

2.6 Geology and Soils

This section describes the existing geology, soils, and seismic conditions within the Project Area and off-site infrastructure improvement areas, and evaluates the potential impacts related to seismic hazards, underlying soil characteristics, slope stability, erosion, and excavation that may result from implementation of Otay Ranch Village 14 and Planning Areas 16/19 (Proposed Project). The primary source of the information contained in this section is from the Geotechnical Review of Preliminary Tentative Map and Grading Plan, Otay Ranch Village 14 and Planning Areas 16/19, County of San Diego, California (Geotechnical Review Report), which is included in Appendix 2.6-1 of this environmental impact report (EIR). The Geotechnical Review Report was prepared by Advanced Geotechnical Solutions Inc.

This section tiers from the 1993 Otay Ranch Final Program EIR (Otay Ranch PEIR) (City of Chula Vista and County of San Diego 1993a) because the Proposed Project is within the boundaries of the Otay Ranch General Development Plan/Otay Subregional Plan, Volume II (Otay Ranch GDP/SRP) (City of Chula Vista and County of San Diego 1993b), and development of the Project Area was analyzed in the Otay Ranch PEIR. The Otay Ranch PEIR analyzed geology and soils and determined that implementation of mitigation measures would reduce impacts to below a level of significance through site-specific geotechnical and soils investigations and compliance with applicable building codes. Since certification of the Program EIR, conditions in the Project Area with respect to geology and soils have not changed substantially. Nonetheless, the development concept for the Proposed Project has been further refined and more precise and site-specific technical analyses were performed to determine the potential impacts of the Proposed Project. Accordingly, this analysis for the Proposed Project is different than that contained within the Otay Ranch PEIR because it specifically considers the Project Area, which is a subset of Otay Ranch. As a result, this EIR's determinations regarding potential impacts to geology and soils and mitigation requirements is specific to the Proposed Project.

2.6.1 Existing Conditions

2.6.1.1 Environmental Setting

Geologic Setting

The Project Area is located in the lower Peninsular Range region of San Diego County (County), a subset of the greater Peninsular Ranges Geomorphic Province of California. The Peninsular Ranges Geomorphic Province is approximately bounded to the east by the Elsinore Fault Zone, to the north by the Transverse Ranges, to the south by Baja California, and to the west by the Pacific Ocean. This portion of the Peninsular Ranges is underlain by Jurassic and

Cretaceous plutonic rocks of the Peninsular Ranges Batholith, which contains screens of variably metamorphosed Mesozoic supracrustal rocks. Late Jurassic and Early Cretaceous volcanic and volcanoclastic rocks exposed southwest of the Elsinore Fault Zone represent an older superjacent part of the Peninsular Ranges magmatic arc. These basement rocks are non-conformably overlain by a thick sequence of relatively undisturbed sedimentary rocks ranging from upper Cretaceous to Pleistocene in age.

More specifically, the Project Area is located near the eastern edge of the coastal plain at the contact with the metavolcanic rocks of the Jamul Mountains. Geologically, the Project Area is underlain by two principal rock types: the Late Jurassic- to early Cretaceous-age metavolcanic rocks of the Santiago Peak Volcanics and the Tertiary-age sedimentary rocks of the Otay Formation. The Otay Formation is informally subdivided into three subunits: an upper sandstone–claystone member, a middle gritstone member, and a basal angular-clast conglomerate member. Minor exposures of upper Pleistocene older alluvium exist locally as relatively flat-lying river terraces, and unconsolidated alluvium of Holocene age occupies the active drainages within the Project Area.

Stratigraphy

A basement complex consisting of Mesozoic-aged pre-Batholithic volcanic and metavolcanic rocks underlies the Project Area at depth and is exposed at the surface at higher elevations in the easterly and northerly portions of the Project Area. The basement rocks are non-conformably overlain by Tertiary-age sedimentary bedrock, which is subsequently mantled by Quaternary-age surficial soil units.

Soils and Geologic Formations

Soils

The surficial soil types found within the Project Area include undocumented artificial fill (afu), topsoil/colluvium, young alluvium (Qal), older alluvium (Qoal), and landslide debris (Qls). More detailed descriptions of these units are presented below.

Artificial Fill (afu)

Although not encountered during the subsurface exploration, undocumented artificial fill soils were observed locally at the Project Area. The undocumented fills are primarily located along the current alignment of Proctor Valley Road as embankment fills for the road and associated culverts. Based on limited observed exposures, these materials can generally be described as clayey to gravelly sands with abundant rock fragments in a dry to slightly moist and loose to moderately dense condition. In addition, minor undocumented fills exist locally within the

Project Area along existing unpaved roads and trails, some of which have been used for unauthorized off-highway-vehicle use. In consideration of the limited extent of the material and the plan scale, these fills are not mapped.

Topsoil/Colluvium (no map symbol)

Undifferentiated topsoil and colluvium exist throughout the Project Area as a thin soil veneer. Thicker accumulations commonly occur near the base of slopes and natural topographic swales. As encountered, these materials ranged from less than 1 foot to 4 feet in thickness and are generally composed of silty to clayey sand and sandy clay in a dry to slightly moist and loose to moderately dense condition. Roots and minor to moderate porosity are common.

Alluvium (Qal)

Young alluvial deposits occupy the bottoms of the primary and tributary drainages within the Project Area. These materials can generally be described as silty to clayey sand with gravel and small rock fragments in a dry to moist and loose condition and sandy clay in a moist and soft condition.

Older Alluvium (Qoal)

Older alluvium occurs within the Project Area as moderately dissected terraces that flank modern drainage channels/valleys. The older alluvium consists of poorly bedded, poorly to moderately well consolidated sand to boulder-sized sediment in a clayey sand matrix. Clasts are generally subangular to subrounded. Matrix soils are commonly rubified and locally exhibit weak cementation.

Landslide Debris (Qls)

Postulated landslide debris is mapped outside the Project Area, near the central portion of the site, southeasterly and adjacent to the proposed alignment of Proctor Valley Road. Subsurface exploration was not performed in this area because it is outside of the proposed Development Footprint limits. However, strong geomorphic evidence suggests the presence of landslide debris.

Geologic Formations

Otay Formation–Fanglomerate (Tof)

Regional mapping of the El Cajon 30- by 60-foot quadrangle by Todd (2004) identifies the unit as an unnamed fanglomerate of Pliocene and Miocene age. Tan (2002) identifies the unit in the Jamul Mountains 7.5-minute geologic map (USGS 1994) as Otay Formation–Fanglomerate of Oligocene and Miocene age. In consideration of the non-conformable contact with the underlying Santiago Peak Volcanics, the presence of intertongued lenses of bentonitic sandstone and claystone common to the Otay Formation, and the presence of Otay Formation overlying the

fanglomerate facies west of the Project Area, the fanglomerate unit can be considered to be roughly coeval with the Otay Formation and are following Tan's (2002) designation.

The Otay Formation–Fanglomerate underlies much of the Project Area and occupies the lower flanks and valleys of the highlands to the east and north of the Project Area. The fanglomerate has a more subdued topography and is moderately to highly dissected. This unit is typified by thickly to massively bedded breccia intertwined with a finer-grained subunit consisting of claystone and sandstone. The breccia subunit is generally in a slightly moist to moist and moderately hard to hard condition. The breccia subunit is composed of subangular to angular gravel to cobble-sized clasts in a clayey sand matrix. Occasional to common boulder-sized clasts were encountered in borings and excavator test pits. Rock clasts appear to be locally derived from the Santiago Peak Volcanics. The clay matrix is commonly waxy and highly expansive, and is likely bentonitic. The finer-grained subunit is generally composed of olive-gray to pale brownish-yellow, sandy claystone and clayey sandstone in slightly moist to moist and soft to hard condition.

Santiago Peak Volcanics (Jsp)

The Project Area is underlain by Jurassic-age Santiago Peak Volcanics at depth and outcrops at the surface primarily in the eastern and northern portions of the Project Area. The contact between the Santiago Peak Volcanics and the overlying younger geologic units represents a significant geologic hiatus. This contact is irregular and reflects a relatively high-relief Mesozoic landscape. Subsequent erosion has exhumed portions of this ancient landscape, creating modern topographic highs including San Miguel Mountain to the north and the Jamul Mountains to the east.

The Santiago Peak Volcanics are generally dense and mildly metamorphosed volcanic rocks. Composition of the volcanic rocks varies from basalt to rhyolite, but is predominantly dacite and andesite. Typically, the metavolcanics display crude to moderate bedding and foliation. Fracturing is poorly to moderately well developed. In general, outside of boulder areas, a weathered halo only a few feet thick exists. Below this, the rock is very dense and hard.

Geologic Structure

The Otay Formation rests non-conformably over metavolcanic basement rock of the Santiago Peak Volcanics. Geologic structure within the sedimentary Otay Formation is typically characterized by regional westerly to southwesterly dipping beds with inclinations on the order of 3 to 7 degrees from horizontal. However, geologic mapping by Tan (2002) shows a bedding attitude within the fanglomerate having a northeasterly strike with a 30-degree dip to northwest. Crude bedding observed within the Otay Formation as encountered during the subsurface exploration was generally flat-lying to very slightly dipping to the west and east. Contacts

between the breccia (fanglomerate) and finer-grained subunits are conformable and typically near horizontal to undulatory and indicative of scour and fill type successions.

Dominant foliations, fracture patterns, and other structural features common to bedrocks were not mapped during the geotechnical review. Geologic mapping by Tan (2002) shows foliation in the Santiago Peak Volcanics as predominantly striking northwest to north-northeast and dipping steeply to the west and east. Lineaments identified by air photo analysis are also presented on this map and strongly correlate with the local foliation.

Faults and Seismicity

Regional Faulting

The San Andreas Fault Zone is the dominant and controlling tectonic stress regime of Southern California. As the boundary between the Pacific and North American structural plates, this northwest-trending, right-lateral strike-slip active fault has controlled the crustal structural regimes of Southern California since Miocene time. Numerous related active fault zones with a regular spacing, including the Elsinore–Whittier–Chino, Newport–Inglewood–Rose Canyon, and San Jacinto Fault Zones characterize the stress regime and also trend to the northwest as do the Santa Ana Mountains and the Peninsular Ranges.

The Silver Strand section of the Newport–Inglewood–Rose Canyon fault zone is the closest known active fault to the Project Area and is located approximately 15 miles to the west.

Local Faulting

Alquist–Priolo County Special Studies Fault Zones and San Diego County Fault Zones are not located within the Project Area (Appendix 2.6-1). The most influential geologic fault potentially affecting the Project Area is the active Silver Strand section of the Newport–Inglewood–Rose Canyon Fault Zone. La Nacion Fault is located approximately 6 miles west of the Project Area. La Nacion Fault is currently considered to be a potentially active fault, having evidence of displacement within the Quaternary Period. Some recent, independent reports indicate that there is evidence to support classification as an active fault (movement within the last ~11,000 years) (Appendix 2.6-1).

No faults have been mapped within the Project Area on published geologic maps and none were observed during the geotechnical investigation conducted by Advanced Geotechnical Solutions Inc. (Appendix 2.6-1). Outside the Project Area to the northwest, lineaments were observed both in the field and on aerial photos. These lineaments occur in the Santiago Peak Metavolcanics and are considered to be related to foliation in the metamorphic rock and not related to faulting (Appendix 2.6-1).

Ground Shaking

The Project Area is located in the tectonically active Southern California area, and would likely experience shaking effects from earthquakes. All of San Diego County is located within Seismic Zone 4 (Section 1629.4.1 of the California Building Code (CBC)), which is the highest seismic zone, and, like most of Southern California, is subject to ground shaking. In 1997, the Uniform Building Code (replaced by the International Building Code (IBC) in 2000) incorporated Near-Source Shaking Zones for calculating base shear, which accounts for high motion and damage observed within a few kilometers of historic earthquake ruptures. As described in Appendix 2.6-1, several Near-Source Shaking Zones occur in the County, based on data from the County of San Diego. Active faults in the unincorporated portion of the County were classified as A or B in accordance with the criteria specified in 1997 Uniform Building Code Table 16-U.

Type A faults are capable of producing earthquakes with a moment magnitude 7.0 or greater, and include segments of the San Jacinto and Elsinore Fault Zones. Type B faults, which make up the majority of the rest of the seismogenic faults in California, include segments of the San Jacinto, Elsinore, and Rose Canyon Fault Zones. Near-source velocity effects need to be considered in the design of buildings within 15 kilometers (9 miles) of a Type A fault and 10 kilometers (6 miles) of a Type B fault. The Project Area is within Zone B due to its proximity to the La Nacion Fault (i.e., the Project Area is within 10 kilometers of the La Nacion Fault).

Liquefaction

Liquefaction is the phenomenon where seismic agitation of loose, saturated sands and silty sands can result in a buildup of pore pressures that, if sufficient to overcome overburden stresses, can produce a temporary quick condition. Localized, loose lenses/layers of sandy soils may be subject to liquefaction when a large and prolonged seismic event affects the site. As the excess pore water pressure dissipates, the liquefied zones/lenses can consolidate, causing settlement. Post-liquefaction effects at a site can manifest in several ways and may include ground deformations, loss of shear strength, lateral spread, dynamic settlement, and flow failure.

In general, the more recently sediment has been deposited, the more likely it is to be susceptible to liquefaction. Further, liquefaction potential is greatest in loose, poorly graded sands and silty sands with mean grain size in the range of 0.1 to 0.2 millimeters (0.004 to 0.008 inches). Other factors that must be considered are groundwater, confining stresses, relative density, and intensity and duration of ground shaking. It is generally held that soils possessing clay content (particle size <0.005 millimeters (0.0002 inches)) greater than 15% to 20% may be considered non-liquefiable (SCEC 1999).

The State of California (CGS 2008) has mandated that the California Geological Survey identify areas that may be susceptible to liquefaction and provide U.S. Geological Survey quadrangle maps showing these zones, establish procedures for investigating same, and ensure that local agencies require such studies prior to a project's approval. Similarly, the County of San Diego has established its study zones. The Project Area is not located within a state liquefaction susceptibility zone; however, localized areas of the Proposed Project are situated within an area zoned by the County of San Diego as a Potential Liquefaction Area (Appendix 2.6-1). The area identified by the County of San Diego as potentially susceptible to liquefaction appears to be related to young alluvial soils contained within the primary drainage north of Upper Otay Reservoir but, likely due to scale, the County's mapped boundary extends beyond the limits of the drainage and includes areas not susceptible to liquefaction.

Landslides

Landslides occur when masses of rock, earth, or debris move down a slope, including rockfalls, deep failure of slopes, and shallow debris flows. Landslides are influenced by human activities such as grading and other construction activities, irrigation of slopes, and mining activities, and by natural factors such as precipitation, geology/soil types, surface/subsurface flow of water, and topography. Landslides may also be triggered by floods and earthquakes (County of San Diego 2007).

The potential for seismically induced landsliding of engineered fill slopes is considered to be very low. For cut slopes excavated in the metavolcanic bedrock and remaining shallow natural slopes, the potential for seismically induced landsliding is considered to be very low. Cut slopes excavated in the fine-grained subunit of the fanglomerate have low to moderate potential for seismically induced landsliding. However, cut slopes within this unit would likely be removed and replaced with engineered fill in the form of buttresses or stability fills. Pseudo-static slope stability analyses were performed using a horizontal destabilizing seismic coefficient (k_h) of 0.15 g for the highest design cut and fill slopes and were determined to be grossly stable.

Tsunamis and Seiches

A tsunami is a series of large waves that are caused by a sudden disturbance that displaces water. Triggers for a tsunami include earthquakes, undersea landslides, volcanic eruptions, or meteor impacts. Tsunamis are not expected to affect inland areas of unincorporated San Diego County.

A seiche is a free or standing wave in a completely or partially enclosed body of water. Seiches are most likely to be initiated by an earthquake, and can vary in height from several centimeters to a few meters. Areas located along the shoreline of lakes or reservoirs are susceptible to inundation by a seiche. The Project Area is not likely to be inundated by a tsunami or seiche given its location inland.

Expansive Soils

Certain types of clay soils expand when they are saturated and shrink when dried. These are called expansive soils, and can pose a threat to the integrity of improvements that are built on them without proper engineering. Expansive soils are derived primarily from weathering of feldspar minerals and volcanic ash. Areas with potential to have expansive soils in the County occur predominantly in the coastal plains, an area of dissected marine terraces and uplands. They can also be found in valleys, on slopes in the foothills and mountains of the Peninsular Ranges region, and to a lesser extent, in the desert.

The soils within the Project Area are considered to exhibit very low to very high expansion potential, with the majority of the on-site soils possessing low to high expansion potential.

Groundwater

Shallow groundwater was not observed during the geotechnical investigation (March 2017) (Appendix 2.6-1). Intermittent flows within the active primary and tributary drainages should be anticipated during rain events.

2.6.1.2 Regulatory Setting

Set forth below are short descriptions of the various federal, state, and local regulations that generally apply to the resource or impact category analyzed in this section of the EIR. This information helps to place the impact analysis within its proper regulatory context. Note, however, that compliance with all applicable regulations is required. For this reason, the EIR does not specifically assess the Proposed Project's ability to comply with such regulations, except in those instances where a regulatory standard is being used as the threshold for determining impact significance.

Federal Regulations

International Building Code

The International Building Code (IBC) is a model building code developed by the International Code Council. The purpose of the IBC is to provide minimum standards for building construction to ensure public safety, health, and welfare. Prior to the creation of the IBC, several different building codes were used; however, by 2000, the IBC had replaced these previous codes. The IBC is updated every 3 years.

Occupational Safety and Health Administration Regulations

Excavation and trenching are among the most hazardous construction activities. The Occupational Safety and Health Administration (OSHA) Excavation and Trenching Standard (29 CFR, Part 1926(P) et seq.) covers requirements for excavation and trenching operations. OSHA requires that all excavations in which employees could potentially be exposed to cave-ins be protected by sloping or benching the sides of the excavation, supporting the sides of the excavation, or placing a shield between the side of the excavation and the work area.

State Regulations

California Geological Survey

The California Geological Survey provides guidance with regard to seismic hazards. The California Geological Survey's Special Publication 117A, Guidelines for Evaluating and Mitigating Seismic Hazards in California (2008), provides guidance for evaluation and mitigation of earthquake-related hazards for projects within designated zones of required investigation.

California Building Code

The state regulations protecting structures from geo-seismic hazards are contained in the California Code of Regulations, Title 24, Part 2 (the CBC), which is updated on a triennial basis. These regulations apply to public and private buildings in the state. Until January 1, 2008, the CBC was based on the then-current Uniform Building Code and contained additions, amendments, and repeals specific to building conditions and structural requirements of the State of California. The 2016 CBC, effective January 1, 2017, is based on the current (2015) IBC and enhances the sections dealing with existing structures. Seismic-resistant construction design is required to meet more stringent technical standards than those set by previous versions of the CBC.

Chapters 16 and 16A of the 2016 CBC include structural design requirements governing seismically resistant construction, including factors and coefficients used to establish seismic site class and seismic occupancy category for the soil/rock at the building location and the proposed building design. Chapters 18 and 18A include the requirements for foundation and soil investigations (Sections 1803 and 1803A); excavation, grading, and fill (Sections 1804 and 1804A); damp-proofing and water-proofing (Sections 1805 and 1805A); allowable load bearing values of soils (Sections 1806 and 1806A); the design of foundation walls, retaining walls, and embedded posts and poles (Sections 1807 and 1807A), and foundations (Sections 1808 and 1808A); and design of shallow foundations (Sections 1809 and 1809A) and deep foundations (Sections 1810 and 1810A). Chapter 33 of the 2016 CBC includes requirements for safeguards at work sites to ensure stable excavations and cut or fill slopes (Section 3304).

Construction activities are subject to occupational safety standards for excavation and trenching, as specified in the California Safety and Health Administration regulations (Title 8 of the California Code of Regulations) and in Chapter 33 of the CBC. These regulations specify the measures to be used for excavation and trench work where workers could be exposed to unstable soil conditions. The Proposed Project would be required to employ these safety measures during excavation and trenching.

As indicated above, the CBC is updated and revised every 3 years. The 2019 version of the CBC will be effective January 1, 2020. It is anticipated that future development of the Proposed Project would use the most current CBC at the time of specific construction activity.

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act of 1972 (Alquist-Priolo Act) (California Public Resources Code, Sections 2621 et seq.) regulates development and construction of buildings intended for human occupancy to avoid the hazard of surface fault rupture. The Alquist-Priolo Act helps define areas where fault rupture is most likely to occur and groups faults into categories of active, potentially active, and inactive. Historic and Holocene-age faults are considered active, Late Quaternary and Quaternary-age faults are considered potentially active, and pre-Quaternary-age faults are considered inactive. These classifications are qualified by the conditions that a fault must be shown to be sufficiently active and well defined by detailed site-specific geologic explorations to determine whether building setbacks should be established. Cities and counties affected by the zones must regulate development projects within the zones. Agencies with jurisdiction must withhold development permits for sites within the zones until geologic investigations demonstrate that the sites are not threatened by surface displacement from future faulting.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act (California Public Resources Code, Section 2690 et seq.) addresses earthquake hazards from non-surface fault rupture, including liquefaction, landslides, strong ground shaking, and other earthquake and geologic hazards. The Seismic Hazards Mapping Act also specifies that the lead agency for a project may withhold development permits until geologic or soils investigations are conducted and mitigation measures are incorporated into plans to reduce hazards associated with seismicity and unstable soils.

Local Regulations

County of San Diego General Plan

The San Diego County General Plan guides future growth in the unincorporated areas of the County and considers projected growth anticipated to occur within various communities. The

following goals and policies from the General Plan Safety Element were determined to be applicable to the Proposed Project (County of San Diego 2011a):

Goal S-7: Reduced Seismic Hazards. Minimized personal injury and property damage resulting from seismic hazards.

- **Policy S-7.1: Development Location.** Locate development in areas where the risk to people or resources is minimized. In accordance with the California Department of Conservation Special Publication 42, require development be located a minimum of 50 feet from active or potentially active faults, unless an alternative setback distance is approved based on geologic analysis and feasible engineering design measures adequate to demonstrate that the fault rupture hazard would be avoided.
- **Policy S-7.2: Engineering Measures to Reduce Risk.** Require all development to include engineering measures to reduce risk in accordance with the California Building Code (CBC), Uniform Building Code, and other seismic and geologic hazard safety standards, including design and construction standards that regulate land use in areas known to have or potentially have significant seismic and/or other geologic hazards.
- **Policy S-7.3: Land Use Location.** Prohibit high occupancy uses, essential public facilities, and uses that permit significant amounts of hazardous materials within Alquist-Priolo and County special studies zones.

Goal S-8: Reduced Landslide, Mudslide, and Rock Fall Hazards. Minimized personal injury and property damage caused by mudslides, landslides, or rock falls.

- **Policy S-8.1: Landslide Risks.** Direct development away from areas with high landslide, mudslide, or rock fall potential when engineering solutions have been determined by the County to be infeasible.
- **Policy S-8.2: Risk of Slope Instability.** Prohibit development from causing or contributing to slope instability.

Jamul/Dulzura Subregional Plan

The Project Area is located within the Jamul/Dulzura Subregional Plan area boundary. The Jamul/Dulzura Subregional Plan (a supplement to the County General Plan) establishes goals and policies to guide development within the unincorporated areas of Jamul, Steel Canyon, Dulzura, Barrett Junction, and the remainder of the area that composes the Jamul/Dulzura Subregion of southern San Diego County. The goals and policies of the Jamul/Dulzura Subregional Plan are intended to be more specific than those of the County General Plan; they consider the distinct history, character, and identity of the Jamul and Dulzura communities.

The following policies in the Jamul/Dulzura Subregional Plan (County of San Diego 2011b) relate specifically to geology and soils:

Goal 5: Environmental resources in the Jamul/Dulzura area that are carefully managed to maintain them for future needs.

- **Policy 7:** Discourage development in areas with geologic hazards, such as landslide prone soils and seismic risks.

Otay Ranch General Development Plan/Otay Subregional Plan, Volume II

Due to the size and complexity of Otay Ranch, the policies governing development of the Otay Ranch areas within the Jamul/Dulzura planning boundaries are included in Volume II of the Otay Ranch GDP/SRP. In the case of conflict between the Jamul/Dulzura Subregional Plan policies and those of the Otay Ranch GDP/SRP, the policies contained in the Otay Ranch GDP/SRP take precedence. The following policies in the Otay Ranch GDP/SRP relate specifically to geology and soils (City of Chula Vista and County of San Diego 1993b):

- **Policy:** Arrange land uses in a manner consistent with recognized seismic safety practice to promote the continuous services of governmental and emergency facilities and services.
- **Policy:** Identify and appraise those areas particularly susceptible to damage from geologic phenomena.
- **Policy:** Prohibit development in areas of extensive land sliding where stabilization cannot reasonably be accomplished.
- **Policy:** Protect and preserve significant geological features from destruction, damage or loss, to the extent practical.
- **Policy:** Reduce soil loss through slope stabilization, vegetation protection, revegetation and other techniques.
- **Policy:** Provide geotechnical investigations with each SPA plan.
- **Policy:** Roadways shall be designed to follow the natural contours of hillsides and minimize visibility of road cuts and manufactured slopes.
- **Policy:** Excessive use of manufactured slopes in the Otay River Valley, Jamul and San Ysidro Mountains, and the area around Otay Lakes shall not be permitted.
- **Policy:** Natural buffering (e.g., undeveloped open space) shall be provided between development and significant land forms, including the Jamul and San Ysidro Mountains.
- **Policy:** Variable slope ratios not exceeding 2:1 shall be utilized when developing grading plans.

- **Policy:** 83% of the steep slopes (steeper than 25%) shall be preserved.
- **Policy:** As development occurs on steep lands, as defined by the governing jurisdictions, contour grade to reflect the natural hillside forms as much as possible, and round the top and toe of slopes to simulate natural contours.
- **Policy:** Grade and rehabilitate graded areas in conformance with grading regulations of the governing jurisdiction. Ensure proper drainage, slope stability and ground cover revegetation in conformance with applicable land use regulations.

San Diego County Code

Grading Ordinance

Division 7, of Title 8, of the San Diego County Code, Grading Ordinance, establishes the requirement to obtain a grading permit prior to grading operations. The grading ordinance requires the submittal of grading plans or improvement plans for review by the County Official (Director of Public Works or his or her authorized representative) prior to issuance of a grading permit. The ordinance contains design standards and performance requirements that must be met to avoid or reduce, to an acceptable level, the potential for slope instabilities, expansive soils, excessive erosion, and sedimentation (County Code Chapter 4). The ordinance sets forth the maximum slope allowed for cut and fill slopes; the requirement for drainage terraces on cut or fill slopes exceeding 40 feet in height; requirements for cuts and fills on expansive soil; requirements for minimum setback for buildings on cut or fill slopes; and reporting requirements, including a soil engineer's report and a final engineering geology report by an engineering geologist, which includes specific approval of the grading as affected by geological factors. The ordinance also contains requirements to reduce effects on air quality (Section 87.428, Dust Control), native habitat (Section 87.503), cultural and paleontological resources (Sections 87.429 and 87.430), and watercourses (County Code Chapter 6). Upon review of grading plans, the County Official has the authority to approve, attach conditions of approval, or deny the permit application.

The applicant for the Proposed Project would be required to submit a soil investigation report that would include data regarding the nature, distribution, and strength of existing soils and rock on the site; the soil engineer's conclusions and recommendations for grading requirements, including the correction of weak or unstable soil conditions and treatment of any expansive soils that may be present; and an opinion as to the adequacy of building sites to be developed by the proposed grading operations (Section 87.209). The applicant would provide an engineering geology report by an engineering geologist when required by the County Official. Recommendations included in such reports and approved by the County Official would be incorporated in the grading plan or specifications.

Zoning Ordinance Fault Displacement Area Regulations

The San Diego County Zoning Ordinance, Sections 5400 through 5406, implements the requirements of the Alquist-Priolo Act. The provisions of Sections 5400 through 5406 outline the allowable development, permitting requirements, and construction limitations within fault rupture zones, as designated by the Alquist-Priolo Act. For non-discretionary permits (such as building permits), the County Planning and Development Services, Building Division, requires any above-surface structure to conform to the seismic requirements of the CBC and to incorporate design recommendations contained within the soils and geologic report, as required per the CBC. The County prohibits any buildings or structures that will be used for human occupancy to be constructed over or within 50 feet of the trace of a known fault (County of San Diego 1978, Section 5406). The County generally requires geologic reports for development proposed in Alquist-Priolo Fault Zones (County of San Diego 1978, Section 5406(b)).

Other related Zoning Ordinance sections include the following regulations:

- Prohibit construction of essential facilities and high-occupancy structures in special study zones as defined under the Alquist-Priolo Act or in special study zones defined by the County of San Diego (County of San Diego 1978, Section 5404).
- Require a geologic report for other development proposed in special study zones as defined under the Alquist-Priolo Act or in special study zones defined by the County of San Diego (County of San Diego 1978, Section 5406).
- Prohibit new construction of structures to be used for human occupancy over or within 50 feet of the trace of an active known fault, with the exception of single-family wood-frame dwellings not exceeding two stories in height, built or located as part of a development of less than four dwellings, and mobile homes wider than 8 feet (County of San Diego 1978, Sections 5406(c) and 5406(d)).
- Delineate special study zones along active faults as new geologic information becomes available. These special study zones shall be administered in the same manner as those delineated by the State of California (County of San Diego 1978).

2.6.2 Analysis of Project Effects and Determination as to Significance

2.6.2.1 Fault Rupture

Guidelines for the Determination of Significance

For the purpose of this EIR, the County's Guidelines for Determining Significance, Geologic Hazards (Geologic Hazards Significance Guidelines) (County of San Diego 2007) applies to both

the direct impact analysis and the cumulative impact analysis. These significance guidelines were developed by the County to address Question VI(a)(i) in the California Environmental Quality Act (CEQA) Guidelines, Appendix G (14 CCR 15000 et seq.), and to ensure compliance with Fault Displacement Area regulations within the County Zoning Ordinance.

A significant impact would result if:

- The project would propose any building or structure to be used for human occupancy over or within 50 feet of the trace of an Alquist-Priolo Fault or County Special Study Zone fault.
- The project proposes the following uses within an Alquist-Priolo Fault Zone which are prohibited by the County:
 - i. Uses containing structures with a capacity of 300 people or more. Any use having the capacity to serve, house, entertain, or otherwise accommodate 300 or more persons at any one time;
 - ii. Uses with the potential to severely damage the environment or cause major loss of life. Any use having the potential to severely damage the environment or cause major loss of life if destroyed, such as dams, reservoirs, petroleum storage facilities, and electrical power plants powered by nuclear reactors;
 - iii. Specific civic uses including police and fire stations, schools, hospitals, rest homes, nursing homes, and emergency communication facilities.

Analysis

No faults have been mapped within the Project Area on published geologic maps, and no faults were observed during the geotechnical investigation. The Project Area is not located within 50 feet of an Alquist–Priolo Fault or County Special Study Zone Fault (Appendix 2.6-1). The Silver Strand section of the Newport–Inglewood–Rose Canyon Fault Zone is the closest known active fault to the Project Area, and is located approximately 15 miles to the west. La Nacion Fault, a potentially active fault, is located approximately 6 miles west of the Project Area. Outside the Project Area, to the northwest, lineaments were observed both in the field and on aerial photos. These lineaments occur in the Santiago Peak Metavolcanics geologic formation and are considered to be related to foliation in the metamorphic rock and not related to faulting (Appendix 2.6-1).

Based on the lack of active or potentially active faults underlying the Project Area, the potential for surface fault rupture is low and the Project Area would not be subject to a greater seismic risk than other locations within the region. Additionally, the Proposed Project would not place any prohibited uses (e.g., uses containing structures with a capacity of 300 people or more; uses with the potential to severely damage the environment or cause major loss of life; or specific civic uses including police and fire stations, schools, hospitals, rest homes, nursing homes, and

emergency communication facilities) within an Alquist–Priolo Fault Zone. Therefore, impacts associated with fault rupture would be **less than significant**.

2.6.2.2 *Ground Shaking*

Guidelines for the Determination of Significance

For the purpose of this EIR, the Geologic Hazards Significance Guidelines (County of San Diego 2007) apply to both the direct impact analysis and the cumulative impact analysis. These significance guidelines were developed by the County to address Question VI(a)(ii) in the CEQA Guidelines, Appendix G. A significant impact would result if:

- The project would be located within a County Near-Source Shaking Zone or within Seismic Zone 4 and the project does not conform to the Uniform Building Code.

Analysis

All of San Diego County is located within Seismic Zone 4, which is the highest Seismic Zone, and like most of Southern California is subject to ground shaking (County of San Diego 2007). Thus, the Project Area will likely experience shaking effects from earthquakes. The anticipated peak ground acceleration (expressed as “g”) was calculated to range from 0.14 g to 0.40 g within bedrock areas, and from 0.22 g to 0.51 g within stiff soil in the Project Area (Appendix 2.6-1).

The Proposed Project would be designed and constructed in conformance with the IBC (which replaced the Uniform Building Code in 2000), CBC, and County Building Code, including required seismic design considerations, such as specialized reinforcement measures (e.g., tie-downs and strapping), which are used to minimize the structural damage in the event of ground shaking. Conformance with required standards and applicable regulations would reduce hazards related to ground shaking. Therefore, impacts associated with ground shaking would be **less than significant**.

2.6.2.3 *Liquefaction*

Guidelines for the Determination of Significance

For the purpose of this EIR, the County’s Geologic Hazards Significance Guidelines (County of San Diego 2007) apply to both the direct impact analysis and the cumulative impact analysis. The following significance guidelines were developed by the County to address Question VI(a)(iii) and the portion of Question VI(c) that addresses on-site and off-site lateral spreading or liquefaction in the CEQA Guidelines, Appendix G. A significant impact would result if:

- The project site has potential to expose people or structures to substantial adverse effects because: (i) the project site has potentially liquefiable soils; (ii) the potentially liquefiable

soils are saturated or have the potential to become saturated; and (iii) in-situ soil densities are not sufficiently high to preclude liquefaction.

Analysis

Liquefaction typically occurs when a site is subjected to strong seismic shaking, on-site soils are cohesionless, groundwater is encountered within 50 feet of the surface, and soil relative densities are less than approximately 70%. If the four previous criteria are met, a seismic event could result in a rapid pore water pressure increase from the earthquake-generated ground accelerations.

Based on geologic mapping, subsurface exploration, and laboratory testing specific to the Project Area, a large portion of the area identified by County of San Diego as being susceptible to liquefaction is not liquefiable due to soil age, density, and fines content (Appendix 2.6-1). To better evaluate the potential for liquefiable soils to impact the Proposed Project, the portion of the Project Area zoned by the County of San Diego as a Potential Liquefaction Area has been further delineated to show the limits of areas considered not liquefiable and those areas that are potentially susceptible to liquefaction (Figure 2.6-1, Liquefaction Potential). The areas identified as not susceptible to liquefaction are delineated with purple cross-hatching. The yellow cross-hatching delineates areas considered to be potentially susceptible to liquefaction. Areas potentially susceptible to liquefaction include a portion of the proposed school site (S-1) in Central Village 14 and portions of proposed Proctor Valley Road south and west of South Village 14. As such, liquefaction and associated effects related to seismic activity would be a **potentially significant impact (Impact GE-1)**; see Section 2.6.5, Mitigation, for mitigation measures.

The potentially liquefiable soils in the area of the proposed school site are shallow and would be mitigated through complete removal and replacement with compacted fill during grading operations. Proposed off-site improvements located in areas susceptible to liquefaction would also be mitigated through complete removal and replacement with compacted fill. If complete removal and replacement cannot be accomplished, mitigation in the form of ground improvement (e.g., stone columns) and/or deepened foundation elements will be required to mitigate the liquefaction potential to an acceptable level of risk.

In consideration of the recommended remedial grading, and dense nature of the formational materials and proposed fills within the limits of the Proposed Project, the potential for liquefaction or seismically induced settlement is considered remote.

2.6.2.4 Landslides

Guidelines for the Determination of Significance

For the purpose of this EIR, the County's Geologic Hazards Significance Guidelines (County of San Diego 2007) apply to both the direct impact analysis and the cumulative impact analysis. The following significance guidelines were developed by the County to address Question VI(a)(iv) and the portion of Question VI(c) that relates to on-site or off-site landslide or collapse in the CEQA Guidelines, Appendix G. A significant impact would result if:

- The project site lies directly below or on a known area subject to rockfall which could result in collapse of structures.
- The project would expose people or structures to substantial adverse effects, including the risk of loss, injury, or death involving landslides.
- The project is located on a geologic unit or soil that is unstable, or would become unstable as a result of the project, potentially resulting in an on-site or off-site landslide.

Analysis

The potential for rockfall is generally considered to be low given the limited rock outcrops and subdued topography in the majority of the Project Area. Based on Appendix 2.6-1, localized areas within the steeper northerly and easterly portions of the Project Area have more rock outcrops and therefore possess moderate risk for rockfall hazard. However, development within this area would not have superjacent natural or graded slopes. As a result, rockfall impacts are considered unlikely. Nevertheless, Appendix 2.6-1 indicates that mapping and evaluation of hard rock slopes should be performed by an engineering geologist prior to and during site development. Rockfall hazards could become potentially significant if unforeseen conditions are encountered during site development. Localized areas within the northerly and easterly portions of the Project Area may be susceptible to rockfall when graded, and if not mitigated during construction, there would be **potential for significant impacts** to residential property, infrastructure, and buildings, and therefore to human health and safety (**Impact GE-2**); see Section 2.6.5 for mitigation measures.

Based on Appendix 2.6-1, a review of aerial photographs and observations within the Project Area indicated there is geomorphic evidence that suggests the presence of landslide(s) locally near the central portion of the Project Area. It is anticipated that the failure occurred within a weak claystone bed of the Otay Formation–Fanglomerate. However, the potential landslide is located outside the limits of the Development Footprint and is not anticipated to have an adverse effect on the Proposed Project. The majority of the Project Area slopes at shallow to moderate slope ratios and is underlain by bedrock that is not considered to be generally susceptible to mass

wasting. Additionally, due to the presence of the steeper off-site terrain composed of highly fractured/jointed Santiago Peak Volcanics, there is the potential for debris flows to come from the mouths of the up-gradient drainages; however, this is considered unlikely.

As such, the potential for landsliding is low to moderate in its current state. In the unlikely event that during development landsliding occurs, the potentially adverse effects of landsliding can be mitigated during development through the use of design avoidance or through typical remedial grading measures (i.e., construction of stabilization and buttress fills); see Section 2.6.5. Therefore, while susceptibility to landsliding within the Development Footprint of the Project Area is considered unlikely, impacts could become **potentially significant** if unforeseen conditions are encountered during site development (**Impact GE-3**).

2.6.2.5 Expansive Soils

Guidelines for the Determination of Significance

For the purpose of this EIR, the County's Geologic Hazards Significance Guidelines (County of San Diego 2007) apply to both the direct impact analysis and the cumulative impact analysis. The following significance guidelines were developed by the County to address Question VI(d) in the CEQA Guidelines, Appendix G. A significant impact would result if:

- The project would be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), and does not conform with the Uniform Building Code.

Analysis

Expansive soils are soils that are high in expansive clays or silts and that swell and shrink with wetting and drying, respectively. This shrinking and swelling can be detrimental to foundations, concrete slabs, flatwork, and pavement. The soil expansion potential for the Project Area ranges from very low to very high, with a majority of the Project Area having an expansion potential of low, medium, or high (Appendix 2.6-1). The final geotechnical investigation would identify the expansion potential of soils within the Development Footprint, if any, and provide recommendations to address any concerns. Areas where the potential for expansive soils exist would be mitigated using a variety of geotechnical techniques (see Section 2.6.5). Further, construction is anticipated to follow the requirements of the IBC. However, for purposes of this analysis, because development is proposed in areas with high or very high soil expansion potential, implementation of the Proposed Project could have a **potentially significant impact** (**Impact GE-4**); see Section 2.6.5 for mitigation measures.

The improvements for the Proctor Valley Road North and Perimeter Trial Option improvements would be subject to the same geologic conditions as analyzed above, and impacts would be the

same as those described in **Impacts GE-1** through **Impact GE-4**. No physical improvements are proposed for the Preserve Trail Option, therefore, no additional impacts would occur.

2.6.3 Cumulative Impact Analysis

Potential cumulative impacts on geology and soils could result from projects that combine to create geologic hazards, including unstable geologic conditions, or substantially contribute to coastal erosion. However, most geology and soil hazards associated with development projects in the surrounding area would be site-specific and could be mitigated on a project-by-project basis. Such hazards include exposure of people or structures to rupture of an earthquake fault, liquefaction, landslides, unstable geologic units, and expansive soils. Individual project mitigation for these hazards would ensure that there are no residual cumulative impacts. Proper engineering design, utilization of standard construction practices, and implementation of the recommendations found in the Geotechnical Review Report (Appendix 2.6-1) would ensure that the potential for geological impacts resulting from the Proposed Project would be less than significant, after mitigation. Because geologic hazards are site-specific and not cumulative in nature, the Proposed Project **would not result in a cumulatively considerable impact** related to geologic hazards.

2.6.4 Significance of Impacts Prior to Mitigation

Four potentially significant impacts related to geologic hazards were identified:

Impact GE-1	Liquefaction associated with seismic events could result in damage to structures and thereby impact human health and safety.
Impact GE-2	Portions of the Project Area may be susceptible to rockfall, which could result in damage to structures, and thereby impact human health and safety.
Impact GE-3	Construction of buildings on or within landslide debris, or downslope from landslides, could result in damage to structures and thereby impact human health and safety.
Impact GE-4	Development in areas with high or very high soil expansion potential could result in damage to structures and thereby impact human health and safety.

2.6.5 Mitigation

The 1993 Otay Ranch PEIR and Mitigation Monitoring Program (MMP) identified mitigation measures to reduce the significant geology and soils impacts of the Otay Ranch GDP/SRP. This EIR conducted a new analysis of the Proposed Project's specific impacts on geology and soils, using updated technical reports that account for changes in conditions, both environmental and regulatory, that have occurred since 1993 when the Otay Ranch PEIR was certified. Based on

this updated, project-specific analysis, the geology and soils mitigation measures identified in the Otay Ranch PEIR are either (i) not applicable; (ii) satisfied; or (iii) replaced with project-specific mitigation measures or regulatory compliance requirements, as determined by the qualified preparers of this EIR. Attached as Appendix 2-1 is a matrix, entitled “1993 GDP/SRP PEIR Mitigation Measure Compliance.”

To reduce the potential for significant impacts resulting from liquefaction (**Impact GE-1**), rockfall (**Impact GE-2**), landslides (**Impact GE-3**), and expansive soil (**Impact GE-4**) within the Project Area, mitigation measure **M-GE-1** is provided. It should be noted that potential impacts related to rockfall and landslides are not anticipated, but if any are encountered during grading, **M-GE-1** would ensure that impacts are less than significant.

M-GE-1 Prior to issuance of a grading permit, a final geotechnical report shall be prepared by a registered civil or geotechnical engineer. The report shall include any additional field efforts, including borings, sampling, and associated laboratory testing, to determine whether liquefaction, rockfall, landslides, and/or expansive soils are concerns for the Proposed Project. The report shall specify foundation designs that are adequate to preclude substantial damage to the proposed structures due to liquefaction. Mapping and evaluation of hard rock slopes shall be performed by an engineering geologist prior to and during site development. The report shall be submitted with the building plans, and all recommendations of the report shall be incorporated into the design of the buildings.

Measures developed in the geotechnical report shall be based on site-specific conditions. Measures would likely include the following, which are provided as examples only:

Liquefaction

- Deposits of concern shall be over-excavated and recompact.
- Deposits of concern shall be replaced with engineered fill.
- Fill shall be surcharged (temporary overloading with fill) to facilitate settlement.
- Densification of deposits of concern shall be performed in place, potentially including any combination of placement of vibra-stone columns and use of wick and blanket drains, compaction grouting, and dynamic compaction.
- Subdrains shall be incorporated.

Rockfall

Impacts related to rockfall are not anticipated; therefore, this example measure would only apply if unforeseen rockfall hazards are encountered during the clearing, grubbing, and grading stages of construction:

- Scaling of the slope faces shall occur.
- Construction of catchment areas or debris fences shall occur.
- Removal of precariously situated boulders shall occur.

Landslides

Impacts related to landslides are not anticipated; therefore, this example measure would only apply if unforeseen landslides are encountered during the clearing, grubbing, and grading stages of construction:

Design features to reduce the potential effects of landslides shall include remedial grading and removal of landslide debris or slope stabilization in the areas of proposed development. In areas where landslide debris would be left in place, the construction of buttress fills shall be required to mitigate the potential for instability of cut slopes composed of landslide debris.

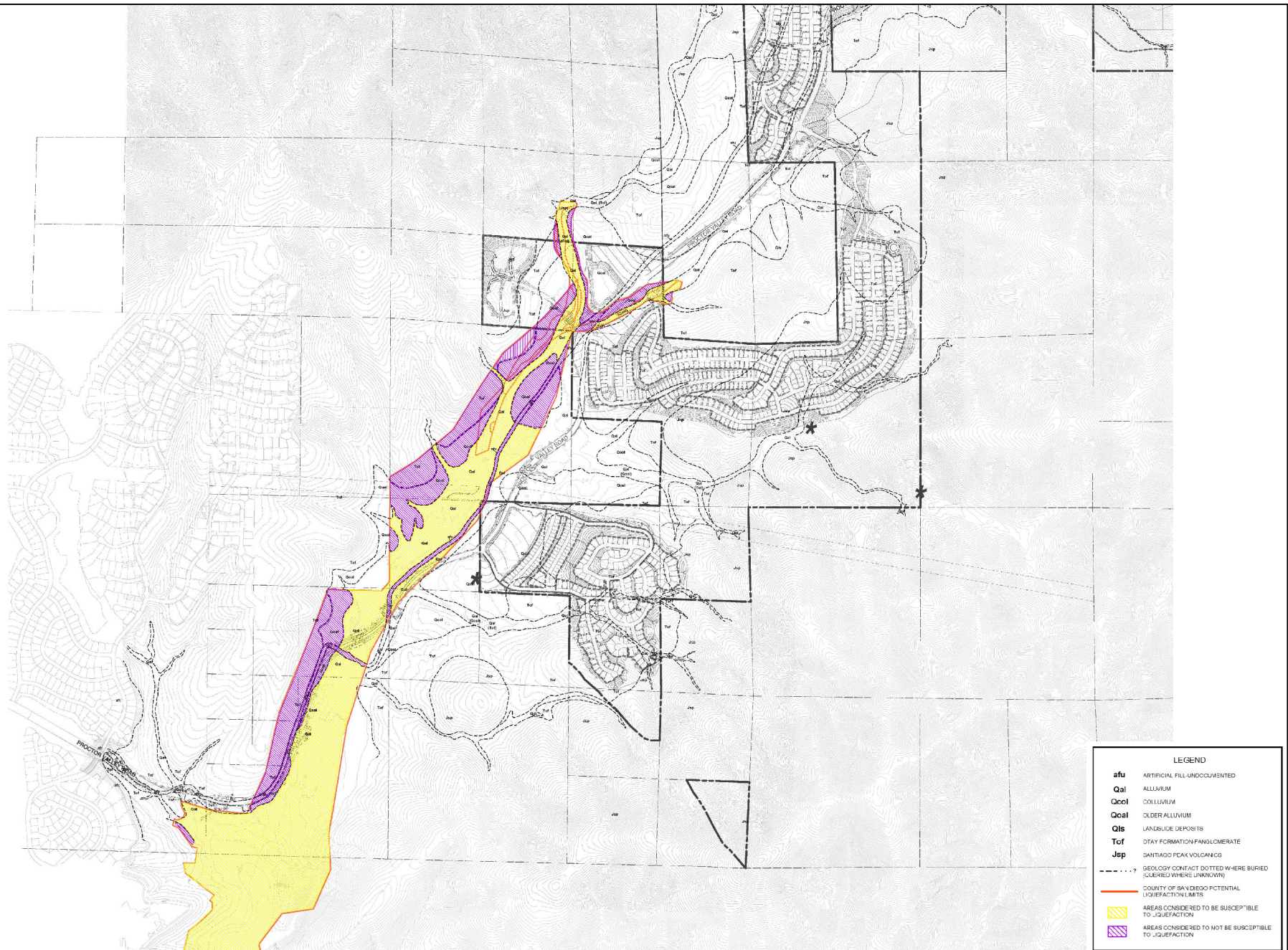
Expansive Soil

Highly expansive soils (typically the upper 3 feet below finish grade) shall be removed and replaced with soils with low expansion potential, lime treatment shall be applied, or moisture conditioning shall occur, in accordance with the standards contained within the then-current edition of the California Building Code. Concrete slabs shall be used in structure foundations, as necessary.

2.6.6 Conclusion

Four potentially significant impacts from geologic hazards have been identified: **Impact GE-1**, liquefaction; **Impact GE-2**, rockfall; **Impact GE-3**, landslides; and **Impact GE-4**, expansive soil.

Mitigation measures are required to avoid or substantially lessen these impacts. Implementation of mitigation measure **M-GE-1** would reduce impacts related to **Impact GE-1** through **Impact GE-4** to less than significant because it requires preparation of a geotechnical report that would include design features requiring removal of unstable soils and compaction of fill, catchment basins for potential rockfalls, remedial grading and slope stabilization, and foundation design. This would reduce the potential impacts to **less than significant**.



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