4.4 GEOLOGY AND SOILS

SUMMARY

This section describes the existing geologic and soils conditions on the project site, and the potential for geotechnical hazards to affect the Via Princessa East Extension project. Soils on the project site are subject to landslides, erosion, hydro-compression, and expansion. 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, landslides, soil expansion, and soil collapse. The proposed project would involve over 100,000 cubic yards of grading, which could also be a significant impact. 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 measures, impacts would be reduced to a less than significant level. Cumulative impacts related to geotechnical hazards would also be less than significant.

INTRODUCTION

Information in this section was derived from the geotechnical analyses prepared specifically for the project site:

- Geologic/Geotechncial Report, "EIR-Level Review of Road Alignment for Via Princessa East from Golden Valley Road to 250 feet west of Sheldon Avenue," prepared by Allen E. Seward Engineering Geology, Inc., August 13, 2010

- Geologic/Geotechnical Report, "Via Princessa Road Alignment and Adjacent Parcels Feasibility Study," prepared by Allen E. Seward Engineering Geology, Inc., September 13, 2010

These documents are included in **Appendix 4.4** of this EIR. The geotechnical report characterizes surface and subsurface geologic conditions, identifies geologic hazards and liquefaction potential, and develops recommendations for mitigation of geologic hazards. 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.

Geologic/Geotechnical Report, "Via Princessa Road Alignment and Adjacent Parcels Feasibility Study," prepared by Allen E. Seward Engineering Geology, Inc., September 13, 2010 was necessary to describe the general landslide geometry, and the stability of the landslide, and preliminary recommendations for mitigation. This report was necessary to determine the extent of the landslide(s) present on the project site. Nearby property owners may use information in part, or in whole, for site-specific development in the future for respective development proposals. However, each property owner would be required to conduct site-specific geotechnical investigation prior to City review. The Geologic/Geotechnical Report, "Via Princessa Road Alignment and Adjacent Parcels Feasibility Study," prepared by Allen E. Seward Engineering Geology, Inc., September 13, 2010 will not be adequate nor solely appropriate for geotechnical review for adjacent property development.

EXISTING CONDITIONS

Regional Geology

The project site is located in the extreme western portion of the Soledad Basin in the western 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 Soledad Basin extends between the San Gabriel fault in the Newhall-Saugus area and the San Andreas Fault near Palmdale.

The vicinity surrounding the proposed road alignment has been affected by slope movements that range in size from small debris flows and surficial failures to large, deep-seated landslide failures.

Geomorphology

The site topography is dominated by northwesterly trending ridges, with drainages that descend to the northwest towards the Santa Clara River, which is located approximately 1.3 to 1.5 miles north of the site. Slope gradients in the hillside areas of the site are moderate with an average gradient of about 2:1. Ground surface elevations range from approximately 1,390 feet above mean sea level (msl) in the southwest portion of the site to approximately 1,830 feet above msl in the northeast portion of the site.

Geologic Units

Soil and bedrock materials encountered on site consist of the Sunshine Ranch Member of the Saugus Formation, Saugus Formation, alluvium, slopewash, residual soil, artificial fill and debris, and certified engineered fill.

Saugus Formation

This formation is exposed at the surface of nearly the entire site, but a large portion of it has been disturbed by landsliding. Intact Saugus Formation bedrock is located on the southwest portion of the site. The observed bedrock is dominated by moderately hard, light gray to yellowish-gray sandstone and conglomerate with local interbeds of greenish-gray siltstone and sandy siltstone, and uncommon reddish-brown mudstone in this area. Siltstone and mudstone units of the Saugus Formation are potentially expansive. Thin, low-strength clay seams occur in the mudstone.

Sunshine Ranch Member of the Saugus Formation

The Sunshine Ranch member at the project site is exposed at the ground surface in the northeast corner of the site. It consists primarily of massive silty sandstone, with interbeds of siltstone and clayey mudstones that dip gently to the northwest. This unit contains very weak, clay rich interbeds that act as the failure surface at the base of many of the mapped landslides in this area. The interpreted boundary/contact between the Sunshine Ranch Member of the Saugus Formation and the overlying portion of the Saugus Formation consists of a relatively continuous horizon informally known as the Friendly Valley Horizon that contains very weak clay deposits.

Alluvium

Minor amounts of recent river-channel deposits are present in the lower elevations of the project site, largely underlying the immediate modern drainage and major tributaries of the Santa Clara River. The alluvial deposits consist of interbeds of sandy, silty, and clayey soils with gravels and pebbles.

Slopewash

Swales and side-canyons in the vicinity of the proposed alignment commonly contain loose debris consisting of poorly sorted sand, silt, and bedrock fragments. This material has accumulated via daily surface wash and periodic debris flows and is present above levels where they are incorporated and reworked by modern stream flow. They are generally poorly consolidated.

Residual Soil

Ungraded areas of the site are mantled by surface soils consisting of moderate- to yellowish-brown and yellowish-gray silty sand with scattered pebbles. Soil developed in the alluvial flats and in the relatively flat mesa areas has been disturbed by past agricultural and grading activities.

Artificial Fill

Non-compacted artificial fill may be present along the proposed road alignment. These deposits would include minor spill fills generated during past grading of minor access roads.

Certified Engineered Fill

Certified engineered fill has been placed at the western portion of the proposed alignment during the construction of Golden Valley Road and Golden Valley High School.

Groundwater

Groundwater beneath the proposed project site is either contained in the recent alluvium or perched above low-permeability layers in the Saugus Formation and landslide deposits. The thickness of the alluvium is estimated to be approximately 25 feet or less beneath the project site. The closest water well is located adjacent to the Santa Clara River approximately 1.3 to 1.5 miles north of the project site. An alluvial aquifer is not present beneath the project site. Perched groundwater was encountered in the Saugus Formation bedrock and mapped landslide deposits during preliminary limited subsurface exploration of the site.

Seismicity

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.[1] 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.[2] 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

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

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

fault creep. Sudden displacements are more damaging to structures because they are accompanied by shaking.[3]

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 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.

The site is not located in a State of California Alquist-Priolo Earthquake Fault Zone. The closest active fault zone is the San Gabriel Fault Zone, which terminates approximately 3,200 feet northwest 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.

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

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

(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.

Ground Failure

Ground failure is a general term that refers to secondary, permanent ground deformation caused by strong earthquake shaking, including liquefaction of saturated granular deposits or fine-grained soils with low plasticity, lateral spreading, ground lurching, seismic settlement (dynamic densification) of loose, poorly consolidated materials, differential materials response, slope failure, sympathetic movement on weak bedding planes or non-causative faults, and shattered ridge effects.

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 cohesionless 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. Most of the project site is underlain by bedrock and/or landslide deposits that are not susceptible to liquefaction. The alluvium present in the narrow canyon areas of the site is not designated as potentially liquefiable on the State of California Seismic Hazard Zones Map.

Relatively loose granular alluvial soils located within the tributary canyon traversing the road alignment may be prone to dynamic densification as a result of future earthquake shaking. Potential for seismic settlement (dynamic densification) is negligible in the bedrock portions of the site.

Earthquake-induced slope failures include activation and reactivation of landslides, rock falls, debris flows, and surficial failures. Numerous large, deep-seated landslides have been mapped at the proposed road alignment. The potential for earthquake-induced slope failures is moderate to high on the landslide-affected portions of the site and on the steep canyon slopes. Most of the hillside areas directly adjacent to the proposed road alignment are designated on the State of California Seismic Hazard Zones Maps to have potential for earthquake-induced slope instability.

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. A large landslide complex and smaller landslides have been mapped along the subject road alignment as shown on **Figure 4.4-1, Geologic Map of the Project Site**. Based on preliminary investigation of the large landslide complex and review of previous geologic and geotechnical studies performed at the site and vicinity, it is determined that the large landslide consists of a relatively continuous geologic horizon that contains very weak clay deposits informally called the Friendly Valley Horizon. Based on preliminary geologic exploration, this landslide complex is estimated to be up to approximately 140 feet thick at the location of the proposed road alignment.

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.

REGULATORY FRAMEWORK

Federal Regulations

No specific federal regulations were identified that impact the geology and soils considerations. State and local regulations (e.g., building codes) reflect national and international building codes and are discussed below.

State Regulations

The California Geological Survey (CGS)[4] is responsible for enforcing the Alquist-Priolo Earthquake Fault Zoning Act and enforcing the Seismic Hazards Mapping Act. Both are described below.

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

Alquist-Priolo Earthquake Fault Zoning Act

The purpose of Alquist-Priolo Earthquake Fault Zoning Act (formerly called the Alquist-Priolo Special Studies Zones Act)[5] 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).

Seismic Hazards Mapping Act

Under the CGS's Seismic Hazards Mapping Act,[6] 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 guidance on the evaluation and mitigation of earthquake-related hazards for projects within designated zones of required investigations.[7]

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.

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5 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.)

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

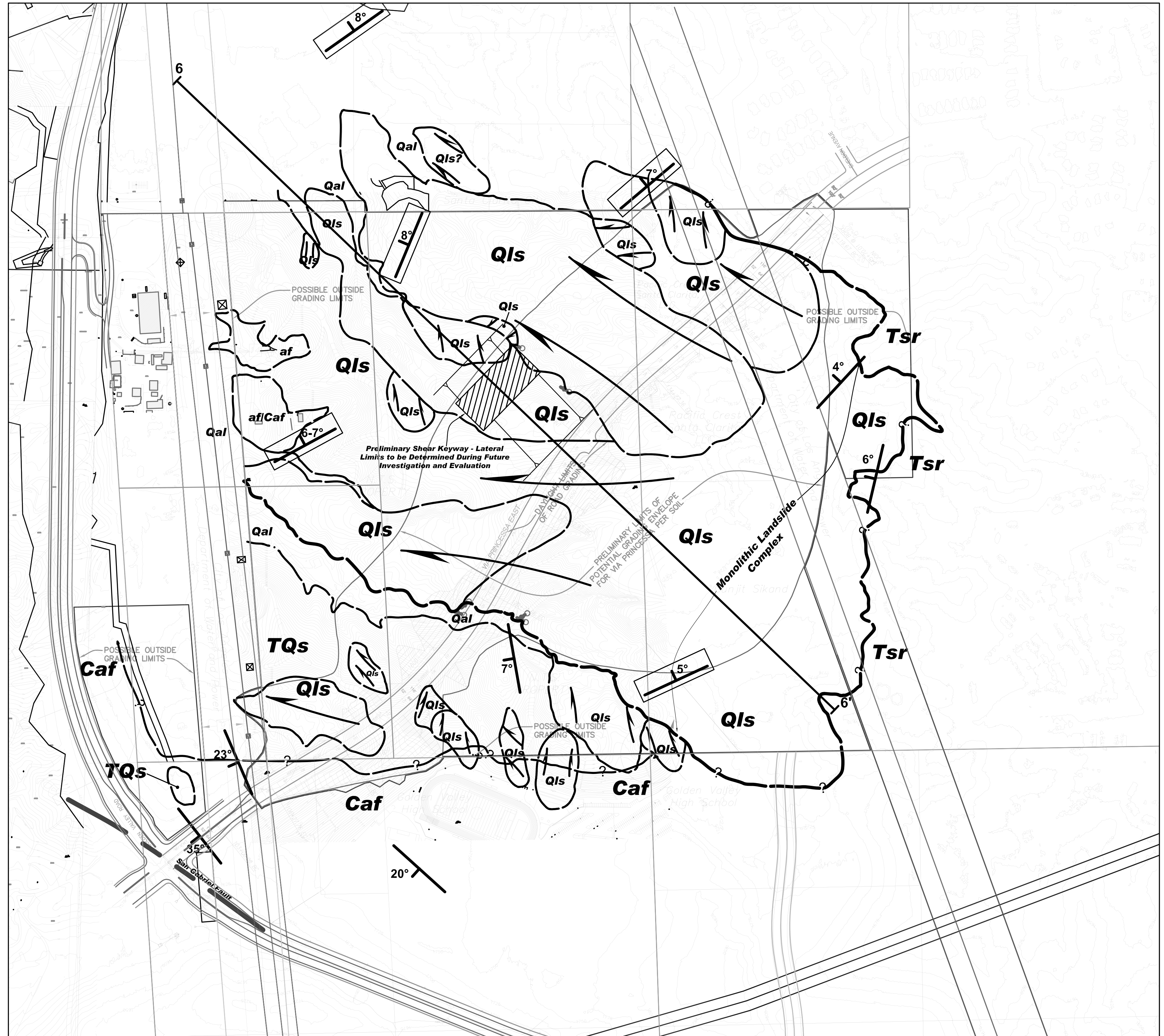
7 California Geological Survey, "Special Publication 117, Guidelines for Evaluating and Mitigating Seismic Hazards in California," 1997.

LEGEND

Caf	Compacted Artificial Fill
af	Artificial Fill
Qal	Quaternary Alluvium
Qls	Quaternary Landslide
TQs	Saugus Formation
Tsr	Sunshine Ranch Member (Upper Facies) of the Saugus Formation
6 — 6′	Geologic Cross Section
?	Geologic Contact for Megalithic Landslide Complex; Queried Where Inferred
?	Geologic Contact; Queried Where Inferred
7°	Regional Bedding Attitude
6°	Bedding Attitude Beneath Landslide
	Seep
	San Gabriel Fault

500 250 0 500

APPROXIMATE SCALE IN FEET



SOURCE: Allan E. Seward Engineering Geology, Inc. – August 2010

FIGURE **4.4-1**

Geologic Map of the Project Site

112-028•12/10

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.

Local Regulations

City of Santa Clarita Unified Development Code

All grading and excavation must comply with Chapters 17.20 to 17.30 (Division 3) of the City of Santa Clarita Unified Development Code (UDC). Rules and regulations contained within these chapters provide for the control of excavation, grading, and earthwork construction, including fills or embankment activities. During the grading permit application process, the City Engineer may require engineering geological and soil reports, as well as seismic hazard zone studies be prepared for proposed developments. The engineering geological report would require an adequate description of the geology of the site, along with conclusions and recommendations regarding the effect of geologic condition of any proposed development. Soil reports would be required to characterize the existing soil resources on a site, and provide recommendations for grading and design criteria. Development in seismic hazard zone will require studies that evaluate the potential for seismically induced liquefaction, soil instability, and earthquake induced landslides to occur on a site.

PROJECT IMPACTS

Significance Threshold Criteria

According to Appendix G of the *State CEQA Guidelines*, the project would normally have a significant effect on the environment if it would

- expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
  - 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*);
  - strong seismic ground shaking;
  - seismic-related ground failure, including liquefaction; or
  - landslides;
- result in substantial soil erosion or the loss of topsoil;
- 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;
- be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property; or
- 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.

The proposed project is a public improvement project that will not utilize wastewater facilities or septic tanks. Consequently, no further analysis is required for this threshold.

The *City of Santa Clarita Local CEQA Guidelines* (Resolution 05-38) adopted on April 26, 2005, also serve as the basis for identifying thresholds to determine the significance of the environmental effects of a project on this resource area. This threshold is also included for analysis.

- There will be a significant impact if the project were to include movement or grading of earth exceeding 100,000 cubic yards.

Impact Analysis

Impact Threshold 4.4-1 **Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:**

- **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*); strong seismic ground shaking; seismic-related ground failure, including liquefaction; or landslides**

Ground Rupture

Rupture is primarily of concern where a project site overlies or is immediately adjacent to a known fault. No known faults are located within the project area with the nearest known fault approximately 3,200 feet from the project site. Therefore, the impacts related to the rupture of a known earthquake fault would be less than significant.

Ground Shaking

The proposed project is located in Southern California, a geologically and tectonically active region, where large magnitude, potentially destructive earthquakes are common. Therefore, ground motions from moderate or large magnitude earthquakes could affect the project site during the design life of the project.

The nearest fault is the San Gabriel Fault located approximately 3,200 feet northwest of the project area. Other faults in the vicinity include the Holser, Northridge, Santa Susana, and Sierra Madre-San Fernando. The most likely significant event in the area could occur along the San Andreas Fault, located 18 miles northeast of the City.

The current standards for construction provided in the CBC are designed to safeguard against major failures and loss of life, but are not intended to prevent damage, maintain function, or provide for easy repair. Conformance to code standards does not constitute any kind of guarantee or assurance that significant structural damage will not occur in the event of a maximum level of earthquake ground motion. However, it is reasonable to expect that a well-planned and constructed structure would not collapse in a major earthquake and that protection of life would be reasonably provided, but not with complete assurance. Therefore, potential impacts would be less than significant as the project is an infrastructure project and contains no habitable structures and would be constructed to the most current CBC standards.

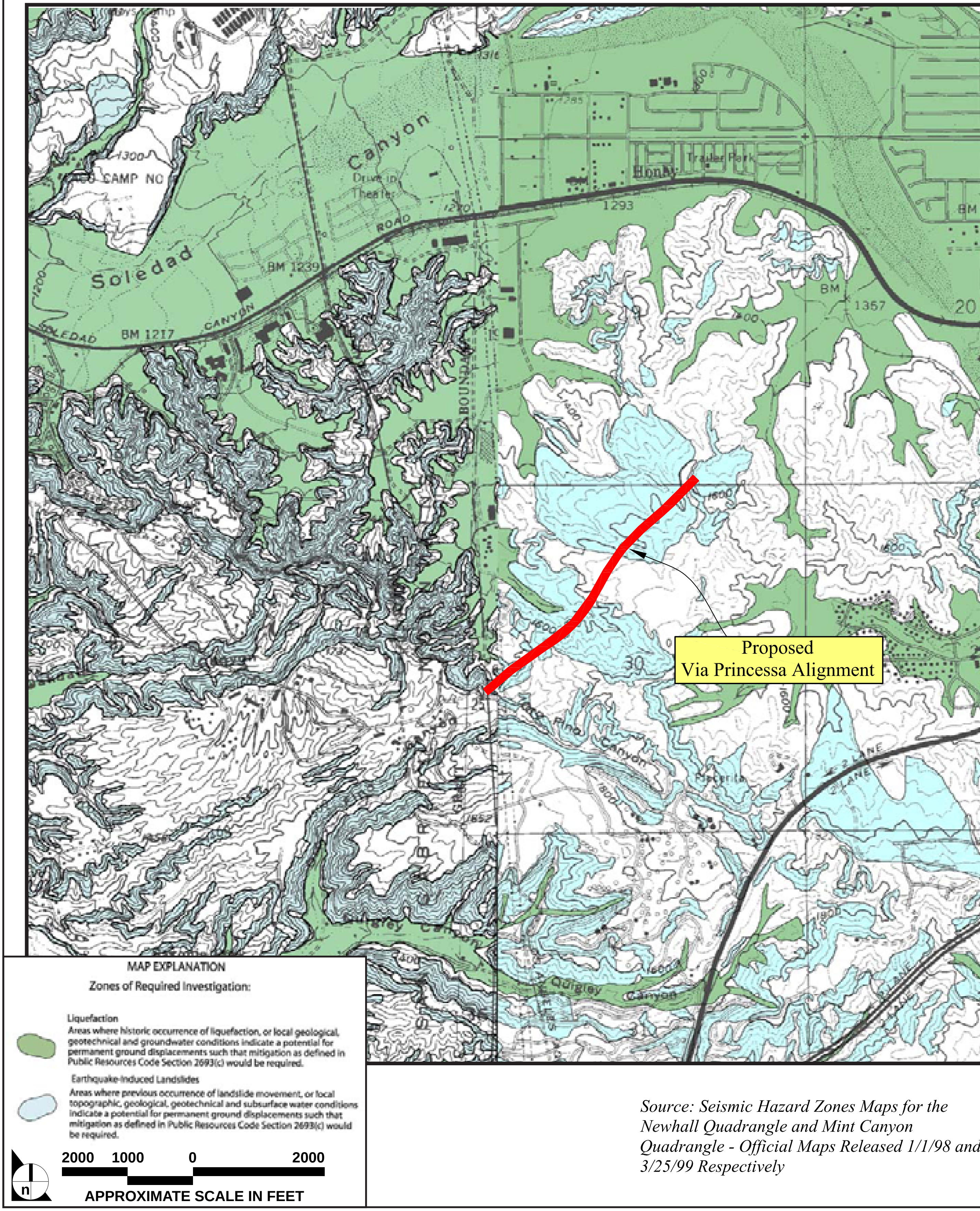
Ground Failure

Ground failure is a general term for seismically induced, secondary, permanent ground deformation caused by strong ground motion. This includes liquefaction, lateral spreading, ground lurching, seismic settlement of poorly consolidated materials (dynamic densification), differential materials response, sympathetic movement on weak bedding planes or non-causative faults, slope failures, and shattered ridge effects.

Most of the site is underlain by bedrock and/or landslide deposits that are not susceptible to liquefaction. The alluvium present in the narrow canyon areas of the site is not designated as potentially liquefiable on the State of California Seismic Hazard Zones Map as shown on **Figure 4.4-2, Seismic Hazard Zones Map**. Therefore, potential impacts from seismically induced liquefaction would be less than significant.

Potential for dynamic densification is negligible in the bedrock portions of the site, although relatively loose granular alluvial soils located within the minor tributary canyon traversing the project site could be prone to dynamic densification as a result of future earthquake shaking. Typically, the potential for dynamic densification of these materials can be mitigated by removing the materials and replacing them with compacted fill.

The potential for earthquake-induced slope failures is moderate to high on the landslide-affected portions of the site and on the steep canyon slopes. Most of the hillside areas directly adjacent to the proposed road alignment are designated to have potential for earthquake-induced slope instability as shown on **Figure 4.4-2**. Numerous large, deep-seated landslides have been mapped on the project site. The proposed cut and fill grading for the proposed project would eliminate some of these areas. Cut and fill slopes constructed per the Uniform Building Code typically are not subject to earthquake-induced failures. Nevertheless, potential impacts related to earthquake-induced landslides may be significant.



Source: Seismic Hazard Zones Maps for the Newhall Quadrangle and Mint Canyon Quadrangle - Official Maps Released 1/1/98 and 3/25/99 Respectively

SOURCE: Allan E. Seward Engineering Geology, Inc. – August 2010

FIGURE **4.4-2**

Seismic Hazard Zones Map

Mitigation Measures

MM 4.4-1 The potential for seismic settlement (dynamic densification) during future seismic events shall be evaluated during the planning and design stages in the alluvial, slopewash, and landslides area of the project site.

MM 4.4-2 All mapped landslides shall be confirmed by subsurface exploration during the planning and design stages. All confirmed landslides shall be evaluated with respect to the proposed road alignment and specific mitigation measures shall be provided where necessary. Possible mitigation would include complete or partial removal, adding shear keyways, buttressing, or avoidance. Restricted Use Areas shall be established around any unmitigated landslide in open space areas.

Residual Impacts

Subject to implementation of mitigation measures, impacts would be less than significant.

Impact Threshold 4.4-2 Result in substantial soil erosion or the loss of topsoil

Evidence of erosion was observed during the preliminary site investigation in soil and landslide deposits that mantle slopes at the project site. Bedrock at the site is less susceptible to erosion than the overlying soil and landslide material. However, fill, bedrock, landslide deposits, and soil material at the site would be susceptible to erosion if drainage features to control sheet flow over the ground surface are not provided.

During construction of the proposed project, the soils on the site would become exposed, and thus subject to erosion. However, the project is required to comply with existing regulations that reduce erosion potential. The proposed project would comply with South Coast Air Quality Management District (SCAQMD) Rule 403, which would reduce the potential for wind erosion. Similarly, water erosion during construction would be substantially reduced by complying with the National Pollution Discharge Elimination System (NPDES) permit requirements. As further detailed in **Section 4.7, Hydrology and Water Quality**, NPDES requires the construction of the project to incorporate Best Management Practices (BMPs) to reduce erosion and prevent eroded soils from washing off site.

According to the Geologic/Geotechnical Report prepared by Allan E. Seward Engineering Geology, Inc., the project site consists of Saugus Formation, alluvium, slopewash, residual soil, artificial fill, and certified engineered fill. Potential operational impacts due to erosion would be less than significant as the proposed improvements would cover the area with asphalt or concrete.

Mitigation Measures

No mitigation measures are required.

Residual Impacts

Impacts would be less than significant.

Impact Threshold 4.4-3 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

A large landslide complex and smaller landslides have been mapped beneath the project site as previously discussed and as shown on **Figure 4.4-1, Geologic Map of Project Site**. Based on preliminary investigation of the large landslide complex and review of previous geologic and geotechnical studies performed at the site and vicinity, the landslide contains very weak clay deposits informally called the Friendly Valley Horizon. This horizon is located at the boundary between the Sunshine Ranch member of the Saugus Formation and the overlying coarser-grained portion of the Saugus Formation. Based on preliminary geologic exploration, this landslide complex is estimated to be up to approximately 140 feet thick at the location of the proposed road alignment. Preliminary stability analyses indicate that the gross stability of the landslide complex does not satisfy standard of practice requirements. Therefore, potential impacts related to landslides may be significant. All mapped landslides would have to be investigated and evaluated and would require geologic and geotechnical analyses to determine stability and compressibility of the landslide material that would be exposed in the proposed graded areas.

Sediments such as slopewash, alluvium, and landslide debris commonly contain extensive voids and, as a result, are subject to hydro-compression (collapse) settlement when inundated. Hydro-compression occurs when water enters sediments and reorients the sediment particles into a more compact arrangement with fewer and smaller voids. Structures constructed over deposits prone to hydro-compression may experience settlement-induced distress and damage. Only one small canyon of the proposed road alignment contains alluvium. The risk of collapse in this area of the project site would be a potentially significant impact. Other alluvial soils on the project site are relatively shallow and would be removed during grading of the proposed road alignment. The phenomenon of hydro-compression does not apply to the bedrock deposits that underlie most of the project site.

Mitigation Measures

The following mitigation measures shall be implemented.

MM 4.4-3 During the planning and design stages, additional geologic and geotechnical investigations shall be performed to refine the three dimensional geometry and geotechnical characteristics of the various landslides within the landslide complex.

MM 4.4-4 See **MM 4.4-2**.

MM 4.4-5 Prior to issuance of a grading permit, additional hydro-compression or consolidation testing shall be conducted to aid in evaluation of settlement within identified geologic units during future geotechnical investigations for grading plans. Possible mitigation of settlement of project soils would include removal and recompaction of loose or soft material.

Residual Impacts

Subject to implementation of mitigation measures, impacts would be less than significant.

Impact Threshold 4.4-4 Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property

Fine-grained units of the Saugus Formation are known to have significant expansion potential when exposed to water. In addition, artificial fill, slopewash, and alluvium deposits present at the site may contain material with significant expansion potential. The alluvial materials on the project site are generally granular and are not typically expansive in nature. Potential removal and recompaction of shallow, loose soils may be required at the site. The native soils are expected to shrink in volume when placed as compacted fill. Therefore, this impact would be potentially significant.

Mitigation Measures

The following mitigation measures shall be implemented.

MM 4.4-6 Expansive materials at the site shall be evaluated by the project Geotechnical Engineer during the grading plan stage of development. Expansion potential of site soils can be mitigated by controlling the water content and density of fill soils, by specifying embedment and reinforcement of structures, and by removing the expansive materials and replacing them with compacted material with low expansion potential.

MM 4.4-7 The expansion index of the site materials shall be verified with laboratory testing at the grading plan stage. If expansive materials are encountered, options to mitigate potential adverse effects include special foundation designs and reinforcement, removal and replacement with soil with low to non-expansive characteristics, or treatment with additives to lower the expansion potential.

Residual Impacts

Subject to implementation of mitigation measures, impacts would be less than significant.

Impact Threshold 4.4-5 Include movement or grading of earth exceeding 100,000 cubic yards

The proposed project would involve approximately 551,590 cubic yards of cut and 210,530 cubic yards of fill. The excess cut material (341,060 cubic yards) would be balanced on site. While this amount of grading exceeds the threshold of 100,000 cubic yards, it would not result in a significant geotechnical impact as long as the geotechnical considerations/mitigation measures are implemented as identified in the geotechnical analysis in **Appendix 4.4**.

The proposed project would also require coverage under the statewide General Permit for discharge associated with construction activities pursuant to National Pollution Discharge Elimination System (NPDES) requirements. A storm water pollution prevention plan (SWPPP) shall be prepared along with a grading plan to fulfill the requirements of the State of California General Permit. The grading plan would require approval by the City Engineer prior to issuance of a grading permit. Implementation of the mitigation measures and compliance with applicable regulations would reduce this potentially significant impact to a less than significant level.

Mitigation Measures

Additional mitigation measures are not required.

Residual Impacts

Subject to implementation of mitigation measures, impacts would be less than significant.

DESIGN MEASURES ALREADY INCORPORATED INTO THE PROJECT

Recommendations provided by the geotechnical engineer identified in *Geologic and Geotechnical Report; EIR-Level Review of Road Alignment for Via Princessa East from Golden Valley Road to 250 Feet West of Sheldon Avenue*, prepared by Allan E. Seward Engineering Geology, Inc., and dated August 13, 2010, shall be incorporated as standard conditions of approval for the proposed project.

The recommendations are as follows:

- All slopes shall be evaluated by the project Geotechnical Engineer at the planning and design stages.
- All mapped landslides shall be confirmed by subsurface exploration relative to their existence at the planning and design stages. All confirmed landslides shall be evaluated with respect to the proposed road alignment and mitigation measures shall be provided where necessary. Mitigation measures shall consist of complete or partial removal, adding shear keyways, buttressing or avoidance. Restricted Use Areas shall be established around any unmitigated landslides in open space areas.
- Proposed cut slopes anticipated to expose landslide material shall be evaluated. These cut slopes may be stabilized with buttress fills or shear keys designed by the project Geotechnical Engineer. These cut slopes may also be redesigned to avoid landslides.
- All cut slopes shall require subsurface investigation at the planning and design stages to determine site-specific geologic conditions. Cut slopes with daylighted bedding conditions shall be evaluated by the Geotechnical Engineer. Cut slopes that do not comply with agency's required minimum factors of safety for static and pseudo-static conditions and/or are anticipated to expose landslide material would require corrective measures such as buttresses or stability fills, or would need to be redesigned to a more stable configuration.
- A study shall be conducted at the planning and design stages for all proposed natural slopes with daylighted bedding conditions. This study shall include subsurface investigation to determine the specific geologic conditions for evaluation by the Geotechnical Engineer. Building/structural setbacks or remedial measures would be required where ascending or descending slopes are not stable as determined by geologic or geotechnical stability analyses.
- A study should be conducted to evaluate potential debris flow hazards on the subject site. Avoidance of the hazard by selective structural locations, construction of impact or debris walls and/or debris basins, control of run-off or removal of loose surficial materials can be used to mitigate debris flow hazards.
- Rapidly buried silty sediments such as thick slopewash, alluvium, and/or landslide debris may be subject to hydro-compression. Materials containing significant void space initially observed in the field and if characterized as susceptible to hydro-compression tests in the laboratory shall be removed prior to the placement of fill. A study shall be conducted to evaluate the hydro-compression potential of the thick slopewash deposits and portions of the alluvium and landslide debris. Specific recommendations shall be provided at the planning and design stages.

- A study shall be conducted to evaluate the expansive potential of the fine-grained units of the Saugus Formations during the planning and design stages. If these potentially expansive units are encountered in the final pad or street grades during construction, they shall be evaluated by Expansion Index (EI) tests by the project Geotechnical Engineer relative to mitigations by special foundation designs and reinforcement. Alternatively, the expansive material can be removed to a specified depth determined by the project Geotechnical Engineer and replaced with soil with very low to non-expansive characteristics. Alternatively, the expansive soil may be treated with additives to lower the expansion potential.

- Soils on site may be corrosive to concrete and ferrous metals. Testing during development shall indicate what special measures, such as cement type in concrete and corrosion protection for metallic pipes, may be required for construction.

- Numerous landslides have been identified at the subject site. If unknown landslides are encountered during development, their potential impact shall be evaluated, including development of mitigation measures such as avoidance (setbacks), construction setbacks, complete or partial removal, construction of buttresses and or shear keyways, etc., where necessary. Restricted Use Areas shall be established around any unmitigated landslides in open space areas that do not affect proposed development or adjacent properties.

- All of the proposed cut slopes shall be evaluated for gross and surficial stability and remediated where necessary. Cut slopes that do not comply with the applicable agency's stability requirements shall require corrective measures, such as avoidance (setbacks), cutting back to a shallower slope gradient, or constructing buttresses and/or shear keys with compacted fill.

- Planting and irrigation of cut slopes and fill slopes shall be included in future design phases in order to improve surficial stability of slopes and to mitigate potential for erosion.

CUMULATIVE IMPACTS

Geotechnical impacts are site specific in nature and each development site is subject to, at minimum, uniform site development and construction standards relative to seismic and other geologic conditions that are prevalent within the locality and/or region. Because the development of each site would have to be consistent with City of Santa Clarita requirements for projects in the City and the Unified Development Code as they pertain to protection against known geologic hazards, impacts of cumulative development would be less than significant given known geologic considerations.

CUMULATIVE MITIGATION MEASURES

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

UNAVOIDABLE SIGNIFICANT IMPACTS

With implementation of the above-identified mitigation measures, project-specific impacts associated with geology and soils would be reduced to less than significant. Therefore, no unavoidable significant project-specific impacts are anticipated.