4.1 GEOTECHNICAL HAZARDS

1. SUMMARY

This section describes the existing geologic and soils conditions on the project site, and the potential for geotechnical hazards to affect the Vista Canyon project. Due to the presence of shallow groundwater and liquefiable soils, the project site could be susceptible to liquefaction. Soils on the project site are also subject to lateral spreading, and exhibit corrosive and expansive properties. The project site also may be subject to ground shaking due to its location within a seismically active region; however, the project site is not underlain by any faults and, therefore, not subject to fault rupture. Based on the results of the geotechnical investigation of the project site, significant impacts could occur as a result of strong seismic ground shaking, liquefaction and its effects (such as lateral spreading and differential settlement), soil expansion, and soil corrosiveness. However, with implementation of certain grading and construction techniques, outlined in the geotechnical report prepared for the proposed project and included within this section as mitigation measure, impacts would be reduced to a less than significant level. Cumulative impacts related to geotechnical hazards would also be less than significant.

2. INTRODUCTION

Information in this section was derived from the geotechnical analyses prepared for the project site by R.T. Frankian & Associates,[1] which are included in **Appendix 4.1** of this EIR. On behalf of the City, the County of Los Angeles, Department of Public Works, completed a peer review of the geotechnical report, (including responses) and approved them.

The geotechnical report characterizes surface and subsurface geologic conditions, identifies geologic hazards and liquefaction potential, and develops recommendations for bulk grading, mitigation of geologic hazards, and preliminary building and utility design. Information in the report is based on the results of subsurface exploration on the project site that included drilling, sampling, and geologic logging of exploratory borings, and a review of data available from the California Geological Survey, California Division of Oil, Gas, and Geothermal Resources, and United States Geological Survey.

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1 See R.T. Frankian & Associates, *Geotechnical Report for Tentative Tract Map No. 69164, Canyon County, California,* November 14, 2008; see also Letter from R.T. Frankian & Associates, dated July 10, 2009, containing responses to County review.

3. REGULATORY SETTING

a. State Regulations

The California Geological Survey (CGS)[2] is responsible for enforcing the Alquist-Priolo Earthquake Fault Zoning Act and enforcing the Seismic Hazards Mapping Act. Both are described below.

(1) Alquist-Priolo Earthquake Fault Zoning Act

The purpose of Alquist-Priolo Earthquake Fault Zoning Act (formerly called the Alquist-Priolo Special Studies Zones Act)[3] is to prohibit the location of most structures for human occupancy across the traces of active surface faults, which are faults that have ruptured the ground surface in the past 11,000 years, and to mitigate the hazard of fault rupture. The act addresses only the hazard of surface fault rupture and is not directed toward other earthquake hazards. Under the act, the State Geologist (Chief of the CGS), is required to delineate "earthquake fault zones" (EFZs) along known active faults in California. The boundary of an EFZ is generally approximately 500 feet from major active faults, and 200 to 300 feet from well-defined minor faults. Cities and counties affected by the EFZs must withhold development permits for certain construction projects proposed within the zones until geologic investigations demonstrate that the sites are not significantly threatened by surface displacement from future faulting. If an active fault is found, a structure for human occupancy cannot be placed over the trace of the fault and must be set back from the fault (generally 50 feet).

(2) Seismic Hazards Mapping Act

Under the CGS's Seismic Hazards Mapping Act,[4] which was passed in 1990, seismic hazard zones are to be identified and mapped to assist local governments for planning and development purposes. The Seismic Hazards Mapping Act differs from the Alquist-Priolo Earthquake Fault Zoning Act in that it addresses non-surface fault rupture earthquake hazards, including strong ground shaking, liquefaction, landslides, or other types of ground failure, and other hazards caused by earthquakes. The CGS provides

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2 The official name for the CGS is the Division of Mines and Geology. The modern pseudonym for the agency was established in January 2002.

3 See Pub. Resources Code, Section 2621 et seq. (The Alquist-Priolo Special Studies Zones Act was signed into law in 1972. In 1994, it was renamed the Alquist-Priolo Earthquake Fault Zoning Act. The Act has been amended ten times.)

4 See Pub. Resources Code, Section 2690 et seq.

guidance on the evaluation and mitigation of earthquake-related hazards for projects within designated zones of required investigations.[5]

(3) California Building Code

The State of California provides a minimum standard for building design through the California Building Code (CBC), which is included in Title 24 of the California Administrative Code. The 2007 edition of the CBC is based on the 2006 International Building Code (IBC), which is published by the International Code Council, and other amendments provided in municipal and other local codes.

The CBC is adopted on a jurisdiction-by-jurisdiction basis, and is subject to further modification based on local conditions. The CBC is a compilation of the following three types of building standards:

- Those adopted by state agencies without modification from building standards contained in national model codes (e.g., the IBC).
- Those adopted and adapted from the national model code standards to meet California conditions (e.g., most of California falls within Seismic Design Categories D and E).
- Those that constitute extensive additions not covered by the model codes that have been adopted to address California concerns.

Standard residential, commercial, and light industrial construction is governed by the CBC, to which cities and counties add amendments. In addition, the CBC regulates excavation, foundations, and retaining walls; contains specific requirements pertaining to site demolition, exaction, and construction to protect people and property from hazards such as excavation cave-ins and falling debris; and regulates grading activities, including drainage and erosion control.

b. Local Regulations

All grading and excavation must comply with Chapters 17.20 to 17.80 of the City of Santa Clarita Unified Development Code. Rules and regulations contained within these chapters provide for the control of excavation, grading, and earthwork construction, including fills and embankment activities. During the grading permit application process, the City Engineer may require that engineering geological and soil reports, as well as seismic hazard zone studies, be prepared for proposed development projects. The engineering geological report requires an adequate description of the geology of the site, along with conclusions and recommendations regarding the effect of geologic conditions on any proposed

5 California Geological Survey, "Special Publication 117, Guidelines for Evaluating and Mitigating Seismic Hazards in California," 1997.

development. Soil reports are required to characterize the existing soil resources on a site, and provide recommendations for grading and design criteria. Development in a seismic hazard zone would require studies that evaluate the potential for seismically induced liquefaction, soil instability, and earthquake induced landslides to occur on a site.

In order to limit structural damage from earthquakes, seismic design codes have undergone substantial revision in recent years. Earthquake safety standards for new construction became widely adopted in local building codes in Southern California following the 1933 Long Beach Earthquake, and have been updated in various versions of the CBC since that date. The 1994 Northridge Earthquake resulted in significant changes to building codes to ensure that buildings are designed and constructed to resist the lateral force of an earthquake and repeated aftershocks. Required construction techniques include adequate nailing, anchorage, foundation, shear walls, and welds for steel frame buildings.

4. EXISTING CONDITIONS

a. Geologic Setting

The project site is located in the Soledad Basin within the Transverse Ranges geomorphic province of California. The Soledad Basin is a narrow sedimentary trough that generally coincides with the Santa Clara River Valley. The Soledad Basin includes a thick section of fluvial and lacustrine beds overlain by marine strata. The oldest beds correlate with the Oligocene Vasquez Formation, which rests unconformably on Precambrian gabbro-anorthosite rock. The youngest beds correlate with the Plio-Pleistocene Saugus Formation.

The Mint Canyon Formation underlies the project site and is exposed at ground surface in several locations. The Mint Canyon Formation has been warped into a north striking homoclinal structure, with northwest dips ranging between 20 and 40 degrees. Bedding planes within the Mint Canyon Formation vary from diffuse and gradational to sharp and planar. A daylighted bedding condition may be present in west and northwest facing slopes.

b. Topography and Surface Features

The approximately 185-acre project site is located south of the Antelope Valley Freeway (State Route 14, or SR-14). The project site is predominantly vacant and undeveloped, excluding a residence and storage yard in the southwest portion of the site. The Santa Clara River crosses a portion of the project site. A small, isolated hill north of the River and south of SR-14, locally referred to as Mitchell Hill, is located in the northeast portion of the project site. Two small knolls, which are fragments of the San Gabriel Mountains, are located south of the River on the project site.

The project site is mostly flat, with upland areas sloping towards the active channel of the Santa Clara River. Elevations across the project site range from approximately 1,470 feet to 1,580 feet above mean sea level (msl), an elevation differential of 110 feet. Isolated bedrock ridges are located along the southeast project boundary. Bedrock is exposed on the north bank of the River, where it forms a resistant promontory. A Castaic Lake Water Agency (CLWA) water pipeline crosses through the western portion of the project site.

c. Subsurface Conditions

(1) Soil Properties

Soil and bedrock materials encountered on site consist of artificial fill, terrace deposits, alluvium, slopewash/colluvium, and bedrock assigned to the Mint Canyon Formation, each of which is partially exposed on the surface of the project site.

Artificial Fill: Artificial fill was previously placed on portions of the project site for railroad bed construction. Artificial fill was also placed on the southwest portion of the project site. Fill soils mainly consist of loose, clast supported mixtures of angular concrete blocks with a silty sand matrix that are four to 8-feet thick.

Terrace Deposits: Pleistocene age terrace deposits cap the Mint Canyon Formation in some areas of the project site. Terrace deposits consist of loose and poorly consolidated sand, gravel and silt, often interspersed with cobbles and boulders.

Alluvium: Holocene age alluvial deposits blanket much of the project site. Alluvial deposits consist of loose to dense mixtures of sand, silty sand, and gravelly sand, often interspersed with cobbles and boulders. Silt layers were identified in some areas of the project site. Coarse grain alluvial deposits are generally found in proximity to the active channel of the Santa Clara River, while fine grain alluvial deposits are generally found along the southeast edge of the site. Fine grain alluvial deposits are generally stiff to hard.

Slopewash/Colluvium: Slopewash blankets are located on the majority of the project site. Slopewash deposits are generally less than 5 feet thick, and consist of loose sand, gravel, and silt.

Mint Canyon Formation: Mint Canyon Formation underlies the site and is exposed at ground surface in several areas. This rock unit consists of fine to coarse-grained arkosic sandstone (a granular sedimentary rock composed of quartz and feldspar or mica) interbedded with conglomerate and siltstone. Beds are several inches to several feet thick and have diffuse planar contacts.

Two mudstone beds are exposed on the south facing slope of the project site. The beds are 12 to 18 inches thick with sharp contacts, and weathered and oxidized in outcrop. No evidence of shear surfaces or large lateral deformation was observed. The beds are separated stratigraphically by 12 to 15 feet. Mudstone beds may be subject to expansion when exposed to repeated cycles of wetting. Where mudstone beds are isolated between non-expansive, coarse-grained horizons, differential expansion may occur.

(2) Groundwater

Groundwater was encountered on the project site during exploratory boring at depths ranging from 12 to 52 feet below the surface. Based on groundwater monitoring conducted for two adjacent wells within the Santa Clara River Corridor, the historic high groundwater level is between 9 and 17 feet below ground surface, and the historic low groundwater level is between 96 and 99 feet below ground surface. A high water table elevation generally coincides with the winter months, while the low water table elevation coincides with summer months.

d. Geologic Hazards

(1) Fault Rupture

The CGS defines a fault as a fracture or zone of closely associated fractures along which rocks on one side have been displaced with respect to those on the other side.[6] A fault is distinguished from those fractures caused by landslides or other gravity-induced ground failures. The CGS defines a fault zone as a zone of related faults that commonly are braided and subparallel to each other, but may be branching and divergent.[7] A fault zone has significant width with respect to the fault, ranging from a few feet to several miles.

Surface rupture occurs when movement on a fault deep within the earth breaks through to the surface. Not all earthquakes result in surface rupture. Fault rupture almost always follows preexisting faults, which are zones of weakness. Rupture may occur suddenly during an earthquake or slowly in the form of fault creep. Sudden displacements are more damaging to structures because they are accompanied by shaking. Fault creep is the slow rupture of the earth's crust.[8]

Faults in Southern California are classified as active, potentially active or inactive, based on their most recent activity. A fault can be considered active if it has demonstrated movement within the Holocene

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6 California Geological Survey, "Fault-Rupture Hazard Zones in California" Sacramento: 2007, p.3.

7 California Geological Survey, "Fault-Rupture Hazard Zones in California" 2007, p.3.

8 California Geological Survey, "Alquist-Priolo Earthquake Fault Zones," available at http://www.conservation.ca.gov/ CGS/rghm/ap/Pages/Index.aspx (2008).

epoch, or approximately the last 11,000 years. Faults that have demonstrated Quaternary movement (last 1.6 million years), but lack strong evidence of Holocene movement, are classified as potentially active. Faults that have not moved since the beginning of the Quaternary period are deemed inactive.

As shown in **Figure 4.1-1, Location of Earthquake Faults**, no known active faults project into or cross the project site. Additionally, the site is not located in a State of California Alquist-Priolo Earthquake Fault Zone.[9] The closest active fault zone is the San Gabriel Fault Zone, located approximately 1.5 miles southwest of the project site. The San Gabriel Fault extends 87 miles from the community of Frazier Park (west of Gorman) to Mount Baldy in San Bernardino County. Within the Santa Clarita Valley, the San Gabriel Fault Zone underlies the northerly portion of the community from Castaic and Saugus, extending east through Canyon Country to Sunland. Holocene activity along the fault zone has occurred in the segment between Saugus and Castaic. The length of this fault and its relationship with the San Andreas Fault system contribute to its potential for future activity. The interval between major ruptures is unknown, although the western half is thought to be more active than the eastern portion. The fault is a right-lateral strike-slip fault, with an estimated earthquake magnitude of 7.2.

Faults confined to the Mint Canyon Formation are located east and southeast of the project site. These faults are branches of the informally named Sulphur Springs Fault. The Sulphur Springs Fault is not active and is not located on the project site.

(2) Ground Shaking

Ground shaking is the most significant earthquake action in terms of potential structural damage and loss of life. Ground shaking is the movement of the earth's surface in response to a seismic event. The intensity of the ground shaking and the resultant damages are determined by the magnitude of the earthquake, distance from the epicenter, and characteristics of surface geology. This hazard is the primary cause of the collapse of buildings and other structures. The significance of an earthquake's ground shaking action is directly related to the density and type of buildings and the number of people exposed to its effect. Seismic shaking (earthquakes) in Southern California primarily occur as a result of movement between the Pacific and North American plates. The San Andreas Fault system generally marks the boundary between the plates.

Given its location within a seismically active region, the project site is subject to ground shaking. The strongest, most proximate, most recent seismic event was the January 1994 Northridge Earthquake

9 R.T. Frankian & Associates, 2008, p. 9.

(Richter magnitude 6.7). The epicenter of this event was located approximately 13 miles southwest of the City of Santa Clarita in the Northridge community of Los Angeles City.

(3) Landslides

Landslides and rock falls occur most often on steep or compromised slopes. Factors controlling the stability of slopes include slope height and steepness, characteristics of the earth materials comprising the slope, and intensity of ground shaking. The project site is located within a State of California Seismic Hazard Zone for Earthquake Induced Landsliding.[10] However, the project site is located on relatively level ground and no known landslides are located on the site. Therefore, the project site is presently not susceptible to any forms of slope instability. A shallow surficial failure was observed on a bedrock ridge off the project site to the southeast. Minor surficial erosion was observed on bedrock ridges on the project site.

(4) Debris Flows

Debris flows, consisting of a moving mass of heterogeneous debris lubricated by water, are generated by shallow soil slips in response to heavy rainfall. Conditions that create the potential for debris flow include presence of a mantle or wedge of colluvial soil or colluvial ravine soil; a slope angle ranging from 27 to 56 degrees; and soil moisture equal to or greater than the colluvial soil's liquid limit. Debris flows are not considered a significant hazard on the project site due to the absence of tall slopes in the immediate vicinity.

(5) Liquefaction

For liquefaction to occur, three conditions are required: the presence of soils that are susceptible to liquefaction; ground shaking of sufficient magnitude and duration; and a groundwater level at or above the level of the susceptible soils during the ground shaking. Susceptible soils are cohesion-less and characterized by loose to medium density. Even if some soil layers do liquefy, the effects of the liquefaction may not be observed on the ground surface if non-liquefiable soils of sufficient thickness overlie the liquefiable soils. The Seismic Hazard Zone Map for the Mint Canyon Quadrangle indicates that the alluvial areas along the Santa Clara River, including those on the project site, are classified as being potentially susceptible to liquefaction.[11] Other soil and rock units on the project site, such as bedrock of the Mint Canyon Formation, are not susceptible to liquefaction.

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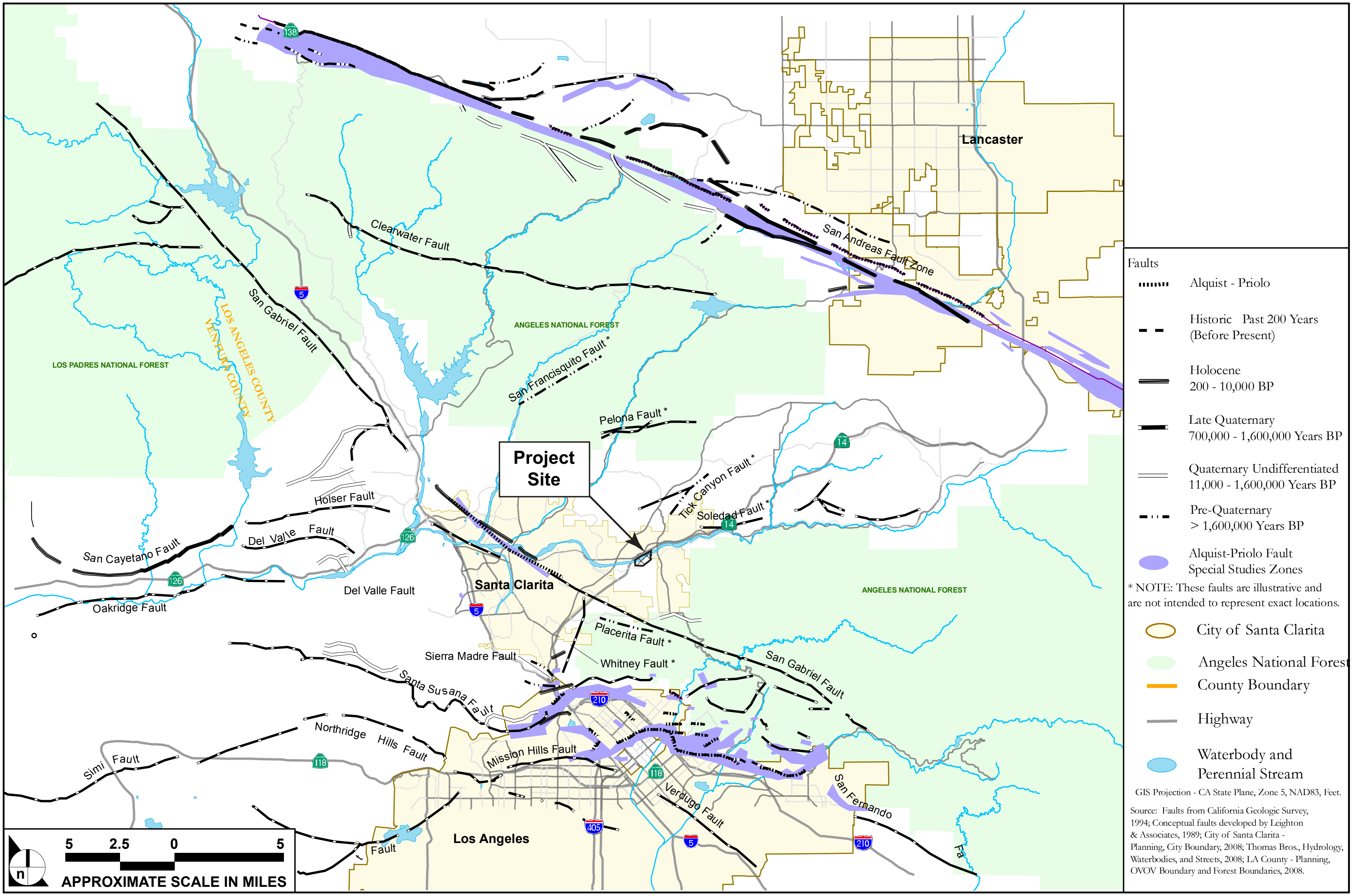
10 R.T. Frankian & Associates, 2008, p. 10.

11 R.T. Frankian & Associates, 2008, p. 15.



SOURCE: California Geologic Survey - 1994

FIGURE **4.1-1**

Location of Earthquake Faults

112-024•06/09

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Lateral spread is a liquefaction-induced landslide of a fairly coherent block of soil and sediment deposits that moves laterally (along the liquefied zone) by gravitational force, sometimes on the order of 10 feet, often toward a topographic low, such as a depression or a valley area. Liquefaction failure can cause damage to surface and subsurface structures, with the severity dependent upon the type and magnitude of failure, and the relative location of the structures.

Another potential consequence of liquefaction is ground surface settlement, also referred to as seismic settlement or seismically induced settlement. Excess pore pressure generated by ground shaking and leading to liquefaction is associated with the tendency for loosely compacted, saturated soil to rearrange into a denser configuration during shaking. Dissipation of that excess pore pressure will produce volume decreases (consolidation or compaction) within the soil that may be manifested at the ground surface as settlement. Whether seismically induced settlement will occur depends on the intensity and duration of ground shaking, and the relative density (the ratio between the in-place density and the maximum density) of the subsurface soils. Spatial variations in material characteristics and thickness may cause such settlement to occur differentially.

As demonstrated by past earthquakes, seismic settlement is primarily damaging in areas subject to differential settlement. These can include cut-and-fill transition lots built on hillsides, where a portion of the house is built over an area cut into the hillside while the remaining portion of the house projects over man-made fill. During an earthquake, even slight settlement of the fill can cause differential settlement to an overlying structure, leading to significant damage.

(6) Expansive Soil

Expansive soils consist of a significant concentration of clay particles, which can give up water (shrink) or absorb water (swell). Excessive swelling and shrinkage cycles can result in distress to improvements and structures. The change in volume exerts stress on buildings and other loads placed on these soils. Expansive soils can be widely dispersed and can be found in hillside areas as well as low-lying alluvial basins. Mudstone beds underlying the project site may be subject to expansion when exposed to repeated cycles of wetting. Where mudstone beds are isolated between non-expansive, coarse-grained soil layers, differential expansion may occur.

(7) Subsidence

Subsidence is the sudden sinking or gradual downward settling and compaction of soil and other surface material with little or no horizontal motion. Subsidence usually occurs as a result of the extraction of subsurface gas, oil, or water or from hydro-compaction; it is not the result of landslide or slope failure. Subsidence typically occurs over a long period of time and can result in structural impacts on developed areas, such as cracked pavement and building foundations, and dislocated wells, pipelines, and water drains. Mitigation of ground subsidence usually requires a regional approach to groundwater conservation and recharge. Such mitigation measures are difficult to implement if the geology of the aquifer and overlying sediment are not well understood. Furthermore, conservation efforts can be quickly offset by rapid growth and attendant heavy water requirements. Because it is not uncommon for several jurisdictions to utilize a continuous groundwater aquifer, mitigation requires regional cooperation among all agencies. No large-scale problems with ground subsidence have been reported in the City's Planning Area.[12] Furthermore, there are no underground mines or tunnels beneath the project site. According to the California Division of Oil, Gas, and Geothermal Resources (DOGGR) Regional Wildcat Map W1-2 (June 19, 1986), no oil wells are located on or immediately adjacent to the site.

(8) Erosion and Blowsand

Wind erosion occurs as a result of wind forces exerted against the surface of the ground, releasing dust particles into the air. Atmospheric dust causes respiratory discomfort, may carry pathogens that cause eye infections and skin disorders, and reduces highway and air traffic visibility. Erodible sandstone beds are common within the Mint Canyon Formation and are present on the project site. Additionally, sand is concentrated along the Santa Clara River. For these reasons, in combination with disturbed, sparse vegetation, the project site is presently susceptible to erosion and generates blowsand.

5. PROJECT IMPACTS

a. Significance Threshold Criteria

The following thresholds for determining the significance of impacts related to geotechnical hazards are contained in the *City of Santa Clarita Environmental Guidelines* and the environmental checklist form contained in Appendix G of the *State CEQA Guidelines*. Impacts related to geotechnical hazards are considered significant if the proposed project would:

(a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

 (i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.

 (ii) Strong seismic ground shaking?

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12 City of Santa Clarita Draft General Plan, "Safety Element," April 4, 2008, p. S-11.

(iii) Seismic-related ground failure, including liquefaction?

(iv) Landslides?

(b) Result in substantial wind or water soil erosion or the loss of topsoil, either on or off site?

(c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?

(d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1997), creating substantial risks to life or property?

(e) Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?

(f) Change topography or ground surface relief features?

(g) Require earth movement (cut and/or fill) of 10,000 cubic yards or more?

(h) Develop and/or grade on a slope greater than 10 percent natural grade?

(i) Destroy, cover or modify any unique geologic or physical feature?

The project is evaluated for all of the above criteria except for Criterion (e) because the proposed project would not require the use of septic tanks for wastewater disposal. Instead, the proposed project would be served by the water reclamation plant and the existing sewage conveyance system.

b. Proposed Improvements

The proposed project would develop approximately 185 acres of mostly vacant land within the Santa Clarita Valley. The land uses proposed for the project site consist of up to 1,350 dwelling units and up to 950,000 square feet of commercial and medical office, retail, theater, restaurant, and hotel uses. The proposed project could result in an estimated population of approximately 4,170 residents.

c. Construction-Related Impacts

Criterion (b) Result in substantial wind or water soil erosion or the loss of topsoil, either on or off site?

Construction activity associated with project site development may result in wind- and water-driven erosion of soils due to grading activities if soil is stockpiled or exposed during construction. The proposed project would be required to comply with the National Pollutant Discharge Elimination System (NPDES) permit program. The NPDES program requires that the project's grading operations include adequate provisions for wind and water erosion control during, as well as after, grading operations to reduce soil erosion during construction. The details of erosion control would be incorporated into the project's Storm Water Pollution Prevention Plan, as specified in **Section 4.8.1, Water Quality**. Additionally, mitigation identified in **Section 4.4, Air Quality**, would reduce the potential for wind erosion during construction.

Furthermore, a grading plan for the project would be submitted to the City of Santa Clarita Building and Safety Department and/or the City Geologist for review and approval. As required by the City, the grading plan shall include erosion and sediment control plans. Measures included in this plan may include, but are not limited to, the following:

- Grading and development plans shall be designed in a manner which minimizes the amount of terrain modification;
- The extent and duration of ground disturbing activities during and immediately following periods of rain shall be limited, to avoid the potential for erosion which may be accelerated by rainfall on exposed soils; and
- The amount of water entering and exiting a graded site shall be limited though the placement of interceptor trenches or other erosion control devices.

Erosion and sediment control plans shall be submitted to the City for review and approval prior to the issuance of grading permits. With incorporation of various erosion control techniques, impacts due to erosion during construction would be less than significant.

Criterion (f) **Change topography or ground surface relief features?**

Criterion (g) **Require earth movement (cut and/or fill) of 10,000 cubic yards or more?**

Criterion (h) **Develop and/or grade on a slope greater than 10 percent natural grade?**

Criterion (i) **Destroy, cover or modify any unique geologic or physical feature?**

The project site is generally flat, sloping toward the active channel of the Santa Clara River. There is a small hill located in the northeast portion of the project site and two small knolls located within the south-central portion of the project site. Grading would occur within these areas, including areas contemplated in Criterion (g) with slopes in excess of 10 percent. The hill and knolls are not considered significant landforms or unique geologic or physical features, and do not constitute Primary or Secondary Ridgelines, as designated by the City of Santa Clarita. Therefore, construction of the proposed project would not alter any significant landforms, or destroy, cover or modify any unique geologic or physical feature, and impacts under Criterion (i) would be less than significant.

Relative to Criterion (f), topographic changes on the project site would occur during grading operations to accommodate the proposed project. The total amount of soil to be cut from the project site is estimated at 590,000 cubic yards (cy). The total amount of fill is estimated at 830,000 cy. This cut and fill grading would be in addition to 1.7 million cubic yards of remedial grading required for the project. Finally, approximately 500,000 cy of soil would be imported to the site; including the 240,000 cy difference between the project's cut and fill and the additional fill needed to compensate for soil shrinkage associated with soil compaction.

The proposed cut and fill diagram is shown in **Figure 1.0-39, Conceptual Grading Plan** of **Section 1.0, Project Description**. Average fill depth is anticipated to be 12 feet and cut activities are generally limited to the elevated areas on the project site. While both the cut and fill volumes exceed the threshold of 10,000 cubic yards identified in Criterion (g), implementation of **Mitigation Measures 4.1-1** through **4.1-13**, which specify grading techniques for the proposed project, would reduce impacts due to earth movement to a less than significant level.

d. Operational-Related Impacts

Criterion (a) **Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:**

(i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault?

As previously discussed, the project site is not located in an Alquist-Priolo Earthquake Fault Zone, and no known active faults are located within the project site. Therefore, impacts due to rupture of a known earthquake fault would be less than significant under Criterion (a)(i).

(ii) Strong seismic ground shaking?

Since the project site is located in Southern California, an area of strong seismic activity, ground shaking on the project site is anticipated. The intensity of ground shaking generally depends on several factors, including the distance to the earthquake epicenter, the earthquake magnitude, the response characteristics of the underlying materials, and the quality and type of construction. In order to reduce impacts due to ground shaking, building design and construction would adhere to the standards and requirements detailed in the California Building Code (California Code of Regulations, Title 24), City of Santa Clarita Building Code, and the professional engineering standards appropriate for the seismic zone in which the project site is located. Furthermore, as specified by **Mitigation Measure 4.1-22**, the seismic force design of structures would comply with Section 1613, "Earthquake Loads," of the International Building Code. Conformance with these design standards would be enforced through building plan review and approval by the City of Santa Clarita Department of Public Works (Building and Safety Division) prior to the issuance of building permits for any structure or facility on the project site. Therefore, impacts due to ground shaking would be less than significant under Criterion (a)(ii).

(iii) Seismic-related ground failure, including liquefaction?

Groundwater was encountered at depths of 12 to 52 feet below ground surface during exploratory boring on the project site. According to the geotechnical report prepared for the project, sandy soil layers beneath the project site could liquefy in the event of a large earthquake on a nearby fault. This would constitute a significant impact. However, with implementation of the grading recommendations identified in **Mitigation Measures 4.1-1** through **4.1-13**, the potentially liquefiable soil layers would be overlain by non-liquefiable soils of sufficient thicknesses such that surface expression of liquefaction (such as sand boils or ground cracks) would not occur. Therefore, impacts due to liquefaction would be less than significant under Criterion (a)(iii).

(iv) Landslides?

The project site is located within a State of California Seismic Hazard Zone for Earthquake Induced Landsliding. However, regional geologic maps do not depict landslides on the project site, nor were any discovered during on-site borings and geotechnical exploration.[13] As described above, the project site is relatively flat and presently not susceptible to any forms of slope instability. For this reason, debris flows are also not considered a significant hazard on the project site due to the absence of tall slopes. Therefore, impacts due to landslides would be less than significant under Criterion (a)(iv).

Criterion (b) Result in substantial wind or water soil erosion or the loss of topsoil, either on or off site?

Erodible sandstone beds are common within the Mint Canyon Formation and are present on the project site. If exposed in graded slopes upon project buildout, these beds could be subject to erosion due to the lack of cementation. However, erosion of the sandstone beds would be controlled by adhering to the grading techniques specified in **Mitigation Measures 4.1-1** through **4.1-13** during the construction phase of the proposed project. Additionally, as specified by **Mitigation Measures 4.1-13**, in order to reduce the potential for erosion following construction activities, all cut and fill slopes would be seeded or planted with proper ground cover as soon as possible following grading operations.

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13 R.T. Frankian & Associates, 2008, p. 10.

Once the project is developed, both wind- and water-driven erosion on the project site would decrease substantially compared to existing conditions because the site would be overcovered with non-erosive surfaces, including pavement, building pads, and landscaping, all which would reduce the area of exposed soil subject to erosion. Therefore, the project would result in a long-term decrease in on-site erosion and would not increase wind and water erosion of the site. Therefore, impacts related to erosion would be less than significant under Criterion (b).

Criterion (c) **Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?**

As previously discussed, impacts due to liquefaction would be less than significant with incorporation of **Mitigation Measures 4.1-1** through **4.1-13.** Landslides do not exist on-site and, therefore, impacts due to landslides would be less than significant.

The following information addresses other potential geotechnical hazards on the project site.

Lateral Spreading. Lateral spreading can occur during a seismic event when a site is sloped or is adjacent to a steep slope. The project site is mostly flat, with upland areas sloping to the active channel of the Santa Clara River. Except at the eastern end of the site, where the potential for liquefaction of the underlying soils is low, the bank of the River does not constitute a steep slope. Development of the proposed project would result in a slope inclined at a 3:1 to 4:1 grade along the River. The proposed slope would consist entirely of compacted fill, and soil cement bank protection would be buried under the slope. If the site is graded as recommended in **Mitigation Measures 4.1-1** through **4.1-13**, soils that could potentially liquefy and result in lateral spreading would be removed and replaced with compacted fill. Additionally, as specified by **Mitigation Measure 4.1-29**, a geotechnical engineer shall be present during grading operations to determine if soils would need to be replaced and compacted in order to avoid lateral spreading and other potential geologic hazards. Therefore, impacts associated with lateral spreading would be less than significant under Criterion (c).

Differential Settlement. Proposed building pads located in a transition zone may experience cracking and movement of the footings and slab due to differing compressibility of the fill, as compared to the bedrock material. Therefore, differential settlement constitutes a potentially significant impact to the project. As required by **Mitigation Measure 4.1-17,** the portion of the project site in bedrock shall be over-excavated to a depth of at least 5 feet below the proposed finished pad elevation, or 3 feet below the bottom of proposed footings, whichever is greater. The over-excavation shall extend at least 5 feet laterally beyond the building limits. This technique would reduce the potential for differential settlement.

Provided that residential and commercial structures are founded in compacted fill soils as recommended, the maximum settlement is estimated to be less than 1 inch, and differential settlements is estimated to be less than 0.75 inch within a horizontal distance of 30 feet. With implementation of mitigation, impacts would be reduced to a less than significant level under Criterion (c).

Corrosive Soils. Tests indicate that on-site soils are mildly to severely corrosive to ferrous metals. Sulfate attack on portland cement concrete is moderate to negligible. Unless mitigated, soil corrosivity impacts to buried metals associated with the project could result in a significant impact. Therefore, as stated under **Mitigation Measure 4.1-1**, the corrosion potential of site soils exposed at rough grade shall be tested again after site grading is complete; the final foundation design and depth shall be based on those test results. With implementation of mitigation, impacts would be reduced to a less than significant level under Criterion (c).

Subsidence. As previously stated, subsidence is not known to occur on the project site. Nevertheless, groundwater extraction could potentially cause subsidence in the general area. Grading of the site in accordance with the approved geotechnical report would include the removal of the upper soils, and their replacement with properly compacted fill. Below the compacted fill are areas covered by massive bedrock or dense alluvium soils, which would not be affected by subsidence. Since the upper soils would be replaced with compacted fills and massive bedrock or dense soils underlie the site, impacts due to subsidence would be less than significant under Criterion (c).

Criterion (d) **Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1997), creating substantial risks to life or property?**

Two mudstone beds exposed in the south facing slope are located in Planning Area 4 of the proposed project. The beds are 12 to 18 inches thick with sharp contacts. Mudstone beds may be subject to expansion when exposed to repeated cycles of wetting. Where mudstone beds are isolated between non-expansive, coarse-grained horizons, differential expansion may occur. Differential expansion can be detrimental to overlying structures. As stated under **Mitigation Measure 4.1-4** and **4.1-6**, any expansive soils on site shall be mixed with non-expansive soils to reduce the expansion potential to an acceptable level. Furthermore, as specified by **Mitigation Measure 4.1-16**, expansive bedrock materials would be removed and recompacted to reduce expansion potential, where necessary. Therefore, impacts due to expansive soil would be reduced to a less than significant level under Criterion (d).

6. MITIGATION MEASURES ALREADY INCORPORATED INTO THE PROJECT

No mitigation measures that address geotechnical hazards are already incorporated into the project.

7. MITIGATION MEASURES PROPOSED BY THIS EIR

The following mitigation measures are recommended within the *Geotechnical Report for Tentative Tract Map No. 69164, Canyon County, California* (Project Geotechnical Report; November 14, 2008, see **Appendix 4.1**) prepared by R.T. Frankian & Associates to reduce project impacts to a less than significant level.

a. Grading

4.1-1 Grading: The applicability of the preliminary recommendations for foundation and retaining wall design shall be confirmed at the completion of grading. Paving studies and soil corrosivity tests shall be performed at the completion of rough grading to develop detailed recommendations for protection of utilities, structures, and for construction of the proposed roads.

4.1-2 Site Preparation: Prior to performing earthwork, the existing vegetation and any deleterious debris shall be removed from the site. Existing utility lines shall be relocated or properly protected in place. All unsuitable soils, uncertified fills, artificial fills, slopewash, upper loose terrace deposits, and upper loose alluvial soils in the areas of grading receiving new fill shall be removed to competent earth materials and replaced with engineered fill. The depth of removal and recompaction of unsuitable soils is noted in the Project Geotechnical Report. Any fill required to raise the site grades shall be properly compacted.

4.1-3 Removal Depths: The required depth of removal and recompaction of the existing compacted fill or natural soils are indicated in the Project Geotechnical Report. Deeper removals shall be required if disturbed or unsuitable soils are encountered during project grading as directed by the Project Geotechnical Consultant. After excavation of the upper natural soils on hillsides and in canyons, further excavation shall be performed, if necessary, and as directed by the Project Geotechnical Consultant, to remove slopewash or other unsuitable soils. Additional removals will also be required for transition lots (a transition lot occurs on a graded pad where relatively shallow or exposed bedrock materials and compacted fills soils are both present on a lot.) and where expansive bedrock occurs as directed by the Project Geotechnical Consultant. The Project Geotechnical Consultant may require that additional shallow excavations be made periodically in the exposed bottom to determine that sufficient removals have been made prior to recompacting the soil in-place. Deeper removals may be required by the Project Geotechnical Consultant based on observed field conditions during grading. During grading operations, the removal depths shall be observed by the Project Geotechnical Consultant and surveyed by the Project Civil Engineer for conformance with the recommended removal depths shown on the grading plan.

4.1-4 Material for Fill: The on-site soils, less any debris or organic matter, may be used in the required fills. Any expansive clays shall be mixed with non-expansive soils to result in a mixture having an expansion index less than 30 if they are to be placed within the upper 8 feet of the proposed rough grades. Rocks or hard fragments larger than 4 inches shall not be clustered or compose more than 25 percent by weight of any portion of the fill or a lift. Soils containing more than 25 percent rock or hard fragments larger than 4 inches must be removed or crushed with successive passes (e.g., with a sheepsfoot roller) until rock or hard fragments larger than 4 inches constitute less than 25 percent of the fill or lift.

4.1-5 Oversized Material: Rocks or hard fragments larger than 8 inches shall not be placed in the fill without conformance with the following requirements: Rock or material greater than 8 inches in diameter, but not exceeding 4 feet in largest dimension shall be considered oversize rock. The oversize rocks can be incorporated into deep fills where designated by the Project Geotechnical Consultant. Rocks shall be placed in the lower portions of the fill and shall not be placed within the upper 15 feet of compacted fill, or nearer than 15 feet to the surface of any fill slope. Rocks between 8 inches and 4 feet in diameter shall be placed in windrows or shallow trenches located so that equipment can build up and compact fill on both sides. The width of the windrows shall not exceed 4 feet. The windrows shall be staggered vertically so that one windrow is not placed directly above the windrow immediately below. Rocks greater than 1 foot in diameter shall not exceed 30 percent of the volume of the windrows. Granular fill shall be placed on the windrow, and enough water shall be applied so that soil can be flooded into the voids. Fill shall be placed along the sides of the windrows and compacted as thoroughly as possible. After the fill has been brought to the top of the rock windrow, additional granular fill shall be placed and flooded into the voids. Flooding is not permitted in fill soils placed more than 1 foot above the top of the windrowed rocks. Where utility lines or pipelines are to be located at depths greater than 15 feet, rock shall be excluded in that area. Excess rock that cannot be included in the fill or that exceeds 4 feet in diameter shall be stockpiled for export or used for landscaping purposes.

4.1-6 Import Material: Import material shall consist of relatively non-expansive soils with an expansion index less than 30. The imported materials shall contain sufficient fines (binder material) so as to be relatively impermeable and result in a stable subgrade when compacted. The import material shall be free of organic materials, debris, and rocks larger than 8 inches. A bulk sample of potential import material, weighing at least 25 pounds, shall be submitted to the Project Geotechnical Consultant at least 48 hours in advance of fill operations. All proposed import materials shall be approved by the Project Geotechnical Consultant prior to being placed at the site.

4.1-7 Compaction: After the site is cleared and excavated as recommended, the exposed soils shall be carefully observed for the removal of all unsuitable material. Next, the exposed subgrade soils shall be scarified to a depth of at least 6 inches, brought to above optimum moisture content, and rolled with heavy compaction equipment. The upper 6 inches of exposed soils shall be compacted to at least 90 percent of the maximum dry density obtainable by the ASTM D 1557-02 Method of Compaction. After compacting the exposed subgrade soils, all required fills shall be placed in loose lifts, not more than 8 inches in thickness, and compacted to at least 90 percent of their maximum density. For fills placed at depths greater than 40 feet below proposed finish grade a minimum compaction of 93 percent of the maximum dry density is required. The moisture content of the fill soils at the time of compaction shall be above the optimum moisture content. Compacted fill shall not be allowed to dry out before subsequent lifts are placed. Rough grades shall be sloped so as not to direct water flow over slope faces. Finished exterior grades shall be sloped to drain away from building areas to prevent ponding of water adjacent to foundations.

4.1-8 Shrinkage and Bulking: In computing fill quantities, about 10 to 15 percent shrinkage of the upper 5 feet is estimated for on-site natural alluvial soils, slopewash, and unsuitable soils. That is, it will require approximately 1.15 cubic yards of excavated alluvium to make 1 cubic yard of fill compacted to 90 percent of the maximum dry density. About 10 percent shrinkage of the alluvium between depths of about 5 to 10 feet is estimated, as well as 5 percent shrinkage below a depth of about 10 feet. Additional loss of material may be due to stripping, clearing, and grubbing. A bulking value of about 5 to 10 percent is anticipated for materials generated from the bedrock when placed as compacted fill. The removal of oversize material generated by excavation of the bedrock may affect volume losses.

4.1-9 Temporary Slopes: For purposes of construction, the soils encountered at the site shall not be expected to stand vertically for any significant length of time in cuts 4 feet or higher. Where the necessary space is available, temporary unsurcharged embankments may be sloped back at a 1:1 without shoring, up to a height of 45 feet in competent bedrock with favorable bedding. Where any cut slope exceeds a height of 50 feet within competent bedrock, a bench at least 10 feet wide shall be located at mid-height. Within alluvial or compacted fill material, temporary excavations may be made at a 1.25:1 cut to a height of 25 feet. If the temporary construction embankments are to be maintained during the rainy season, berms are recommended along the tops of the slopes where necessary to prevent runoff water from entering the excavation and eroding the slope faces. Where sloped embankments are used, the tops of the slopes shall be barricaded to prevent vehicles and storage loads within 5 feet of the tops of the slopes. A greater setback may be necessary when considering heavy vehicles, such as concrete trucks and cranes; in this case, the Project Geotechnical Consultant shall be advised of such heavy vehicle loads so that specific setback requirements can be established. All applicable safety requirements and regulations, including OSHA regulations, shall be met.

4.1-10 Permanent Slopes: Permanent cut and fill slopes may be inclined at 2:1 or flatter. The current bulk-grading plan indicates that the steepest slope to be constructed at the site during grading will be 2:1.

4.1-11 Proposed Cut Slopes: Cut slopes proposed for the rough grading of the subject site have been designated as shown in the Project Geotechnical Report. Each cut slope is discussed with specific recommendations presented in the "Slope Stability Analyses" section of the Project Geotechnical Report. All grading shall conform to the minimum recommendations presented in the Project Geotechnical Report. If these slopes are modified from those that are discussed in the Project Geotechnical Report, the modifications shall be reviewed by the Project Geotechnical Consultant to ascertain the applicability of project recommendations or to revise recommendations. The cut slope designation, gradient, and proposed mitigation are summarized in the Project Geotechnical Report.

4.1-12 Fill Slopes: If the toe of a fill slope terminates on natural, fill, or cut, a keyway is required at the toe of the fill slope. The keyway shall be a minimum width of 12 feet, be founded within competent material, and shall extend a horizontal distance beyond the toe of the fill to the depth of the keyway. The keyway shall be sloped back at a minimum gradient of 2 percent into the slope. The width of fill slopes shall be no less than 8 feet and under no circumstances shall the fill widths be less than what the compaction equipment being used can fully compact. Benches shall be cut into the existing slope to bind the fill to the slope. Benches shall be step-like in profile, with each bench not less than 4 feet in height and established in competent material. Compressible or other unsuitable soils shall be removed from the slope prior to benching. Competent material is defined as being essentially free of loose soil, heavy fracturing, or erosion-prone material and is established by the Project Geotechnical Consultant during grading.

Where the top or toe of a fill slope terminates on a natural or cut slope and the natural or cut slope is steeper than a gradient of 3:1, a drainage terrace with a width of at least 6 feet is required along the contact. As an alternative, the natural or cut portion of the slope can be excavated and replaced as a stability fill to provide an all-fill slope condition.

When constructing fill slopes, the grading contractor shall avoid spillage of loose material down the face of the slope during the dumping and rolling operations. Preferably, the incoming load shall be dumped behind the face of the slope and bladed into place. After a maximum of 4 feet of compacted fill has been placed, the contractor shall backroll the outer face of the slope by backing the tamping roller over the top of the slope and thoroughly covering all of the slope surface with overlapping passes of the roller. The foregoing shall be repeated after the placement of each 4-foot thickness of fill. As an alternative, the fill slope can be over built and the slope cut back to expose a compacted core. If the required compaction is not obtained on the fill slope, additional rolling will be required prior to placement of additional fill, or the slope shall be overbuilt and cut back to expose the compacted core.

4.1-13 Slope Planting: In order to reduce the potential for erosion, all cut and fill slopes shall be seeded or planted with proper ground cover as soon as possible following grading operations in accordance with Section 7019 of the County of Los Angeles Building Code, 1999, or latest edition. The ground cover shall consist of drought-resistant, deep-rooting vegetation. A landscape architect shall be consulted for ground cover recommendations, plant selection, installation procedures, and plant care requirements.

b. Drainage

4.1-14 Subdrains: Canyon subdrains are required to intercept and remove groundwater within canyon fill areas. All subdrains shall extend up-canyon, with the drain inlet carried to within 15 feet of final pad grade. Specific subdrain locations and recommendations shall be provided as part of the future rough grading plan review.

c. Bedrock Overexcavation

4.1-15 Bedrock shall be over-excavated to a minimum depth of 5 feet below lots and streets. Bedrock shall be overexcavated to a depth of at least 3 feet below proposed soil subgrade areas receiving pavement or hardscape improvements.

d. Expansive Bedrock

4.1-16 Mint Canyon Formation bedrock materials exposed at pad grade may contain expansive claystone beds that could cause differential expansion. Therefore, within building areas at locations where expansive Mint Canyon Formation units are exposed at pad grade, it is required that the bedrock be removed and recompacted to a depth of at least 8 feet below the proposed final pad elevations or 5 feet below the bottom of proposed footings, whichever is greater. The soils generated by these over-excavations shall be mixed with non-expansive soils to yield a relatively non-expansive mixture. Shall the resulting fill soil still be expansive, special construction techniques such as pad subgrade saturation or post-tensioned slabs may be required, at the discretion of the Project Geotechnical Consultant, to reduce the potential for expansive soil related distress.

e. Transition Zones

4.1-17 To reduce the potential for cracking and differential settlement, the portion of the lot in bedrock shall be over-excavated to a depth of at least 5 feet below the proposed finished pad elevation; or 3 feet below the bottom of proposed footings, whichever is greater. The over-excavation shall extend at least 5 feet laterally beyond the building limits. Where removal and recompaction for potentially expansive soils or bedrock is also required, it is recommended that the 8-foot removals be performed as described in the "Expansive Bedrock" section of the Project Geotechnical Report.

Foundation and floor slabs for structures located within a transition zone shall also contain special reinforcement as designed by the Project Structural Engineer. Continuous footings located across the transition zone and 20 feet on either side of the contact shall incorporate a minimum of two No. 4 bars, one at the top and one at the bottom.

Floor slabs located across the transition zone and 20 feet on either side of the contact shall have a minimum slab thickness of at least 4 inches and shall contain as a minimum No. 4 bars spaced a maximum of 18 inches on center. As an alternative, post-tensioned floor slabs may be used.

f. Foundations

4.1-18 General: Residential and commercial buildings up to three stories in height may be supported on continuous or individual spread footings established in properly compacted fill. The following recommendations shall be considered preliminary since fill will be used in some lots to raise the site grade and the final design values will depend upon the engineering characteristics of the fill soil. The preliminary design values are based upon the site investigation, experience with the soils in the area, and the site preparation and grading recommendations for this project.

4.1-19 Bearing Capacity: It is assumed that the proposed buildings will be founded at approximately final planned grades, with column loads less than 100 kips, and have normal floor loads with no special requirements. Individual column pads or wall footings for buildings shall have a width of at least 12 inches and be placed at a depth of at least 18 inches below the lowest final adjacent grade.

Structures may be placed on spread footings designed using a bearing value of 2,000 pounds per square foot (psf). The recommended bearing value is a net value, and the weight of concrete in the footings may be taken as 50 pounds per cubic foot (pcf). The weight of soil backfill may be neglected when determining the downward loads from the footings. A one-third increase in the bearing value may be used when considering wind or seismic loads.

While the actual bearing value of the fill placed at the site will depend on the materials used and the compaction methods employed, the quoted bearing value will be applicable if acceptable soils are used and are compacted as recommended. The bearing value of the fill shall be confirmed during grading.

4.1-20 Lateral Resistance: Lateral loads may be resisted by soil friction and by the passive resistance of the soils. A coefficient of friction of 0.4 applied to the dead loads may be used between the footings, floor slabs, and the supporting soils. The passive resistance of properly compacted fill soils may be assumed to be equal to the pressure developed by a fluid with a density of 250 pcf. The frictional resistance and the passive resistance of the soils may be combined without reduction in determining the total lateral resistance.

4.1-21 Foundation Observations: To verify the presence of satisfactory soils at foundation design elevations, the excavations shall be observed by the Project Geotechnical Consultant. Excavations shall be deepened as necessary to extend into satisfactory soils. Where the foundation excavations are deeper than 4 feet, the sides of the excavations shall be sloped back at 0.75:1 or shored for safety. Inspection of foundation excavations may also be required by the appropriate reviewing governmental agencies. The contractor shall be familiar with the inspection requirements of the reviewing agencies.

g. International Building Code Seismic Design

4.1-22 Under Section 1613, "Earthquake Loads" of the International Building Code (IBC), the following coefficients and factors apply to the seismic force design of structures on the project site.

Latitude	34.41599
Longitude	-118.4342
Site Class	D
Ss	1.810
S1	0.673
SMs	1.810
SM1	1.009
SDs	1.207
SD1	0.673

The parameters were determined using the Ground Motion Parameter Calculator (Version 5.0.8) at the United States Geologic Survey (USGS) Earthquake Hazards website.

h. Retaining Walls

4.1-23 General: Backfill placed behind retaining walls shall be compacted to a minimum of 90 percent of the maximum dry density as determined by ASTM D 1557. When backfilling behind walls, it is required that the walls be braced and heavy compaction equipment not be used closer to the back of the wall than the height of the wall.

4.1-24 Lateral Earth Pressures: For design of non-building retaining walls, where the surface of the backfill is level and the retained height of soils is less than 15 feet, it may be assumed that drained, non-expansive soils will exert a lateral pressure equal to that developed by a fluid with a density of 35 pcf. Where the surface of the backfill is inclined at 2:1, it may be assumed that drained soils will exert a lateral pressure equal to that developed by a fluid with a density of 47 pcf.

In addition to the recommended earth pressures, the walls shall be designed to resist any applicable surcharges due to any nearby foundations, walls, storage or traffic loads. A drainage system, such as weepholes or a perforated pipe shall be provided behind the walls to prevent the development of hydrostatic pressure. Recommendations for wall drains are presented as follows.

If a drainage system is not installed, the walls shall be designed to resist an additional hydrostatic pressure equal to that developed by a fluid with a density of 60 pcf against the full height of the wall. In addition to the recommended earth and hydrostatic pressures, the upper 10 feet of walls adjacent to vehicular traffic areas shall be designed to resist a uniform lateral pressure of 100 psf. This pressure is based on an assumed 300 psf surcharge behind the walls due to normal traffic. If the traffic is kept back at least 10 feet from the walls, the traffic surcharge is not required.

4.1-25 Wall Drainage: A drainage system shall be provided behind all retaining walls or the walls shall be designed to resist hydrostatic pressures. Retaining wall backfill may be drained by a perforated pipe installed at the base and back side of the wall. The perforated pipe shall be at least 4 inches in diameter, placed with the perforations down, and be surrounded on all sides by at least 6 inches of gravel. The pipe shall be installed to drain at a gradient of between 0.5 to 1 percent and shall be connected to an outlet device. A filter fabric such as Mirafi 140 or equivalent shall be placed on top of gravel followed by a minimum 2-feet thick compacted soil layer. Alternatively, the filter fabric and gravel is not required when using a continuous slotted pipe and graded sand, which conforms to Los Angeles County Flood Control District (LACFCD) "F1 " Designated Filter Material.

The backside of the wall shall be waterproofed. A 6-inch vertical gravel chimney drain, Miradrain, or equivalent, shall be placed behind retaining walls and extend to within 18 inches below the top of the wall backfill to provide a drainage path to the perforated pipe. The top of the vertical drain shall be capped with 18 inches of on-site soils.

The drainage system shall be observed by the Project Geotechnical Consultant prior to backfilling the retaining wall. Inspection of the drainage system by the City of Santa Clarita will also be required.

i. Channel Lining

4.1-26 General: The proposed development includes a proposed buried soil cement channel liner. Detailed construction plans for the soil cement channel liner are not yet available and will be geotechnically reviewed in a future report to ensure consistency with the findings in the Project Geotechnical Report. The following preliminary recommendations can be used in the planning of the proposed bank protection. The grading recommendations presented in the preceding sections are also applicable to the proposed channel lining. Overexcavation of the natural soils is not expected to be required for the lining, though existing fill soils shall be excavated and replaced with compacted fill. The backcut for the channel lining may be sloped back at 1.25:1. Concrete lined and soil-cement channel liners may be inclined at 1.5:1 or flatter. Grouted and ungrouted rip-rap liners may be inclined at 2:1 or flatter.

4.1-27 Soil Cement: It is expected that portions of the on-site alluvial soils will be suitable for use in soil-cement. For estimating purposes, a cement content of 8 to 12 percent, by weight, may be used. To determine the actual required cement content, the granular soils that are to be used in a soil-cement channel lining shall be stockpiled. Representative samples of the stockpiled material shall be mixed with varying amounts of cement, compacted, and cured for different time intervals. Based on the results of unconfined compression tests on the samples of the soil-cement mixtures, the Project Geotechnical Consultant shall determine during grading activities the percentage of cement content to be used during construction. This testing shall take place when soil intended for soil cement manufacture has been stockpiled on site. The soil-cement shall be placed in layers not more than 8 inches in thickness and shall be compacted to at least 95 percent of the maximum dry density at a moisture content of no more than 2 percent over optimum for the soils. The placement of the soil-cement shall be performed under the observation of the Project Geotechnical Consultant, who shall perform sieve analyses, compaction, unconfined compression, and moisture-density tests.

j. Vista Canyon Ranch Bridge

4.1-28 The Vista Canyon Ranch Bridge shall be constructed to extend the existing Lost Canyon Road across the Santa Clara River. Final construction plans shall be reviewed to ensure consistency with the Project Geotechnical Report. It is anticipated that the bridge will be founded on driven or cast-in-drilled-hole piles at bents and abutments.

k. Geotechnical Observation

4.1-29 The grading operations shall be observed by the Project Geotechnical Consultant. The Project Geotechnical Consultant shall, at a minimum, have the following duties:

- Observe the excavation so that any necessary modifications based on variations in the soil/rock conditions encountered can be made;
- Observe the exposed subgrade in areas to receive fill and in areas where excavation has resulted in the desired finished subgrade. The representative shall also observe proof-rolling and delineation of areas requiring overexcavation;
- Evaluate the suitability of on-site and import soils for fill placement; collect and submit soil samples for required or recommended laboratory testing where necessary;
- Observe the fill and backfill for uniformity during placement;
- Test fill for field density and compaction to determine the percentage of compaction achieved during fill placement;
- Geologic observation of all cut slopes, keyways, backcuts and geologic exposures during grading to ascertain that conditions conform to those anticipated in the report; and
- Observe benching operations; observe canyon cleanouts for subdrains, and subdrain installation.

8. CUMULATIVE IMPACTS

Generally, impacts related to geotechnical hazards are site-specific and, in this case, would be limited to development areas within the project site. Soil stability and erosive conditions for future development sites in the immediate vicinity of the project site are expected to be similar to those found on the project site. Buildings and facilities proposed under related projects are required to be sited, designed, and constructed in accordance with geotechnical, geologic, and seismic building codes. Future projects would also be expected to mitigate their respective impacts to a less than significant level with the implementation of site-specific/project-specific mitigation set forth in their respective soils and geotechnical reports. Additionally, any potential incremental contribution of the project to soil erosion is not cumulatively significant because the proposed project would reduce existing on-site wind- and water-driven erosion. Although the project site is located in an area that is seismically active and susceptible to liquefaction, the project would not contribute to significant geological and soils impacts. Therefore, the contribution to cumulative geological and soils impacts would be less than significant.

9. CUMULATIVE MITIGATION MEASURES

No significant cumulative geotechnical impacts would occur; therefore, no cumulative mitigation measures are required.

10. SIGNIFICANT UNAVOIDABLE IMPACTS

With implementation of the mitigation measures identified above, project-specific impacts related to geotechnical hazards would be reduced to a less than significant level. Additionally, cumulative impacts related to geotechnical hazards would be less than significant. Therefore, no unavoidable significant project-specific or cumulative impacts would occur.