Quality Association (CASQA), 2003. Stormwater Best Management Practices Handbook New Development and Redevelopment and Construction.

Center for Watershed Protection (CWP), 1996. Design of Stormwater Filtering Systems, Prepared for the Chesapeake Research Consortium, December.

Center for Watershed Protection (CWP), 2000. National Pollutant Removal Performance Database.

CH2M Hill, 2004. Memorandum: "Effect of Urbanization on Aquifer Recharge in the Santa Clarita Valley."

CH2MHill and HGL, 2008. *Task 2B-1 – Numerical Model Development and Scenario Results East and Piru Subbasins;* Upper Santa Clara River Chloride TMDL Collaborative Process. Prepared for Los Angeles County Sanitation District and Los Angeles Regional Water Quality Control Board. March 2008.

City of Austin. 1990. Removal Efficiencies of Stormwater Control Structures. Environmental Resources Management Division, Environmental and Conservation Services Department, City of Austin, Austin, TX.

Cole, R.H., R.E. Frederick, and R.P. Healy, 1984. Preliminary Findings of the Priority Pollutant Monitoring Project of the Nationwide Urban Runoff Program. Journal of the Water Pollution Control Federation. 56:898-908.

Colman, John A., Karen C. Rice, and Timothy C. Willoughby, 2001. Methodology and Significance of Studies of Atmospheric Deposition in Highway Runoff. USGS Open-File Report 01-259. A Contribution to the National Highway Runoff Data and Methodology Synthesis. Prepared in cooperation with the Federal Highway Administration. U.S. Department of the Interior, U.S. Geological Survey. Northborough, Massachusetts. 2001.

Colford, JM Jr., TJ Wade, KC Schiff, CC Wright, JF Griffith, SK Sandhu, SB Weisberg. 2005. Recreational Water Contact and Illness in Mission Bay, California, Technical Report 449, Southern California Coastal Water Research Project, Westminster, CA.

Colker, Ryan M. and Robert D. Day, 2005. Environmental Impacts of Emerging Contaminants. Renewable Natural Resources Foundation's 2005 Congress on Environmental Impacts of Emerging Contaminants. (http://www.rnrf.org/)

Department of Land and Water Conservation (DLWC), 1996. DRAFT: Department of Land and Water Conservation "The Manager's Guide to: Sediment, Nutrients, and Gross Pollutant Control," 1st ed., Resource Management Division, Sydney, Australia

Dexter Wilson Engineering, 2010. *Engineering Report for the Vista Canyon Water Factory (Municipal Wastewater Treatment Facility).* Prepared for: JSB Development. April, 2010.

Dudek, 2009. California Rapid Assessment Methodology Report Vista Canyon Ranch Property Los Angeles County, California. Prepared for Impact Sciences by Dudek. February 2009.

Forde Biological Consultants, 2008. Biological Assessment Vista Canyon Ranch Los Angeles County, California. August 27, 2008.

Gaffney, J.S., G.E. Streit, and W.D. Spall, 1987. Beyond Acid Rain: Do Soluble Oxidants and Organic Toxins Interact with SO2 and NOX to Increase Ecosystem Effects? Environmental Science and Technology. 21:519-523.

Geosyntec Consultants, 2002. Hydromodification Management Plan Literature Review, Santa Clara Valley Urban Runoff Pollution Prevention Program.

Geosyntec Consultants, 2004. Hydromodification Management Plan, Santa Clara Valley Urban Runoff Pollution Prevention Program.

Haile, Robert W., JS Witte, M Gold, R. Cressey, C McGee, RC Millikan, A Glasser, N Harawa, C Ervin, P Harmon, J Harper, J Dermand, J Alamillo, K Barrett, M Nides, G Wang, 1999. The Health Effects of Swimming in Ocean Water Contaminated by Storm Drain Runoff, Epidemiology, 1999;10:355-363)

Hammer, Thomas R. 1972. Stream and channel enlargement due to urbanization. Water Resources Research, vol. 8, pg 1530-1540

Hollis, G.E. 1975. The Effect of Urbanization on Floods of Different Recurrence Intervals. Water Resources Research, vol. 11 (3), pg 431-435.

Irvine Ranch Water District (IRWD), 2003. The Residential Runoff Reduction Study Municipal Water District of Orange County. July 2004.

Katznelson, R. and T. Mumley, 1997. Diazinon in Surface Waters in the San Francisco Bay Area: Occurrence and Potential Impact. Prepared for California State Water Resources Control Board, and Alameda County Clean Water Program.

Kim, S. *et al*, 2007. Occurrence and removal of pharmaceuticals and endocrine disruptors in South Korean surface, drinking and waste waters. Water Research 41, 1013-1021.

Kolpin, D. *et al*, 2002. Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in US Streams, 1999-200: A National Reconnaissance. Environmental Science and Technology 36, 1202-1211.

Kurz, 1999. Removal of Microbial Indicators from Stormwater Using Sand Filtration, Wet Detention, and Alum Treatment Best Management Practices. Sixth Biennial Stormwater Research & Watershed Management Conference. September 1999.

Los Angeles County Department of Public Works (LACDPW), 2000. Los Angeles County 1994-2000 Integrated Receiving Water Impacts Report. Available at: http://ladpw.org/wmd/NPDES/IntTC.cfm.

Los Angeles County, 2002. A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP Manual). September 2002.

Los Angeles County Department of Public Works (LACDPW), 2005. Los Angeles County 1994-2005 Integrated Receiving Water Impacts Report Final Report - August 2005. Available at: http://ladpw.org/wmd/NPDES/1994-05_report/contents.html.

Los Angeles County, 2008. Ordinances for Green Building, Low Impact Development, and Drought Tolerant Landscaping (November 14, 2008).

Los Angeles County Department of Public Works (LACDPW), 2009. Stormwater Best Management Practice Design and Maintenance Manual For Publicly Maintained Storm Drain Systems. May 2009. [Online] http://dpw.lacounty.gov/des/Design_Manuals

Los Angeles County, 2009. County of Los Angeles Low Impact Development Standards Manual (January, 2009).

Los Angeles Regional Water Quality Control Board (LARWQCB), 1994. Water Quality Control Plan Los Angeles Region (as amended).

Los Angeles Regional Water Quality Control Board (LARWQCB), 2001. Los Angeles County Municipal Storm Water National Pollutant Discharge Elimination System (NPDES) Permit as Amended by Regional Board Order R4-2007-0042 on August 9, 2007 (Board Order No. 01-182; NPDES Permit No. CAS004001).

Los Angeles Regional Water Quality Control Board (LARWQCB), 2003. Santa Clara River Total Maximum Daily Loads for Nitrogen Compounds Staff Report. California Regional Water Quality Control Board Los Angeles Region. June 16, 2003.

Los Angeles San Gabriel Rivers Watershed Councils, (LASGRWC), 2005. Water Augmentation Study Phase II. August, 2005. (www.lasgrwc.org/WAS/Documents/WAS%20Phase%20II%20Final%20Report_2005.pdf)

Los Angeles Regional Water Quality Control Board, 2006a. Clarification Letter to Part 4.D. Development Planning Program, the Los Angeles County Municipal Storm Water Permit, Order No. 01-182, NPDES PERMIT No. CAS004001, from the Los Angeles Regional Water Quality Control Board to the Los Angeles County Department of Public Works. December 15, 2006.

Los Angeles Regional Water Quality Control Board, 2006b. Waste Discharge Requirements for City of Fillmore, Order No. R4-2006-0049.

Los Angeles Regional Water Quality Control Board, 2007. Waste Discharge Requirements for City of Santa Paula, Order No. R4-2007-0028.

Luhdorff and Scalmanini and GSI, 2009. *Analysis of Groundwater Supplies and Groundwater Basin Yield, Upper Santa Clara River Groundwater Basin, East Subbasin*. Prepared for Santa Clarita Valley Municipal Water Purveyors. August 2009

Lyko, S. *et al*, 2005. Estrogenic trace contaminants in wastewater – possibilities of membrane bioreactor technology. Desalination 78, 95-105.

MacRae, C.R. 1992. The Role of Moderate Flow Events and Bank Structure in the Determination of Channel Response to Urbanization. Resolving conflicts and uncertainty in water management: Proceedings of the 45th Annual Conference of the Canadian Water Resources Association. Shrubsole, Dan, ed. 1992, pg 12.1-12.21.

Marshack, 2003. A Compilation of Water Quality Goals. Prepared by Jon B. Marshack, California Regional Water Quality Control Board, Central Valley Region. August 2003 with tables updated August 2007.

Marsalek, J., Brownlee, B., Mayer, T., Lawal, S., and G. A. Larkin. "Heavy Metals and PAHs in Stormwater Runoff from the Skyway Bridge, Burlington, Ontario." Water Quality Research Journal of Canada, Vol. 32, No. 4 (1997) pp. 815–827.

MEC-Weston Solutions, 2004. Mission Bay Clean Beaches Initiative Final Report, Executive Summary, September 15. Prepared by City of San Diego for the State Water Resources Control Board.

Melin, T. *et al*, 2006. Membrane bioreactor technology for wastewater treatment and reuse. Desalination 187, 271-282.

Novotny, V., D.W. Smith, D.A. Kuemmel, J. Mastriano, and A. Bartosova, 1999. Urban and Highway Snowmelt: Minimizing the Impact on Receiving Water. Project 94-IRM-2. Report for Water Environment Research Foundation.

Natural Resources Conservation Service (NRCS), 2004. Antelope Valley Area Soil Survey, NRCS Soil Map Antelope Valley Area, CA675.

Onesios, K. *et al*, 2009. Biodegradation and removal of pharmaceuticals and personal care products in treatment systems: a review. Biodegradation 20, 441-466.

PACE, 2008. Drainage Concept Report and Fluvial Study. Prepared by Pacific Advanced Civil Engineering, Inc. for Vista Canyon Ranch, LLC.

PACE, 2009. Vista Canyon Ranch VTTM #69164 Santa Clara River Bank Protection; EIR Flood Technical Report. Prepared by Pacific Advanced Civil Engineering, Inc. for Impact Sciences. June 2009.

Phillips, P.J *et a*l, 2005. A multi-disciplinary approach to the removal of emerging contaminants in municipal wastewater treatment plants in New York State (2003-2004). Water Environment Federation's WEFTEC 78th Annual Technical Exhibition and Conference, Conference Proceedings, Washington, DC, November 2005, p. 5095-5124.

Pitt *et al.*, 1994. Pitt, R., S. Clark, and K. Parmer. "Potential Groundwater Contamination from Intentional and Nonintentional Stormwater Infiltration." Journal of Alabama's Water Environment Association. Vol. 15, No. 1. pp. 8-11. Summer 1994.

Pitt, R., A. Maestre, and R. Morguecho, 2003. "The National Stormwater Quality Database (NSWQ, Version 1.0)," Prepared by University of Alabama and Center for Watershed Protection.

Pruss, Annette, 1998. Review of Epidemiological Studies on Health Effects from Exposure to Recreational Water, International Journal of Epidemiology 1998;27 1-9.

Reemtsma, T, *et al*, 2006. Polar Pollutants Entry into the Water Cycle by Municipal Wastewater: A European Perspective. Environmental Science and Technology 40, 5451-5458.

RTFA, 2006. Final Report, Geotechnical Constraints Investigation, Vista Canyon Ranch Project, Santa Clarita, CA. Prepared for Vista Canyon Ranch, LLC February 10, 2006; 72 pages.

RTFA, 2007a. Phase I Environmental Site Assessment Vista Canyon Ranch (Waldron Property). Prepared for Vista Canyon Ranch, LLC June 18, 2007; 183 pages.

RTFA, 2007b. Geotechnical Constraints Investigation, Waldron Property. Prepared for Vista Canyon Ranch, LLC; June 22, 2007; 52 pages.

RTFA, 2008. Limited Hydrogeologic Report, Analysis of Groundwater Resource, Vista Canyon Ranch Project, Santa Clarita, CA. Prepared for Vista Canyon Ranch, LLC; May 20, 2008; 6 pages.

RTFA Personal Communication

Ribes, Sandra, B. Van Drooge, J. Dachs, O. Gustafsson, and J.O. Grimalt, 2003. Influence of Soot Carbon on the Soil-Air Partitioning of Polycyclic Aromatic Hydrocarbons, Environmental Science & Technology 37, 2675-2680.

San Francisco Bay Regional Water Quality Control Board (SFBRWQCB), 2003. Insecticide Market Trends and Potential Water Quality Implications, prepared by K. Moran, TDC Environmental, April, pp. 1-105.

San Francisco Bay Regional Water Quality Control Board (SFBRWQCB), 2005. Diazinon and Pesticide-Related Toxicity in Bay Area Urban Creeks. Water Quality Attainment Stratefy and Total Maximum Daily Load (TMDL) Proposed Basin Plan Amendment and Staff Report. California Regional Water Quality Control Board San Francisco Bay Region. November 9, 2005.

San Francisco Estuary Project (SFEP) 2005. Pesticides in Urban Surface Water, Urban Pesticide Use Trends Annual Report 2005, prepared by TDC Environmental, March.

Sawyer *et al.*, 1994. Chemistry for Environmental Engineering, Fourth Edition. Clair Sawyer, Perry McCarty, and Gene Parkin. McGraw-Hill, Inc., 1994.

SCCWRP, 2005a. Effect of Increases in Peak Flows and Imperviousness on the Morphology of Southern California Streams. Technical Report 450. April 2005.

SCCRWP, 2005b. Managing Runoff to Protect Natural Streams: The Latest Developments on Investigation and Management of Hydromodification in California. Technical Report 475. December 2005.

Schroeder, E.D., W.M. Stallard, D.E. Thompson, F.J. Loge, M.A. Deshusses, H.J. Cox, 2002. Management of Pathogens Associated with Storm Drain Discharge, Center for Environmental and Water Resources Engineering, Dept. of Civil and Environmental Engineering, University of California, Davis prepared for Division of Environmental Analysis, California Department of Transportation, May.

Snyder, S. *et al*, 2007. Role of membranes and activated carbon in the removal of endocrine disruptors and pharmaceuticals, Desalination, 202, 156-181.

Stein, ED, LL Tiefenthaler, KC Schiff, 2007. Sources, Patterns, and Mechanisms of Stormwater Pollutant Loading from Watersheds and Land Uses of the Greater Los Angeles Area, Technical Report #510, Southern California Coastal Water Research Project, Westminster, CA.

Stormwater Quality Task Force (SWQTF), 1993. California Stormwater Best Management Practices Handbook – Industrial/Commercial.

Strecker, E. *et al.*, 2004. Analyses of the Expanded EPA/ASCE International BMP Database and Potential Implications for BMP Design, World Water and Envt. Cong. Proc. (June 27-July 1, 2004).

Surbeck, CQ, AB Grant, JH Ahn, S Jiang, SA Soeller, PA Holden, LC Van Der Werfhorst, DJ Brooks, 2008. Urban Runoff Impact Study Phase III: Land Use and Fecal Indicator Bacteria Generation, National Water Research Institute (NWRI) Final Project Report, November.

Suter, G.W, II, and C.L. Tsao., 1996. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision. Oak Ridge National Laboratory, ES/ER/TM-96/R2, Oak Ridge National Laboratory, Oak Ridge, TN.

Tiefenthaler, L.L., Schiff, K.C., and Leecaster, M.K., 2000. Temporal Variability Patterns of Stormwater Concentrations in Urban Stormwater Runoff, as contained in the Southern California Coastal Research Project 1999-2000 Annual Report. (http://www.sccwrp.org/pubs/annrpt/99-00/table_of_contents.htm)

Tiefenthaler, L.L., E.D. Stein, G.S. Lyon, 2009. Fecal Indicator Bacteria (FIB) Levels During Dry Weather from Southern California Reference Streams, Environmental Monitoring and Assessment, 155:477-492.

USEPA, 1972. Committee on Water Quality Criteria. National Academy of Sciences-National Academy of Engineering. Water Quality Criteria. USEPA R3-73-033, Washington, D.C., 1972.

USEPA, 1981. Exposure and Risk Assessment for Cyanide. Washington, DC: U.S. Environmental Protection Agency. Office of Water. EPA440485008. PB85220572.

USEPA 1983. Nationwide Urban Runoff program. Final Report. Water Planning Division, USEPA, Washington DC.

USEPA, 1986. Ambient Water Quality Criteria for Bacteria—1986, at 1–3 (USEPA 440/5-84-001).

USEPA, 1993. Office of Water. Guidance to Specify Management Measures for Sources of Nonpoint Pollution in Coastal Waters. EPA-840-B-92-002. Washington, DC.

USEPA, 1999a. Stormwater Technology Fact Sheet: Sand Filters, Office of Water, Washington, D.C. EPA 832-F-99-007, September.

USEPA, 1999b. Stormwater Technology Fact Sheet: Bioretention, Office of Water, Washington, D.C. EPA 832-F-99-012, September.

USEPA, 2001. Organophosphate Pesticide; Availability of Revised Risk Assessments. Federal Register: January 31, 2001 (Volume 66, Number 21), Page 8400-8401.

USEPA, 2002a. Total Maximum Daily Loads for Toxic Pollutants – San Diego Creek and Newport Bay, California, June 14, 2002.

USEPA, 2007a. Aquatic Life Ambient Freshwater Quality Criteria – Copper 2007 Revision. United States Environmental Protection Agency Office of Water. EPA-822-R-07-001. February 2007.

USEPA, 2007b. Report of Experts Scientific Workshop on Critical Research Needs for the Development of New or Revised Recreational Water Quality Criteria, Washington, D.C., EPA 823-R-07-006, http://www.epa.gov/waterscience/criteria/recreation

USEPA, 2009. Review of Zoonotic Pathogens in Ambient Waters, EPA 822-R-09-002, Office of Water, Health and Ecological Criteria Division, February.

USGS, 2010. Toxic Substances Hydrology Program, Research Projects - Emerging Contaminants website (http://toxics.usgs.gov/regional/emc/).

Ventura County, 2005. Ventura County stormwater quality monitoring data, from various annual reports (http://www.vcstormwater.org/publications.htm)

Water Environment Federation (WEF), 1998. WEF Manual of Practice No. 23/ASCE Manual of Practice No. 87, Urban Runoff Quality Management.

Water Environment Research Foundation (WERF), 2007. Development of a Protocol for Risk Assessment of Microorganisms in Separate Stormwater Systems. 03-SW-2. 2007.

Water Environment Research Foundation (WERF), 2009. Report on the Experts Scientific Workshop on Critical Research and Science Needs for the Development of Recreational Water Quality Criteria for Inland Waters. PATH4W09. 2009.

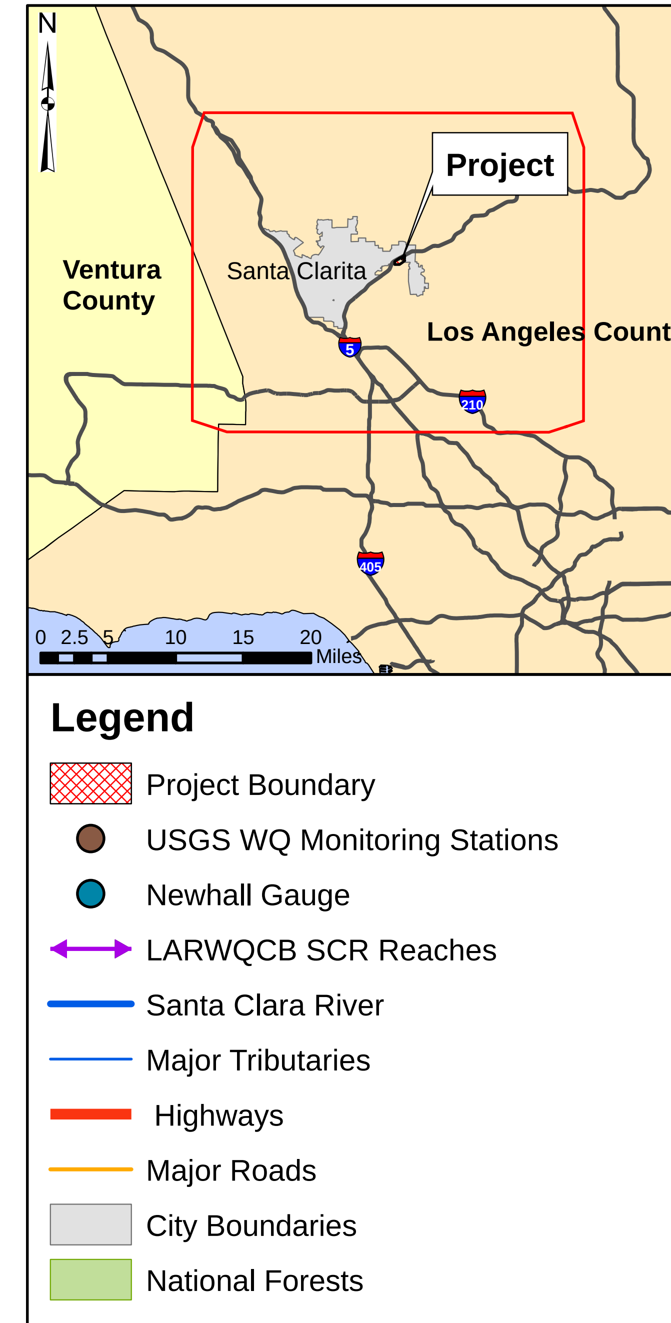


Figure 2-1:
Vista Canyon Vicinity

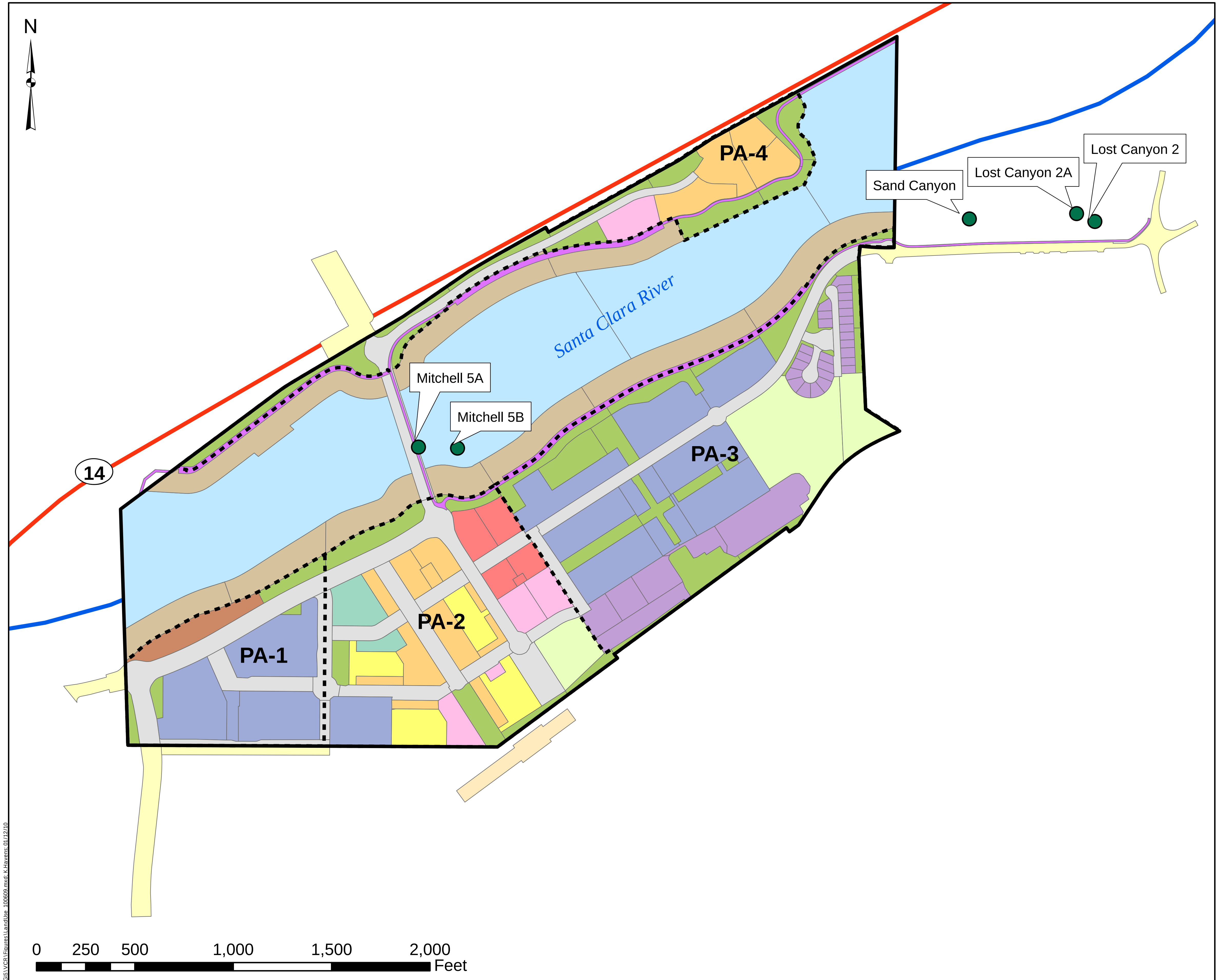
Water Quality Technical Report
Vista Canyon

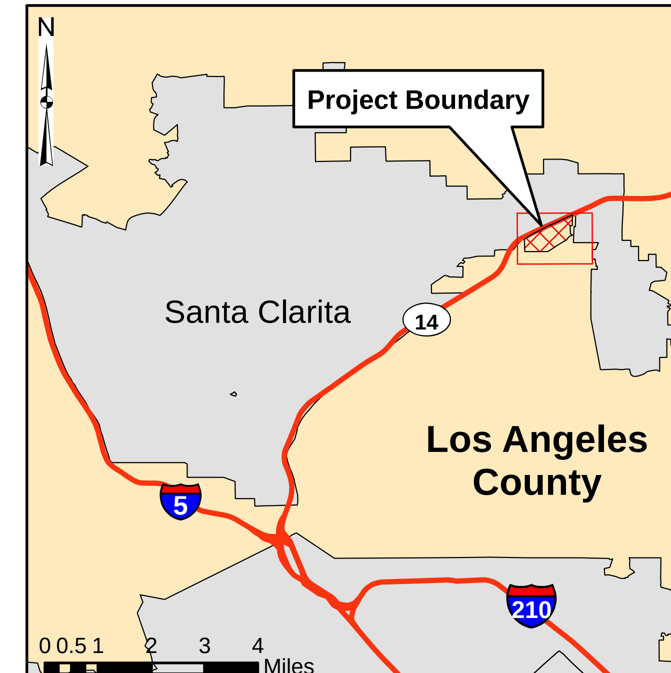
May 2010

Geosyntec consultants

P:\GIS\VCR\Figures\Vicinity_072309

Prepared By: K. Havens; A. Poresky





Legend

- Planning Areas
- Wells*

On-site Land Uses

- Single-Family Detached
- Multi-Family
- Mixed-Use/ Multi-Family
- Mixed-Use - Commercial/Office
- Office**
- Commercial
- Parking Structures
- Water Reclamation Plant
- Parks
- Landscape/Open Space/Recreation
- River Bank Protection***
- Santa Clara River
- Roads

- Trails

Off-site Land Uses

- Metrolink Platform
- Off-site Roadways
- Off-site Trails

* Well locations from Santa Clarita Water Company

** The Specific Plan allows a residential overlay within PA-2. This overlay allows for the conversion of up to 250,000 square feet of office uses to a maximum of 233 attached residential units.

*** River Bank Protection encompasses maintenance access road (2.8 acres), buried bank stabilization (6.8 acres), and areas of the river bed which will be temporarily impacted by construction (12.7 acres).

Figure 2-2: Project Land Uses Map

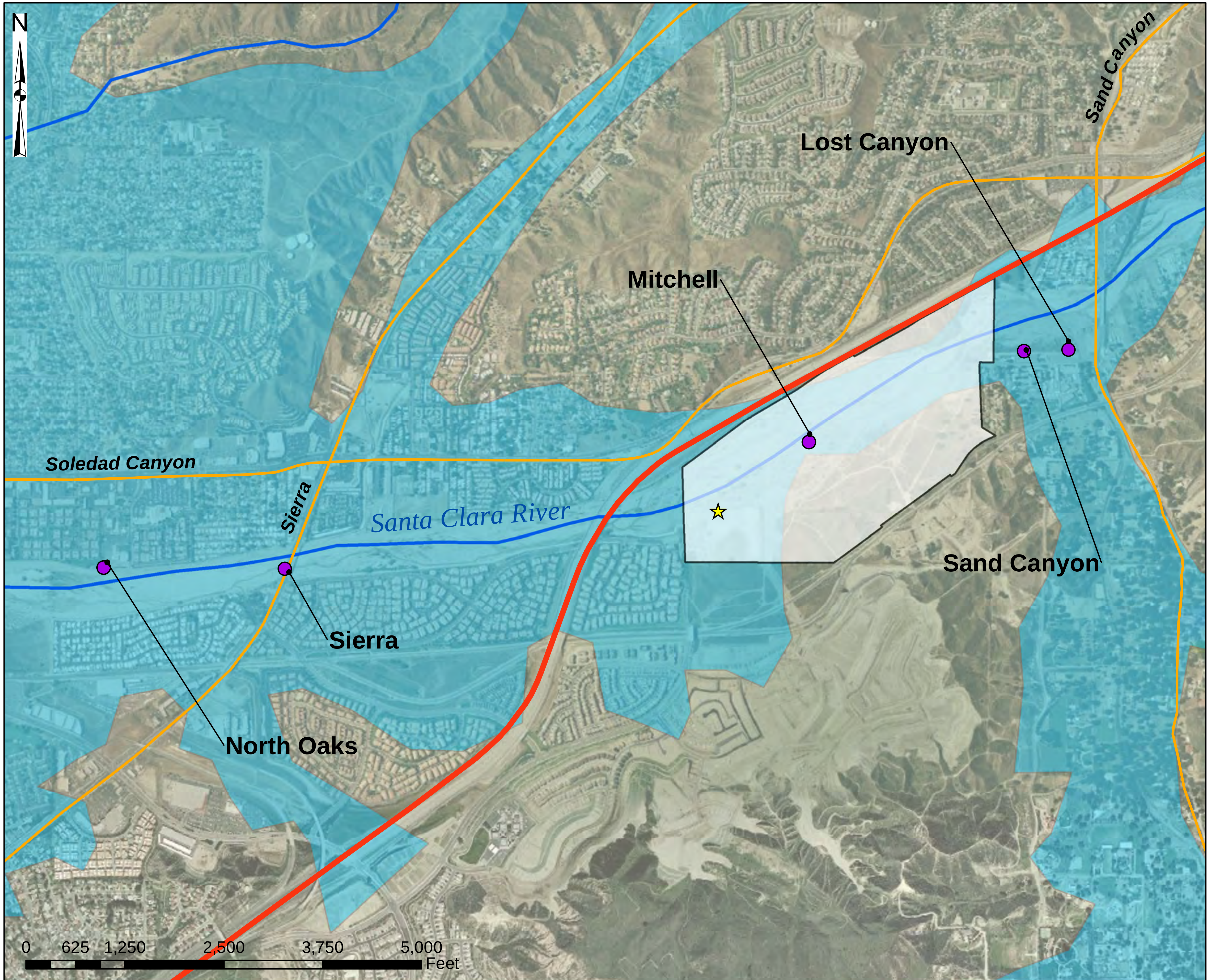
Water Quality Technical Report
Vista Canyon

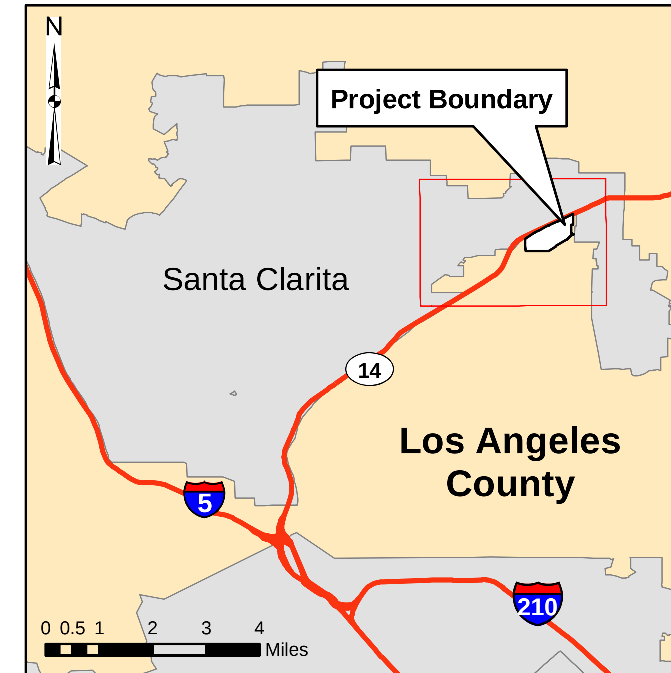
May 2010

Geosyntec consultants

P:\GIS\VCR\Figures\LandUse_092809.mxd

Prepared by K. Havens, A. Poresky





Legend

- ☆ Approximate Percolation Pond Location
- ● CLWA Production Wells
- Santa Clara River Valley Groundwater Basin
- Project Boundary
- Highways
- Major Roads

Notes:
- Well locations are approximate.
- North Oaks includes North Oaks East, North Oaks Central, and North Oaks West.
- Mitchell includes Mitchell 5A and Mitchell 5B.
- Lost Canyon includes Lost Canyon 2 and Lost Canyon 2A.

Figure 2-3: Groundwater Production Well Locations

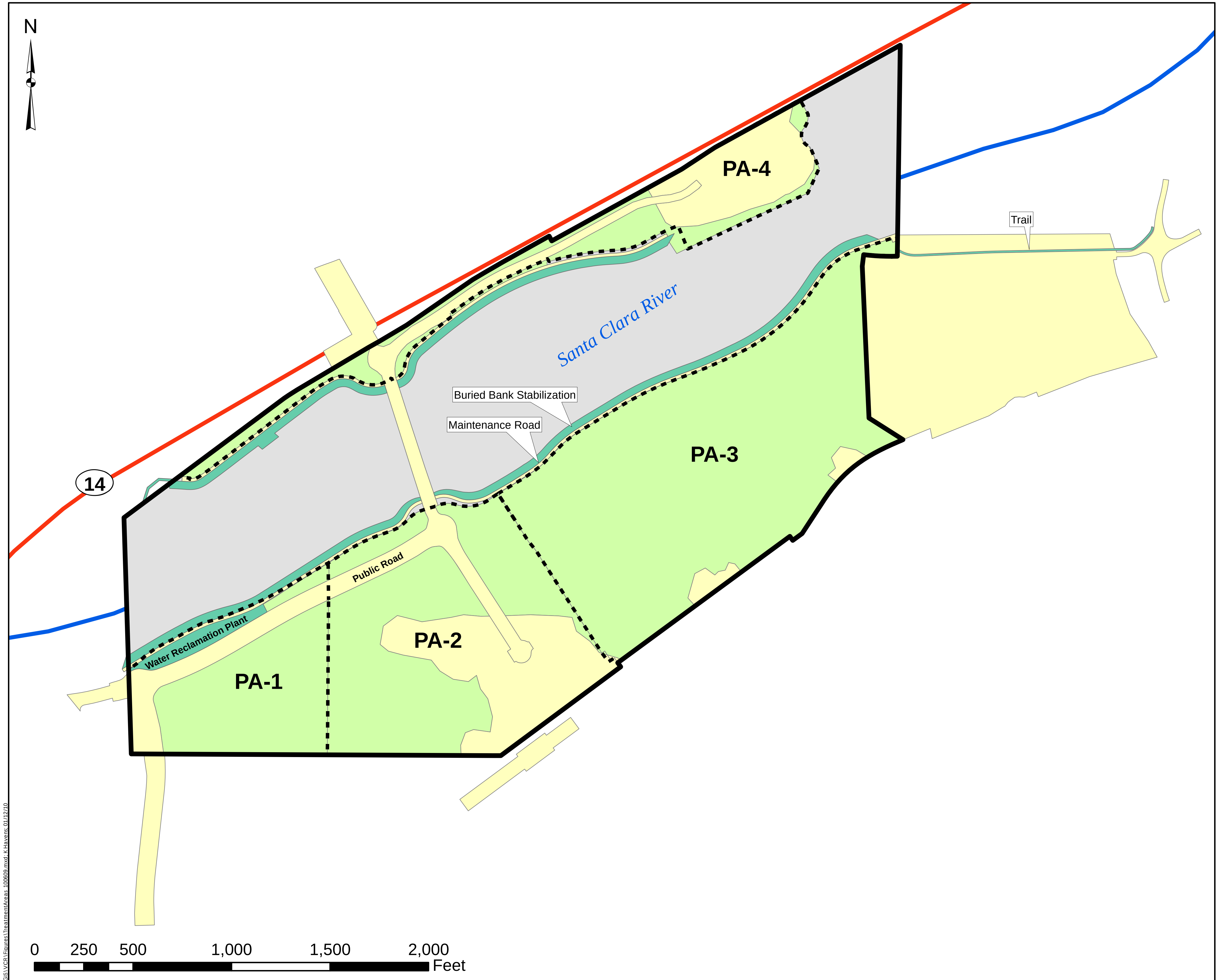
Water Quality Technical Report
Vista Canyon

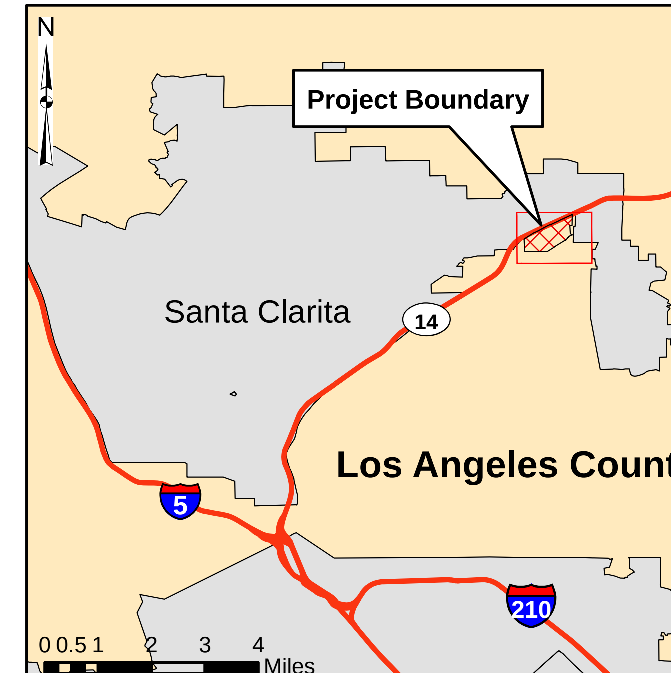
May 2010

Geosyntec consultants

P:\GIS\VCR\Projects\Figures\PercolationVicinity_012510.mxd

Prepared By: K. Havens





Legend

- Property Boundary
- Planning Areas

Treatment Areas

- No Treatment Required
- SUSMP Treatment
- SUSMP Treatment and Delta Volume
- Self Mitigating

Figure 5-1: Project Treatment Areas

Water Quality Technical Report
Vista Canyon

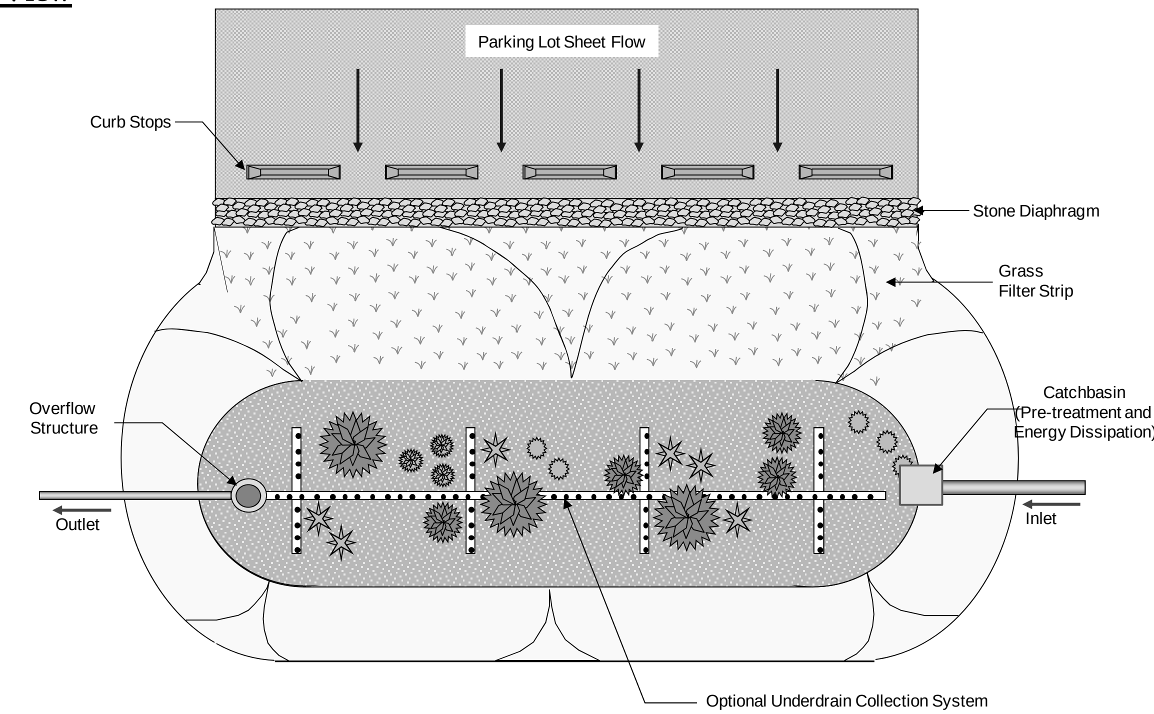
May 2010

Geosyntec consultants

P:\GIS\VCR\Figures\TreatmentAreas_100609.mxd

Prepared by K. Havens, A. Poresky

Plan View



Profile

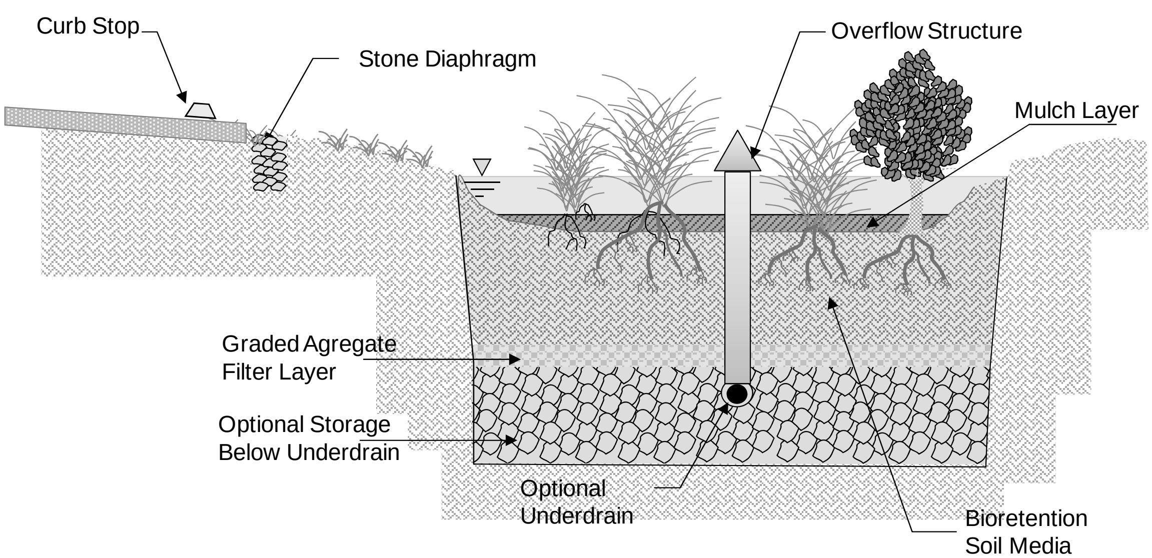
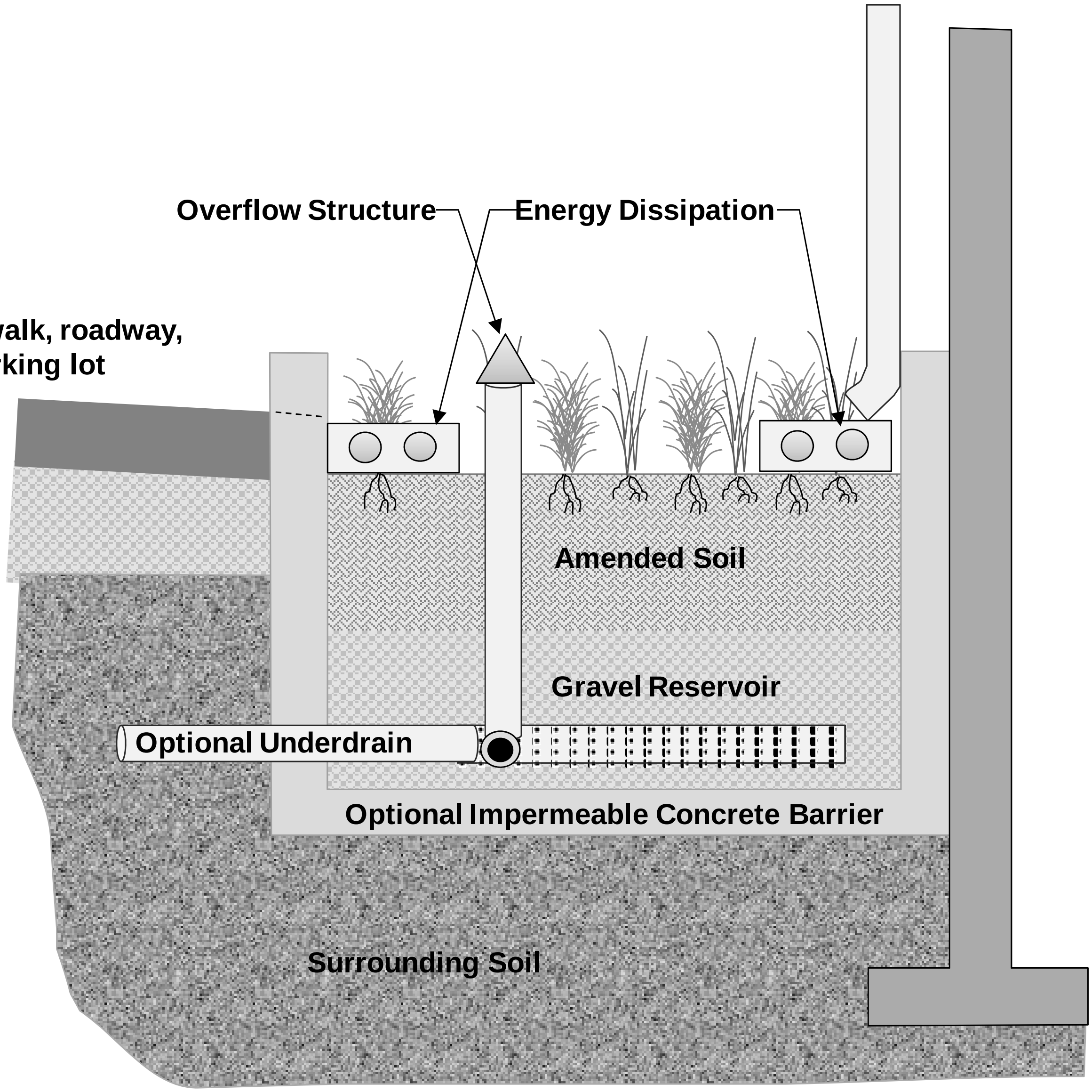


Figure 5-2
Conceptual Illustration of a Bioretention Facility

Conceptual Cross-Section



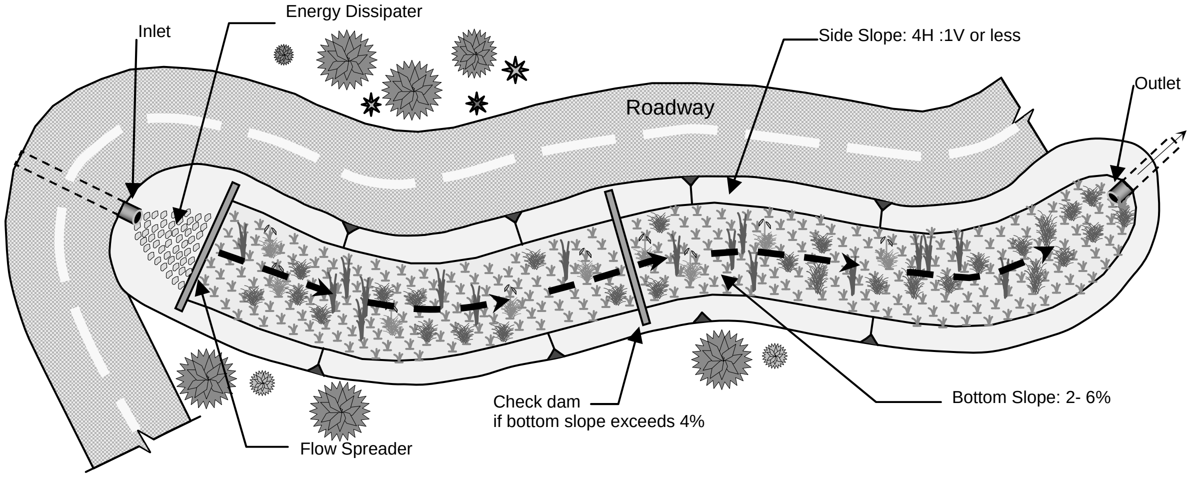
Water enters planter box from rooftops and/or ground-level impervious area

Planter boxes may be designed without bottoms where infiltration is permissible

Figure 5-3
Conceptual Illustration of a Planter Box

May 2010	**Water Quality Technical Report** **Vista Canyon Ranch**	Geosyntec consultants

Plan View



Profile

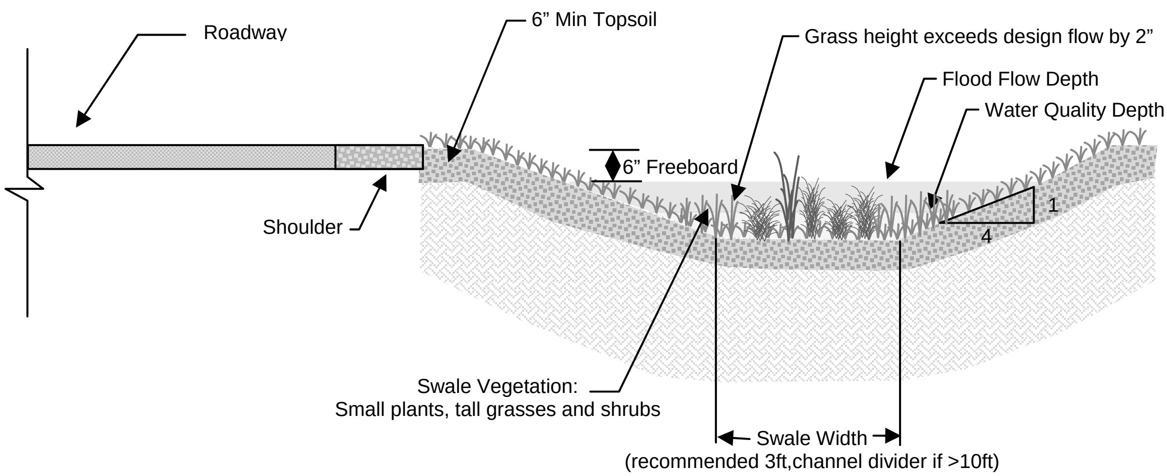
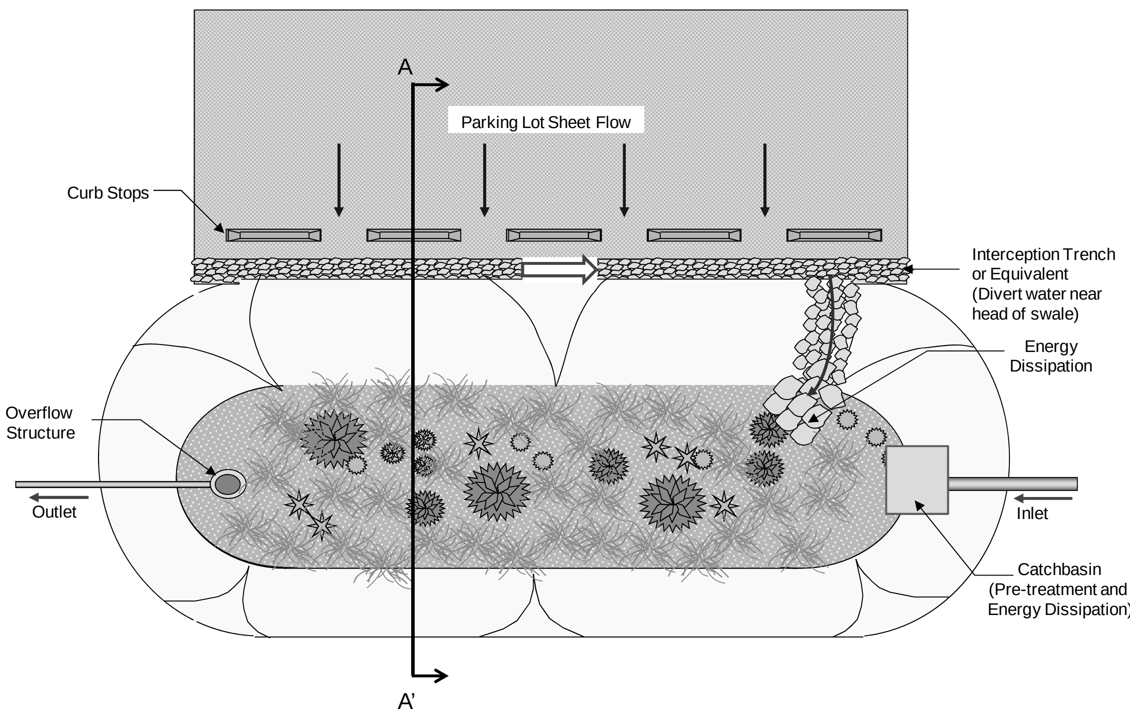
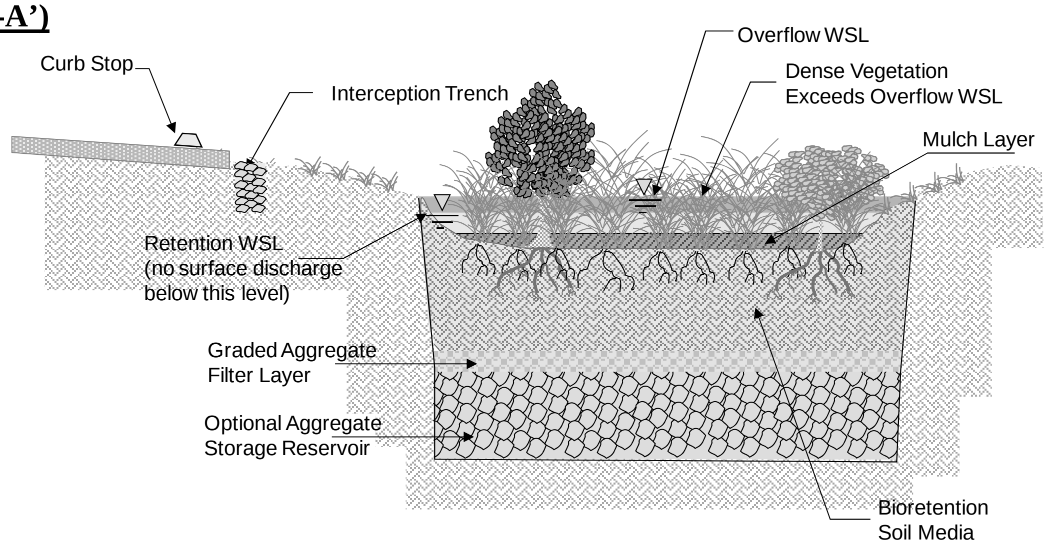


Figure 5- 4
Conceptual Illustration of a Vegetated Swale

Plan View



Profile (A-A')

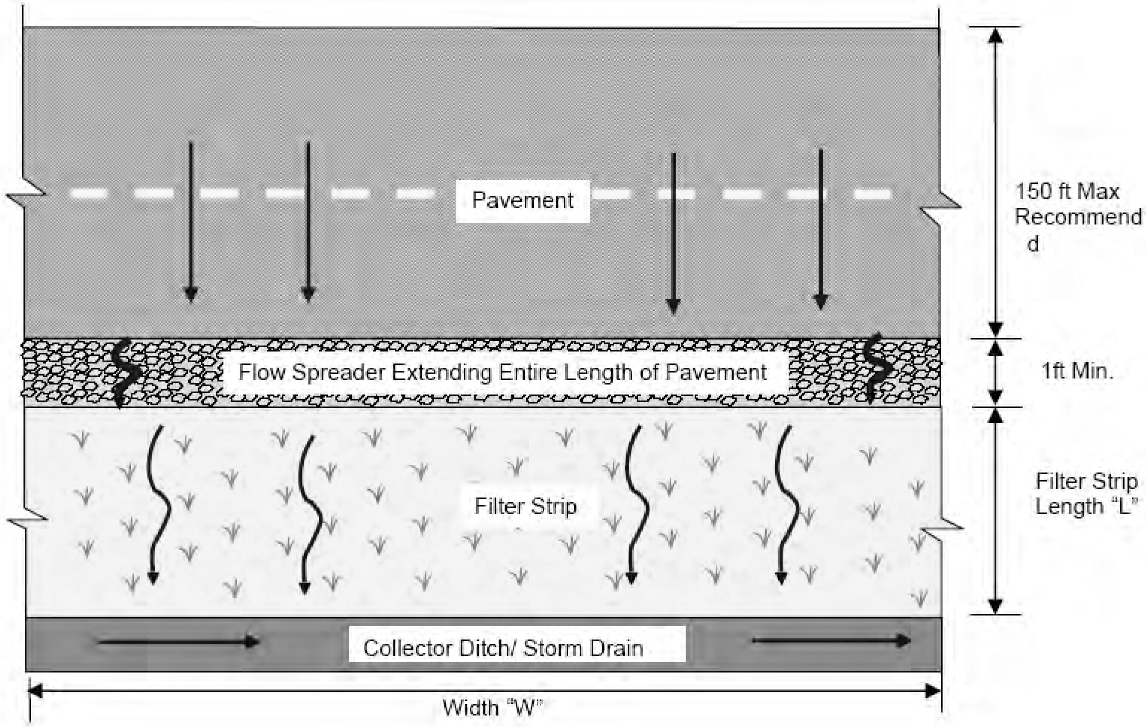


Outlet control designed to control residence time of flow passing through facility below overflow water surface level (WSL). Length, slope and vegetation density designed to promote swale-equivalent treatment.

Figure 5-5
Conceptual Illustration of a Combo Bioretention Swale

May 2010	Water Quality Technical Report Vista Canyon Ranch	Geosyntec consultants

Plan View



Profile

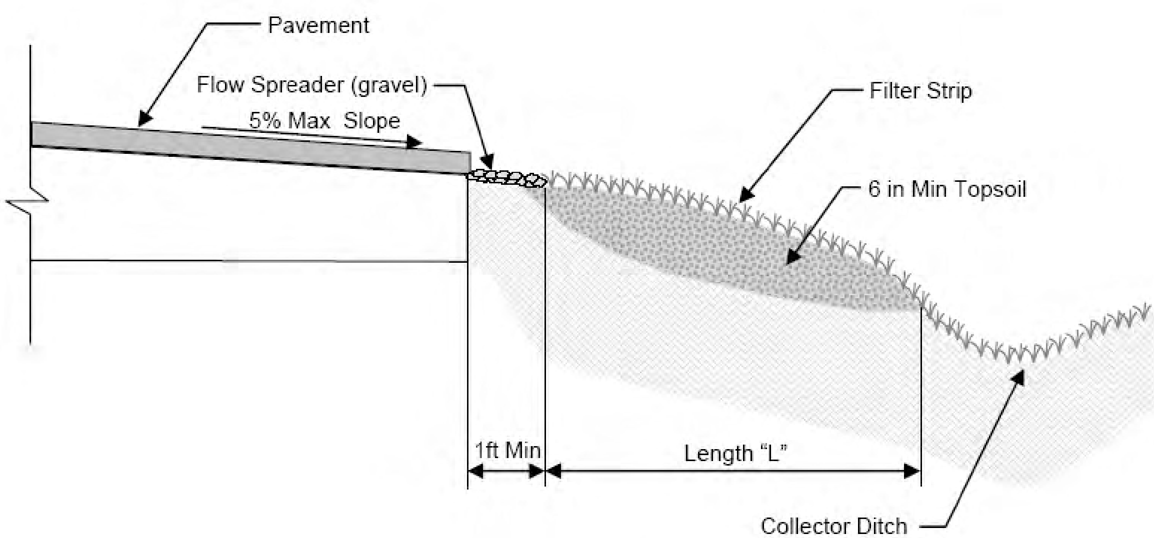
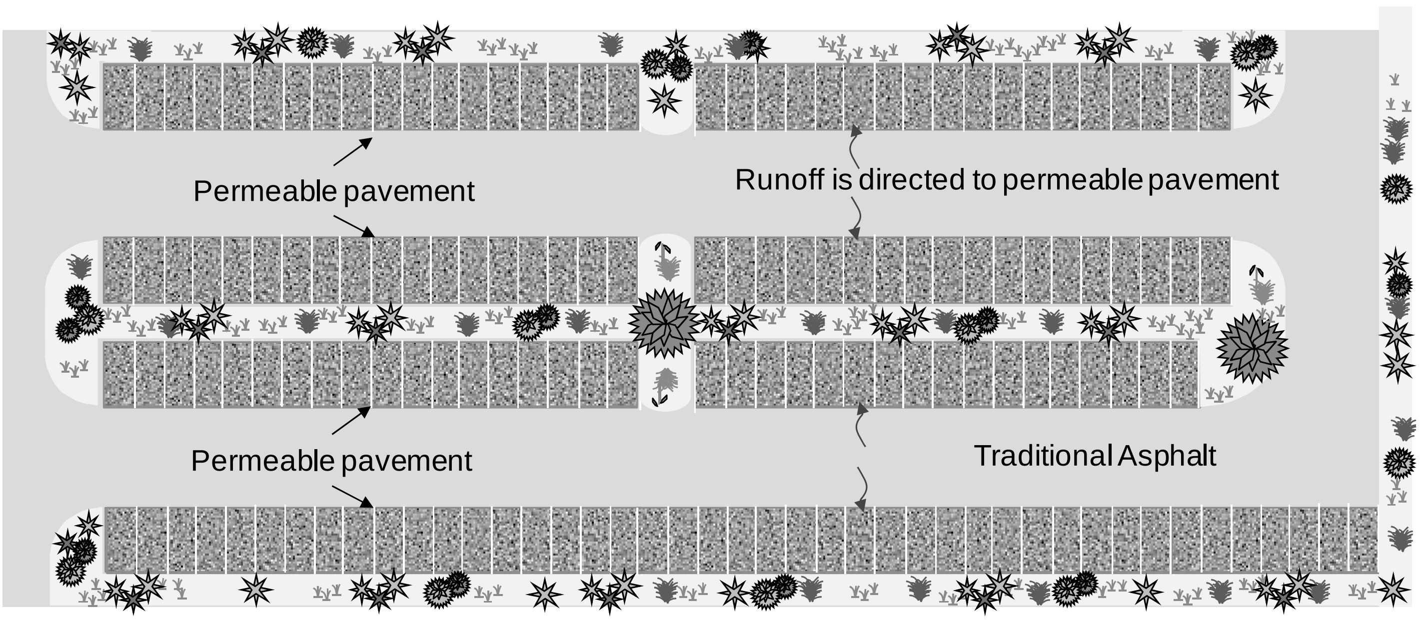


Figure 5-6
Conceptual Illustration of a Filter Strip

Plan View - Parking lot example



Profile

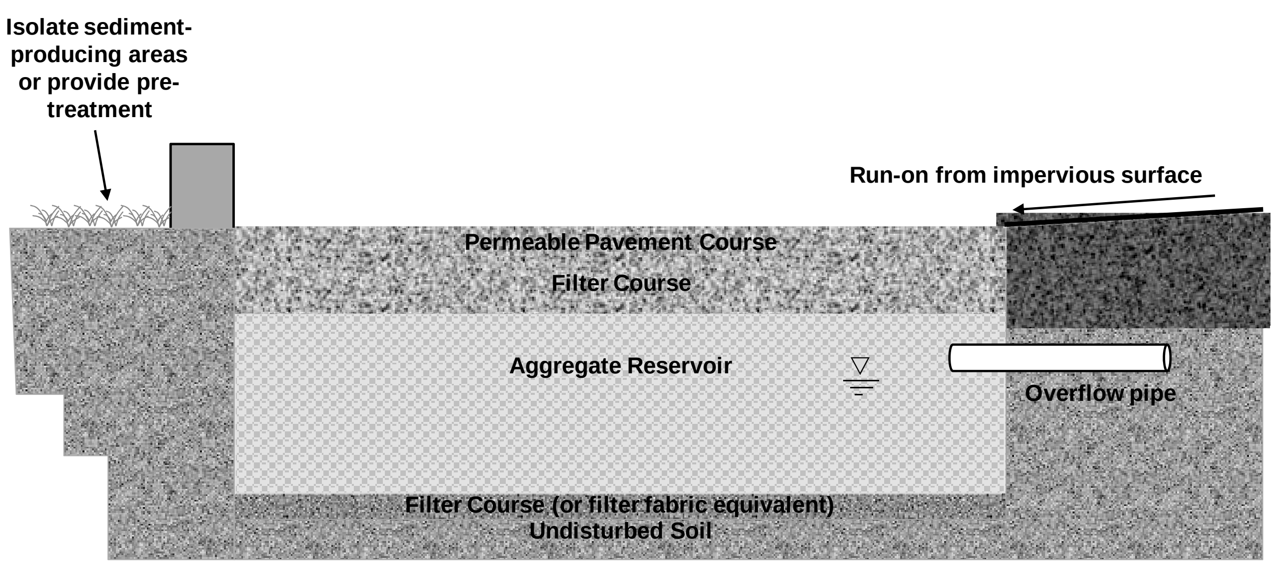
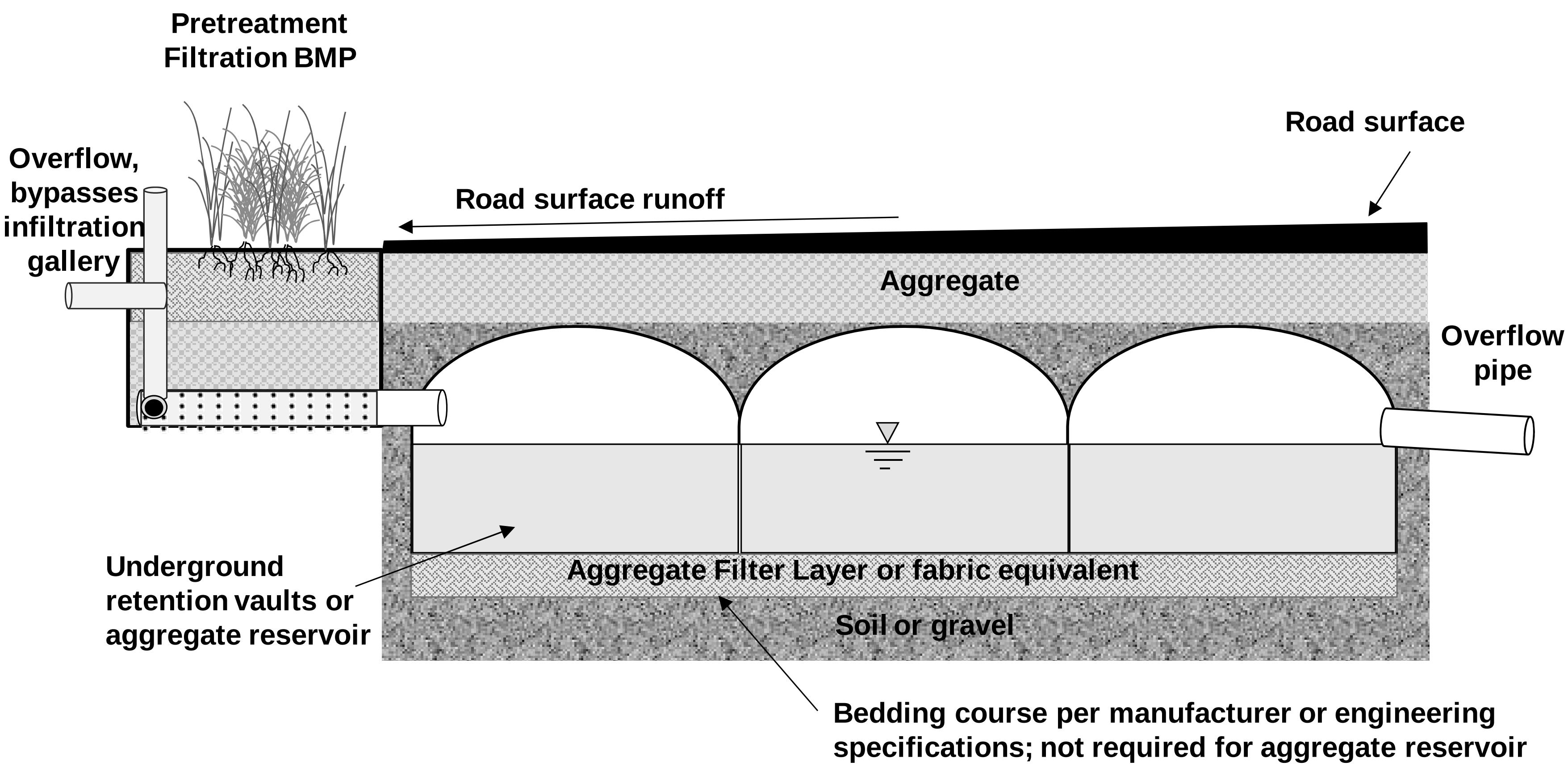


Figure 5 - 7
Conceptual Illustration of Permeable Pavement

Conceptual Cross-Section

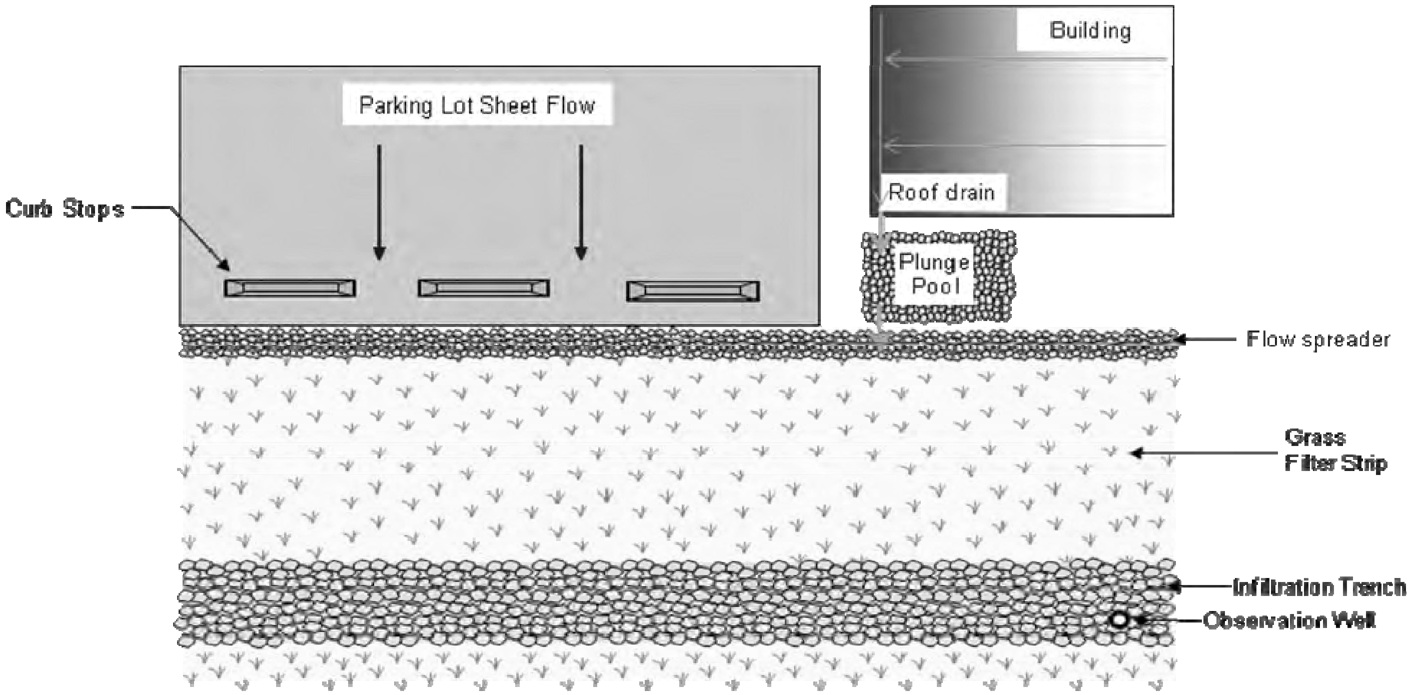


Access and monitoring wells per manufacturer or engineering specifications

Figure 5-8
Conceptual Illustration of an Underground Infiltration Gallery

May 2010	Water Quality Technical Report Vista Canyon Ranch	Geosyntec consultants

Plan View



Profile

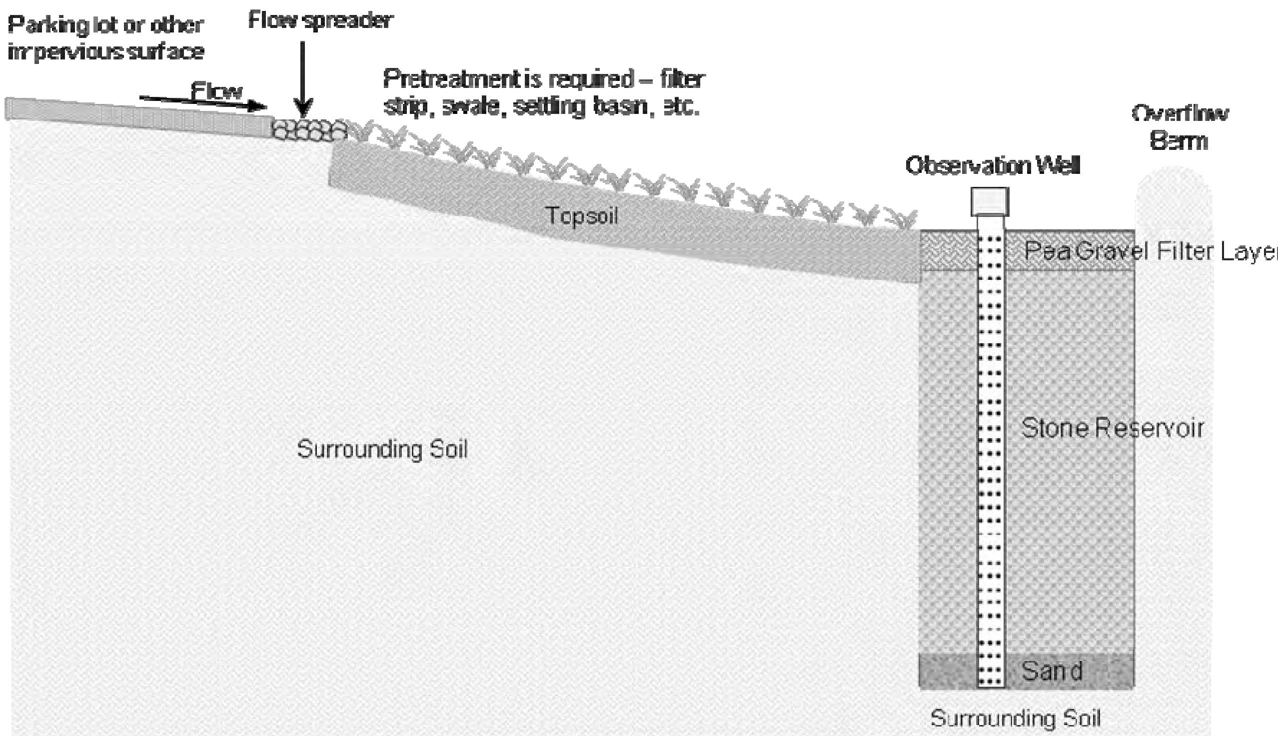
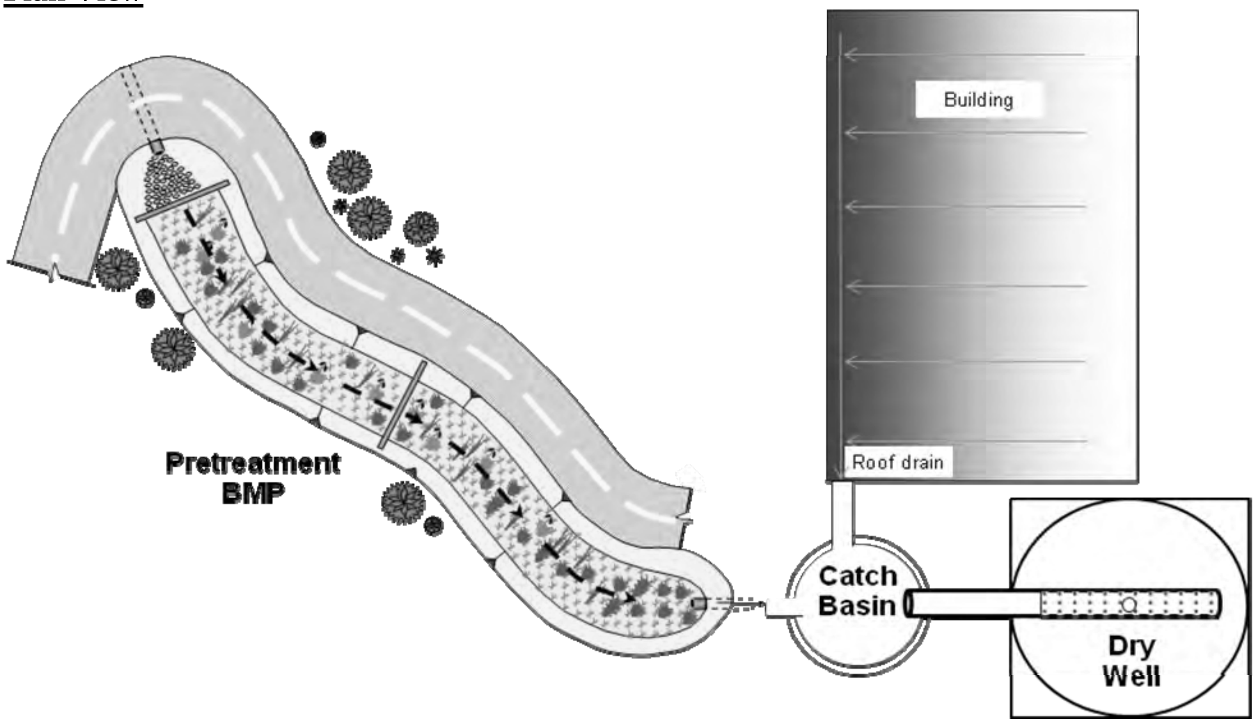


Figure 5-9
Conceptual Illustration of an Infiltration Trench

May 2010	Water Quality Technical Report Vista Canyon Ranch	Geosyntec consultants

Plan View



Profile

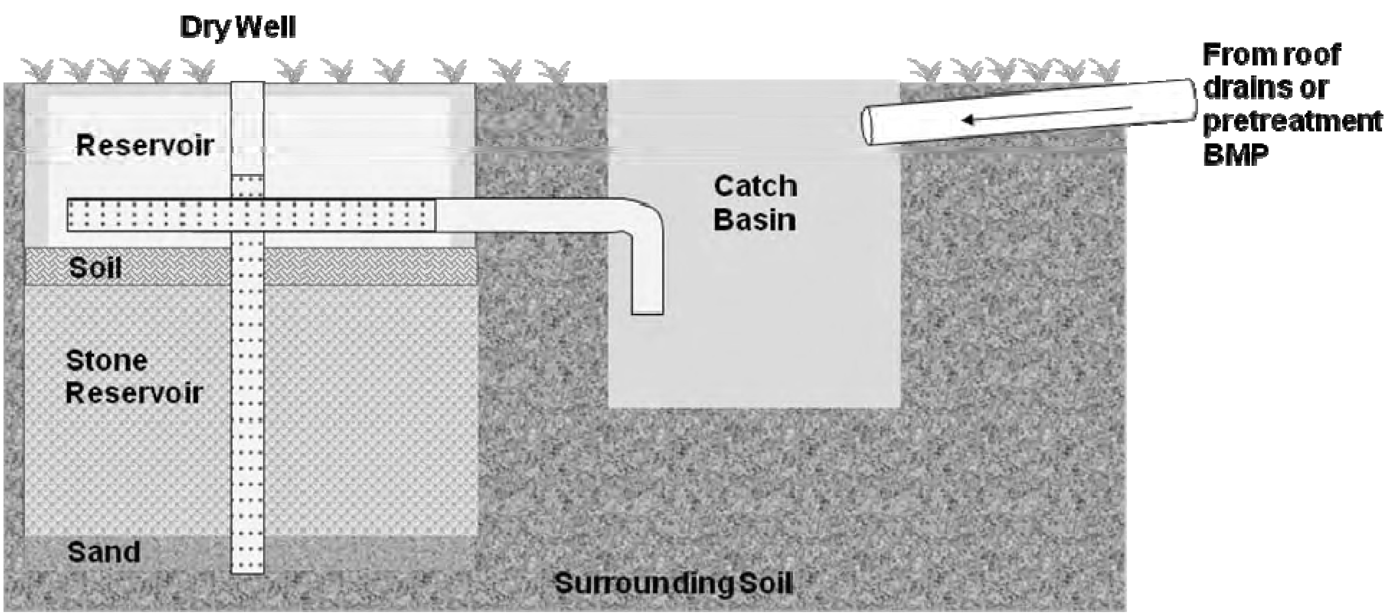


Figure 5-10
Conceptual Illustration of a Dry Well

May 2010	**Water Quality Technical Report** **Vista Canyon Ranch**	Geosyntec consultants

Conceptual System Schematic

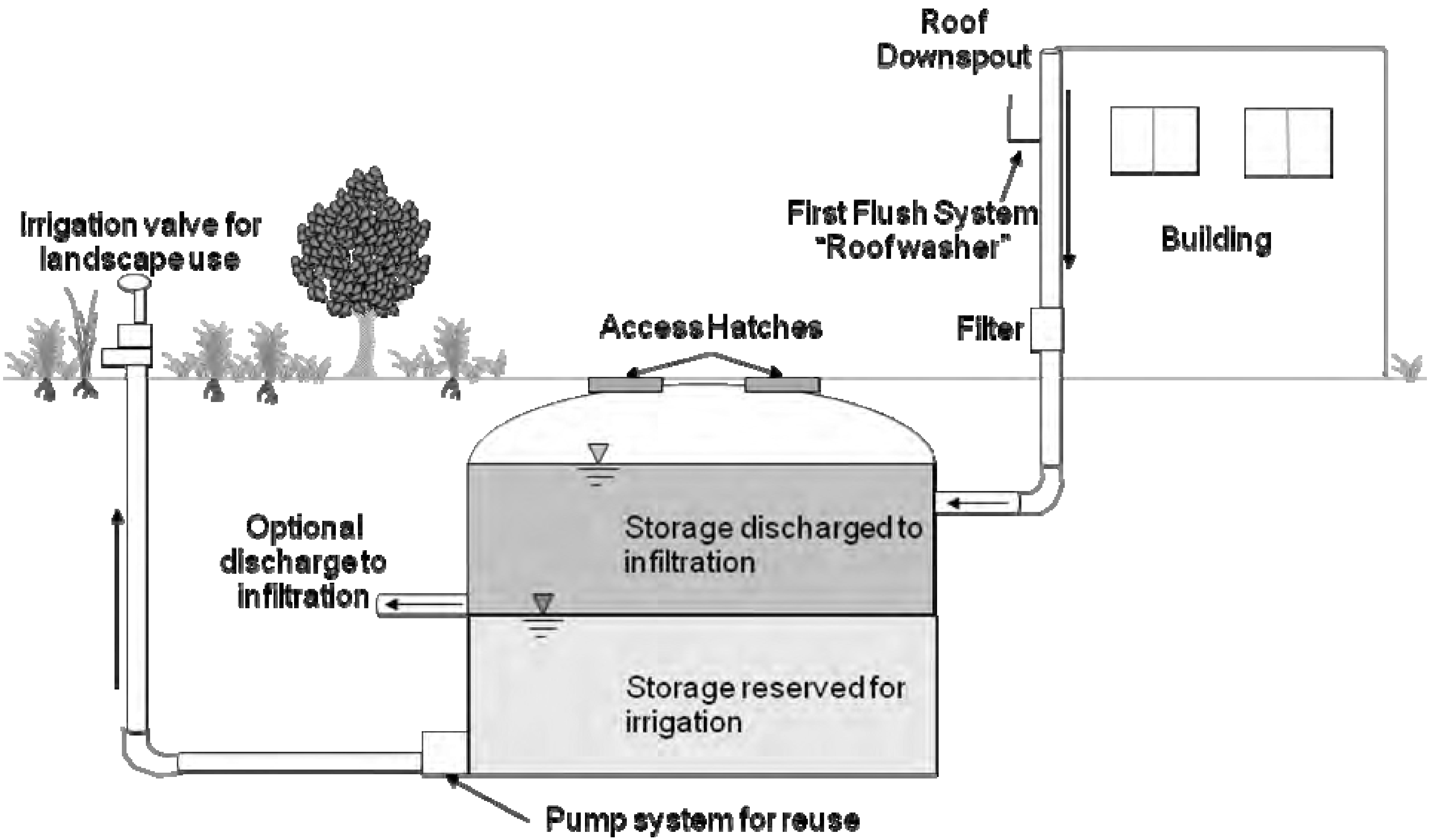
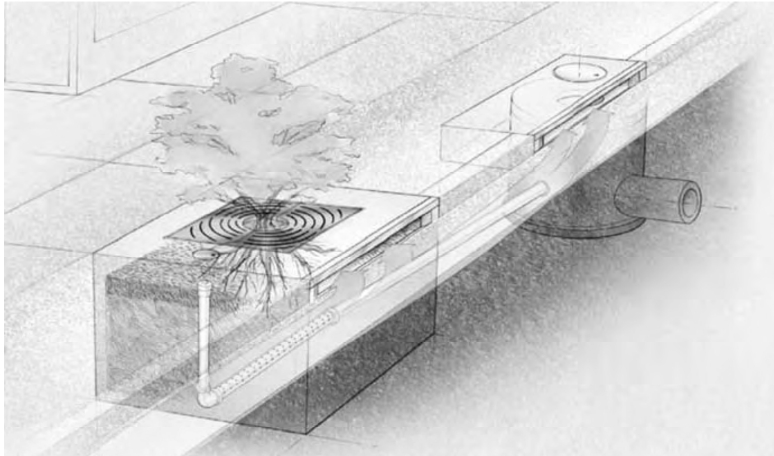
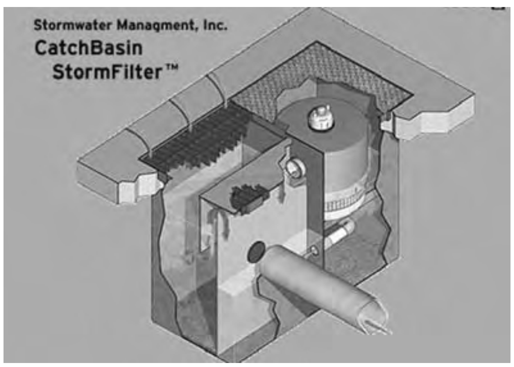


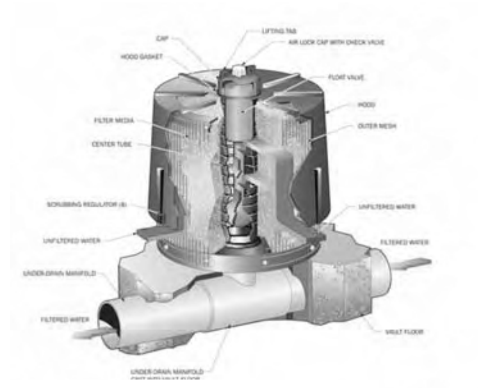
Figure 5-11
Conceptual Illustration of a Cistern

May 2010	Water Quality Technical Report Vista Canyon Ranch	Geosyntec consultants



Filterra® Bioretention Filtration System





Contech StormFilter®

Modular Wetlands MWS-Linear®

Figure is for illustration purposes only. Does not constitute product endorsement of BMPs shown above.

Figure 5 - 12
Conceptual Illustration of Selected Proprietary Treatment BMPs

Vista Canyon
Water Quality Technical Report
Technical Appendices

(A) Pollutants of Concern

(B) Modeling Parameters & Methodology

(C) "Effect of Urbanization on Groundwater Recharge in the Santa Clarita Valley"

(D) "Assessment of Potential Impacts Resulting from Cumulative Hydromodification Effects, Selected Reaches of the Santa Clara River, Los Angeles County, California"

A. POLLUTANTS OF CONCERN AND SIGNIFICANCE CRITERIA

A.1. Pollutants of Concern

<table>
<tr><th>Pollutant of Concern [1]</th><th>Rationale for Selection</th><th>Significance Criteria [2]</th></tr>
<tr>
<td>Bacteria and other Pathogens (Viruses and Protozoa)</td>
<td>1. "Bacteria and viruses are common contaminants of stormwater. For separate storm drain systems, sources of these contaminants include animal excrement and sanitary sewer overflow. High levels of indicator bacteria in stormwater have led to the closure of beaches, lakes, and rivers to contact recreation such as swimming." (CASQA, 2003)
2. Fecal coliform is a frequently monitored indicator organism of human pathogens. Human related activities can increase fecal coliform concentrations.
3. Concentrations of fecal coliform in stormwater can be elevated, often due in part to the presence of coliform bacteria from natural sources.
4. The Santa Clara Reach 7 is listed for coliform bacteria. Additionally, Reaches 5 and 6 are listed for coliform bacteria (303(d) list, LARWQCB, App F, 2009).</td>
<td>1. LA Basin Plan objectives are based on the designated uses of the water body Resolution # 01-018 (LARWQCB, 2001) amended the LA Basin Plan standards for bacteria in waters with a contact recreation beneficial use. These standards for freshwaters (designated REC-1) are:
Bacteria, Coliform Density Limits
<table>
<tr><th></th><th>Geometric Mean Limits</th><th>Single Sample Limits</th></tr>
<tr><td>E. coli</td><td>126/100 mL</td><td>235/100 mL</td></tr>
<tr><td>Fecal Coliform</td><td>200/100 mL</td><td>400/100 mL</td></tr>
</table>
</td>
</tr>
<tr>
<td>Chloride</td>
<td>1. Resolution R03-008 Amendment to the Water Quality Control Plan (Basin Plan) for the Los Angeles Region to Incorporate a Total Maximum Daily Load for Chloride in the Upper Santa Clara River (07/03) states "Elevated chloride concentrations are causing impairments of the water quality objective in Reach 5 (EPA 303(d) list Reach 7) and Reach 6 (EPA 303(d) list Reach 8) of the Santa Clara River. This objective was set</td>
<td>1. LA Basin Plan contains mineral objectives for individual inland surface waters; the chloride objective for Reach 7 is 100 mg/L.
2. A Chloride TMDL is in effect for the Santa Clara River Reaches 5 and 6. The resolution associated with the TMDL (Resolution #03-008) states "The numeric target for this TMDL pertains to Reaches 5 and 6 of the Santa Clara River and is based on achieving the existing water quality objective of 100 mg/L, measured instantaneously, throughout the impaired reaches."</td>
</tr>
</table>

Pollutant of Concern [1]	Rationale for Selection	Significance Criteria [2]
	to protect all beneficial uses; agricultural beneficial uses have been determined to be most sensitive, and not currently attained at the downstream end of Reach 5 (EPA 303(d) list Reach 7) and Reach 6 (EPA 303(d) list Reach 8) in the Upper Santa Clara River. Irrigation of salt sensitive crops such as avocados and strawberries with water containing elevated levels of chloride results in reduced crop yields. Chloride levels in groundwater are also rising." **2.** The Santa Clara River is listed for Chloride in Reaches 3, 5 and 6 (303(d) list, LARWQCB, App F, 2009).	
Nutrients: Phosphorous and Nitrogen (Nitrate+Nitrite-N, Ammonia-N, and TKN)	**1.** "Nutrients including nitrogen and phosphorous are the major plant nutrients used for fertilizing landscapes, and are commonly found in stormwater. These nutrients can result in excessive or accelerated growth of vegetation, such as algae, resulting in impaired beneficial uses in water bodies. For example, nutrients have led to a loss of water clarity in Lake Tahoe. In addition, un-ionized ammonia (one of the nitrogen forms) can be toxic to fish." (CASQA, 2003). **2.** Nutrients are a bio-stimulatory substance. **3.** Santa Clara River is listed for ammonia in Reaches 3, 5, and 6 (303(d) list, LARWQCB, App F, 2009).	**1.** LA Basin Plan standards for ammonia: "In order to protect aquatic life, ammonia concentrations in receiving waters shall not exceed the values listed for the corresponding in-stream conditions in Tables 3-1 to 3-4." The criteria for ammonia toxicity listed in Tables 3-1 to 3-4 vary with pH and temperature; the criteria are lower for lower pH and temperature. These values will be applicable to Santa Clara River Reach 7. **2.** LA Basin Plan surface water quality objectives for nitrogen: "Waters shall not exceed 10 mg/L nitrogen as nitrate-nitrogen plus nitrite-nitrogen (NO3-N + NO2-N), 45 mg/L as nitrate (NO3), 10 mg/L as nitrate-nitrogen (NO3-N), or 1 mg/L as nitrite-nitrogen (NO2-N) or as otherwise designated in Table 3-8." Table 3-8 lists an objective of 5 mg/L NO_3-N + NO_2-N for Reach 7. **3.** Amendments to the Basin Plan address nutrient water quality objectives in downstream reaches of the Santa Clara River. Resolution 03-011 (LARWQCB, 08/2003)- nutrient TMDL for Santa Clara

Pollutant of Concern [1]	Rationale for Selection	Significance Criteria [2]
		Reaches 3, 5 and 6- promulgates a numeric target for total ammonia as nitrogen and for nitrate-nitrogen + nitrite-nitrogen: **TMDL 30-day Average** Columns: NH_3-N; NO_3-N + NO_2-N Reach 3: 1.9 mg/L; 4.5 mg/L Reach 5: 2.0 mg/L Reach 6: 3.2 mg/L **4.** A second revision (Resolution #2007-005, LARWQCB, 2007) updated the water quality objective for Reach 5 and 6 for ammonia, such that the 30-day average objective is now calculated as follows:
	Santa Clara River, Reach 6 (Bouquet Canyon Rd. Bridge to West Pier Hwy 99) **ELS Present (from February 1 – September 30)** $CCC = \left(\frac{0.0676}{1+10^{7.688-pH}} + \frac{2.912}{1+10^{pH-7.688}}\right) * 0.854 * MIN(2.85, 3.24 * 10^{0.028*(25-T)})$ **ELS Absent (from October 1 – January 31)** $CCC = \left(\frac{0.0676}{1+10^{7.688-pH}} + \frac{2.912}{1+10^{pH-7.688}}\right) * 0.854 * 3.24 * 10^{0.028*(25-Max(T,7))}$ **Santa Clara River, Reach 5 (West Pier Hwy 99 to Blue Cut gaging station)** **ELS Present (from February 1 – September 30)** $CCC = \left(\frac{0.0676}{1+10^{7.688-pH}} + \frac{2.912}{1+10^{pH-7.688}}\right) * 0.854 * MIN(2.85, 3.20 * 10^{0.028*(25-T)})$ **ELS Absent (from October 1 – January 31)** $CCC = \left(\frac{0.0676}{1+10^{7.688-pH}} + \frac{2.912}{1+10^{pH-7.688}}\right) * 0.854 * 3.20 * 10^{0.028*(25-Max(T,7))}$	
		5. Reach 7 (EPA Reach 9) of the Santa Clara River is listed as having ground water recharge as a beneficial use in the LA Basin Plan. LA Basin Plan groundwater standards for nitrogen: "Ground waters shall not exceed 10 mg/L nitrogen as nitrate-nitrogen plus nitrite-nitrogen (NO3-N + NO2-N), 45 mg/L as nitrate (NO3), 10 mg/L as nitrate-nitrogen (NO3-N), or 1 mg/L as nitrite-nitrogen (NO2-N)."
Sediment: Total Suspended Solids (TSS) & Turbidity	**1.** "Sediment is a common component of stormwater, and can be a pollutant. Sediment can be detrimental to aquatic life (primary producers, benthic invertebrates, and fish) by interfering with photosynthesis, respiration, growth, reproduction, and oxygen	**1.** Narrative objective in the Los Angeles Basin Plan: "Water shall not contain suspended or settleable material in concentrations that cause nuisance or adversely affect beneficial uses." **2.** LA Basin Plan objective for turbidity: "Waters shall be free of changes in turbidity that cause nuisance or adversely affect

Pollutant of Concern [1]	Rationale for Selection	Significance Criteria [2]
	exchange in water bodies. Sediment can transport other pollutants that are attached to it including nutrients, trace metals, and hydrocarbons. Sediment is the primary component of total suspended solids (TSS), a common water quality analytical parameter." (CASQA, 2003) **2.** Turbidity is a measure of suspended matter that interferes with the passage of light through the water or in which visual depth is restricted. Turbidity may be caused by a wide variety of suspended materials, which range in size from colloidal to coarse dispersions, depending upon the degree of turbulence. In lakes or other waters existing under relatively quiescent conditions, most of the turbidity will be due to colloidal and extremely fine dispersions. In rivers under flood conditions, most of the turbidity will be due to relatively coarse dispersions. Erosion of clay and silt soils may contribute to in-stream turbidity. Organic materials reaching rivers serve as food for bacteria, and the resulting bacterial growth and other microorganisms that feed upon the bacteria produce additional turbidity. Nutrients in runoff may stimulate the growth of algae, which may also contribute to turbidity. Discharges of turbid runoff are primarily of concern during the construction phase of development.	beneficial uses. Increases in natural turbidity attributable to controllable water quality factors shall not exceed the following limits: **Basin Plan WQ Objectives for Turbidity** Natural Turbidity — Maximum Increase 0-50 NTU — 20% >50 NTU — 10% Allowable zones of dilution within which higher concentrations may be tolerated may be defined for each discharge in specific Water Discharge Requirements."
Trace metals: Copper, Lead, Zinc, Arsenic, Cadmium, Chromium, Mercury, Nickel,	**1.** Exposed surfaces in the urban environment (e.g., galvanized metal, paint, automobiles, or preserved wood) contain metals, which enter stormwater as the surfaces corrode, flake, dissolve,	**1.** Narrative objective in the LA Basin Plan: "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life. Compliance with this objective

Pollutant of Concern [1]	Rationale for Selection	Significance Criteria [2]
Iron	decay, or leach. Depending on the pollutant, much of the trace metal load carried in stormwater can be associated with sediments. Metals are of concern because they can be acutely toxic to aquatic organisms, can bioaccumulate in organisms and cause chronic toxicity, and have the potential to contaminate drinking water supplies. **2.** "Metals including lead, zinc, cadmium, copper, chromium, and nickel are commonly found in stormwater. Many of the artificial surfaces of the urban environment (e.g., galvanized metal, paint, automobiles, or preserved wood) contain metals, which enter stormwater as the surfaces corrode, flake, dissolve, decay, or leach. Over half the trace metal load carried in stormwater is associated with sediments. Metals are of concern because they are toxic to aquatic organisms, can bioaccumulate (accumulate to toxic levels in aquatic animals such as fish), and have the potential to contaminate drinking water supplies." (CASQA, 2003) **3.** Urban development can increase potential sources of these metals due to sources from vehicles and building materials. **4.** Downstream reaches of the Santa Clara River are listed for iron (Reach 5, 6) and copper (Reach 6) (303(d) list, LARWQCB, App F, 2009)	will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, bioassays of appropriate duration and/or other appropriate methods as specified by the Regional Board." **2.** The survival of aquatic life in surface waters subjected to a waste discharge, or other controllable water quality factors, shall not be less than that for the same water body in areas unaffected by the waste discharge, or when necessary, for other control water that is consistent with the requirements for "experimental water" as defined in Standard Methods for the Examination of Water and Wastewater (American Public Health Association, et al. 1992)." **3.** There shall be no acute toxicity in ambient waters, including mixing zones. The acute toxicity objective for discharges dictates that the average survival in undiluted effluent for any three consecutive 96-hour static or continuous flow bioassay tests shall be at least 90%, with no single test having less than 70% survival when using an established USEPA, State Board, or other protocol authorized by the Regional Board **4.** The CTR criteria are the applicable water quality objectives for protection of aquatic life (40 CFR 131.38). The CTR criteria are expressed for acute and chronic (4-day average) conditions; however, only acute conditions are applicable for stormwater discharges because the duration of stormwater discharge is typically less than 4 days. CTR criteria are expressed for dissolved metal concentrations and are determined on the basis of hardness in the receiving water. In application of criteria to the Project, local hardness data will be used to determine most appropriate criteria.

Pollutant of Concern [1]	Rationale for Selection	Significance Criteria [2]
Bioaccumulation & Toxicity	**1.** Certain pollutants, such as pesticides, selenium and mercury, have a tendency to bioaccumulate in aquatic organisms potentially affecting the health of those organism or other species higher up the food chain. These contaminants may be contained in stormwater, causing runoff to be highly toxic to aquatic organisms. **2.** The Basin Plan and the CTR criteria set forth toxicity objectives for receiving water levels of substances that bioaccumulate in aquatic resources to prohibit concentrations of toxic substances that are harmful to human health and adversely affect beneficial uses. **3.** Santa Clara River Reaches 1, 3, and 6 are listed for toxicity (303(d) list, LARWQCB, App F, 2009)	**1.** LA Basin Plan objectives for toxicity: "All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, bioassays of appropriate duration or other appropriate methods as specified by the State or Regional Board." **2.** LA Basin Plan requires that discharges into receiving waters shall not cause or contribute to toxicity.
Biostimulatory substances	**1.** Biostimulatory substances include excess nutrients and other compounds that stimulate aquatic growth resulting in impaired aesthetics and water quality impairments such as lowered dissolved oxygen values.	**1.** LA Basin Plan objectives for biostimulatory substances: "Waters shall not contain biostimulatory substances in concentrations that promote aquatic growth to the extent that such growth causes nuisance of adversely affects beneficial uses."
Chemical Pollutants, including Organic Chemicals	**1.** Chemical pollutants in excessive amounts in drinking water are harmful to human health. **2.** The chemical pollutants referenced under this water quality objective, such as trace metals and nitrate are either subsumed by the categories above, or are not found in urban runoff (e.g., fluoride). **3.** Organic chemicals, both volatile and non-volatile, are used in a variety of applications associated with development, including landscaping amendments, cleaning	**1.** LA Basin Plan objectives for chemical Pollutants: "Surface waters shall not contain concentrations of chemical pollutants in amounts that adversely affect any designated beneficial use." **2.** The LA Basin Plan lists maximum contaminant levels for organic chemicals in table 3-7.

Pollutant of Concern [1]	Rationale for Selection	Significance Criteria [2]
	substances, vehicle maintenance and repair and other household applications.	
Chlorine, Total Residual	**1.** Municipal pools and private pools in areas served by a municipal sanitary system are required to be discharged into the sanitary system. Chlorine disinfection will not take place on the Project site and there will not be any sources of elemental chlorine. Chloride sources (e.g. fertilizers or other compounds with salts) are evaluated separately. Therefore, total residual chlorine will not be present in runoff from the Project. **2.** A number of chlorinated substances are listed on the 303(d) list for downstream reaches of the Santa Clara River (303(d) list, LARWQCB, App F, 2009). Such substances can be formed by residual chlorine discharged into receiving waters.	**1.** LA Basin Plan objectives for total residual chlorine: "Chlorine residual shall not be present in surface water discharges at concentrations that exceed 0.1 mg/L and shall not persist in receiving waters at any concentration that causes impairment for beneficial uses".
Color, Taste, and Odor	**1.** Undesirable tastes and odors in water may be a nuisance and may indicate the presence of a pollutant(s). Odor associated with water can result from decomposition of organic matter or the reduction of inorganic compounds, such as sulfate. Other potential sources of odor causing substances, such as industrial processes, will not occur as part of the Project. Color in water may arise naturally, such as from minerals, plant matter, or algae, or may be caused by industrial pollutants. **2.** The Project will contain no industrial uses. Commercial areas of the Project are not expected to be a significant source of Pollutants that might impart color	**1.** LA Basin Plan objective for color: "Waters shall be free of coloration that causes nuisance or adversely affects beneficial uses". **2.** LA Basin Plan objectives for taste and odor: "Ground waters shall not contain taste or odor-producing substances in concentration that cause nuisance or adversely affect beneficial uses".

Pollutant of Concern (1)	Rationale for Selection	Significance Criteria (2)
	or odor to stormwater flows from the Project area. Source controls are expected to reduce the amount of plant material and BMPs will reduce sediment which could contribute to color or odor nuisances. Therefore, color-, taste-, or odor-producing substances are not pollutants of concern for the Project.	
Cyanide	**1.** Cyanide has been identified by the Los Angeles County Department of Public Works as a constituent of concern for the Santa Clara River based on monitoring conducted at mass emission Station S29 (LACDPW, 2005). Natural cyanides are produced by certain bacteria, fungi, and algae, and they are present in a number of plants and foods as cyanogenic glycosides. Man-made cyanides typically enter the environment from metal finishing and organic chemical industries. Other sources include iron and steel works, municipal waste burning, cyanide-containing pesticides, road deicers, and vehicle exhaust.	**1.** LA Basin Plan has a maximum contaminant level for cyanide (for MUN beneficial uses) of 0.2 mg/L. **2.** The CTR criteria are the applicable water quality objectives for protection of aquatic life (40 CFR 131.38). The CTR criteria are expressed for acute and chronic (4-day average) conditions; however, only acute conditions are applicable for stormwater discharges because the duration of stormwater discharge is typically less than 4 days in the Project area. CTR freshwater aquatic life protection acute criteria is 22 µg/L.
Exotic Vegetation	**1.** Exotic vegetation typically provides little habitat value and can out compete native vegetation that is more suitable habitat for aquatic and terrestrial organisms. **2.** The landscape management plan will not use exotic vegetation, and undesirable invasive vegetation will be eradicated to the extent possible. Therefore, exotic vegetation is not a pollutant of concern for the Project.	**1.** LA Basin Plan objective for 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."

Pollutant of Concern [1]	**Rationale for Selection**	**Significance Criteria** [2]
Mineral Quality [TDS, Boron, Sulfate, Sodium Absorption Ratio (SAR)]	**1.** LADPW stormwater monitoring data arithmetic mean concentrations for TDS, sulfate, and boron for urban land uses are below the water quality objectives for minerals. Calculated SAR values are 0.6 for SF residential and 1.9 for commercial based on LADPW data. The minerals listed in the Basin Plan, except chloride and nitrogen, are not believed to be pollutants of concern due to the absence of river impairments and /or anticipated runoff concentrations below the Basin Plan objectives. **2.** Santa Clara River Reach 11 (downstream of Reach 7) is listed for Boron (303(d) list, LARWQCB, App F, 2009).	**1.** LA Basin Plan objectives for minerals: **Basin Plan WQ Objectives for Selected Minerals Santa Clara River Reach 7** TDS 800 mg/L Sulfate 150 mg/L Boron 1.0 mg/L SAR 5 mg/L
MBAS (Methylene blue activated substances)	**1.** MBAS are 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. Further, the Project will employ source controls such as educational materials for homeowners regarding elimination of discharges from car washing to the storm drain system, control of construction vehicle, street, and pavement washing activities to control wash water. LADPW stormwater monitoring found MBAS concentrations below the water quality criteria for all urban land use except transportation; therefore this Pollutant is not anticipated to be a pollutant of concern for the Project.	**1.** LA Basin Plan objective for MBAS: “Waters shall not have MBAS concentrations greater than 0.5 mg/L in water designated (MUN).”

Pollutant of Concern [(1)]	Rationale for Selection	Significance Criteria [(2)]
Oxygen, Dissolved & BOD (Biochemical Oxygen Demand)	**1.** Adequate DO levels are required to support aquatic life. Depressed levels may lead to anaerobic conditions. **2.** BOD can result in decreased dissolved oxygen levels affecting beneficial uses such as habitat designations. **3.** DO & BOD are correlated to nutrients and other organic compounds and are subsumed by those categories.	**1.** Basin Plan objectives for dissolved oxygen (DO): "At a minimum, the mean annual dissolved oxygen concentration of all waters shall be greater than 7 mg/L, and no single determination shall be less than 5.0 mg/L, except when natural conditions cause lesser concentrations. The dissolved oxygen content of all surface waters designated as WARM shall not be depressed below 5 mg/L as a result of waste discharges." **2.** LA Basin Plan objective for BOD: "Waters shall be free of substances that result in increases in the BOD which adversely affect beneficial uses."
Pesticides	**1.** "Pesticides (including herbicides, fungicides, rodenticides, and insecticides) have been repeatedly detected in stormwater at toxic levels, even when pesticides have been applied in accordance with label instructions. As pesticide use has increased, so too have concerns about adverse effects of pesticides on the environment and human health. Accumulation of these compounds in simple aquatic organisms, such as plankton, provides an avenue for biomagnification through the food web, potentially resulting in elevated levels of toxins in organisms that feed on them, such as fish and birds." (CASQA, 2003) **2.** Pesticides loads may be present in runoff from developed areas due to pesticide use for urban landscaping. **3.** Reaches downstream of the Project area are listed for DDT, Diazinon, Chlorpyrifos and PCBs (formerly used as a "pesticide extender" along with other uses) (303(d) list, LARWQCB, App F, 2009).	**1.** Narrative objective in the LA Basin Plan: "No individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses. There shall be no increase in pesticide concentrations found in bottom sediments or aquatic life. Waters designated as MUN shall not contain concentrations of pesticides or herbicides in excess of the limiting concentrations specified in Table 64444-A of Section 64444 (Organic Chemicals) of Title 22 of the California Code of Regulations which is incorporated by reference into this plan." **2.** CTR lists numeric objectives for some, but not all pesticides. There are no CTR criteria for diazinon and chlorpyrifos, but these substances are now banned by EPA from most urban uses.

Pollutant of Concern [1]	Rationale for Selection	Significance Criteria [2]
Petroleum Hydrocarbons: Oil & Grease and Polycyclic Aromatic Hydrocarbons (PAHs)	**1.** "Oil and grease includes a wide array of hydrocarbon compounds, some of which are toxic to aquatic organisms at low concentrations. Sources of oil and grease include leakage, spills, cleaning and sloughing associated with vehicle and equipment engines and suspensions, leaking and breaks in hydraulic systems, restaurants, and waste oil disposal." (CASQA, 2003) **2.** 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 PAH compounds associated with transportation-related sources, such as automobile exhaust. Due to this source, development is generally assumed to increase PAH levels.	**1.** Narrative objective in the LA Basin Plan for 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 beneficial uses." **2.** PAHs are a class of compounds. CTR values for individual PAHs are available for protection of human health only. There are no regulatory standards for the protection of aquatic health.
pH	**1.** Mean runoff concentrations in the Los Angeles County stormwater monitoring data ranged from 6.5 for mixed- and single-family residential land uses to 7.0 for commercial land use. Therefore, pH in the Santa Clara River is not expected to be affected by runoff discharges from the Project.	**1.** LA Basin Plan objective for pH: "the pH of inland waters 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."
PCBs	**1.** PCBs are highly toxic persistent chemicals that have been historically released into the environment from industrial uses, such as transformers. Due to their persistence, PCBs can still be detected in urban runoff due to historic industrial sources of these	**1.** LA Basin Plan narrative regarding PCBs: "The purposeful discharge of PCBs to waters of the Region, or at locations where the waste can subsequently reach waters of the Region, is Prohibited. Pass-through or uncontrollable discharges to waters of the Region, or at locations where the waste can subsequently reach waters of the Region,

Pollutant of Concern [1]	Rationale for Selection	Significance Criteria [2]
	chemicals. **2.** The Project area did not historically include PCB-producing land uses and industrial land uses are not included in the proposed Project. Therefore, PCBs are not a pollutant of concern for the Project. **3.** Downstream of Project site, Santa Clara River Reach 5 is listed for PCBs (303(d) list, LARWQCB, App F, 2009).	are limited to 70 pg/L (30 day average) for protection of human health and 14 ng/L and 30 ng/L (daily average) to protect aquatic life in inland fresh waters and estuarine waters respectively".
Radioactive Substances	**1.** Some activities such as mining or industrial activities can increase the amount of radioactive substances impairing beneficial uses. **2.** The Project will not have industrial or other activities that would be a source of any radioactive substances, and development will stabilize any naturally radioactive soils, though unlikely to be present in the Project area. Therefore, radioactive substances are not a pollutant of concern for the Project.	**1.** LA Basin Plan narrative objective for radioactive substances: "Radionuclides shall not be present in concentrations that are deleterious to human, plant, animal, or aquatic life or that result in the accumulation of radionuclides in the food web to an extent that presents a hazard to human, plant, animal, or aquatic life".
Temperature	**1.** Elevated temperatures are typically associated with discharges of process wastewaters or non-contact cooling waters. Increase in temperature can result in lower dissolved oxygen levels impairing habitat and other beneficial uses of receiving waters. Stormwater runoff from the Project site is expected to cool somewhat during treatment in structural BMPs and will be diluted in the receiving water. **2.** As the beneficial uses in the receiving waters for the Project include warm freshwater habitat to support warm water ecosystems,	**1.** LA Basin Plan objectives for temperature: "For waters designated WARM, water temperature shall not be altered by more than 5º F above the natural temperature. At no time shall these WARM-designated waters be raised above 80 º F as a result of waste discharges".

Pollutant of Concern [1]	Rationale for Selection	Significance Criteria [2]
	any increase in temperature resulting from stormwater runoff from the Project is expected to be less than significant.	
Trash and Debris	**1.** "Gross Pollutants (trash, debris, and floatables) may include heavy metals, pesticides, and bacteria in stormwater. Typically resulting from an urban environment, industrial sites and construction sites, trash and floatables may create an aesthetic "eye sore" in waterways. Gross pollutants also include plant debris (such as leaves and lawn-clippings from landscape maintenance), animal excrement, street litter, and other organic matter. Such substances may harbor bacteria, viruses, vectors, and depress the dissolved oxygen levels in streams, lakes, and estuaries sometimes causing fish kills." (CASQA, 2003) **2.** Aquatic organisms and birds may also ingest or become entangled by trash and debris. **3.** Lakes in the upper part of the watershed which drain to the Santa Clara River have an associated TMDL for Trash (Resolution #R4-2007-009, LARWQCB).	**1.** LA Basin Plan narrative floating material objective: "Waters shall not contain floating materials, including solids, liquids, foams, and scum, in concentrations that cause a nuisance or adversely affect beneficial uses." **2.** Basin Plan narrative settleable materials objective: "Waters shall not contain suspended or settleable material in concentrations that cause nuisance or adversely affect beneficial uses."

1. Pollutants of concern are those pollutants that are anticipated or potentially could be generated by development that have been identified by regulatory agencies as potentially impairing beneficial uses in the receiving water bodies or that could adversely affect receiving water quality.
2. The Los Angeles Basin Plan applies to the entire Project area.

A.2. References

California Stormwater Quality Association (CASQA), 2003. *Stormwater Best Management Practices Handbook New Development & Redevelopment.*

Los Angeles Regional Water Quality Control Board, 1995. Water Quality Control Plan Los Angeles Region Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties.

Los Angeles Regional Water Quality Control Board, October, 25th, 2001. Resolution 01-018: Amendment to the Water Quality Control Plan for the Los Angeles Region to Update the Bacteria Objectives for Water Bodies Designated for Water Contact Recreation

Los Angeles Regional Water Quality Control Board, July, 10th, 2003. Resolution R03-008 Revision of interim waste load allocations for chloride in the Amendment to the Water Quality Control Plan for the Los Angeles Region to include a TMDL for Chloride in the Upper Santa Clara River.

Los Angeles Regional Water Quality Control Board, August, 7th, 2003. Resolution R03-011 Amendment to the Water Quality Control Plan for the Los Angeles Region to include a TMDL for Nitrogen Compounds in the Santa Clara River.

Los Angeles Regional Water Quality Control Board, June, 7th, 2007. Resolution NO. 2007-005 Amendment to the Water Quality Control Plan for the Los Angeles Region to Incorporate Site-specific Objectives in Select Waterbodies in the Santa Clara, Los Angeles, and San Gabriel River Watersheds.

Los Angeles Regional Water Quality Control Board, June, 7th, 2007. Resolution R4-2007-009 Amendment to the Water Quality Control Plan for the Los Angeles Region to Incorporate a total Maximum Daily Load for Trash in Lake Elizabeth, Munz Lake and Lake Hughes in the Santa Clara River Watershed.

Los Angeles Regional Water Quality Control Board, April, 2009. Los Angeles Region Integrated Report: Clean Water Act Section 305(b) Report and Section 303(d) List of Impaired Waters, 2008 Update.

US Environmental Protection Agency California Toxics Rule (CTR), 40 C.F.R. §131.38.

B. WATER QUALITY MODEL METHODOLOGY

B.1. Model Description

B.1.1. Model Overview

The model used to assess stormwater quality impacts associated with the proposed Vista Canyon Project (Project) is an empirical, volume-based, pollutant loads model, referred to in this document as the Monte Carlo Water Quality Model or water quality model. This type of loadings model is generally applicable in the planning and evaluation stages of a Project. The model was developed to assess the potential impact of development on water quality and to evaluate the effectiveness of the structural Best Management Practices (BMPs) that will treat storm water runoff as part of the Project storm water treatment system. Two Project conditions were evaluated with the water quality model:

1. Pre-development
2. Post-development with Project design features (treatment BMPs)

Measured runoff volumes and water quality characteristics of storm water are highly variable. To account for this variability, a statistical modeling approach was used to estimate the volume of storm water, the concentration of pollutants in storm water, and the overall pollutant load (total mass of pollutants) in storm water runoff. A statistical description of storm water provides an indication of the average characteristics and variability of the water quality parameters of storm water. It does not forecast runoff characteristics for specific storms or monitoring periods.

The statistical model is based on relatively simple rainfall/runoff relationships and estimated pollutant concentrations in storm water runoff. The volume of storm water runoff is estimated using a modification to the Rational Formula, an empirical expression that relates runoff volume to the rainfall depth and the basin characteristics such as imperviousness, and soils infiltration characteristics. The pollutant concentration in storm water runoff is represented by an expected average pollutant concentration, called the event mean concentrations (EMC). The EMCs are estimated from available monitoring data and are strongly dependent on the land-use type.

The flow chart in Figure B-1 provides an overview of the modeling methodology.

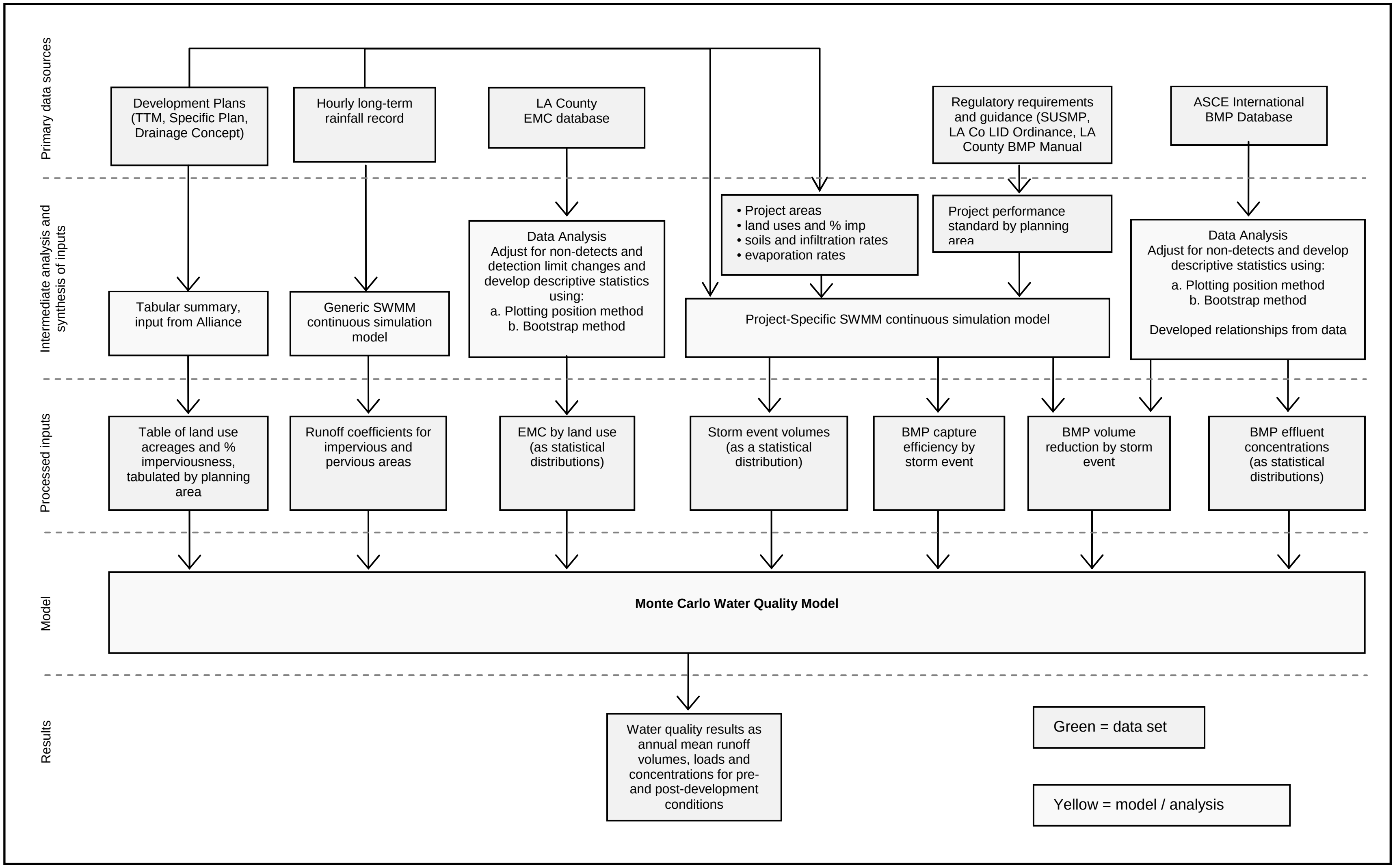


Figure B-1. Overview of Water Quality Analysis Methodology

The model does not incorporate the hydraulics or detailed hydrology of the site, which would be more appropriate for design stages and requires additional data and more sophisticated modeling. The model includes water quality benefits achieved by structural BMPs. Source control BMPs are not included in the model because data is generally not available or conclusive. Model results are presented for average annual runoff volumes, pollutant loads, and pollutant concentrations.

As with all environmental modeling, the accuracy of results is dependent on how well the hydrologic, water quality and BMP effectiveness data describe the actual site characteristics. Local and regional data are used to the fullest extent possible to help minimize errors in predictions, but such data are limited and traditional calibration and verification of the model is not feasible. It is important to note that the predictions of relative differences should be more accurate than absolute values.

B.1.2. Model Assumptions

The water quality modeling methodology requires that some assumptions are made for both the model input parameters and the way the modeling calculations are carried out. Section B.2.6 discusses the assumptions that were made in specifying the model parameters and Section B.3.4 discusses the assumptions regarding the modeling approach. Section B.4 discusses model accuracy.

B.2. Model Input Parameters

Many parameters affect pollutant loads and concentrations. Examples include source concentrations, topography, soil type, and rainfall characteristics, all of which can influence the buildup and mobilization of pollutants. The following model parameters represent the best data currently available for representation of existing and developed site conditions in the water quality model.

B.2.1. Storm Events

Rainfall analysis was conducted with data from the National Climatic Data Center (NCDC) Newhall rain gauge (station number 046162), located in the town of Newhall, California. Figure B-2 shows the location of the Newhall gauge in relation to the Vista Canyon Project area. This gauge is located approximately 6 miles from the Project. The gauge elevation of 1,243 ft above mean sea level (AMSL) is comparable to the Vista Canyon Project area elevation of approximately 1,500 ft AMSL.

While the period of record rainfall data collected at the Newhall rain gauge is quite long (39 years), there are still some gaps in the record. In order to improve the characterization of rainfall at the Project site, estimates of the missing rainfall data were made through correlation of the Newhall rain gauge with the San Fernando rain gauge (NCDC station number 047762), which is located approximately 6 miles away from the Newhall gauge (south and slightly east).

The Castaic Junction gauge monitored by LACDPW is located closer to the Project; however the usable period of record at this gauge is limited to approximately 12 years which is considered too short to produce significant results in long-term simulation.

Other gauges in the area report daily rainfall totals only. Hourly data are required to support water quality modeling efforts.

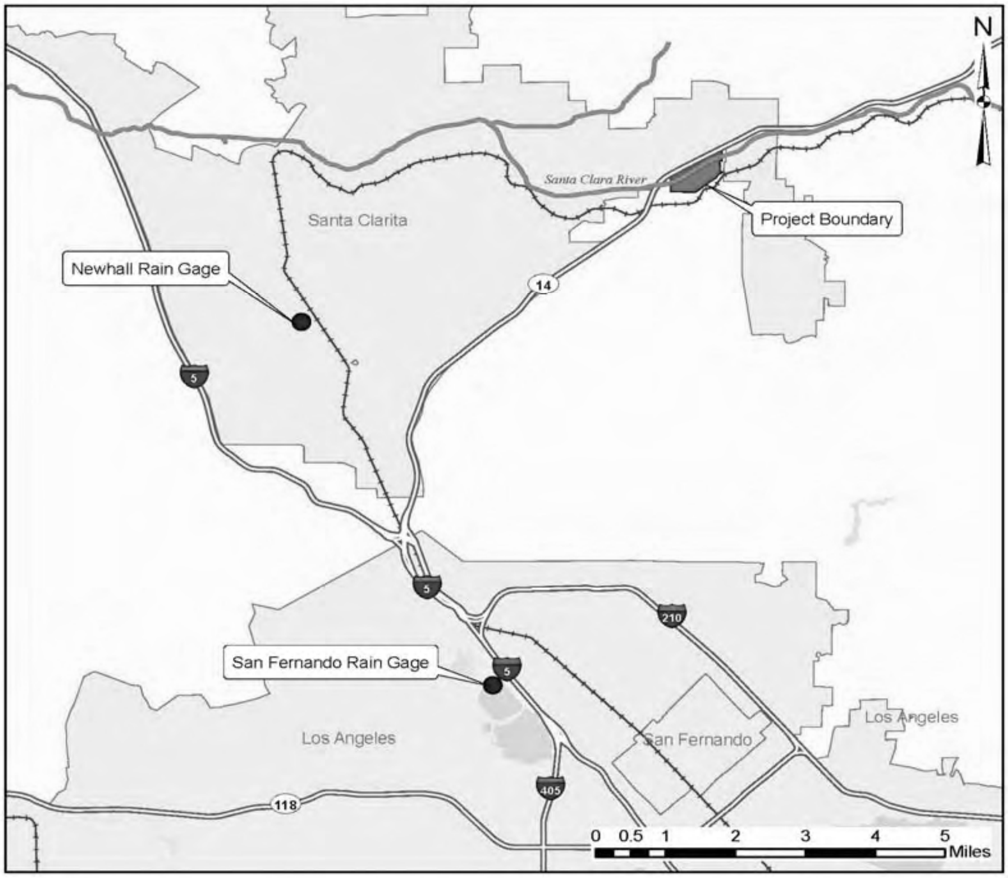


Figure B-2: Location of Newhall Rain Gauge in the Vicinity of the Project Area

San Fernando rainfall data was adjusted based on comparison between the two gauges over periods for which they both contained data. A comparison of hourly or daily rainfall totals is not expected to yield a strong correlation as spatial variability is exaggerated on short time scales (i.e. a single storm could result in appreciable rainfall at one gauge and little rainfall at the other). However, monthly correlations are expected to yield meaningful comparison between the gauges. Data from the gauges from 1969 to 2008 were screened to keep only the months without missing data and with measured rainfall at both stations. Correlation of the monthly rainfall totals is shown in Figure B-4.

This monthly correlation indicated slightly higher rainfall amounts at the Newhall gauge compared to the San Fernando gauge.

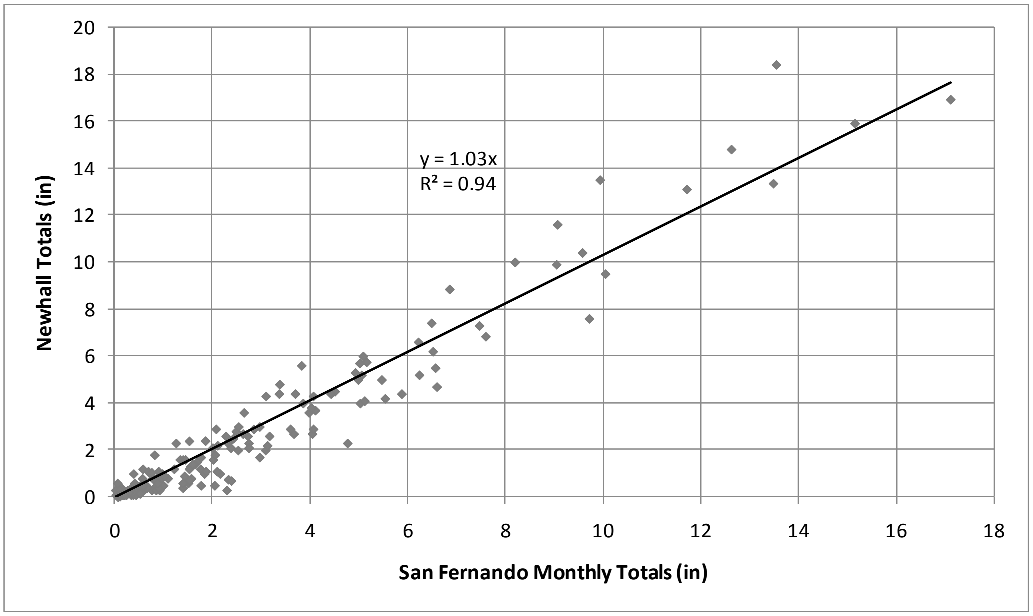


Figure B-3: Correlation of Monthly Totals Newhall & San Fernando 3 Gauges

Based on the relationship developed through the monthly comparison, a multiplier of 1.03 was applied to the hourly rainfall data from the San Fernando gauge to fill in the missing periods of rainfall data at the Newhall gauge. Values were rounded to the nearest 1/100 inch after the adjustment.

Rainfall analysis was conducted for two data groups: all storm events; and only the storms that were expected to contribute to stormwater runoff (storms >0.1 inches). The rainfall data were analyzed using a code similar in performance to EPA's Synoptic Rainfall Analysis Program (SYNOP). The customized code (GeoSYNOP) facilitates resolving missing periods of data and is more robust when handling the date and time of storms. GeoSYNOP subdivides the rainfall record into discrete events separated by an inter-event dry period, which in this case was set to a minimum of 6 hours. Small rainfall events, which resulted in rainfall of less than or equal to 0.10 inches, were deleted from the record as such events tend to produce little if any runoff (USEPA, 1989; Schueler, 1987). For the Newhall gauge, a total of 619 storm events (>0.1 inches) were segregated from the continuous data from October 1, 1968 to September 30, 2008. Storm statistics for the full (all storms) and the trimmed (storms > 0.1 inch) data sets are shown in Table B-1.

Table B-1: Analysis Results for the Patched Newhall Rainfall Data

Storms	Newhall Gauge WY 1969 – 2008	Patched Record
All Storms	Average annual rainfall (in):	18.4
	Total number of storms:	1021
	Average number of storms per year:	25.5
	Average storm volume (in):	0.72
	Average storm duration (hrs):	7.6
	Average storm intensity (in/hr):	0.095
Storms >0.1 inch	Average annual rainfall (in):	17.5
	Total number of storms:	619
	Average number of storms per year:	15.5
	Average storm volume (in):	1.13
	Average storm duration (hrs):	10.7
	Average storm intensity (in/hr):	0.105

B.2.2. Runoff Coefficients

The runoff coefficient (i.e. the fraction of precipitation that runs off as stormwater) is dependent on a number of factors. The runoff coefficient is most strongly dependent on catchment imperviousness. However, soil characteristics, watershed slope and roughness, rainfall patterns, evapotranspiration rates and a variety of other factors also influence runoff coefficient. The following describes how the runoff coefficients were estimated for use in the Water Quality model.

B.2.2.1. Derivation of Runoff Coefficients for Water Quality Modeling

The water quality model uses an equation consistent with the Los Angeles County Hydrology Manual to estimate a runoff coefficient for sub-basins as a function of the percent impervious. The format of this equation is described as:

$$C = C_i * i + C_p * (1-i)$$

Where:

C = composite runoff coefficient
C_i = runoff coefficient from impervious areas
C_p = runoff coefficient from pervious areas
i = imperviousness fraction (ranges from 0 to 1)

Per the Los Angeles County Hydrology Manual, $C_i = 0.90$ and C_p is a function of Los Angeles County soil type and rainfall intensity. Los Angeles County soil types observed on the site include #020 and #099. While the C_p value characteristic of these soils is also dependent on rainfall intensity, which varies during each storm event, a value of 0.1 is typically assumed for small to moderate storms. Because small to moderate storms make up the majority of average annual rainfall volume, this value is appropriate for use as a long term average runoff coefficient consistent with the Hydrology Manual method.

Because the pervious and impervious runoff coefficients that make up the runoff coefficient equation are dependent on many site-specific parameters, the runoff coefficient equation used in modeling should be determined on a Project-specific basis. It is recognized that C_p for smaller storms may be zero, while for larger storms it may greatly exceed the long term average. Thus the water quality model should ideally estimate Project-specific pervious area runoff coefficients on a storm-by-storm basis, using a robust method that accounts for more detailed hydrologic processes and antecedent conditions. Such a method should consider the range of conditions that could occur and select appropriately conservative values to account for uncertainty.

Continuous simulation modeling, using the Storm Water Management Model (SWMM), was conducted for a hypothetical catchment representative of average Project conditions to generate appropriate storm-by-storm pervious and impervious coefficients to use in the runoff coefficient equation for each storm event. A modified version of SWMM 4.4h was used that segregates rainfall into storm events (using algorithms identical in performance to GeoSYNOP, described above), tracks the fate of rainfall to losses (i.e. infiltration, evapotranspiration) and runoff for each storm, and tabulates runoff coefficients by storm event. The majority of the SWMM modeling parameters assumed for this analysis are shown in Table B-2.

Table B-2: SWMM Runoff Module Parameters

SWMM Runoff Parameters	Units	Values
Wet time step	seconds	600
Wet/dry time step	seconds	600
Dry time step	seconds	14,400
Impervious Manning's n		0.012
Pervious Manning's n		0.25
Drainage area modeled for Rv determination	acres	5
Shape		Rectangular, 500 ft flow path length for pervious areas, 250 ft flow path length for impervious area (represents typical overland flow path lengths, not a very sensitive parameter)
Slopes	ft/ft	0.02 (represents average of relatively flat landscaping, streets, and roofs)
Evaporation	in / month	60% of reference ET values contained in Table B-3.
Soil properties / infiltration		Green-Ampt soil parameters as shown in Table B-4
Depression storage, impervious	inches	0.02, based on Table 5-14 in SWMM manual (James and James, 2000)

SWMM Runoff Parameters	Units	Values
Depression storage, pervious	inches	0.06, based on Table 5-14 in SWMM manual (James and James, 2000)

Reference ET values for estimating actual ET rates were taken from the California Irrigation Management Information System (CIMIS) map, shown in Figure B-3. The Vista Canyon site is located in Zone 14. Reference ET values for zone 14 are shown in Table B-3.

The reference ET values in Table B-3 are based on a well irrigated vegetated sedge, and are likely to overestimate the actual ET of the Project development areas, where there will be a mix of drought-tolerant, low water use vegetation, and landscaping, with only the latter being irrigated. Drought-tolerant native vegetation would tend have a potential ET of approximately 20 to 40 percent of the reference ET. Irrigated landscaping in typical urban areas would likely have a potential ET of 60 to 80 percent of the reference ET. While it is likely a high estimate for existing Project conditions, 60 percent of reference ET was assumed for both existing and proposed. This is has the effect of slightly overestimating impacts (i.e. runoff in existing conditions would be biased somewhat low as a result of this parameter selection.)

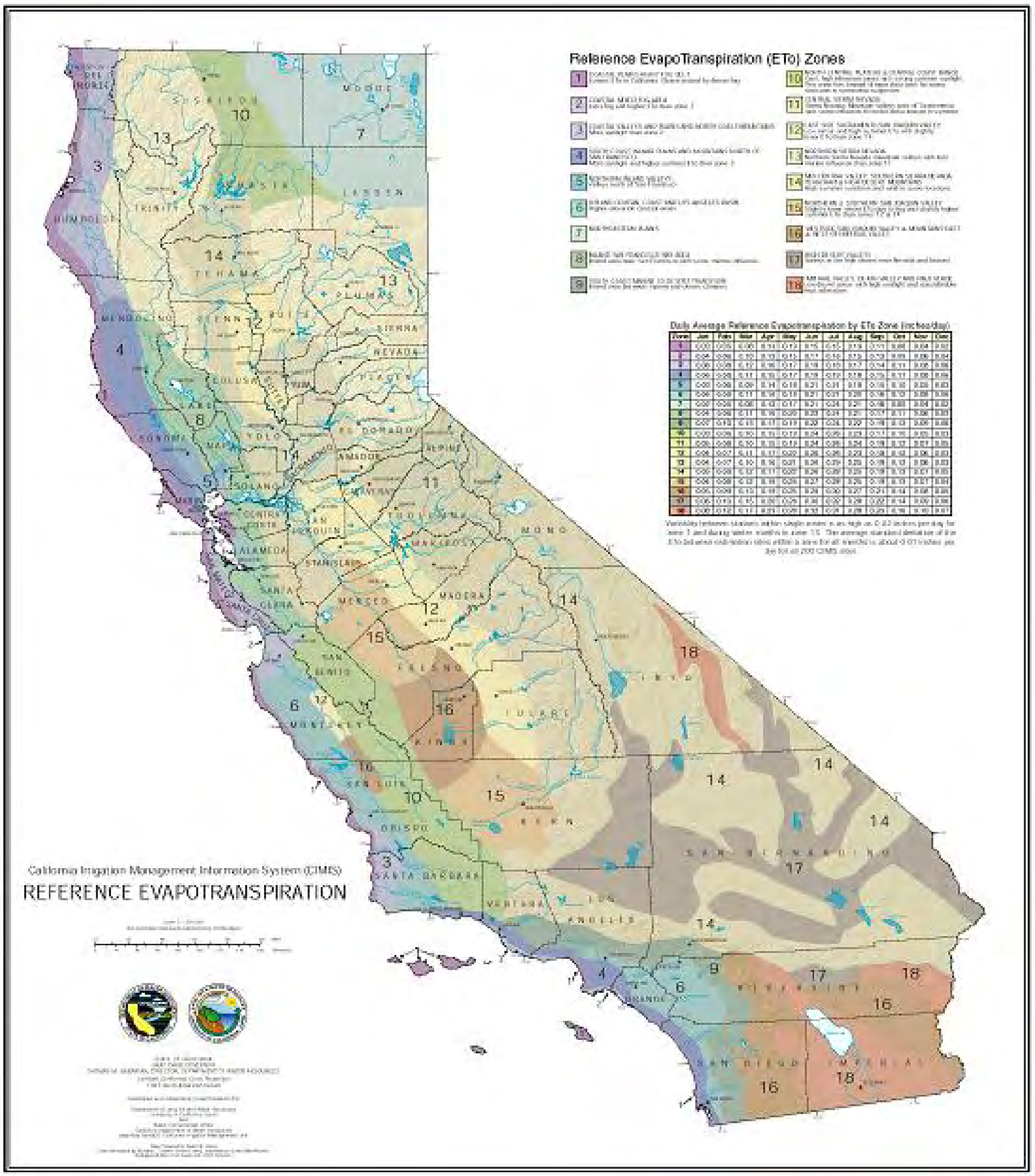


Figure B-3: Reference ET for CA Zones

Table B-3: Evaporation Parameters for Hydrology Model (from CA ETo map)

Month	Evapotranspiration Rates (Zone 14)			60%
	in / day	days / month	in / Month	in / Month
January	0.05	31	1.55	0.93
February	0.08	28	2.24	1.34
March	0.12	31	3.72	2.23
April	0.17	30	5.10	3.06
May	0.22	31	6.82	4.09
June	0.26	30	7.80	4.68
July	0.28	31	8.68	5.21
August	0.25	31	7.75	4.65
September	0.19	30	5.70	3.42
October	0.13	31	4.03	2.42
November	0.07	30	2.10	1.26
December	0.05	31	1.55	0.93
	Total	365	57.0	34.2

Soil infiltration rates have a strong influence on the runoff coefficient from pervious areas. Soils in the Project area are expected to exhibit a range of infiltrative capacity, depending on soil type and condition. Site soils are divided between alluvial soils and bedrock outcrops. Alluvial soils are further divided between river deposits and upland deposits, the latter of which tends to be less infiltrative (Personal Communication, RTFA). The Los Angeles County soil layer does not contain degree of detail, but provides sufficiently detailed soil information for planning level analysis.

In preparation for development, some site soils will be excavated and replaced with fill material. Fill material will also be used over some areas of the site to raise finish pad elevations. In areas where fill is not required, incidental compaction may still occur, reducing infiltration rates. Because the characteristics and placement of fill material are not currently known, generic assumptions of hydrologic soil properties consistent with Hydrologic Soil Group C were employed for developed areas of the Project site in the proposed condition. Per NRCS TR-55 (Engineering Staff, 1986):

> "Hydrologic group C soils have a slow rate of infiltration rate when thoroughly wet. Water movement through these soils is moderate or moderately slow and they generally have a restrictive layer that impedes the downward movement of water. The depth to the restrictive layer is greater than 50 cm (20 inches) and to a permanent water table is deeper than 60 cm (2 feet)."

This characterization is believed to be accurate to somewhat conservative (i.e. would over-predict runoff) in representing the developed areas of the proposed site which may be impacted by direct and incidental compaction.

Table B-4 contains the relative distribution of Los Angeles County soil types on the Project site and the hydrologic soil properties assumed for each type.

Table B-4: Green-Ampt Soil Parameters Assumed for Modeling Existing and Proposed Condition Soils

Description	% of Project	Suction Head, inches	Saturated Hydraulic Cond., in/hr	Initial Moisture Deficit, in/in	Source
Existing Conditions					
LA County Soil 020	90	8.6	0.27	0.24	K_{sat} from county soil curves, Suction head and IMD by soil type from James and James, 2000
LA County Soil 099	10	8.6	0.25	0.24	
Selected for Modeling	-	8.6	0.27	0.24	
Proposed Conditions					
Generic C Soil	100	8	0.15	0.2	James and James, 2000

Pervious and impervious runoff coefficients were estimated from SWMM modeling and are provided in Table B-5.

Table B-5: Long-term Average Pervious and Impervious Runoff Coefficients from Continuous Simulation

Condition	C_p	C_i
Existing	0.035	0.96
Proposed	0.11	0.96

Existing condition pervious areas were predicted to have a long-term runoff coefficient substantially less than the Los Angeles County Hydrology Manual default (Cp = 0.1). This is reasonable considering that site soils are generally sandy and the site is relatively flat, promoting infiltration. Proposed condition runoff coefficients are reasonably consistent with the Hydrology Manual defaults (Cp = 0.1 and Ci = 0.9).

The Project area includes the Santa Clara River, but minimal impacts will occur to the river corridor. Thus this area was not modeled in existing or proposed conditions.

It is important to note that Table B-5 reports long term average runoff coefficients, but storm-by-storm runoff coefficients, which may vary significantly, were computed by SWMM for use in the water quality model.

B.2.3. Land Uses

Vista Canyon Specific Plan and accompanying Tentative Tract Map No 69164 were used to tabulate developed condition land uses and model Project impacts. Table B-6 shows the planned post-development land uses for the approximately 183 acre Project site. Specific Plan descriptions and supplemental linework from TTM 69164 were used to delineate 34.7 acres of off-site impacts (Table B-7).

Table B-6: Specific Plan Modeled Proposed Land Uses

Planning Area	Land Use Category	Acreage	Percent Impervious[1]	Modeled Land Use[2]
Planning Area 1				
	Multi-Family	8.5	85	MFR
	Private Drives	0.9	90	MFR
	Landscape/Open	0.8	10	Vacant
	Water Factory	1.5	NA	Not Modeled
Planning Area 2				
	Multi-Family	3.0	85	Commercial
	Commercial/Mixed Use	14.9	90	Commercial
	Private Drives	7.0	90	Commercial
	Park	1.3	20	Vacant
	Landscape/Open	4.2	10	Vacant
Planning Area 3				
	Multi-Family	13.7	85	MFR
	Single-Family Detached	8.1	66	HSFDR
	Private Drives	4.7	90	MFR
	Recreation	6.4	50	Educational
	Landscape/Open Space	5.1	10	Vacant
	Park	6.5	25	Vacant
Planning Area 4				
	Commercial	6.1	80	Commercial
	Landscape/Open Space	6.7	10	Vacant
Outside of Planning Area				
	Public Streets	8.8	90	Transportation
	River Bank Protection[3]	22.1	25	Vacant/Transportation
	Santa Clara River	52.5	NA	Not Modeled
Total		**182.8**	**45.2%**	

[1] Imperviousness by land use based on assumptions provided by Project civil engineer, Jason Vroom, Alliance Land Planning and Engineering
[2] Land use category for simulating stormwater runoff quality (i.e. pollutant concentrations)
[3] River Bank Protection encompasses maintenance access roads, buried bank stabilization, and areas of the river bed which will be temporarily impacted by construction. Access road (2.8 acres) was assumed to be 100 percent impervious and assigned half transportation and half vacant land use EMCs to reflect very limited vehicular use. Buried bank stabilization (6.8 acres) will be entirely covered by soil, but was assumed to be 25 percent impervious to reflect areas where soil coverage is thin and may result in increased runoff volume.

Table B-7: Proposed Condition Off-site Land Uses

Land Use	Modeled % Imp[1]	Modeled Land Use[2]	Area, acres		
			To WQ Treatment BMP	Self-mitigating	Off-site Total
Roads (includes 1.7 acre of adjacent non-paved areas)	77%	Transportation	7.2		7.2
Residential[3]	70%	HSFD	8.4		8.4
Schools[3]	55%	Education	16.5		16.5
Metrolink Platforms	100%	Transportation	1.3		1.3
Degraded Granite Trails	0%	Vacant		0.4	0.4
Grading in Metrolink ROW	0%	Not modeled		1.6	1.6
Total Off-site Impacts			33.4	2	35.4

[1] Imperviousness by land use based on assumptions provided by Project civil engineer, Jason Vroom, Alliance Land Planning and Engineering
[2] Land use category for simulating stormwater runoff quality (i.e. pollutant concentrations)
[3] Off-site school and residential land uses are not proposed to be improved as part of the Project, but drainage will be routed to Project BMPs

The existing land uses within the Project bounds, shown in Table B-8, include vacant open space and river corridor. Existing land uses in the off-site impact areas, also shown in Table B-8, include roadway, residential, school and open space land uses.

Table B-8: Existing Condition Land Uses

Land Use	On-site Area (acres)	Off-site Impacts (acres)	Total (acres)	% Impv	Modeled Land Use[1]
Open Space/Vacant	128.8	6.0	134.8	1[a]	Vacant
River Corridor	52.5	0	52.5	5 [b]	Not Modeled
Open Storage (Lt Industrial)	1.5	0	1.5	35[c]	Lt Industrial
Roads	0	2.8	2.8	100[b]	Trans.
Residential	0	8.4	8.4	70 [b]	HSFD
School	0	16.5	16.5	55 [b]	Education
Grading in Metrolink ROW	0	1.6	1.6	NA	Not Modeled
Total	182.8	35.4	218.2		

[1] Land use category for simulating stormwater runoff quality (i.e. pollutant concentrations)
[a] From LA County Hydrology Manual .
[b] Imperviousness by land use provided by Project Civil Engineer, Jason Vroom, Alliance Land Planning and Engineering
[c] Based on inspection of aerial photography

B.2.4. Treatment BMPs

Treatment control BMPs were modeled based on a "performance standard" approach. The performance standard established for this Project is described in the main body of the WQTR, and generally includes:

1. Capture and treatment in vegetated BMPs the runoff from the 1.4 inch storm design storm (based on 48-hr drawdown time) or equivalent.

2. Infiltration or re-use of the difference in runoff between pre-developed and post-developed conditions for the 1.4 inch design storm (based on 48-hr drawdown time) or equivalent.

3. Item 2 does not apply to public roads, transportation infrastructure, and existing off-site development treated by the Project, and may be waived where infiltration and re-use are not feasible.

Detailed BMP plans are not currently available. However, the performance standard, coupled with soils data and land use data, allows simulation of a BMP scenario representative of the performance of the eventual system design. BMP representations were developed based on known site opportunities and constraints so as to correspond to probable designs and subsequent performance. A generic off-line combination retention/treatment BMP was assumed for areas required to fulfill (1) and (2) above. A generic volume-based biofiltration BMP (without an intended retention component) was assumed for areas required to fulfill (1) only.

The BMP implementing (1) and (2) was assumed to be off-line with a diversion rate equal to the flow-based design intensity required by SUSMP (0.2 in/hr), sized to infiltrate or re-use the delta runoff volume from the 1.4 inch storm in 48 hours. Above the delta volume, the BMP was assumed to process water at a rate of one quarter the SUSMP design intensity (0.05 in/hr) and to provide residence times and vegetation height above the maximum water surface elevation commensurate with swale design requirements. Volumetric retention and drawdown time are consistent with the performance standard. The assumption of an off-line BMP inherently reduces the capture efficiency since peak flows will bypass regardless of the storage conditions in the BMP. While generally any flow that is diverted to the BMP would be treated to some degree, it may not receive full treatment at higher diverted flowrates when the basin is full. The assumption of treatment at one quarter of the SUSMP design flow when the BMP is full ensures that the performance of BMP program will not be over-estimated by the model.

Treated water discharged from BMPs was assumed to be treated to levels equivalent to biofilters in the International BMP Database.

B.2.5. Stormwater Runoff Pollutant Concentrations

Stormwater monitoring data collected by the Los Angeles Department of Public Works (LADPW) was used to derive estimates of pollutant concentrations in runoff from urban land uses.

B.2.5.1. Los Angeles County Monitoring Data

Recent and regional land-use based stormwater quality monitoring data was collected through the LA County Stormwater Monitoring Program. This program was initiated with the goal of providing technical data and information to support effective watershed stormwater quality management programs in Los Angeles County. Specific objectives of this project included monitoring and assessing pollutant concentrations from specific land uses and watershed areas. In order to achieve this objective, the County undertook an extensive stormwater sampling project that included 8 land use stations and 5 mass emission stations (located at the mouths of major streams and rivers), which were tested for 82 water quality constituents. These data are presented in *Los Angeles County 1994-2000 Integrated Receiving Water Impacts Report, 2000* and *Los Angeles County 2000-2001 Stormwater Monitoring Report, 2001*.

Stormwater quality for the Vista Canyon Project was estimated based on the recent EMC data collected by LA County (LA County, 2000, 2001). These data were used because of the relatively close location to the Project site and because the monitored land uses were representative of the proposed land uses for the Project. The monitored land use stations are listed in Table B-9 with a brief description of the site and when monitoring data were collected.

Table B-9: LA County Land Use Monitoring Stations Available for Water Quality Modeling

Station Name	Sta-tion	Modeled Land Use	Site Description[1]	Years Monitoring Conducted
Santa Monica Pier	S08	Commercial	The monitoring site is located near intersection of Appian Way and Moss Avenue in Santa Monica. The storm drain discharges below the Santa Monica Pier. Drainage area is approximately 81 acres. The Santa Monica Mall and Third St. Promenade dominate the watershed with remaining land uses consisting of office buildings, small shops, restaurants, hotels and high-density apartments.	1995-1999
Sawpit Creek	S11	Open Space (& Parks)	Located in Los Angeles River watershed in City of Monrovia. The monitoring station is Sawpit Creek, downstream of Monrovia Creek. Sawpit Creek is a natural watercourse at this location. Drainage area is approximately 3300 acres.	1995-2001
Project 620	S18	Single Family Residential	Located in the Los Angeles River watershed in the City of Glendale. The monitoring station is at the intersection of Glenwood Road and Cleveland Avenue. Land use is predominantly high-density, single-family residential. Drainage area is approximately 120 acres.	1995-2001
Dominguez Channel	S23	Freeway (Roadways)	Located within the Dominguez Channel/Los Angeles Harbor watershed in Lennox, near LAX. The monitoring station is near the intersection of 116th Street and Isis Avenue. Land use is predominantly transportation and includes areas of LAX and Interstate 105.	1995-2001
Project 474	S25	Education (Schools)	Located in Los Angeles River watershed in the Northridge section of the City of Los Angeles. The monitoring station is located along Lindley Avenue, one block south of Nordoff Street. The station monitors runoff from the California State University of Northridge. Drainage area is approximately 262 acres.	1997-2001
Project 404	S26	Multi-Family Residential	Located in Los Angeles River watershed in City of Arcadia. The monitoring station is located along Duarte Road, between Holly Ave and La Cadena Ave. Drainage area is approximately 214 acres.	1997-2001

1) Los Angeles County 1999-2000 Draft Stormwater Monitoring Report (Los Angeles County, 2000)

B.2.5.2. Data Analysis for Derivation of Land Use EMCs

The County of Los Angeles Department of Public Works (LADPW) has monitored stormwater runoff quality from various land uses throughout the County on an annual basis beginning in 1995 through 2001. For each year of monitoring several storm Event Mean Concentrations (EMCs) are reported and included in the County's annual water quality report to the Los Angeles Regional Water Quality Control Board. The convention for dealing with the censored data (e.g., data only known to be below the analytical detection limit) is to substitute ½ of the detection limit for all non-detects. L.A. County has followed this convention when providing summary arithmetic statistics of the stormwater monitoring data. This method tends to introduce bias into the estimate of the mean and standard deviation and the summary statistics are not believed to be robust or to adequately account for non-detects. To further complicate matters, the detection limit for dissolved copper and total lead changed during the period stormwater monitoring was conducted by LADPW.

In an effort to provide accurate estimates of land use EMC population summary statistics for stochastic modeling, a robust method for dealing with censored data with multiple detection limits was employed. The plotting position, or regression-on-order statistics (ROS), method described in Helsel and Cohn (1988) was used to estimate censored values using the distribution of uncensored values. Descriptive statistics were then estimated using the standard bootstrap method suggested by Singh, Singh, and Engelhardt (1997).

The final land use EMC input parameters developed for the Monte Carlo water quality model include the log-normal mean and log-normal standard deviation. Analyses demonstrate that nearly all of the Los Angeles County land use data sets can be more closely represented by the log-normal distribution than the normal distribution[1], which is consistent with findings by Pitt et al. (2004) based on analyses of the NSQD. Table B-14 summarizes the number of data points and the percent non-detects for the pollutants and land uses of interest that have sufficient data available for modeling based on the Los Angeles County data set. While data may be available to develop descriptive statistics for other pollutants (e.g., organics, other metal constituents, trash), reliable land use EMCs statistics could not be computed due to statistically insufficient number of detected results or due to the use sampling techniques not amenable to estimating representative EMCs (e.g., catch basin clean-outs in the case of trash). Also, the availability of BMP effluent quality data similarly limits the number of pollutants that can be effectively modeled; i.e., other pollutants (e.g., organics, other metal constituents) may have land use EMC data available but not BMP effluent data.

Example Data Set

To illustrate the statistical methods used to obtain land use EMCs, the LADPW stormwater monitoring data collected for total lead from the transportation land use station is used. The data were collected from 01/1996 to 04/2001. At the beginning of March 1997 the detection limit for total lead changed from 10 μg/L to 5 μg/L. Table B-10 describes the data according to the number of censored and uncensored values in the example data set.

---

[1] Statistical distribution test results reported by Los Angeles County also confirm this assessment, as summarized by Table 4-14 found at http://ladpw.org/wmd/npdes/Int_report/Tables/Table_4-14.pdf.

Table B-10. Number of Censored and Uncensored Data Points in the Total Lead Transportation Land Use Data Set

Total Lead EMC Data for Transportation Land Use	
Uncensored	37
Censored < 10 µg/L	2
Censored < 5 µg/L	38
Total Data Count	77

Prior to applying the plotting position method, it is necessary to check the normality of the data. Figure B-6 shows histograms and probability plots of the transportation land use total lead data above detection limits in normal and lognormal space. As indicated in the figure, the data tends to follow a lognormal distribution, a finding that is common with many pollutants in stormwater.

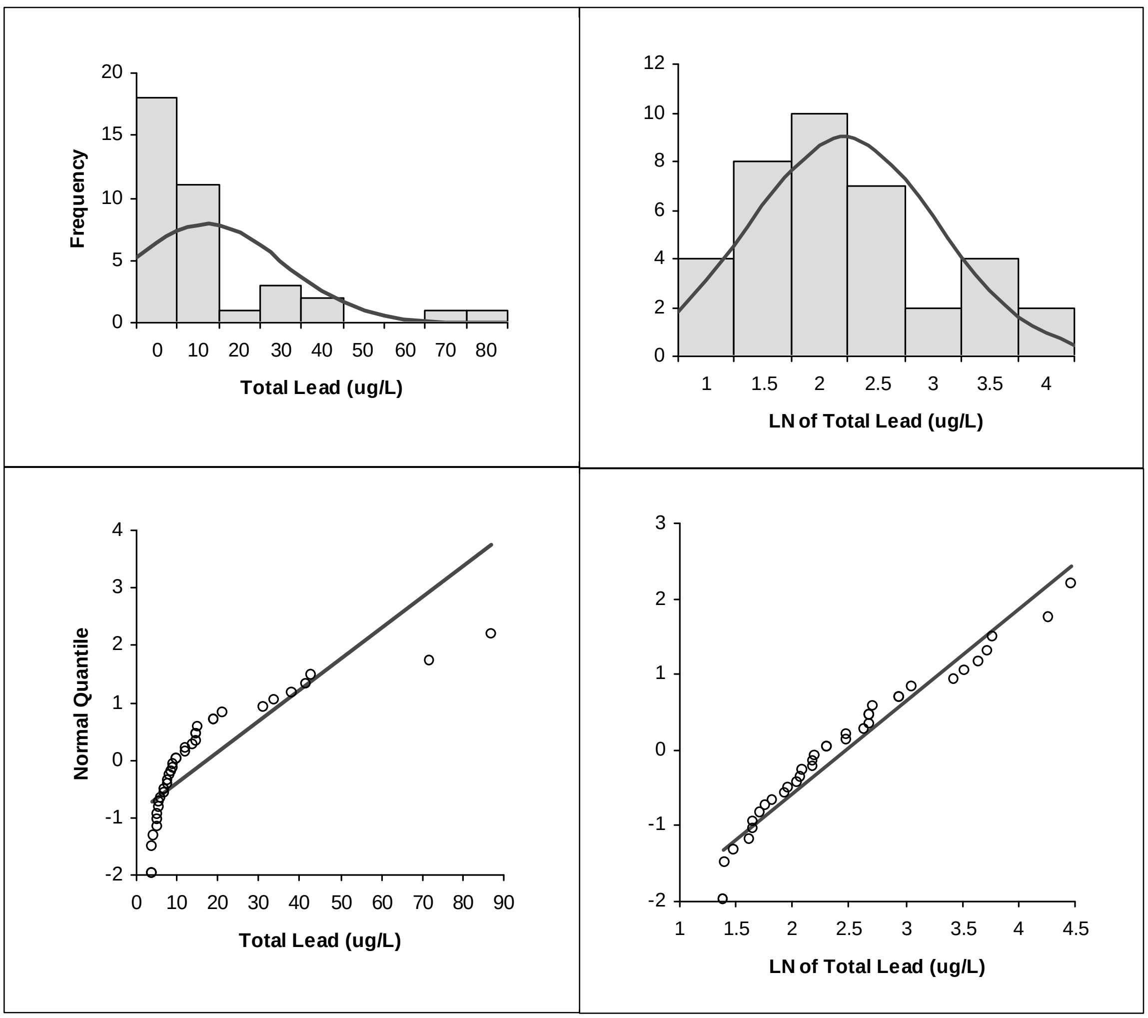


Figure B-6: Histograms and Probability Plots of Transportation Total Lead Data in Arithmetic and Lognormal Space.

To verify the visual check that the data are lognormally distributed, the Shapiro-Wilk goodness-of-fit test was used (Royston, 1992). In this test, if $p > 0.1$, the null hypothesis that the log data follow a normal distribution cannot be rejected. For this example data set, the p-value of the log-transformed uncensored data is 0.293, which indicates that lognormal distribution is a good approximation of the distribution of the data set.

Method for Dealing with Multiple Detection Limits

To account for the multiple detection limits in the censored data sets, a regression on order statistics (ROS) method was employed. ROS is a category of robust methods for estimating descriptive statistics of censored data sets that utilize the normal scores for the order statistics (Shumway et al. 2002). The plotting position method by Hirsch and Stendinger (1987) (summarized by Helsel and Cohn, 1988) was the ROS method used. In this method, plotting positions are based on conditional probabilities and ranks, where the ranks of the censored (below detection) and uncensored data (above detection) related to each detection limit are ranked independently. The method is summarized in the equations below.

After plotting positions for the censored and uncensored values have been calculated, the uncensored values are plotted against the z-statistic corresponding to the plotting position and the best-fit line of the known data points is derived. Using this line and the plotting positions for the uncensored data, the values for the uncensored data are extrapolated. Figure B-7 illustrates the results the application of the plotting position method on the total lead data for transportation land use.

$$pe_j = pe_{j+1} + \frac{A_j}{(A_j + B_j)} \times (1 - pe_{j+1}) \qquad (1)$$

Where:

A_j = the number of uncensored observations above the j detection limit and below the j +1 detection limit.

B_j = the number of censored and uncensored observations less than or equal to the j detection limit.

pe_j = the probability of exceeding the j threshold for j = m, m -1, … 2, 1 where m is the number of thresholds; by convention $pe_{m+1} = 0$.

Equation 2 was used for plotting the uncensored data and equation 3 was used for the plotting censored data; the plotting positions of the data were calculated using the Weibull plotting position formula.

$$p(i) = (1 - pe_j) + \frac{(pe_j - pe_{j+1}) \times r}{(A_j + 1)} \qquad (2)$$

Where:

p(i) = the plotting position of the uncensored i data point.

r = the rank of the i^{th} observation of the A_j observations above the j detection limit.

$$pc(i) = \frac{(1 - pe_j) \times r}{(n_j + 1)} \quad (3)$$

Where:

pc(i) = the plotting position of the censored i data point.

r = the rank of the i^{th} observation of the n_j censored values below the j detection limit.

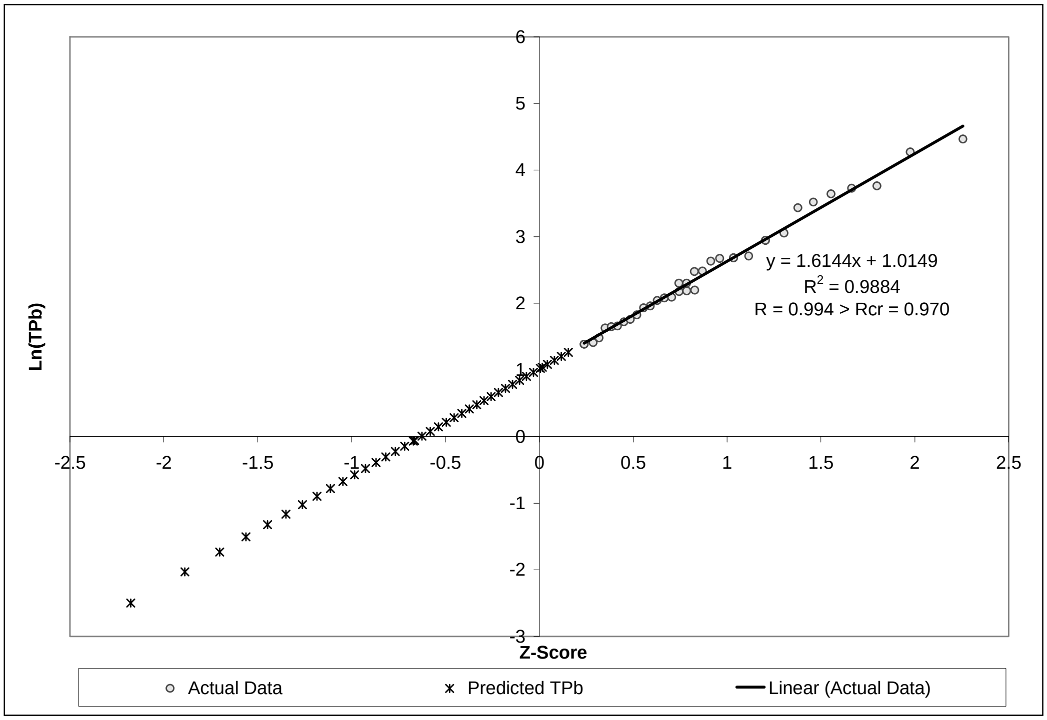


Figure B-7: Probability Plot of the Uncensored and Predicted (Censored) Total Lead Transportation EMCs.

Method for Calculating Descriptive Statistics

After the censored data are estimated (or for datasets without non-detects), descriptive statistics were computed using the bootstrap method (Singh *et al*. 1997). The bootstrap method samples from the data set with replacement several thousand times and calculates the desired descriptive statistics from the sampled data. The steps of the bootstrap estimation method are described below.

1. Take a sample of size *n* with replacement (the sampled data point remains in the data set for subsequent sampling) from the existing data set (Singh et al. recommends n be the same size as the original data set, this recommendation was followed for the analysis) and compute the descriptive statistic, θ_i, from the sampled data.
2. Repeat Step 1 independently N times (10,000 for this analysis) each time calculating a new estimate for θ_i.

3. Calculate the bootstrap estimate θ_B by averaging the θ_i's for i=1 to N

Fundamentally, the bootstrap procedure is based on the Central Limit Theorem (CLT), which suggests that even when the underlying population distribution is non-normal, averaging produces a distribution more closely approximated with normal distribution than the sampled distribution (Devore, 1995). Figure B-8 compares the total lead data after estimating censored values using the ROS method described prior to applying the bootstrap method with bootstrapped means of the ROS data. Note the bootstrap means are more normally distributed than the original data and the central tendency of the data is centered near 8 ug/L.

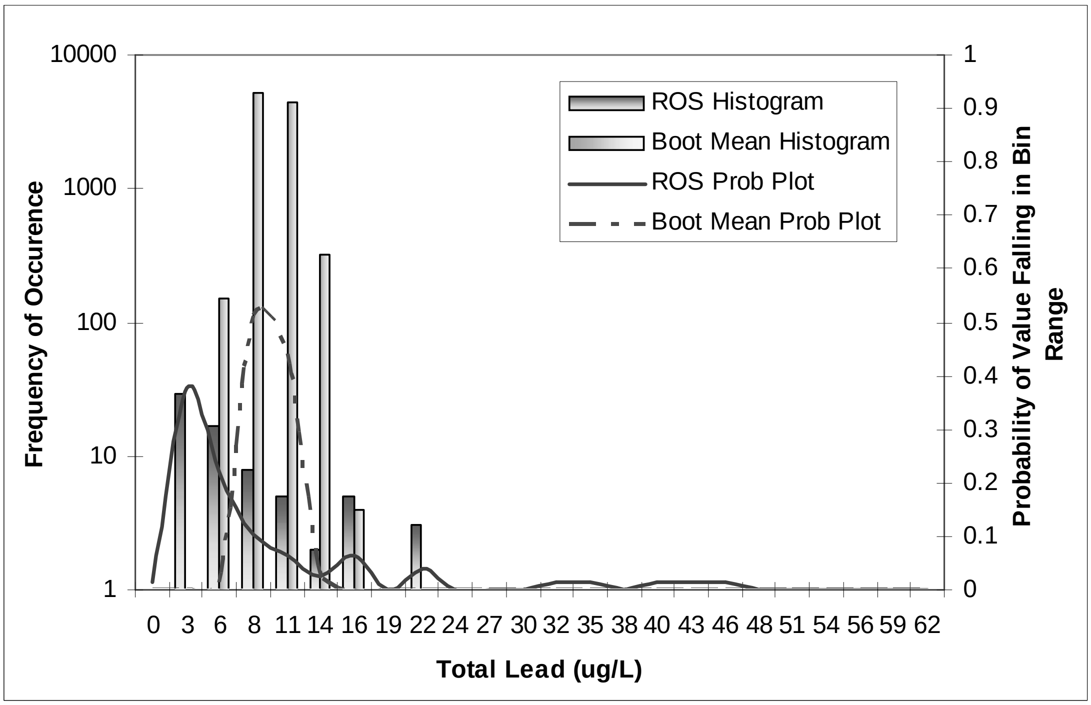


Figure B-8: Comparison of the Distribution of ROS Method Total Lead Data and the Bootstrap Means of the ROS Data.

The majority of the LADPW stormwater monitoring for the pollutant land use combinations analyzed fit a lognormal distribution. The data that did not statistically fit the lognormal distribution were more closely approximated with a lognormal distribution than a normal distribution.

Conclusions

The plotting position method for multiple detection limits has been used in conjunction with the bootstrap procedure for calculating the descriptive statistics used to represent pollutant EMC distributions in the water quality model. Table B-12summarizes the lognormal descriptive statistics, and Table B-13 summarizes the resulting arithmetic means. The latter data represent the land use specific pollutant EMCs in the Monte Carlo water quality model.

Table B-11: Summary of Number of Data Points and Percent Non-Detects for Los Angeles County Land Use EMC Data

Land Use		TSS	TP	NH3-N	NO3-N	NO2-N	TKN	Diss Cu	Tot Pb	Diss Zn	Cl
Commercial	Count	31	32	33	33	7	36	40	40	40	33
	% ND	0%	3%	21%	21%	0%	3%	15%	45%	10%	0%
Industrial	Count	53	55	57	56	9	57	61	61	61	57
	% ND	0%	5%	19%	5%	16%	0%	15%	43%	7%	0%
Transportation	Count	75	71	74	75	10	75	77	77	77	76
	% ND	0%	1%	27%	20%	0%	0%	1%	52%	6%	4%
Education	Count	51	49	52	51	15	51	54	54	54	52
	% ND	0%	0%	35%	24%	0%	0%	19%	76%	39%	4%
Multi-Family Residential	Count	45	38	46	46	11	50	54	54	54	46
	% ND	2%	3%	24%	26%	0%	0%	37%	72%	41%	8%
Single Family Residential	Count	41	42	44	43	15	46	48	48	48	43
	% ND	0%	0%	16%	30%	0%	0%	40%	52%	81%	2%
Vacant / Open Space	Count	48	46	48	50	35	50	52	57	52	50
	% ND	2%	41%	67%	2%	70%	0%	90%	88%	96%	0%

Table B-12: Summary of Lognormal Statistics used for Modeling Pollutant Concentrations

Land Use		TSS	TP	NH3	NO3	NO2	TKN	Diss Cu	Tot Pb	Diss Zn	Cl
Commercial	Mean	4.00	-1.19	-0.947	-2.63	-1.08	0.698	2.25	1.45	4.87	3.44
	St. Dev	0.634	0.733	0.832	1.17	1.60	1.04	0.723	1.47	0.575	0.969
Industrial	Mean	5.07	-1.30	-0.532	-2.67	-1.14	0.803	2.39	1.68	5.57	2.27
	St. Dev	0.798	0.860	0.891	0.788	1.12	0.711	0.818	1.49	0.978	0.620
Transportation	Mean	3.97	-0.909	-0.863	-2.69	-1.71	0.373	3.24	1.60	5.10	1.58
	St. Dev	0.878	1.03	1.06	0.755	1.20	0.690	0.693	1.12	0.776	0.718
Education	Mean	4.14	-1.35	-0.888	-3.05	-1.92	0.359	2.20	0.770	4.13	2.06
	St. Dev	0.961	0.538	0.886	1.22	1.41	0.599	0.773	1.02	0.626	1.54
Multi-Family Residential	Mean	3.20	-1.75	-0.401	-2.94	-1.26	0.391	1.76	0.827	3.96	1.71
	St. Dev	0.988	0.777	1.28	1.20	1.07	0.624	0.687	1.17	0.882	1.69
Single Family Residential	Mean	4.24	-1.13	-1.17	-3.14	-1.20	0.776	1.91	1.85	2.49	1.49
	St. Dev	1.08	0.672	1.35	1.24	0.996	0.787	0.811	1.07	1.28	0.640
Vacant / Open Space	Mean	3.44	-3.20	-0.0306	-3.95	-3.18	-0.354	-1.83	-0.375	3.24	1.87
	St. Dev	1.97	1.44	0.615	0.494	1.37	0.792	1.59	1.72	0.438	0.249

Table B-13: Resulting Arithmetic Means from Lognormal Statistics used for Modeling Pollutant Concentrations[1]

Land Use	TSS	TP	NH3	NO3	NO2	TKN	Diss Cu	Tot Pb	Diss Zn	Cl
Commercial	67	0.40	0.55	0.14	1.2	3.4	12	12	150	50
Industrial	220	0.39	0.87	0.094	0.60	2.9	15	16	420	12
Transportation	78	0.68	0.74	0.091	0.37	1.8	32	9.2	220	6.3
Education	100	0.30	0.61	0.10	0.40	1.7	12	3.6	75	26
Multi-Family Residential	40	0.23	1.5	0.11	0.50	1.8	7.4	4.5	78	23
Single Family Residential	120	0.40	0.78	0.093	0.49	3.0	9.4	11	27	5.4
Vacant / Open Space	220	0.12	1.2	0.022	0.11	0.96	0.57	3.0	28	6.7

1 – Calculated from values provided in Table B-12

B.2.6. Estimate of BMP Performance Parameters

BMP performance is a function of three factors: (1) the fraction of stormwater runoff receiving treatment (often referred to as percentage of runoff captured, or simply percent capture); (2) the pollutant removal achieved in the treatment unit by virtue of improved water quality; and (3) the pollutant removal achieved in the unit by virtue of infiltration.

B.2.6.1. BMP Capture Efficiency and Volume Reduction

BMP representations were simulated in SWMM 4.4h using inputs described above. Results were then post-processed in a modified SWMM engine to yield capture efficiency and volume reduction for each storm.

The modified SWMM engine works by tracking rainfall, runoff, and treatment system routing in the context of individual storm events. In the RAIN block, storm events are delineated from within the continuous rainfall record using algorithms identical in performance to GeoSYNOP, described herein; depth and start and stop times of each event are recorded. In the RUNOFF block, the rainfall volume associated with each event is tracked between the volume lost and that which runs off; start and stop times of runoff for each storm are recorded for later use. Finally, in the STORAGE/TREATMENT block, the runoff volume associated with each storm event is tracked between treated volume, bypassed volume, infiltrated volume and evapotranspired volume. This constitutes a volume-tracking approach of calculating capture efficiency and volume reduction by storm event. The result of these algorithms is a capture efficiency and volume reduction for each storm in the period of record.

For BMPs not specifically designed to infiltrate stormwater, volume reductions are still expected to occur. Data in the International BMP Database (IBMPDB) have shown that as much as 30 percent of the stormwater volume captured by dry extended detention basins and 35 percent captured by swales can be lost to infiltration (Strecker et al., 2004). Swales and bioretention with underdrains (i.e. BMPs that do not specifically promote infiltration) were conservatively modeled with 20 percent volume reduction based on the findings from the IBMPDB.

B.2.6.2. BMP Pollutant Removal

BMP effluent quality, like land use EMCs, is highly variable. To account for this variability, effluent quality data were analyzed and descriptive statistics were generated by means of a technique similar to that used to generate land use EMCs. The descriptive statistics generated were used as BMP effectiveness inputs to the Monte Carlo model.

The International Stormwater BMP Database (www.bmpdatabase.org) is a comprehensive source of BMP performance information. The BMP Database is comprised of carefully examined data from a peer-reviewed collection of studies that have monitored the effectiveness of a variety of BMPs in treating water quality pollutants for a variety of land use types. Research on characterizing BMP performance suggests that effluent quality rather than percent removal is more reliable in modeling stormwater treatment (Strecker et al. 2001). Schueler (1996) also found in his evaluation of detention basins and stormwater wetlands that BMP performance is often limited by an achievable effluent quality, or "irreducible pollutant concentration;" acknowledging that a practical lower limit exists to which stormwater pollutants can be removed by a given technology. While there is likely a relationship between influent and effluent for some BMPs and some constituent concentrations, the analyses that have been conducted to date do not support flat percent removal values relative to influent quality. As such, the distribution of effluent concentrations of stormwater BMPs reported in the BMP Database are used to estimate BMP performance for water quality modeling of the proposed conditions.

Future studies may support a refinement to the approach of effluent concentration-based BMP performance modeling, such as the development of more complex influent-effluent relationships. However, it should be noted that the stochastic modeling approach accounts for, at least in part, the uncertainty of not knowing the relationship between influent and effluent concentrations since the BMP effluent distributions are based on a variety of BMP studies with a wide-range of influent concentrations, representing a variety of tributary drainage area land use characteristics. Furthermore, the Monte Carlo model employed only accounts for pollutant reductions if the predicted influent is greater than the achievable effluent quality estimated for the modeled BMP (i.e. effluent equals influent [or land use-based] concentrations up until the influent concentration exceeds the effluent concentration). Therefore, influent (or land use EMC-based) concentrations are considered by the model since they are directly used to determine whether or not treatment occurs.

Similar to the estimation of land use EMCs, final BMP effluent values used were determined using a combination of regression-on-order statistics and the "bootstrap" method. Log-normality was assumed for BMP effluent concentrations. This assumption was confirmed through goodness-of-fit tests on the BMP effluent concentration data, where it was found that 41% of the BMP data sets fit the lognormal distribution and the remaining data sets fit this distribution better than the normal distribution. Table B-14 summarizes the number of data points (individual storm events) and percent non-detects for the pollutants and BMP types of interest for which sufficient data were available. Table B-15 summarizes the log-normal statistics that will be used in the water quality model, and Table B-16 summarizes arithmetic descriptive statistics for those data sets.

BMP effluent concentrations are assumed to be limited by an "irreducible effluent concentration," or a minimum achievable concentration. Lower limits are currently set at the 10th percentile effluent concentration of BMP data in the International BMP Database for each modeled BMP type for which the BMP data show statistically significant differences in influent and effluent means. If the differences are not statistically significant, the 90th percentile is used as the minimum achievable effluent concentration, which essentially assumes no treatment. Table B-17 summarizes the irreducible effluent concentration estimates used by for water quality modeling of the proposed condition.

Bioretention areas with underdrains operate on somewhat different mechanisms than swales; however a review of performance data indicates no significant difference in effluent concentrations. Therefore, bioretention areas have been modeled with the same volume reduction and pollutant removal characteristics as swales. Infiltration BMPs are assumed to provide no treatment for water that either overflows the BMP or bypasses the BMP. Pollutant removal is only simulated for those pollutants with available data from the International BMP Database. In instances where data are not available for a parameter (i.e. nitrite-nitrogen and chloride), no concentration reduction was assumed for that parameter. However, load reductions may still be estimated as a result of volume reductions.

Table B-14: Summary of Number of Data Points and Percent Non-Detects for BMP Effluent Concentration Data from the International BMP Database

BMP		TSS	TP	NO3	NO2	NH3	TKN	Diss Cu	Tot Pb	Diss Zn	Cl
Biofilters	Count	467	539	476	NA	14	395	399	483	399	NA
	% ND	1%	1%	3%	NA	29%	1%	1%	10%	1%	NA

NA - Not available

Table B-15: International BMP Database Lognormal Statistics of BMP Effluent Concentrations.

BMP		TSS	TP	NO3	NO2	NH3	TKN	Diss Cu	Tot Pb	Diss Zn	Cl
Biofilters	Mean	3.01	-1.49	-1.41	NA	-3.34	0.07	1.74	2.00	2.88	NA
	St. Dev	1.44	1.07	1.63	NA	0.94	1.24	0.93	1.18	0.93	NA

Table B-16: International BMP Database Arithmetic Estimates of BMP Effluent Concentrations.

BMP		TSS	TP	NO3	NO2	NH3	TKN	Diss Cu	Tot Pb	Diss Zn	Cl
	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	mg/L
Biofilters	Mean	57.5	0.40	0.92	NA	0.06	2.31	8.7	14.8	27.4	NA
	St. Dev	152.1	0.58	3.37	NA	0.07	4.43	10.2	25.8	32.0	NA

Table B-17: International BMP Database Arithmetic Irreducible Effluent Concentration Estimates.

BMP	TSS	TP	NO3	NO2	NH3	TKN	Diss Cu	Tot Pb	Diss Zn	NO2
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	mg/L
Biofilters	3.04	0.815	1.601	NA	0.142	0.63	1.53	1.00	5.00	NA

B.2.7. Model Parameter Assumptions & Reliability

The input parameters for the water quality model include the following five main categories:

- Rainfall data;
- Runoff Coefficients;
- Land Use data;
- Stormwater pollutant EMCs; and
- BMP performance estimates.

Each of the categories of input data is evaluated for accuracy in reflecting the Project site conditions.

Rainfall Data: The rainfall data collected at the Newhall gauge was used. The San Fernando gauge which was used to fill in missing periods in the Newhall gauge measures only slightly lesser average rainfall depths than the Newhall gauge and the data used from this gauge were corrected to account for this small difference. Thus the use of San Fernando gauge data to fill gaps in the Newhall record results in a more accurate representation of actual rainfall and does not significantly bias estimates of runoff volume or concentration.

Runoff Coefficients: The estimation of runoff coefficients, described in B.2.2, is highly dependent on soil properties (i.e. infiltration potential) and less dependent on parameters such as ET rates, slopes, and surface roughness. Soil properties are estimated as accurately as possible from available data such as soil surveys and site specific geotechnical studies. The result is estimates for runoff coefficients that may somewhat overestimate or underestimate stormwater runoff. The net result on the water quality model is that this parameter is not conservatively estimated; however, it is estimated as accurately as the available information permits.

Land Use Data: Land use data are generally considered to be a relatively accurately quantified input parameter. The land use data for the developed conditions can be used to classify land use type and compute acreage. The percent impervious values used in the water quality model for the urban land uses in the developed Project condition are based upon estimates made by the Project civil engineer (Alliance Land Planning and Engineering) based on knowledge of site designs. Existing condition percent impervious values for vacant land were obtained from the values listed in the LA County Hydrology Manual (2006) and provided by the Project civil engineer. Both sources are believed to be relatively accurate. The emphasis of assumptions made in this modeling effort was to quantify imperviousness as accurately as possible without intentionally incorporating conservatism.

Stormwater Pollutant EMCs: Stormwater pollutant EMCs estimated from monitoring data collected by LACDPW from land use characterization stations generally do not have site design and source control BMPs that will be implemented for the Vista Canyon Project. Therefore the stormwater pollutant EMCs estimated from the LACDPW data are probably slightly to moderately conservative compared to the pollutant concentrations in stormwater runoff that will occur from the developed conditions of the Project site.

BMP Capture Efficiency & Effluent Concentrations: Stormwater capture efficiency estimates were calculated in SWMM to provide results on a storm-by-storm basis for input into the water quality model, to accurately reflect the anticipated performance of the structural stormwater BMPs. Capture efficiency and volume reduction are believed to be estimated accurately, for the BMP configuration assumed to represent the Project performance standard.

BMP effluent concentrations are based on studies contained in the International BMP database. These studies are screened to remove data for undersized (i.e., inadequate design criteria) BMPs that are likely to have pollutant removal performance substantially less than the BMPs that are to be constructed for the Vista Canyon Project. This screening is believed to improve the accuracy of BMP performance estimates; however it is only intended to remove BMPs that are clearly unrepresentative in terms of sizing. The screening process is intended to include BMPs with adequate performance that may not be as well designed or maintained as the structural BMPs that will be part of the Project. It is anticipated that the BMPs for the Project will perform as well, if not a slightly better than, the Projected performance based on the database. A major advantage to the use of the International Database is its representation of semi-arid climates. Though the database contains sites from several different climates, it includes a number of sites from semi-arid climates, including data for over 40 sites studied by Caltrans.

Conclusions: The land use type, area and imperviousness are thought to be reasonably accurate representations of the site conditions and do not increase the conservativeness of the water quality model. BMP capture efficiency and volume reduction are believed to be reasonably accurate representations of likely performance. The stormwater pollutant EMC estimates are believed to result in conservative estimates of pollutant concentrations and therefore pollutant loads. Overall the pre-development model input parameters may slightly overestimate or underestimate pollutant loads and concentration. The water quality estimates for the developed Project condition are believed to be conservative (i.e., tend to overestimate loads and concentrations) due to conservative pollutant concentration estimates that in general do not include the benefits of site design or source control BMPs that are planned to be implemented in the Project. Overall, the model assumptions are believed to result in a somewhat high estimate of the difference in runoff volumes, pollutant loads, and pollutant concentrations from the existing to proposed Project conditions.

B.3. Model Methodology

A Monte Carlo simulation method was used to develop the statistical description for storm water quality. In this approach, the storm water characteristics from a single rainfall event are estimated. The rainfall depth is determined by randomly sampling from the historical rainfall depth frequency distribution. Similarly, an EMC is determined by randomly sampling from the frequency distribution of EMCs. The rainfall volume and EMC are used to determine runoff volume, pollutant concentration, and pollutant load for the single storm event. BMP volume reduction and performance (effluent quality), determined by randomly sampling from the developed frequency distributions, are used to calculate the pollutant removal resulting from treatment in the BMP system. This procedure is then repeated thousands of times (20,000), recording the volume, EMC and load from each randomly selected storm event, including treatment for the developed Project condition. The statistics of these recorded results provide a description of the average characteristics and variability of the volume and water quality of storm water runoff.

This method was applied to the Project using Project-specific inputs as described above. The modeled pollutants for the Project were:

- Total Suspended Solids (sediment)
- Total Phosphorus
- Ammonia
- Nitrate
- Nitrite
- Total Nitrogen[2]
- Dissolved Copper
- Total Lead
- Dissolved Zinc
- Chloride

The steps in the Monte Carlo Water Quality Model are as follows:

1. Develop a statistical description of the number of storm events per year, and randomly select a number N_{storms}.
2. Estimate the volume of storm runoff for each land use area from a randomly selected storm event.
3. Randomly select a pollutant concentration in storm runoff for each land-use area and each pollutant.
4. Calculate the total runoff volume, pollutant load, and concentration in runoff from the modeled portion of the Project, for both existing and developed conditions.
5. Calculate a total annual pollutant load by repeating steps 2-4 N_{storms} times, where N_{storms} is the number of storms per year, randomly selected in step 1.
6. Repeat steps 1 - 6 a total of 20,000 times for each pollutant modeled, recording the estimated pollutant concentration and annual load for each iteration.
7. Develop a statistical representation (mean annual value) of the recorded storm water pollutant loads and concentrations.

Each of the seven steps is described below.

B.3.1. Storms & Stormwater Runoff (steps 1 & 2)

Step 1 – Statistical Representation of Number of Storm Events per Year

Number of Storms per Year

The number of storm events per year was calculated for the 40 complete years in the available period of record from Water Year 1969 – 2008. The modeled average number of storm events per year (> 0.1 inches) was 15.5, with a standard deviation of 6.1. Figure B-9 illustrates a frequency histogram of the number of storm events per year at the patched Newhall gauge. The number of storm events per year was modeled with a normal distribution.

[2] TKN is modeled, but the results are not reported. Total Nitrogen results are reported from the sum of ammonia, nitrate, nitrite, and TKN.

In the simulation, the number of storms per year was determined by randomly sampling from the normal distribution and rounding to the nearest whole number, using the equation:

$$N_{\text{storms}} = 15.5 + 6.1 R_N \quad (12)$$

where:

R_N = a standard normal variant with a mean of 0 and a standard deviation of 1.

If the number of storms per year was zero or negative, then the normal distribution was re-sampled until a positive number was obtained (years without any storms did not occur in the available period of record so this situation was not simulated in the water quality model).

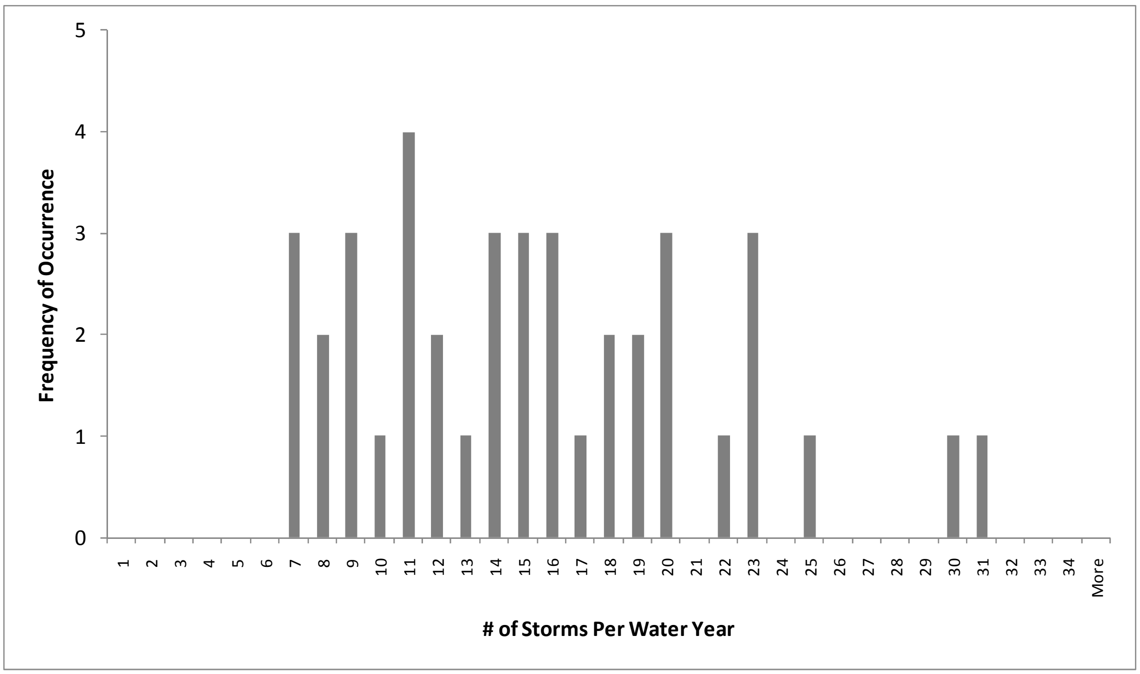


Figure B-9: Distribution of Storms per Year at the patched Newhall Gauge.

Step 2 – Estimate the Volume of Storm Runoff from a Storm Event.

The runoff volume from each storm was estimated using the following equation:

$$V = R_v P A \quad (5)$$

where:

- V = the stormwater runoff volume (ft^3)
- P = the rainfall depth of the storm (ft)
- A = the drainage area (ft^2)
- R_v = the mean volumetric runoff coefficient, a unit-less value that is a function of the imperviousness of the drainage.

For sub-basins that contain multiple land-use types, the total stormwater runoff volume is determined as the sum of runoff from each land-use type:

$$V_{wshed} = \Sigma_{lu} V_{lu} = \Sigma_{lu} (R_{v\,lu}\, PA_{lu}) \quad (6)$$

where *lu* designates the land-use type. It is assumed that rain falls uniformly over all land-uses in the sub-basin.

The steps used to calculate the volume of runoff from a randomly selected storm event were:

Step 2a Obtain a rainfall depth by randomly sampling from the 619 storm events.

Step 2b For each land-use area calculate a runoff volume using equation (5). The same rainfall depth is applied to each land-use area.

Step 2c Sum the runoff volumes from each land-use area to obtain the total runoff from the watershed for a particular storm event with equation (6).

B.3.2. Pollutant Loads & Concentrations (step 3 & 4)

Step 3 – Estimate a Pollutant Concentration in Storm Runoff from Each Land Use Area

Runoff Concentration

The distribution of land use-based pollutant concentration in storm runoff was developed based on the process described in Section B.2.4.3. For each storm event, stormwater EMCs were sampled randomly for each modeled land use and water quality parameter. The runoff concentration from each land-use area was evaluated with the expression:

$$C_{land-use} = \exp\left(\mu_{\ln x} + \sigma_{\ln x} R_N\right) \quad (7)$$

where:

$\mu_{\ln x}$ = the log-normal mean

$\sigma_{\ln x}$ = the log-normal standard deviation

R_N = a standard normal random variable

Step 4 – Calculate the Total Runoff Volume, Pollutant Load, and Pollutant Concentration in a Storm Event

Step 4A - The total runoff volume in the watershed was calculated with equation (6) as discussed in Step 2:

$$V_{wshed} = V_{land-use1} + V_{land-use2} + \ldots + V_{land-usei} \quad (8)$$

where the same randomly selected rainfall event was used to calculate runoff volume in each of the land-use areas.

Step 4B - The total pollutant load from the watershed was calculated by:

$$L_{wshed} = V_{land-use1} C_{land-use1} + \ldots + V_{land-usei} C_{land-usei} \quad (9)$$

where the concentration in each individual land-use area was calculated with equation (7) discussed in step 3.

Step 4C - The average pollutant concentration in runoff from the entire watershed from a single storm event was calculated by dividing the total watershed load (Step 4B) by the total watershed runoff volume (Step 4A):

$$C_{wshed} = L_{wshed} / V_{wshed} \qquad (10)$$

The results of step 4B (Eq 9) and step 4C (Eq. 10) were used to compute model results for existing conditions.

The developed condition with treatment BMPs used additional calculations to determine the reduction in pollutant load and concentration achieved with treatment BMPs. The fraction of stormwater runoff receiving treatment was calculated for each storm event, using the capture efficiency associated with that event, as described in Section B.2.5. BMP performance was modeled using a randomly selected effluent concentration achieved within the BMP for each water quality pollutant.

Step 4D - The total pollutant load from watersheds with treatment BMPs was calculated by:

$$L_{wshed\_BMPs} = \left[Cap_{\%} \times V_{wshed} \times C_{eff} \times (1 - VR\%)\right] + \left[(1 - Cap_{\%}) \times V_{wshed} \times C_{wshed}\right] \qquad (11)$$

where:

$Cap_{\%}$ is the volumetric percent capture of the BMP.

C_{eff} is the randomly determined effluent concentration from the BMP. C_{eff} was determined from sampling from the lognormal distribution described by the parameters contained in Table B-16.

$VR\%$ is the percent reduction in effluent volume achieved by the BMP (see Section B.2.5.1.3).

V_{wshed} and C_{wshed} were calculated per Steps 4A and 4C, respectively

Step 4E - The average pollutant concentration in runoff from the entire watershed with treatment from a single storm event was calculated by dividing the total watershed load with treatment by the total watershed runoff volume less the volume lost in BMPs:

$$C_{wshed\_BMPs} = L_{wshed\_BMPs} / V_{wshed\_BMPs} \qquad (12)$$

where:

$$V_{wshed\_BMPs} = V_{wshed} \times \left[1 - (Cap_{\%} \times VR\%)\right] \qquad (13)$$

The results of step 4D (Eq 11) and step 4E (Eq. 12) were used to compute model results for developed conditions with treatment.

Figure B-10 provides a diagrammatic representation of these water quality calculations.

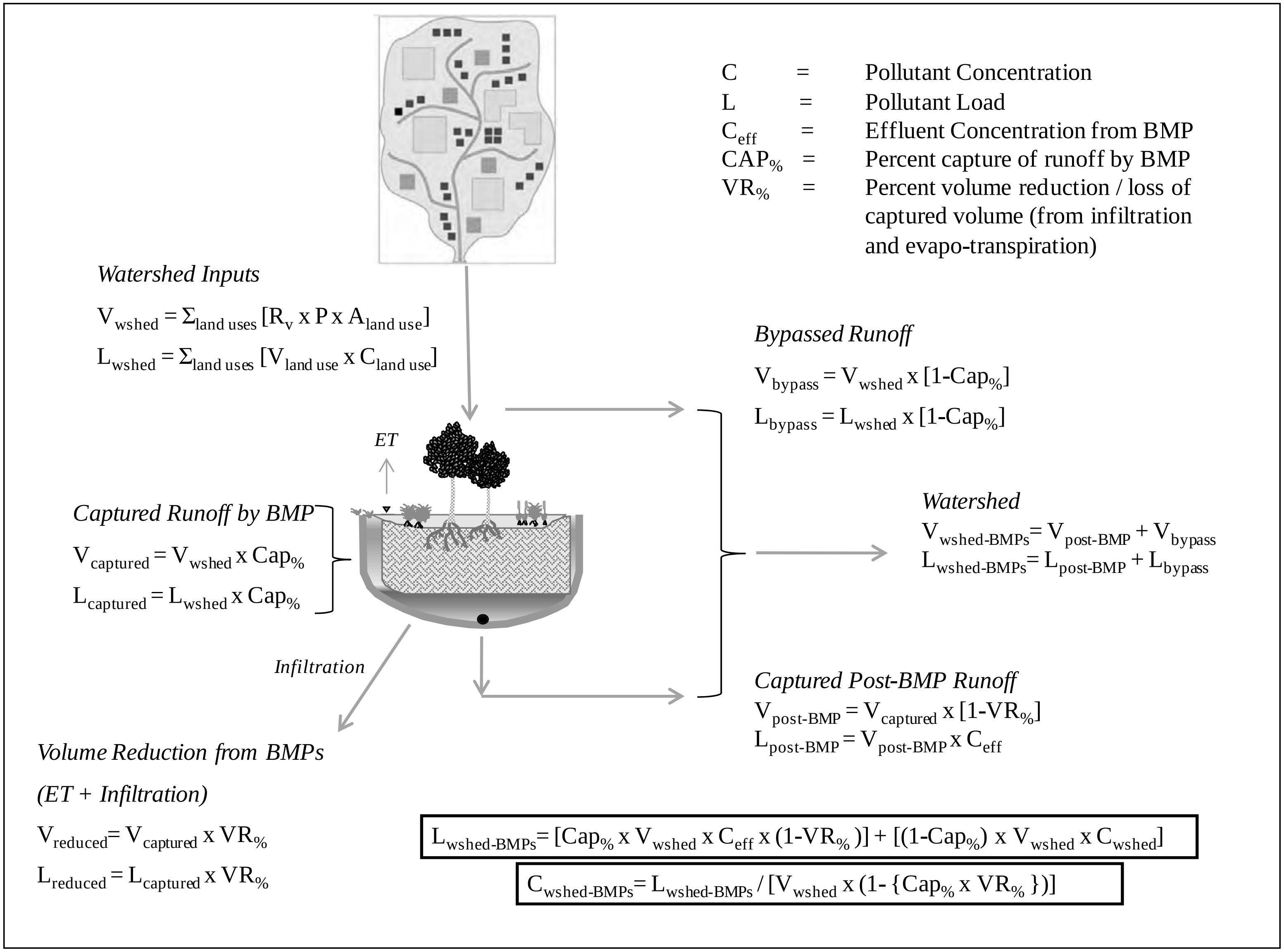


Figure B-10: Diagrammatic representation of water quality calculations.

B.3.3. Annual Pollutant Loads, Concentrations, and Distributions (Steps 5, 6, & 7)

Step 5 – Calculate a Total Annual Pollutant Load

The annual pollutant load is the sum of pollutant loads generated from all storms in a given year, based on the random selection described in Step 1. Therefore, steps 2-4 were repeated N_{storms} times (where N_{storms} was randomly selected per step 1), recording the total pollutant load from each randomly selected storm event. The individual storm loads were summed to obtain the total annual pollutant load.

Step 6 & 7 – Determine Distribution of Storm Concentration and Annual Loads

Steps 1-5 were repeated a total of 20,000 times, recording the pollutant concentration and annual load from each iteration. The resultant distributions can be used to present a frequency distribution for pollutant concentrations or loads using statistics calculated from the 20,000 Monte-Carlo iterations.

B.3.4. Model Methodology Assumptions

The following five key assumptions are made for the Monte Carlo water quality modeling methodology:

1. The assumed probability distributions of model parameters;
2. The assumption of independence between model parameters (i.e. no correlation between randomly determined variables);
3. Assigning a Lower Limit to BMP Effluent Concentrations;
4. Limiting pollutant removals to pollutants with data; and
5. Modeling structural BMPs to only remove pollutants and not acting as a source.

The implications of each of these assumptions to the water quality projections are discussed below.

<u>1) Distribution Assumptions</u>: Probability distributions are assumed to represent the number of storms per year, stormwater pollutant concentrations, and BMP effluent concentrations. Observed rainfall data (i.e., storm frequency) and stormwater monitoring data are fit with either a normal or lognormal distribution using standard statistical procedures. The values of storms per year, rainfall depth, runoff pollutant concentration, and BMP effluent concentrations used in a given iteration in the Monte Carlo analysis are governed by the selected distributions. Large samples of these estimated variables will approximate the assumed distributions, and will have same mean and variance that was observed in the rainfall and monitoring data. The following describes the distributions for various input parameters.

Storms per Year: Figure B-9 shows the number of storms per year occurring at the patched Newhall rain gauge. The number of storms occurring per year at this gauge appears to lie between the normal and lognormal distributions. The normal distribution was used to determine the number of storms per year simulated in the water quality model. Use of the lognormal distribution would overestimate the average annual rainfall, as well as its variability, because the distribution of the data in Figure B-8 is not heavily skewed. When using the normal distribution to randomly determine the number of storms per year, the resulting average annual rainfall output from the water quality model is in close agreement with the average annual rainfall from runoff producing storms of 17.5 inches determined directly from the rainfall data (see Table B-1).

Stormwater Pollutant Concentrations: The Shapiro-Wilk Test was used to determine the statistical distribution that best represents the raw stormwater runoff monitoring data collected in Los Angeles County. In most instances the data were found to be log-normally distributed at a confidence level of 0.10. In some instances, the data were not well fit by either the normal or lognormal distributions, but were found to be more closely approximated by the log-normal distribution. Since stormwater pollutant concentrations, in general, tend to be well approximated by the lognormal distribution (Helsel and Hirsh, 2002), the data sets that did not meet the lognormal criterion are still believed to belong to a log-normally distributed population, though the number of data points is too few to statistically confirm that this is the case. Therefore, simulations of stormwater concentrations in the water quality model were still conducted in lognormal space. This assumption is believed to result in a more accurate prediction than would the application of the normal distribution.

BMP Effluent Concentrations: Goodness-of-fit tests conducted on the raw BMP effluent monitoring data from the International BMP Database with the Shapiro-Wilk Test either resulted in (1) confirmation of the appropriateness of the lognormal distribution for the data; or (2) in the instances when the data did not meet the significance criteria of a p value > 0.1, the data being more closely approximated with the lognormal distribution than the normal. The use of the lognormal distribution to represent BMP effluent concentrations results in higher average estimates of BMP effluent concentration. This is believed to be a more accurate estimation of BMP performance than use of the normal distribution, and is considered a more conservative assumption (leading if anything to higher than anticipated effluent concentrations).

2) Assumption of No Correlation between Model Parameters: The water quality model randomly selects stormwater pollutant concentrations independent of the storm depth or antecedent dry period for each storm event modeled. The validity of the assumption of independence between variables is supported by analyses conducted by Environmental Defense Sciences (2002), who did not find a strong correlation between rainfall volume and event mean concentrations (EMCs) in the LA County data for the education land-use site. Data analyses for the single family residential land use were found to be weakly correlated (R^2 of 0.6 ± 0.1) for some pollutants with storm depth; however some pollutant showed little correlation between these variables. Where weak correlations were present, stormwater pollutant concentrations tended to decrease with storm size. Correlations between pollutant concentration and antecedent dry period were similarly variable. For the single family land use, correlations between pollutant concentration and antecedent dry period were moderately significant for a few pollutants (R^2 of 0.8 ± 0.03), and weak for other pollutants. Correlations between pollutant concentration and antecedent dry period varied widely for the educational and multi-family land uses.

The results of these analyses indicated that no consistent level of correlation has been demonstrated between the stormwater EMCs and the rainfall depth or the antecedent dry period, with weak or no correlation observed for most pollutants and land-uses. On this basis, random selection of stormwater pollutant concentrations, independent of storm depth and antecedent dry period, is warranted for the water quality model.

Effluent concentrations are considered a more reliable estimator of treatment performance than percent removal (Strecker et al. 2001). BMP effluent concentrations were sampled independently of stormwater concentrations (i.e. influent concentration to the BMP) in the water quality model. As with the pollutant EMCs, independent sampling of effluent concentrations preserves the mean and standard deviation in the monitoring data.

3) BMP Performance – Irreducible Pollutant Effluent Concentrations: When sampling from the lognormal distribution to estimate BMP performance with an effluent concentration it is possible to select values approaching or equal to zero. While well functioning BMPs are capable of achieving high rates of pollutant removal, it is generally accepted that BMPs cannot completely remove pollutants from the water column. In effect BMPs, at best, can achieve what is called an "irreducible pollutant concentration" (Schueler, 1996). In an effort to prevent overestimating BMP performance in the model, lower limits were set for the effluent concentrations of each modeled pollutant and BMP as described in Section B.2.5.2.

Table B-15 and Table B-17 present model parameters used for estimating BMP pollutant effluent concentrations. Pollutant removal is only simulated for those pollutants which have available data in the IBMPDB. In instances where data is not available for a parameter, no treatment is assumed for that parameter. This does not prevent the model from calculating load reductions of the pollutant as a result of hydrologic source control.

5) BMP Performance – BMPs are not a Source of Pollutants: In instances when the randomly determined BMP effluent concentration exceeds the modeled influent concentration, no pollutant removal occurs and the model assumes that the effluent concentration is equal to the influent concentration. This prevents BMPs from acting as a source of pollutants in the water quality model. The commitment to regular and effective maintenance of the stormwater BMPs provides support for this assumption.

Conclusions: The above assumptions are expected to improve the accuracy of the water quality model estimates. The net result for the model outputs are somewhat conservative estimates of pollutant loads and concentrations.

B.4. Model Reliability

Factors that affect model reliability include inherent variability in environmental conditions, and model error. To account for environmental variability, a statistical modeling approach was used that takes into account the observed variability in precipitation from storm to storm and from year to year. The model also takes into account the observed variability in water quality from storm to storm, and for different types of land uses. One way to express this variability is the coefficient of variation (COV), which is the ratio of the standard deviation of the variable to the mean value. Based on the statistical model, the range of COVs for pollutant loads was from 0.5 to 1.4 on an average annual basis for proposed conditions, and 0.5 to 3.8 for existing conditions, depending on the pollutant. This variability, or greater, is expected in typical storm water runoff, thus the model can be considered statistically sound on this basis.

Model error relates to the ability of the model to properly simulate the processes that affect storm water runoff, concentrations, and loads. Ideally model error is measured through calibration, but calibration is not feasible when considering a future condition. We are confident that the model is a reasonable reflection of storm water processes because the model relies largely on measured regional data. For example, the runoff water quality data are obtained from a comprehensive monitoring program conducted by LA County that has measured runoff concentrations from a variety of land use catchments and for a statistically reliable number of storm events. In addition, parameter estimation is fairly conservative resulting in moderately conservative estimates of pollutant concentrations and loads.

B.5. <u>References</u>

ASCE/EPA (American Society of Civil Engineers Urban Water Resources Research Council and United States Environmental Protection Agency) 2003, International Stormwater Best Management Practices Database (www.bmpdatabase.org).

Casey, R. and Klaine, S., 2001. "Nutrient Attenuation by a Riparian Wetland During Natural and Artificial Runoff Events," *Journal of Environmental Quality*, 30:1720-1731.

Devore, J.L. (1995). *Probability and Statistics for Engineering and the Sciences. Fourth Ed.* Brooks/Cole Publishing Co., Pacific Grove, CA.

Engineering Staff. 1986. Urban Hydrology for Small Watersheds, Technical Release 55. USDA-NRCS, Engineering Division. U.S. Gov. Print. Office, Washington, DC. Part 630, Section 4, Chapter 7.

Federal Highway Administration (FHWA), 1990. "Pollutant Loadings and Impacts from Stormwater Runoff, Volume III: Analytical Investigations and Research Report," Prepared by Woodward-Clyde Consultants: E.D. Driscoll, P.E. Shelley, and E.W. Strecker. FHWA-RD-88-008.

Helsel, D.R. and T. A. Cohn 1988. "Estimation of descriptive statistics for multiply censored water quality data." *Wat. Resour. Res.* 24, 1997-2004.

Helsel, D.R. and Hirsch, R.M. (2002). *Statistical Methods in Water Resources*. U.S. Geological Survey, Techniques of Water-Resources Investigations Book 4, Chapter A3. Water Resources Division, USGS. Reston, VA

Hirsch, R.M., and J. R. Stedinger 1987. "Plotting positions for historical floods and their precision," *Wat. Resour. Res.*, 23(4), 715-727

James, W. and R. C. James 2000. Hydrology: A Guide to the Rain, Temperature and Runoff Modules of the USEPA SWMM4. Computational Hydraulics International, Ontario, Canada.

Los Angeles County (LA County), 1991. Los Angeles County Hydrology Manual, Department of Public Works, Alhambra, California, December

Los Angeles County (LA County), 2000. Los Angeles County 1994-2000 Integrated Receiving Water Impacts Report.

Los Angeles County (LA County), 2001. Los Angeles County 2000-2001 Stormwater Monitoring Report.

Maidment, D.R. (ed.), Handbook of Hydrology. McGraw-Hill Inc., New York, NY (1993).

Royston, P. 1992. "Approximating the Shapiro-Wilk W test for Non-Normality." *Statistics and Computing*; 2:117-119.

Schueler, T., 1987. “Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs,” Publication No. 87703, Metropolitan Washington Council of Governments, Washington, DC.

Schueler, T. 1996. Irreducible Pollutant Concentrations Discharged from Urban BMPs. *Watershed Protection Techniques*, 1(3): 100-111. *Watershed Protection Techniques* 2(2): 361-363.

Shumway, R.H., Azari, R.S., and Kayhanian, M. 2002. "Statistical approaches to estimating mean water quality concentrations with detection limits." *Environ. Sci. Technol*. 36, 3345-3353.

Singh, A.K., A. Singh, and M. Engelhardt 1997. "The lognormal distribution in environmental applications." *EPA Technology Support Center Issue*, EPA 600-R-97-006.

Strecker, E., Quigley, M., Urbonas, B., Jones, J., and Clary, J., 2001. “Determining Urban Stormwater BMP Effectiveness,” *Journal of Water Resources Planning and Management* May/June 2001.

Strecker, E.W., Quigley, M.M., Urbonas, B. and J. Jones., 2004. Analyses of the Expanded EPA/ASCE International BMP Database and Potential Implications for BMP Design, In Proceedings of the World Water and Environmental Resources Congress, Salt Lake City, Utah, American Society of Civil Engineers.

United States Environmental Protection Agency (USEPA), 1989. Analysis of Storm Event Characteristics for Selected Rainfall Gauges throughout the United States, Prepared by Woodward-Clyde Consultants: E.D. Driscoll, G.E. Palhegyi, E.W. Strecker, and P.E. Shelley.

Water Environment Federation (WEF), 1998. WEF Manual of Practice No. 23/ASCE Manual of Practice No. 87, Urban Runoff Quality Management.

APPENDIX C
Effect of Urbanization on Groundwater Recharge in 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

---

[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.

APPENDIX D

Assessment of Potential Impacts Resulting from Cumulative Hydromodification Effects, Selected Reaches of the Santa Clara River, Los Angeles County, California

Assessment of potential impacts resulting from cumulative hydromodification effects, selected reaches of the Santa Clara River, Los Angeles County, California

Report prepared for:

GeoSyntec Consultants

Prepared by:

Scott Brown

Barry Hecht

Balance Hydrologics, Inc.

October 2005

A report prepared for:

GeoSyntec Consultants
55 SW Yamhill Street
Suite 200
Portland, OR 97204
(503) 242-1416
Attn: Lisa Austin

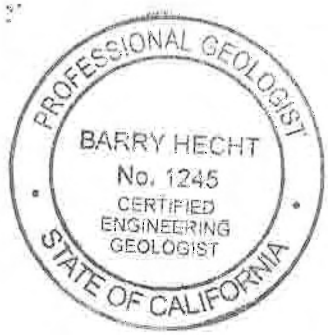
Assessment of potential impacts resulting from cumulative hydromodification effects, selected reaches of the Santa Clara River, Los Angeles County, California

Balance Project Assignment 205018

by

Scott Brown
Hydrologist, Geomorphologist

Barry Hecht, CEG 1245, CHg 50
Principal



841 Folger Avenue
Berkeley, California 94710-2800
(510) 704-1000
sbrown@balancehydro.com
bhecht@balancehydro.com

October 27, 2005

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

1. INTRODUCTION

1.1 Background and purpose

The Newhall Ranch Specific Plan projects will urbanize a portion of the Santa Clarita Valley in Los Angeles County during the coming decades. The project is an extension of prior community growth, which commenced in earnest during the 1960s, in accordance with the adopted General Plan and adopted growth projections. Concern has been expressed that future urbanization may result in changes in the Santa Clara River, a stream of regional scale draining westward from northern Los Angeles County through Ventura County, flowing into the Pacific Ocean near Oxnard. Prior analysis by Geosyntec Consultants (2005) indicates that cumulative future urbanization in the upper watershed of the Santa Clara River, of which Newhall ranch will contribute a portion, will reach approximately 9 percent at "built-out" conditions. A survey of the literature (reviewed in GeoSyntec, 2002) shows that many western-state streams begin to exhibit effects when impervious areas exceed a threshold of about 10 percent, with some considerable site-by-site variability. Additional studies by GeoSyntec in the San Francisco Bay area (2004) and a recent Southern California regional study (Coleman and others, 2005) indicate that, for watersheds smaller than about 25 square miles, channels in granular, non-cohesive sediments may become unstable downstream from urbanizing areas when impervious coverage reaches as little as 2 to 3 percent.

This report uses an empirical approach to assess the potential effects of urbanization on channel morphology associated with the implementation of the Newhall Ranch Specific Plan, combined with other existing and future development in the upper watershed of the Santa Clara River as described in the adopted General Plan. We use historical changes in the Santa Clara River channel pattern to help bracket potential morphological effects on the river of hydromodification due to accumulated urban development. We note that historical changes (both natural and human-induced) in the three factors most likely to affect the Santa Clara River stability (magnitude and frequency of stormflow events, sediment supply and caliber, and channel vegetation) are very large relative to the effects, if any, of the Newhall Ranch project and other planned future urban development. We hypothesize that it will prove useful to learn from history, and to assess the nature and general degree of change that may result from future urbanization by applying these insights.

Much of what is learned from this analysis may be applicable in other aspects of planning and managing the Santa Clara River in the Newhall Ranch reach and reaches downstream. It is not, however, an immediate objective of this report to develop management plans, to assess potential changes in tributary channels, or to explore how habitat conditions might be changed by potential hydromodification, beyond that which is related to the physical channel form and dynamics.

1.2 Technical approach

The history of the Santa Clara River in the Santa Clarita Valley and eastern Ventura County allows us to explore the three factors most likely to affect the stability and morphology of the river downstream from existing and future development in the Santa Clarita Valley (including Newhall Ranch):

- High streamflows, including increased peak flows, volumes, and/or durations of stormflows,
- Coarse-sediment supply, including sharp curtailment of sediment entering the river following completion of Castaic (1974) and Santa Felicia-Piru (1958) Dams.
- Mature riparian vegetation, with interpenetrating roots, which can stabilize the banks and maintain the channel pattern.

We consider the 'pre-urban' condition to be the form and functions of the river during the 1950s and 1960s, prior to significant urban growth and modification of the flow and sediment regimes due to the construction of the Castaic and Santa Felicia-Piru Dams. Historic deviations from the pre-urban condition can be evaluated using the geomorphic evidence left by a period of floods and high flows from 1938 to about 1945. The effects of sediment supply can be evaluated by quantifying effects of eliminating coarse-sediment delivery from Castaic Creek (with a drainage area of 155 square miles, approximately 25 percent of the Santa Clara watershed at the L.A./Ventura County line. Supporting evidence can also be obtained similarly at Piru Creek (approximately 40 percent of the watershed at its confluence with the Santa Clara River at Piru).

1.3 Report organization

The analysis begins with an overview of the factors affecting the form and geomorphic history of the Santa Clara River (Chapter 2). The larger events and fluctuations, and manner in which they may have affected the river, are considered in Chapter 3. The fourth chapter explains the source materials and methods used to quantify the river's response to these perturbations, which are summarized in Chapter 5. Chapter 6 is a discussion of what we have learned from this study, and Chapter 7 draws conclusions as to how these findings relate to potential hydromodification effects in response to anticipated future watershed urbanization.

2. GEOMORPHIC SETTING

2.1 Channel pattern influences

Several previous reports have described the overall and geomorphic histories of the Santa Clara River (c.f., Schwarzberg and Moore, 1995; SCREMP 2005). In each case, authors have noted that the forms and functions of the river have varied with climatic cycles and with episodes such as floods and fires. It is this variability that is characteristic of the river. In the this report, we utilize the study of historic influences of some of the more pronounced events and cycles to better understand the impacts of drainage changes, if any, that can be expected to result from the anticipated future development in the Santa Clarita Valley, including Newhall Ranch.

2.1.1 Physiography

The Santa Clara River flows through a complex, tectonically-active trough generally bounded by reverse faults on the San Cayetano Mountain and South Mountain fronts. Some of the most rapid rates of geologically-current uplift in the world are reported from the Ventura anticline and San Gabriel Mountains, just to the northwest and southeast, respectively, of the river. Slopes are very steep, with local relief of 3000 to 4000 feet being common. These faults bring harder, more resistant sedimentary rocks over softer and younger sedimentary formations, but all formations are fundamentally soft and erodible. On either side of the faults, sandstone (generally multi-cyclic and fine-grained) and mudstones prevail. The northeastern and southeastern corners of the watershed are underlain by deeply-weathered granitic and schistose rocks, which produce sands that are coarser than those of other rock units when they weather and erode. The San Gabriel fault crosses the valley near the county line, bringing slightly more resistant rock to the surface and creating a local base level reflected as a slight rise or 'bump' on the river's longitudinal profile.

Most geologic materials in the watershed decompose mainly to silts and clays and to sand, with some coarser materials. Rhea Williams and his colleagues at the U. S. Geological Survey found that most sediment moved by the Santa Clara River and its main tributaries are quite fine, with less than 5 percent bedload-sized material (>0.25 mm, or about 0.01 inches in diameter). Some gravels and cobbles do occur within the beds of the streams and in their alluvium. Nonetheless, both the bed and the sediment transported by the river tend to be finer than in most Southern California watersheds (c.f., Knudsen and others, 1992).

The Santa Clara River watershed drains a watershed of 1,600 square miles, of which 625 square miles are within Los Angeles County, upstream of the "county-line gage" (USGS No. 11108500), near the western edge of the Newhall Ranch Specific Plan area.

2.1.2 Climate

Much of the watershed upstream of the Newhall Ranch Specific Plan area receives rainfall averaging about 18 to 25 inches per year (NOAA). As throughout Southern California, rainfall in the Santa Clara watershed alternates between wet and dry periods, a variation that is central to understanding the cultural and geomorphic histories of the upper watershed (Schwarzberg and Moore, 1995; Lynch, 1931; Reichard, 1981). Wet cycles tend to persist for several years, sometimes for periods of 6 or 8 years, during which rainfall, although variable, may average about 140 to 150 percent of the long-term average. For the woody riparian vegetation along the banks and on islands in the braided channels, these are crucial periods for establishment and growth. During dry cycles, the roots of the riparian vegetation must grow downward to the water table or perched zones, and where it cannot do so, this band of vegetation will die back.

2.1.3 Flows

Flows in the Santa Clara River, as in most southern California streams, are highly episodic. For the gaged period between 1953 and 1996 annual flow at the Los Angeles/Ventura County line gage ranged between 253,000 acre-feet (1969) and 561 acre-feet (1961). In general, however, streamflow, and especially dry-season streamflow, has increased over the past few decades primarily due to discharges from two wastewater treatment plants. Mean annual flow at the County Line increased from 25,700 acre-feet in 1972 (averaged over a 20-year record) to 35,360 acre-feet in 1988 (36-year record), with a significant decrease in the number of very low years over that period (UWCD and CLWA, 1996). Downstream of the County line, however, the Santa Clara River flows through the Piru groundwater basin, which represents a "Dry Gap" where dry-season streamflow is lost to groundwater.

Annual peak flows at the County line between 1953 and 1996 ranged from 68,800 cfs (1969) to 109 cfs (1960). Of note is that the second highest annual peak, 32,000 cfs in 1966, was less than half of the highest peak (68,800 in 1969). Both of these events occurred in the late pre-urban to early-urbanization stages within the Santa Clarita Basin and no consistent increase in peak flow is evidence since this time. Flow data for the 2005 flood event are not yet available, however the peak flow at the County line may have approached the flow observed in 1969. As discussed below these large episodic events have a significant impact on the geomorphic characteristics of the Santa Clara River mainstem.

2.1.4 Ground-water supported riparian vegetation

The Santa Clara River is underlain by several distinct alluvial ground-water basins—the Piru, Fillmore, and Santa Paula Basins (Reichard and others, 1999; SCREMP 2005). These basins are divided longitudinally by sills or ridges of bedrock that support areas of locally-high ground water, including the area upstream from the County line (above the Piru Basin), and upstream from the mouth Sespe Creek (the transition between the Piru and Fillmore Basins). This locally-high ground water sustains summer baseflow and riparian vegetation within the Santa Clara River corridor even through relatively dry climatic cycles.

3. PERTURBATIONS

This section describes several major perturbations (those with the potential to affect channel- and floodplain-form) that occurred in the Santa Clara River watershed since the early 1900s (summarized in Figure 1). Aerial photographs were selected to bracket these events and analyzed, both qualitatively and quantitatively, to try to discern and quantify responses of the Santa Clara River channel to:

(1) changes in flow regime during wet and dry multi-year cycles,

(2) sediment supply, notably describing the channel's adjustments to construction of large dams, and

(3) development of mature riparian vegetation with interpenetrating roots.

3.1 Streamflow cycles and events

As described above, streamflow within the Santa Clara watershed is highly episodic, and can vary drastically from year to year. However, decade-scale patterns of wet and dry periods have been identified in the historic record—as early as the 1700s. Previous wet periods (with associated high flows) are reported from 1810 to 1817, 1831 to 1840, 1883 and 1893, and 1903 to 1916, during each of which periods the area received a total of an additional 60 to 80 inches above the mean annual rainfall over the duration of the wet cycle. Prolonged static or drying periods similar to that observed between 1945 and 1977 also occurred from 1780 to 1810, 1842 to 1882, and 1919 to 1935 (with associated reductions in streamflow). The river is likely to have remained most stable during the latter periods, with the notable exceptions of a few major storms of record, such as 1862 (c.f., Lynch, 1931; Reichard, 1981; Schwartzberg and Moore, 1995). The primary wet periods in this study occurred between 1938 and 1946, and 1978 to 1983 (Figures 1 and 2). Other large storm events occurred in 1966, 1969, 1972, 1983, 1998, and 2005. Notable dry periods occurred between 1946 and the late 1960s, and 1983 and 1991.

3.2 Dam construction

Castaic Dam was completed on Castaic Creek (a tributary of the Santa Clara River just upstream of the Newhall project) in 1974. The watershed area above the dam is approximately one-quarter of the watershed area of the Santa Clara River at the L.A./Ventura County line, downstream of the Castaic confluence, and therefore the dam effectively reduced the sediment contributing area by about 25 percent. For comparison purposes, we also considered the effects of the construction of the Santa Felicia Dam (Lake Piru), which resulted in an approximate 38 percent decrease in sediment contribution area below the confluence of Piru Creek and the Santa Clara River[1].

3.3 Urbanization

Settlement of the Los Angeles County portion of the watershed transitioned from rural to mixed-use suburban during the mid- to late-1960s. This change initiated a period of ongoing urban expansion, with associated increases in the area of impervious or compacted surfaces as homes, commercial and industrial centers, highways and diverse infrastructure have developed throughout the Santa Clarita Valley. Future General Plan urbanization within the upper watershed, inclusive of Newhall Ranch, will bring the percent of urban area west of the County line to about nine percent (GeoSyntec, 2005).

3.4 Treated effluent discharge

Since the 1960's, treated effluent from two water reclamation plants (Saugas and Valencia) has been released directly to the Santa Clara River. This, combined with an increase in applied, imported agricultural water, has led to increased summer baseflows in the Santa Clara River at the County line, which had only rarely occurred under pre-urban conditions. This led to an increase in available water to support woody riparian vegetation. The increase in baseflow is evident in the USGS gaging record at the county line (Figure 2). In some stream corridors, vegetation growth in response to increased baseflow can provide additional bank cohesiveness and reduce erosion; though in others heavy in-channel vegetation growth (riparian encroachment) can serve to destabilize the stream and induce lateral erosion by directing flows toward the banks.

Newhall Ranch has proposed an additional plant that would ultimately treat approximately 5.8 million gallons per day at project build-out. However discharge from the plant in the summer is not expected, as this water will be re-used for irrigation purposes, and we therefore do not expect further change in riparian vegetation growth as a result.

3.5 Saint Francis Dam Breach

On March 12, 1928 the Saint Francis Dam, located in San Francisquito Canyon upstream of the Newhall project, failed and released approximately 30,000 acre-feet of water over the course of a few hours, with an estimated peak discharge of up to 800,000 cubic feet per second (Newhall,

[1] Drainage area calculations were based on USGS gaging station watershed data at Piru and Castaic Dams, and gages on the Santa Clara River at the L.A./Ventura County line and near Piru.

1928; and SCREMP, 2005). This event had drastic effects on the stream reaches downstream, as the resulting flows were much higher than anticipated from any natural event. Aerial photograph coverage during this time period is limited, however, and therefore an assessment of this event was not feasible. In addition, because of the extreme size of the event, it is unlikely that an assessment would be beneficial for assessing hydromodification impacts.

4. METHODS

We analyzed aerial photographs from 1927, 1947, 1957, 1966/67, 1989, 2002, and 2005 to describe channel change in response to the major episodes described above. The main criteria described were the width of the active braiding area (or meander belt width if there was no braiding), bank vegetation, number of channels, and width of the active channel. Also described, where they could be identified, were the width and length of "islands" (vegetated mid-channel bars) within the stream. Islands were typically easier to identify where vegetation was heavy, as the color of the vegetation highlighted the differences between channel and meta-stable islands.

The aerial photographs were analyzed in two different ways. First, a qualitative comparison of the alluvial corridor shown in the different years' photos was made, describing general differences in channel pattern and vegetation on a reach-wide scale. Second, specific cross sections were defined and the above parameters measured for each year with photo coverage in that area to provide a quantitative comparison of channel change at these standard locations along the Santa Clara River (Figure 3).

4.1 Descriptions of analysis criteria

4.1.1 Width of active braiding corridor

For braided reaches, the active channel width was identified primarily by noting the extent of active channels or recent sediment deposition. In many cases the active corridor was bounded by a significant change in vegetation or sediment deposition characteristics.

4.1.2 Relict channel corridor

The relict channel corridor is the portion of the flood plain that does not appear to have been active in the recent past (within the last 5 years or so). Typically the relict corridor is identified by areas of heavy or scattered vegetation containing no or few distinct channels, or areas that do not appear to have experienced recent sediment deposition. Alternatively, identification was based on the width between farmed fields[2]. Measurements of this feature were made from outside bank to outside bank, and include the active corridor.

[2] The total width of the former channel migration corridor is difficult to identify in aerial photographs due to past and present agricultural field reclamation following major perturbations. Where necessary, we used the width between agricultural fields as a estimate of the relict corridor.

4.1.3 Channel width

Where a distinct channel or channels could be identified, the widths of the individual channels were measured. The number of individual channel threads was also recorded, where threads could be distinguished. In some cases, measurement of these features was complicated by poor photo resolution or contrast, and difficulty in distinguishing major channels from minor ones (where a full spectrum was present).

4.1.4 Vegetation

Vegetation was described qualitatively as bare, scattered, moderate, and heavy. The location of specific areas of vegetation, such as vegetated islands, vegetation within the relict corridor, or vegetation along banks, was also described. Where the resolution was adequate, the growth form of vegetation, or state of maturity, was also described (trees or shrubs).

4.1.5 Number of vegetated islands

The number of distinct vegetated islands (mid-channel bars) was also recorded at each cross-section, where the resolution of the photographs was adequate. Where islands could be identified, measurements of width and length were recorded.

5. RESULTS

5.1 Qualitative descriptions

Initial inspection of the series of aerial photographs showed that significant changes in channel planform have occurred throughout the 1900s, as would be expected in a large, braided stream in southern California. Vegetation within the relict corridor (see definition above) near the Newhall Ranch planning area appears to become progressively heavier through time, likely due to the increase in agricultural water and discharge of treated effluent to the channel through the summer months.

The photos show many areas of net deposition, and corresponding channel shifts in major depositional areas. Single-thread, dominant channel segments are rarely present, especially in years following large events. Even when there is one main channel, secondary channels are often present within the active channel corridor.

Portions of the stream have been altered for flood control purposes, including stabilization of banks bounded by orchards and fields, or construction of levees within the active corridor. These levees are most prominent in the 1989 photographs (upstream of the L.A./Ventura County line), where the substantial segments of the main channel are confined in a flood control channel approximately 225 feet wide. By 2002, however, little evidence can be discerned in the aerial photographs of these levees.

The 2005 flood events caused significant changes within the Santa Clara River. Vegetation within the channel was almost all completely washed out (compared to 2002 conditions), and many areas of significant bank-widening were identified, even in areas of heavy bank vegetation (Figure 4).

There appears to be little change in agricultural constriction of the Santa Clara River over the span of photographs reviewed. Through the Newhall reach, the agricultural areas appear to be well buffered by the relict channel and the vegetation supported there. There were only a few places identified where the active channel cut into agricultural areas rather than staying within the relict corridor. In contrast, within the Piru Basin (downstream of the Newhall reach), significant agricultural constriction and subsequent channel widening occurred over the time span of the photos reviewed.

Areas of shallow ground water between Piru and Sespe Canyon[3], which support denser riparian vegetation than typical for the river between Valencia and Fillmore, show little if any significant change for all years in the studied photo-sets. Both the density and extent of vegetation in these areas does not appear to change over time (despite significant differences in climate and other watershed factors) nor does the amount of vegetation appear to significantly affect channel planform, compared to upstream and downstream reaches (the braided channel does not shift to a single-threaded channel through the wetted reach).

5.2 Quantitative results

For the quantitative portion of the aerial photograph analysis we looked at four different types of criteria to identify physical changes to the Santa Clara River channel (Table 1; see also section 4.1.1 for descriptions of criteria). Because of difficulties in identifying and measuring the width/number of channels and number/dimensions of vegetated islands, because of the varying resolutions and contrasts of the photographs, we concluded that analysis of these two criteria were less meaningful for this study. In other words, there was more variation due to the ability to identify the features for the varying quality of the photos than there was actual variation in the system. While we believe that these criteria may be a valid indicator of channel change, more study would be needed to adequately quantify these features so they were used a supplementary qualitative metric.

For this study we found that measurement of the "active corridor" (see section 4.1.1) was the most useful and easiest to work with to identify channel changes. In most cases there is enough vegetation along the banks that the active braiding corridor is easily identified, and changes in the width of the corridor can be tracked from year-to-year.

Figure 5 summarizes the changes in active corridor width over the time span of the reviewed photos. Within the Newhall reach, the width of the "active corridor" at the four measured cross-sections varies from year-to-year by as much as 500 feet, though most of the variation is considerably less. One station, in the narrows above the Piru Basin, has a very consistent channel width, varying by less than about 50 feet from year to year.

To provide additional analysis, we looked at a series of recent photos (1994, 2000, and 2002-2005) at one cross section downstream of the Castaic confluence. For this photo set, the channel widened significantly between 1994 and 2000 (probably in response to the 1995 or 1998 large

[3] See Reichard and others (1999) for a discussion of the hydrogeology of these shallow ground water areas; although downstream from the Los Angeles County line, results are applicable to the upstream as well, as discussed later in this report.

storms), but showed almost no change between 2000 and 2004 (Figure 6). The channel then widened considerably again in response to the high-flow events in 2005.

As a secondary check of the numbers derived for the measured standardized cross sections, we also measured active channel widths at approximately twenty different locations through the Newhall Reach on three different photo sets—1967, 2004, and 2005. From these measurements an average active braiding corridor width was calculated and compared with the other years. In 1967, the average channel width was approximately 580 feet, which was significantly wider than the average width in 2002 (392 feet). However, after the 2005 storms, the active width was approximately 560 feet, similar to the 1967 conditions.

The "relict corridor" (see section 4.1.2 for definition) also proved useful as a secondary criterion, providing a measurement of potential changes due to agricultural encroachment or constriction of the flood corridor. Measurement of the "relict corridor" at the standard cross sections showed that while there was some variation between photos, there is no consistent trend of agricultural constriction to the Santa Clara River flood corridor. These measurements, along with qualitative observations that within the Newhall reach agricultural activities were generally restricted to outside the active corridor, suggest that agricultural encroachment has not historically affected the geomorphology of the Santa Clara River within the Newhall Reach.

6. DISCUSSION

The Santa Clara River is a dynamic, episodic system. The above analyses highlight the magnitude of geomorphic change over the course of recent history, in response to natural and human disturbances in the watershed. Understanding the magnitude of past response is a key factor in assessing the potential response to future urbanization within the watershed.

The construction of Castaic Dam in 1974, regulating approximately 25 percent of the watershed at the L.A./Ventura County line, cut off a significant supply of sediment to the Santa Clara River. This change, however, does not appear to have had an effect on the channel dimensions of the Santa Clara River mainstem. The width of the active corridor, as well as the general form of the channel, are generally consistent both before and after construction of the dam. It appears that the Santa Clara River adjusted without morphological expression to absorb this change. One factor contributing to the lack of change is the seemingly large volume of sediment stored in the tectonic basin above the county line—a result of bedrock control associated with movement along the San Gabriel fault, which supports the large extent of semi-consolidated and alluvial deposits adjoining the drainage net.

The amount of vegetation within the Santa Clara River corridor appears to have increased since the 1960s, likely due to the increased summer return flows from agricultural water and to year-round augmentation of baseflows due to treated effluent discharge to the river. However, this vegetation does not seem to provide enough erosion resistance to maintain a "stable" channel capable of withstanding regular 're-sets', which occur at intervals averaging about a decade – or much less than the expected lifetime of the riparian woodlands which do get established. Despite heavy vegetation on the active channel banks near Newhall ranch and in areas of shallow ground-water, the stream still responds to large events by a general widening and/or shift of the channel. The role of vegetation in large-channel stability and morphology in Southern and Central California does fundamentally differ from that of smaller streams and streams elsewhere in the country. The geomorophic and historical record shows that resets have been occurring throughout the recent geologic past in basins exceeding a certain size. One partial explanation may be that 're-set' flood events in these larger channels exert stresses beneath or around the riparian vegetation exceeding the vegetation's threshold of stability[4].

[4] Sedimentologists note that crossbeds in the alluvium of the Santa Clara River are often 8 to 12 feet high, equal or greater than the depth to which roots can interpenetrate in most riparian settings in the region.

As stated above, the Santa Clara River, as with many streams in semi-arid southern California, is highly episodic. Concepts of "normal" or "average" sediment-supply and flow conditions have limited value in this "flashy" environment where episodic storm and wildfire events have enormous influence on sediment and stormflow conditions. Many of these channels are actively adjusting to lower flows than the last major event, which may have occurred some years before[5] (Hecht, 1993). In these streams, a large portion of the sediment movement events can occur in a matter of hours or days. In many of these channels most sediment is moved—and most bed changes occur—during the large flow events resulting from storms that may be expected approximately every 5 to 15 years (c.f., Capelli and Keller, 1993; Hecht,1993; Inman and Jenkins, 1999; Knudsen and others, 1992; Kroll and Porterfield, 1969).

Evidence of episodic channel changes can be seen in the Newhall reach of the Santa Clara River. Based on aerial-photograph interpretation of a near-yearly sequence of aerial photographs from within the last decade, the channel appears to maintain a consistent planform during average or dry rainfall years (such as between 2000 and 2004). Large events, however, (such as that which occurred in February 1998 and January 2005) can significantly modify this channel form. This widened and/or shifted channel (like that which was present after the 1998 or 2005 stormflow events) then sets the geomorphic template for subsequent normal to dry years. This model, similar to that described for the Ventura River by Capelli and Keller (1993), suggests that the geomorphology of the Santa Clara River is primarily driven by these large events.

Other perturbations which potentially affect channel geometry appear to have transitory or minor manifestations. For example, effects on the channel width due to 1980s levee construction are barely discernible by the first few years of the 21st century, probably mostly due to morphologic compensation associated with the mid- to late-1990s storm events.

[5] Actively adjusting channels may be aggrading, incising, expanding or otherwise changing channel dimensions, depending on the magnitude, type, and various effects of the episodic event.

7. CONCLUSIONS

Based on the study of historic aerial photographs described above we conclude that:

- Major perturbations within the Santa Clara River watershed (dam construction, levee construction, changes in flows in response to decadal-scale climatic patterns, and increases in woody vegetation) do not appear to have had a significant impact on the geomorphic expression of the Santa Clara River, as quantified from measurements made from a series of historical aerial photographs flown during the years 1927 through 2005.

- Large events (those which are typically not as affected by increases in impervious area and associated increases in stormwater peaks and runoff volume) can completely alter the form of the Santa Clara River channel. We call these events "re-set" events. These events, perhaps occurring on average once every ten years, are a dominant force in defining channel characteristics.

- The geomorphic dominance of "re-set" events overwhelms geomorphic effects of hydromodification on smaller events. Due to these episodic "re-sets" we do not expect hydromodification feedback "unraveling" of the Santa Clara River mainstem, as is seen in many smaller southern California watersheds[6]. The "re-set" events appear to adequately buffer changes that may occur in short-term sediment transport.

- While there is no expected increase in summer flows due to additional treated effluent discharge to the Santa Clara River, even if summer baseflow do increase we would not expect a significant change within the channel. Additional growth in the extent or density of vegetation is not anticipated, as the reach near Newhall already appears to have enough flow to support summer vegetation, and the existing vegetation does not appear to affect channel form for durations longer than the "re-set" interval. Further, re-sets occur at intervals significantly shorter than the period required for maturation of riparian vegetation, such that full development of bank-holding properties is frequently interrupted.

- Given that the channel morphology of the Santa Clara River mainstem has not adjusted significantly to much larger perturbations in flow, sediment yield, and riparian

[6] In many smaller streams, hydromodification of moderate events can induce incision of the stream bed, which reduces the connection of the stream to the floodplain. This disconnect, in turn, increases the erosive forces of the flows (concentrating more flow in the channel) and causing further erosion, and thus a positive feedback response.

vegetation growth factors, within the Newhall reach, we do not expect a significant geomorphic impact to the Santa Clara River mainstem due to the anticipated increase in 'urban area' from four to nine percent.

8. LIMITATIONS

The analyses in this report were designed to help bracket the range of likely effects on the geomorphology of the Santa Clara River due to proposed urban expansion under the General Plan, inclusive of the Newhall Ranch Specific Plan projects. It does not consider specific elements of the project or of evolving mitigation measures; rather, it focuses upon the susceptibility to perturbation of the Santa Clara River corridor as a whole. We believe that it conforms with the standard of care applicable to reconnaissance studies of this nature; no other warranty, expressed or implied, is made.

The above analyses and discussion were intended to assess the potential cumulative impacts to the Santa Clara River *mainstem* (not tributaries) due to the anticipated urban expansion in the watershed. While we conclude that urban expansion from approximately four- to nine-percent urbanized (not 'impervious') will not significantly affect the channel geomorphology of the Santa Clara River, we do expect that there might be a response to urbanization on a larger scale. However, further study would be required to define what the likely threshold and magnitude of response might be.

We ask readers to note that this is a reconnaissance report. It is intended to bracket likely future conditions, to identify factors which must be better known, and to help guide initial planning. This report should *not* be used to site or design individual facilities without further site-specific investigations. Similarly, it is *not* intended to serve as basis for flood management or detailed floodplain planning, both of which should be conducted by well-defined and site-specific procedures, and which frequently require multiple lines of evidence.

The application of geomorphic history to inferring future channel and corridor change has a long and respected record in the earth sciences. As with all history or archival analysis, the better the record is known and understood, the more relevant and predictive the analysis can be. We do encourage readers who have knowledge of other events or processes which may have affected the river to let the authors know at the first available opportunity. The authors and their contacts via several different media are given on the signature page of this report.

9. REFERENCES

AMEC Earth and Environmental, 2005, Santa Clara River Enhancement and Management Plan (SCREMP May 2005): Consulting report prepared for the Ventura County Watershed Protection District , the Los Angeles County Department of Public Works Watershed Management Division, and SCREMP Project Steering Committee, 198 p.

Coleman, D., MacRae, C., and Stein, E.D., 2005, Effects of increases in peak flows and imperviousness on the morphology of Southern California streams: Southern California Coastal Water Research Project Technical Report 450. 70 p.

Coulthard, T. J., 2005, Effects of vegetation on braided stream pattern and dynamics, Water Resources Research, 41, W04003, doi:10.1029/2004WR003201.

GeoSyntec Consultants, 2005, Draft Newhall Ranch Specific Plan sub-regional stormwater mitigation plan: Consulting report prepared for Newhall Land, August 2005.

GeoSyntec Consultants, 2004, Appendix C: Technical memoranda: Appendix to the Santa Clara Urban Runoff Pollution Prevention Program (SVURPPP) Hydromodification Management Plan (HMP), six memoranda, multi-paged.

GeoSyntec Consultants, 2002, Hydromodification Management Plan Literature Review: Consulting report prepared for the Santa Clara Valley Urban Runoff Pollution Prevention Program, 80 p.

Glysson, G.D., 1977, Sedimentation in Santa Margarita Lake, San Luis Obispo County, California: U.S. Geological Survey Water-Resources Investigations 77-56, 20 p.

Hecht, B., 1993, South of the spotted owl: Restoration strategies for episodic channels and riparian corridors in central California: in Western Wetlands: Selected proceedings of the 1993 Conference of the Society of Wetland Scientists, Davis, CA: p. 104 -117

Inman, D.L., and Jenkins, S.A., 1999, Climatic change and the episodicity of sediment flux of small California rivers: Journal of Geology, v. 107, p. 251-270

Knudsen, K., Hecht, B., Holmes, D.O, and Flaschka, I., 1992, Hydrologic and geomorphic factors affecting management of the lower Sisquoc River alluvial corridor, Santa Barbara County, California: Consulting report prepared by Balance Hydrologics, Inc. for SP Milling Company, 66 p. + 5 appendices.

Kroll, C.G., and Porterfield, G., 1969, Preliminary determinations of sediment discharge San Juan drainage basin, Orange and Riverside Counties, California: U.S. Geological Survey Open-File Report, 28 p. + 5 plates.

Lynch, H.B., 1931, Rainfall and stream run-off in Southern California since 1769: Metropolitan Water District of Southern California publication, 31 p.

Hoey, T. and Sutherland, A. (1991). Channel morphology and bedload pulses in braided rivers: a laboratory study. Earth Surface Processes and Lanforms, 16:447–462.

Meunier, P., and Metiver, F., 2004, Sediment transport in a micro-scale braided stream: From grain size to reach size: Preprint submitted to Braided Rivers, 2004

Newhall, A.M., and Newhall, G.A., 1928, Report on St. Francis Dam flood. Letter to the Newhall Land and Farming Company, dated March 24, 1928.

Reichard, E.G., 1982, Reconstruction of water availability along the San Luis Rey River in southern California: M.S. thesis, Stanford University, 146 p.

Reichard, E.G., Crawford, S.M., Schipke Paybins, K., Martin, P., Land, M., and Nishikawa, T, 1999, Evaluation of surface-water/ground-water interactions in the Santa Clara River Valley, Ventura County, California: U.S. Geol. Survey Water-Resources Investigations Report 98-4208, 58 p.

Schwartzberg, B.J., and Moore, P.A., 1995, A History of the Santa Clara River: Santa Clara River Enhancement and Management Plan Study report, 79 p., April 1995 (Report stamped 'subcommittee working draft copy not for public dissemination'), 79 p.

SCREMP 2005: See AMEC Earth and Environmental

UWCD and CLWA. 1996. Water Resources Report, April 1996. Prepared by United Water Conservation District and Castaic Lake Water Agency.

Warburton, J. and Davies, T. (1994). Variability of bed load transport and channel morphology in a braided river hydraulic model. Earth Surface Processes and Landforms, 19:403–421.

Wells, W.G., II, 1981, Hydrology of mediterranean-type ecosystems: A summary and synthesis: in Proceedings of the Symposium on Dynamics and Management of Mediterranean-Type Ecosystems, USDA Forest Service, Pacific Southwest Forest and Range Experiment Station General Technical Report PSW-88, p. 426-430

Wohl, E., 2000, Mountain rivers. American Geophysical Union Water Resources Monograph 14, Washington, DC, 320 p.

TABLES

Table 1. Aerial photograph cross section data at selected locations near Newhall Ranch, Los Angeles County, CA. See text for explanation and interpretation of data. Locations of cross section are labeled on Figure 2. Photo sources are listed in Appendix A.

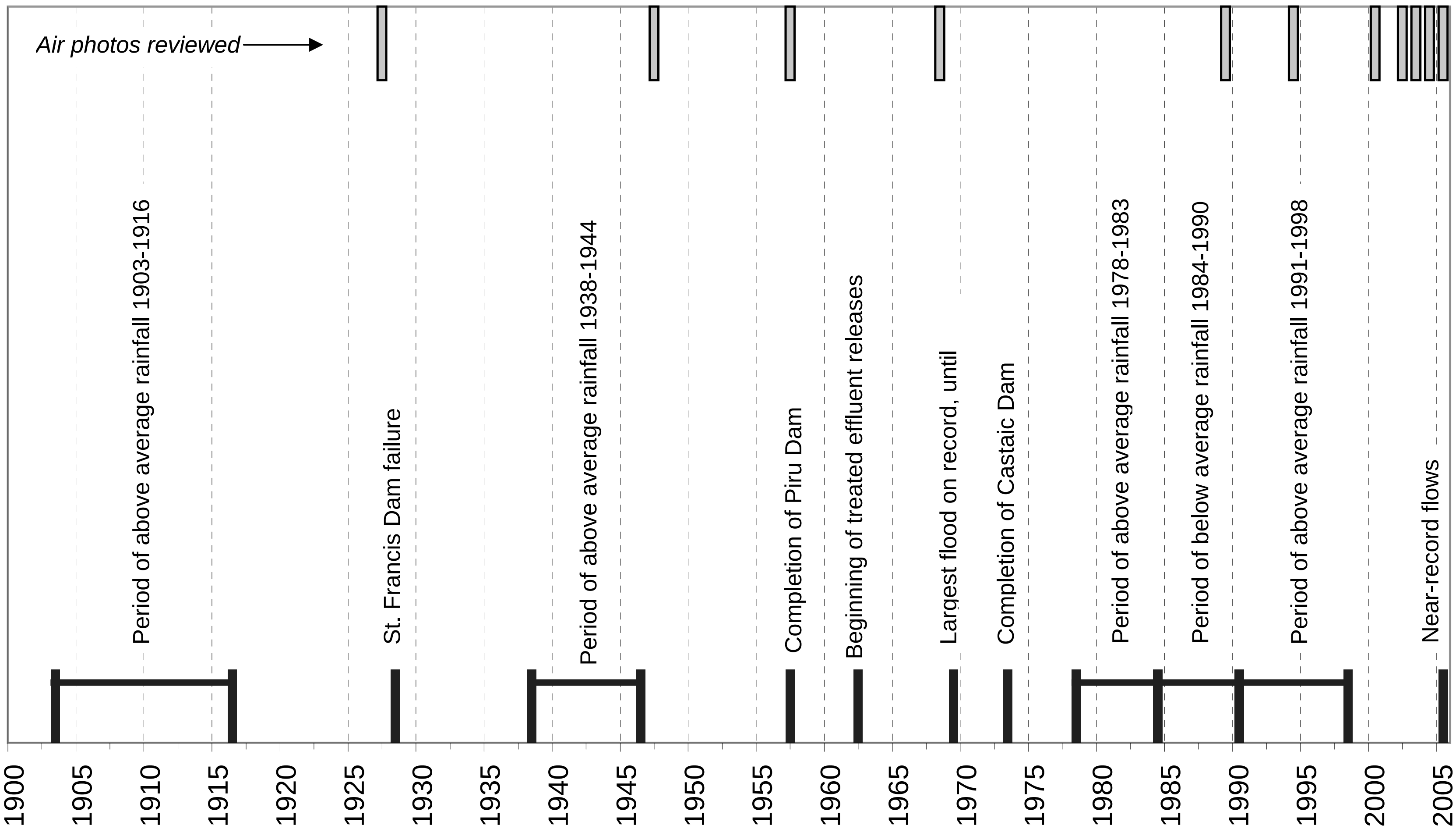
Cross section	location description	photo date	width of active braiding corridor (feet)	width of relict braiding corridor (feet)	is there one primary channel visible?	width of main channel (feet)	number of identifiable channels	total width of channels (including main) (feet)	number of islands	length of islands encountered (feet)	width of islands (feet)	vegetation	other descriptions
X1	downstream of Castaic	8/16/1947	570	1247	yes?	71	3?	107	can't define	n/a	n/a	moderately vegetated with some portions of relict corridor heavily vegetated	Just downstream a heavily vegetated bar is cut by a very distinct secondary channel
		7/20/1966	729	1173	yes	27	1	27	1	497	86	almost no vegetation within primary corridor except two areas near the primary channel and scattered small patches, only scattered vegetation on relict corridor	while there is only one main channel the rest of the primary corridor is section is almost deltaic in planform, spreading out from constriction upstream (possibly high sediment load coming in from Castaic)
		5/26/1989	173	1171	yes, but small	43	1	43	0	n/a	n/a	banks of meander corridor have scattered vegetation (less than 2000) with very little within braiding corridor	meander corridor is very distinct and straight, could be from flood control dredging;
		6/1/1994	337	1167	yes	72	2	97	1	551	171	light to moderate vegetation on braiding corridor banks	very little vegetation within braiding corridor
		2/1/2002	505	984	yes	42	2	50	poorly defined	n/a	n/a	relict braiding corridor is well-vegetated; meander belt/bar is lightly to moderately vegetated; at least one main channel bank is well-vegetated (alternates w/ meanders)	secondary channel essentially cuts off meander
		4/1/2004	505	978	no	n/a	3	87	2	929, 251	248, 56	heavy vegetation along former primary channel; relict corridor also heavily vegetated	there are two distinct channels, approximately the same size
		3/1/2003	510	965	yes	75	1	45	0	n/a	n/a	heavy vegetation on northern bank; some scattered vegetation within active corridor and surrounding low-flow channel	channel branches just downstream of cross section; very similar to 2002 and 2004 photos
		2/1/2005	601	999	no	n/a	3	106	poorly defined	n/a	n/a	no vegetation in main portion of channel; right bank has heavy tree cover, left bank has few trees	the main channel is about 340 feet wide with an obvious overbank deposition area (with very little vegetation)
X2	Upstream of County line	8/16/1947	532	1197	yes	89	2	133	1	355	133	vegetation is heavy (probably trees) on relict corridor; moderate (probably scrub) within active corridor (difficult to distinguish)	very distinguishable difference between active and relict corridor within this reach
		3/6/1963	491	1352	no	n/a	difficult to define	n/a	6	252, 283, 82, 441, 94, 410	44, 57, 52, 76, 38,63	several well-defined islands behind established vegetation (individual shrubs or small trees); relict corridor has moderate to heavy tree cover	very braided planform; switches to predominately single-thread channel just downstream
		5/26/1989	651	651	yes	43	3	108	1	2385	477	relict corridor has scattered trees with moderate to heavy shrub or grass cover; central island (along levee) has similar vegetation	well-defined flood control channel, but has been breached and there is a significant secondary channel to the north of the levees; included a portion of the island between the flood control channel and the secondary channel in the relict channel (no sign of recent deposition)

Cross section	location description	photo date	width of active braiding corridor	width of relict braiding corridor	is there one primary channel visible?	width of main channel	number of identifiable channels	total width of channels (including main)	number of islands	length of islands encountered	width of islands	vegetation	other descriptions
			(feet)	(feet)		(feet)		(feet)		(feet)	(feet)		
		6/1/2002	608	1258	yes	131	1	131	0	n/a	n/a	relict corridor on north bank has heavy tree cover; meander bends are eroding tree bank vegetation in places	stream has meandering planform, though meander belt (400' wide) has high sediment deposition and little vegetation; no evidence of flood control levees (meanders have widened to erode levees); active channel includes meander belt and area of significant recent sediment deposition to the north of the meander belt
		2/1/2005	674	1240	yes	97	3	192	1	475	155	almost no vegetation within active channel; relict corridor on both banks has moderate tree cover; much vegetation eroded away since 2002	numerous very small channels present as well
X3	downstream of county line	8/16/1947	362	805	yes, at this xs	80	2	121	can't define	n/a	n/a	outer banks of braiding corridor seem heavily vegetated	there seems to be one main channel through this reach, with extensive deposition of sediment outside of the channel
		7/20/1966	140	714	yes	51	2	77	0	n/a	n/a	banks of braiding corridor are heavily vegetated	
		5/26/1989	273	864	yes	91	2	114	1	136	23	only scattered vegetation on banks of braiding corridor	braiding corridor looks as though it may be a leveed flood control channel
		2/1/2002	249	1466	yes	41	3	79	2	344, 219	66, 36	scattered vegetation on u/s ends of islands; some recent deposition of sediment within relict braiding corridor (which is predominately heavily vegetated	
		2/1/2005	587	1472	yes	97	3	145	1	543	110	no vegetation in active corridor; right bank has heavy shrub cover with some trees, left bank has light shrub cover	
X4	upstream of Piru Basin	8/16/1947	282	885	yes	121	1	121	can't define	n/a	n/a	little to no vegetation within braiding corridor; relict braiding corridor has heavy tree/shrub cover	
		7/20/1966	281	383	no	n/a	3	26	poorly defined	n/a	n/a		
		5/26/1989	318	591	yes	68	1	68	1	91	23	meander belt banks lined with trees; meander belt itself covered with shrubs	"braiding corridor" is actually the meander belt; meander belt outside of channel is heavily vegetated
		2/1/2002	266	426	yes	35	3	45	1	340	36		secondary channels may be present in other photos, but resolution is poor, esp. 1948
		2/1/2005	281	495	yes	44	1	44	0	n/a	n/a	vegetation on right bank of main channel has diverted some flow over the relict corridor, though conditions are similar in 2002; moderate to heavy trees and shrubs on both banks	conditions are very similar to 2002, but with slightly wider and much clearer channel

Cross section	location description	photo date	width of active braiding corridor (feet)	width of relict braiding corridor (feet)	is there one primary channel visible?	width of main channel (feet)	number of identifiable channels	total width of channels (including main) (feet)	number of islands	length of islands encountered (feet)	width of islands (feet)	vegetation	other descriptions
X5	upstream of Piru confluence	4/1/1927	1834	3191	no	n/a	many	n/a	3	3060, 1170, 468	540, 450, 90	sparse scrub vegetation within active corridor, but enough to define the complex channel pattern; only slightly more vegetation (or possibly just less recent sediment deposition) in relict corridor	relict channel is mainly an artifact of flow deflection by several long levees just upstream; typical braided stream with channels of varying widths and scales (can not define number of channels due to complexity and scale variation of channels); only measured large islands
		8/16/1947	1449	3066	no	n/a	0	n/a	1	1282	279	island appears heavily vegetated; relict channel has moderate vegetation, possibly some farming	active channel is very burnt in; no evidence of levees, but would be difficult to see
		11/10/1966	957	3051	no	n/a	complex channel pattern	n/a	too complex to define	n/a	n/a	no vegetation within active corridor; sparse scrub vegetation within relict corridor, but very patchy (may be due to clearing)	flood control channel is present down middle of active corridor (196' wide); stream has complex braiding pattern, even with flood control channel present
		6/20/1989	1796	2993	no	n/a	complex channel pattern	n/a	too complex to define	n/a	n/a	light scrub vegetation within active corridor; vegetation is obviously stabilizing small islands, at least until the next big event; relict corridor is sparsely vegetated	little evidence of flood control channel but may have been some excavation in middle of active corridor (~300' wide);
		6/1/2002	1730	2452	no	n/a	5	1000	3	1200, 1085, 1520	384, 406, 400	moderate scrub vegetation on islands within active channel, similar to 1989 but slightly heavier	channels were relatively easy to pick out due to moderate scrub vegetation; channel width does not necessarily correlate to other measurements (where the only measurable parameter was wetted width)
X6	downstream of Piru confluence	4/1/1927	1713	1983	yes	18	1	18	0	n/a	n/a	no vegetation within braiding corridor; only scattered vegetation on relict corridor; heavy trees along portions of the south bank of relict corridor	very wide braided corridor with little definition (too burnt-in to define secondary channels)
		8/16/1947	1767	1983	no	n/a	0	n/a	0	n/a	n/a	looks similar to 1927 conditions	
		9/1/1957	1220	1449	yes	25	3	51	2	875, 1750	325, 425	very sparse scrub vegetation in active corridor; some small trees on relict corridor (where corridor is present)	well-defined flood control channel through this reach (136' wide), but there are several secondary channels outside the levees; diversion ponds present near the north bank; larger island cut by flood control channel
		11/10/1966	1132	1563	yes	32	4	388	2	2125, 750	850, 250	large island is moderately vegetated with scrub and one line of heavy vegetation; relict braiding corridor is similarly vegetated	braiding corridor has been confined on both sides by levees (especially on the northern portion); looks like the southern levee was recently overtopped (that area was included in the relict corridor); main channel divides in two in some areas
		6/20/1989	1082	1082	no	n/a	n/a	n/a	1	685	180	sparse scrub vegetation growing on poorly-defined islands within channel and near piers	lots of recent grading within the channel, several levees in the middle of the corridor and a series of piers on the southern bank
		6/1/2002	1050	1245	no	n/a	none	n/a	0	n/a	n/a	very little vegetation in this portion of the stream; some scattered scrub on relict corridor, even less within active channel	217-foot wide flood control channel begins just d/s of xs (poorly defined, though)

Cross section	location description	photo date	width of active braiding corridor	width of relict braiding corridor	is there one primary channel visible?	width of main channel	number of identifiable channels	total width of channels (including main)	number of islands	length of islands encountered	width of islands	vegetation	other descriptions
			(feet)	(feet)		(feet)		(feet)		(feet)	(feet)		
X7	between Piru and Sespe (ground-water upwelling)	8/16/1947	1694	2472	no	n/a	4	difficult to define the widths	can't define	n/a	n/a	this area is heavily vegetated; difficult to distinguish active braiding corridor from relict corridor	looks like there has been some flood control work in this area, two very straight channels through here, but masked some by vegetation
		9/1/1957	1446	2253	yes	168	4	370	2	4624, 8500	272, 408	northern portion of the corridor (including flood control channels) have heavy vegetation outside of the channels; the southern portion of the corridor has sparse vegetation	the main channel, and possibly the secondary channel, have been altered for flood control
		6/20/1989	749	2697	yes	37	2	150	1	1386	449	thick vegetation (with trees) along main channel; very little vegetation otherwise within active braiding corridor; moderate vegetation in northern portion of relict corridor, but only scattered brush in southern	no evidence of flood control alteration; downstream the corridor has been severely constrained by encroaching agriculture
		6/1/2002	551	2767	yes	42	2	65	1	396	108	heavy vegetation (trees) along secondary channel along north bank; scattered shrub (with some trees) vegetation within active corridor, some defining the edges of bars; heavy scrub vegetation on south relict corridor with scattered trees; heavy trees and scrub on northern relict corridor	just upstream there is a distinct main active corridor and an overbank area of deposition; the main active corridor has portions lined with heavy trees, but becomes less distinct further upstream (no vegetation)
X8	just downstream of Sespe Creek	8/20/1947	2003	2003	no	n/a	6	601	can't define	n/a	n/a	limited, if any	photo very burnt in, but channels less well-defined than in other photos
		8/13/1967	701	2203	yes	100	3	250	1	2804	401	limited, if any	one single-thread channel with one minor channel
		6/20/1989	1532	1723	yes, but less so than 1967	153	5	306	poorly defined; small and well-vegetated	n/a	n/a	islands are more heavily vegetated away from main channel; main channel bank is ~75 vegetated w/ thin vegetation line; more vegetation than in other photos	
		6/1/2002	670	1820	no	n/a	3	170	1	801	216	islands are moderately well-vegetated; relict corridor has scattered vegetation, Sespe mainstem has heavy vegetation along low-flow channels	interpretation complicated by Sespe confluence, but looks very similar to 1989 photo

FIGURES



Balance Hydrologics, Inc.

Figure 1. Timeline of selected major events in the upper Santa Clara River, California. Also shown (at top) are the years for which aerial photographs were analyzed.

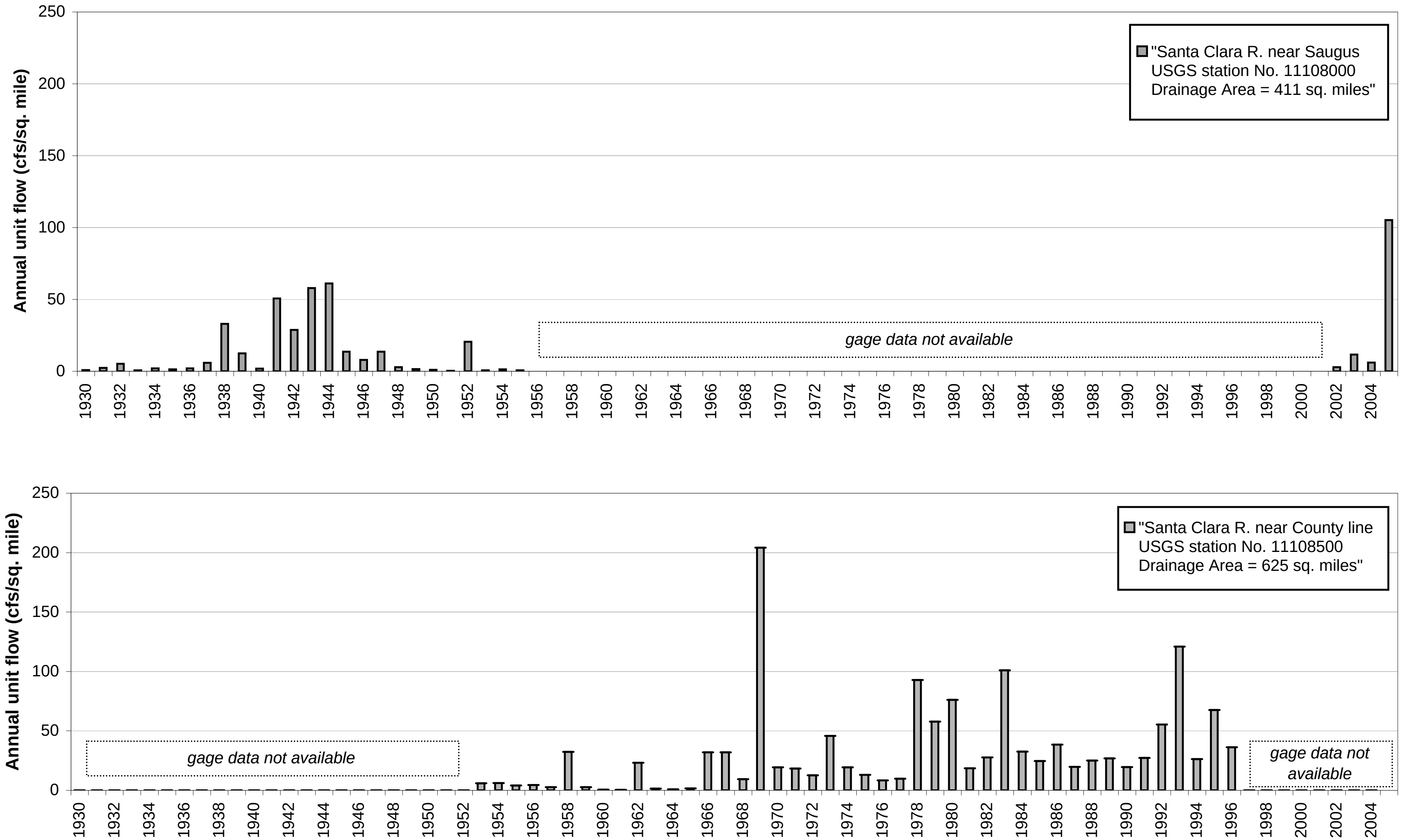
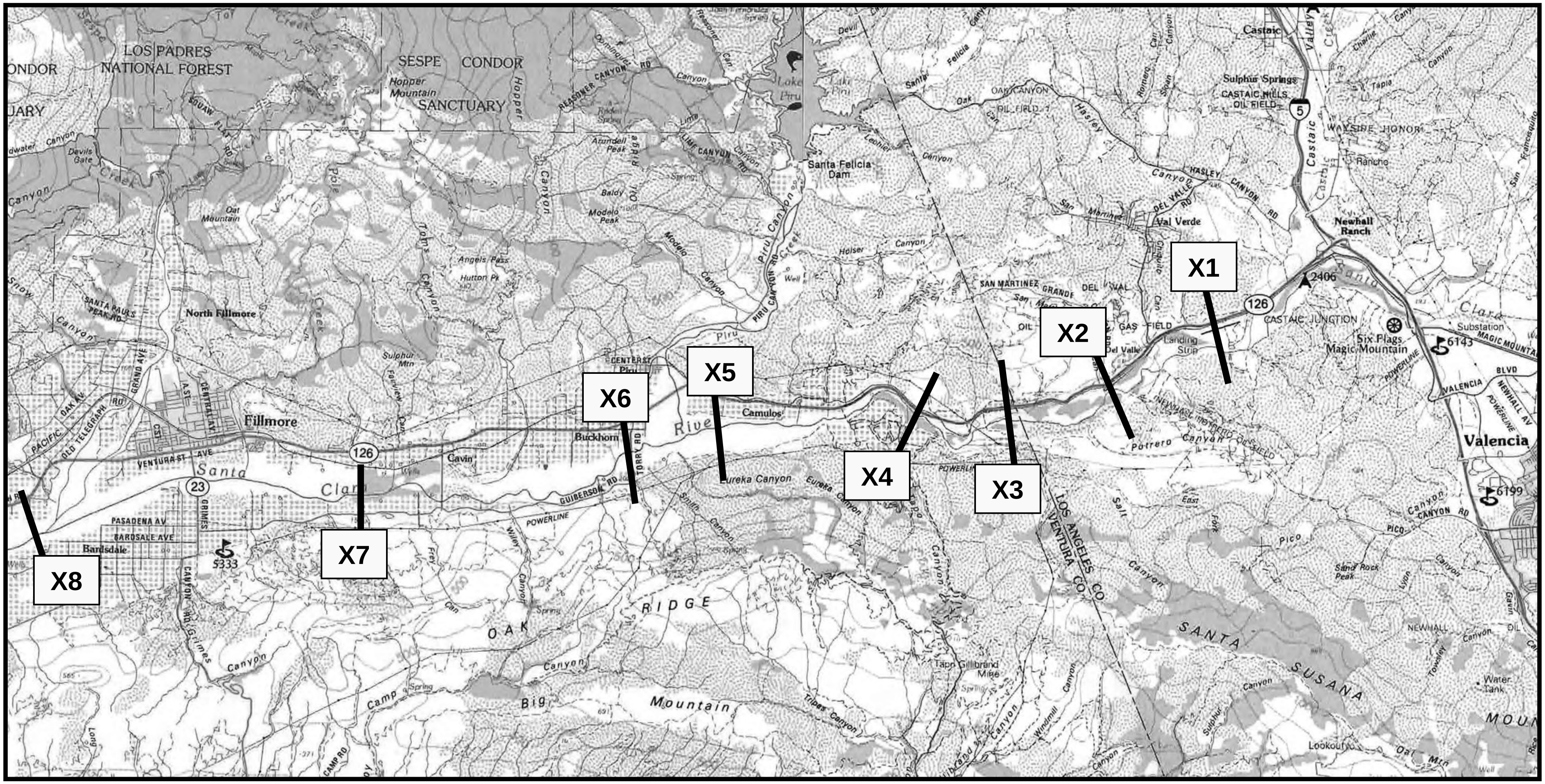


Figure 2. Annual unit runoff (annual flow per square mile) for the Santa Clara River near Newhall at two separate gaging stations. Note that flow in drier years has increased since the 1960s, most likely due to release of treated effluent to the River.

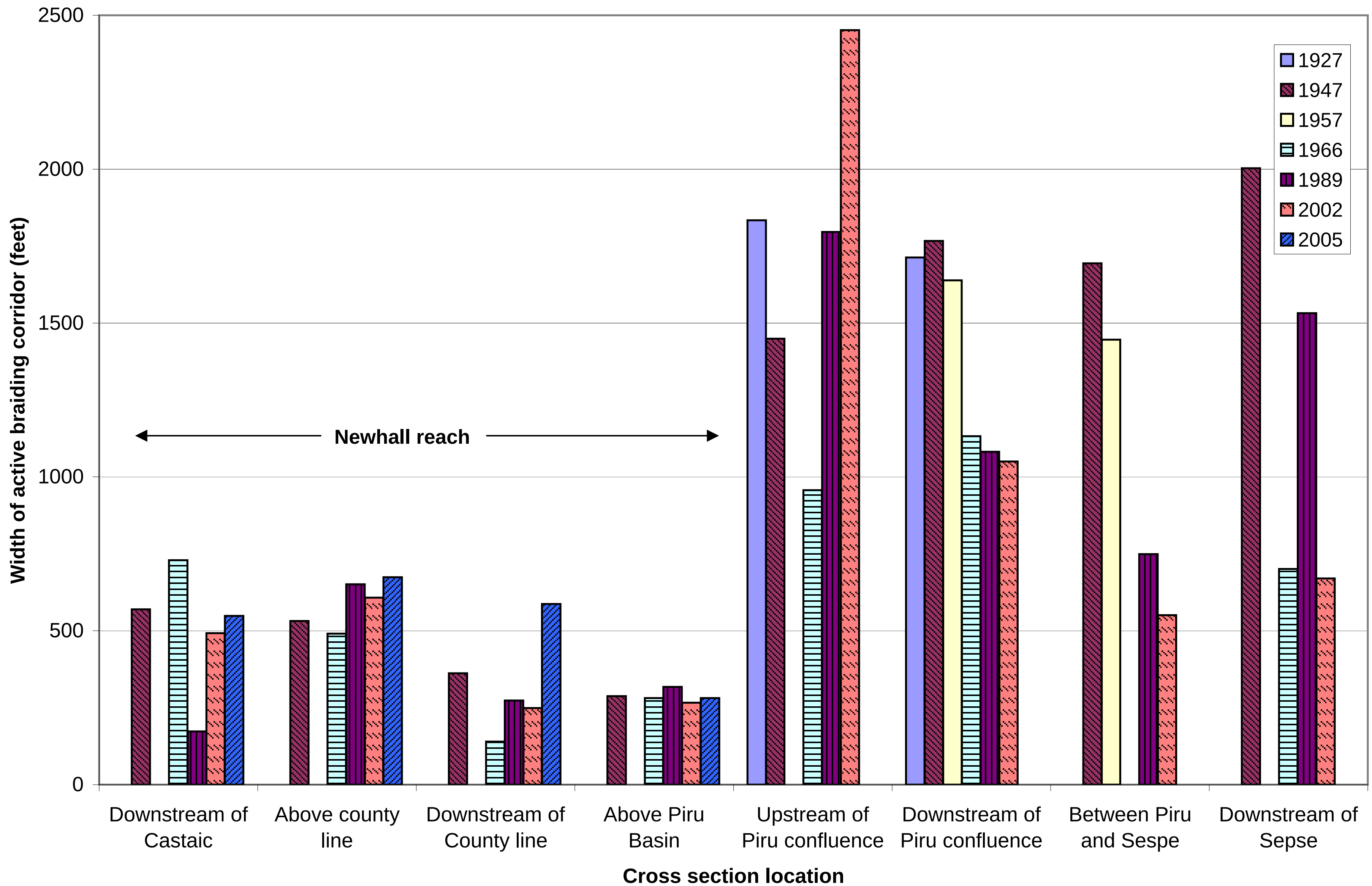


Balance Hydrologics, Inc.

Figure 3. Location of channel cross sections on the Santa Clara River, measured on aerial photographs.

Balance Hydrologics, Inc.

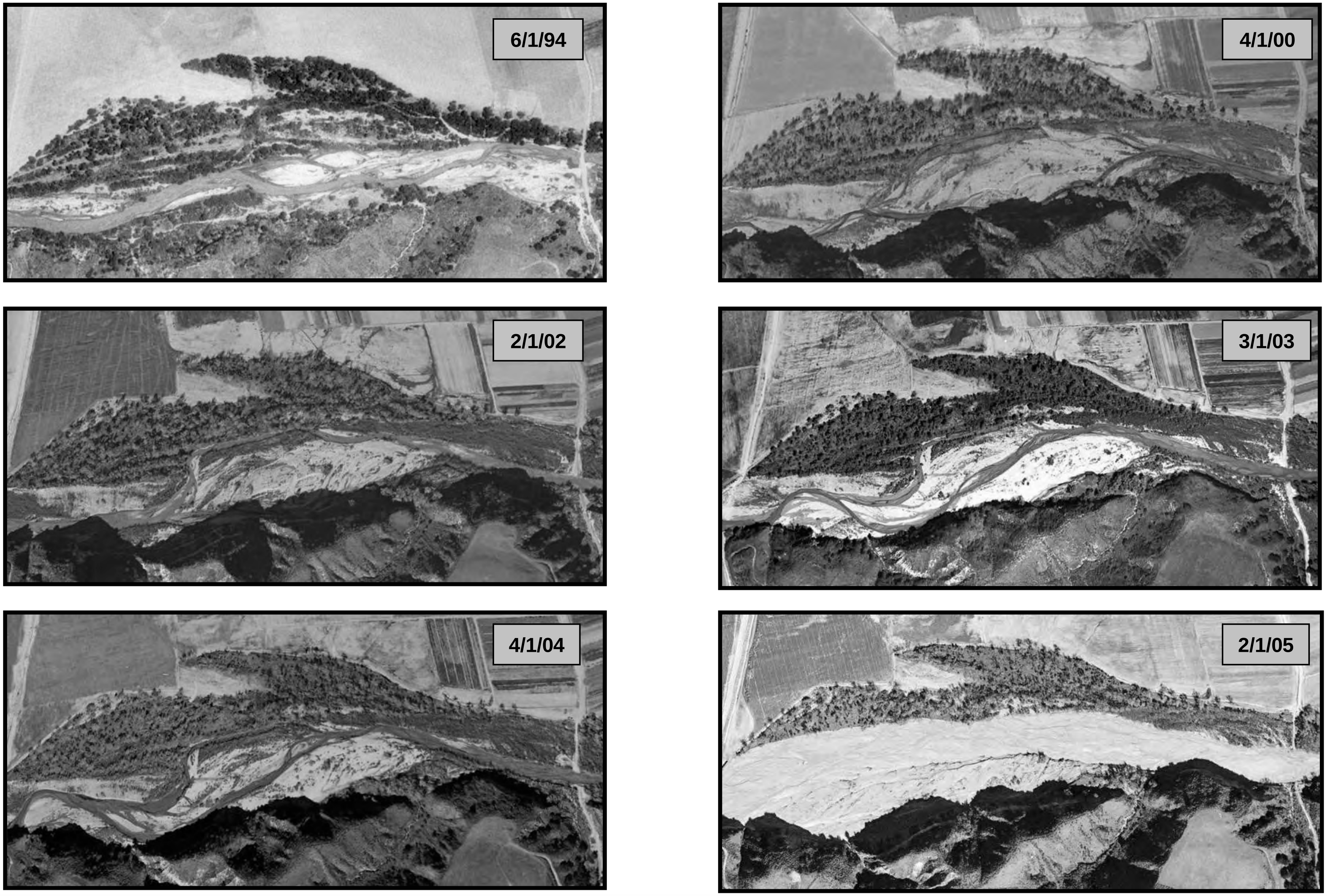
Figure 4. Comparison of 2004 and 2005 conditions on the Santa Clara River, just downstream of the L.A./Ventura County line. Note that significant channel widening occurred in response to the 2005 events, even in heavily vegetated areas. See appendix A for photo sources.



Balance Hydrologics, Inc.

Figure 5. Measurements of active braiding corridor width from aerial photographs, for cross sections on the Santa Clara River.

Photo cross section data.xls, Summary graph



Balance Hydrologics, Inc.

Figure 6. Progression of aerial photographs downstream of Castaic Canyon, showing channel change between 1993 and 2005. Note that there was little change between 2000 and 2004, but the active corridor widened significantly in response to the 2005 events, and that channel traces within the active corridor were effectively erased. See appendix A for photo sources.

APPENDICES

Appendix A: Summary of aerial photographs used for assessment of potential hydromodification effects on the Santa Clara River, Newhall, California.

Date	Number of photos	Nominal Scale	Hard Copy?	Electronic copy?	Image Type	Source/Vendor	Remarks
1927	6	2000	yes	yes	b/w	Whittier College: 80, 82, 84, F27, F28, F31	Only available photography prior to the March 1928 collapse of the Saint Francis Dam. Photos show area near Piru confluence
August 16, 1947	34	24000	no	yes	b/w - Vert Cart	USGS_GS-EM, Rolls 3, 5, 7	Previews downloaded already are sufficient.
1957	2	2000	yes	yes	b/w	Whittier College: 109, 123	1957 photos are for justdownstream of Piru Creek. Piru Dam was closed in 1957.
March 6, 1963	1 (2)	21670	no	yes	b/w - Vert Recon	USGS_ARMC630001L0049 a,b	high resolution scans
July 20, 1966	2 (4)	21670	no	yes	b/w - Vert Recon	USGS_ARM6625001L1362 a,b USGS_ARM6625001R1357 a,b	high resolution scans
August 19, 1966	1 (2)	21670	no	yes	b/w - Vert Recon	USGS_ARM6628502L1314 a,b	high resolution scans
September 13, 1966	1 (2)	21670	no	yes	b/w - Vert Recon	USGS_ARM6631405R1165 a,b	high resolution scans
November 10, 1966	2 (4)	21670	no	yes	b/w - Vert Recon	USGS_ARM6638605L1238 a,b USGS_ARM6638605L1242 a,b	high resolution scans
August 13, 1967	1	30000	no	yes	b/w - Vert Cart	USGS_AR1VBUK00010110	Preview already obtained. Downstream of Sespe Creek
May 26, 1989	5	31680	yes	yes	b/w	WAC-89CA, 27-42	LA County
						WAC-89CA, 27-62	LA County
						WAC-89CA, 27-84	LA County
						WAC-89CA, 27-109	LA County
						WAC-89CA, 27-135	LA County
May 1, 1989	6	2000	yes	yes	Color	PAS_89 06-20 PW VEN 7-229	Ventura County
						PAS_89 06-20 PW VEN 7-231	Ventura County
						PAS_89 06-20 PW VEN 7-233	Ventura County
						PAS_89 06-20 PW VEN 7-235	Ventura County
						PAS_89 06-20 PW VEN 7-269	Ventura County
						PAS_89 06-20 PW VEN 7-237	Ventura County
June 1, 1994	n/a	unknown			b/w, georeferenced	GlobeXplorer	downloaded select sections from LA and Ventura County
April 1, 2000	n/a	unknown	no	yes	color, georeferenced	GlobeXplorer	downloaded select sections from LA and Ventura County
February 1, 2002	4	Unknown	no	yes	Color, georeferenced	AirPhotoUSA (from GeoSyntec)	Covers all of Newhall project area

Date	Number of photos	Nominal Scale	Hard Copy?	Electronic copy?	Image Type	Source/Vendor	Remarks
July 23, 2002	n/a	unknown	no	yes	Color, georeferenced	GlobeXplorer	downloaded select sections from LA and Ventura County
March 1, 2003	n/a	unknown	no	yes	Color, georeferenced	GlobeXplorer	downloaded select sections from LA and Ventura County
April 1, 2004	n/a	unknown	no	yes	Color, georeferenced	GlobeXplorer	downloaded select sections from LA and Ventura County
October 13, 2004	n/a	unknown	no	yes	Color, georeferenced	GlobeXplorer	downloaded select sections from LA and Ventura County
February 1, 2005	n/a	unknown	no	yes	Color, georeferenced	GlobeXplorer	only avaialable for LA County