3.8 Geology and Soils

This section evaluates the potential impacts of the Proposed Action on geology and soils, and impacts of geology, soils and seismicity on the Proposed Action. This evaluation includes an assessment of the direct, indirect, short-term, long-term, and cumulative effects of the Proposed Action on geology, soils, and seismic hazards. The evaluation is based on information contained in the Engineering Summary Report (GEI, 2007c).

3.8.1 Affected Environment

3.8.1.1 Environmental Setting

The following discussion describes the existing geologic and soils conditions within the SV 100K study area.

Topographic Setting

Elevations in the general vicinity of San Vicente Reservoir range from approximately 450 feet AMSL near the base of the existing dam to 2,696 feet AMSL at the top of Iron Mountain. Elevations across the remainder of the SV 100K study area range from approximately 450 feet to 1,500 AMSL.

Geologic Setting

A geologic map of the region surrounding San Vicente Reservoir is shown in Figure 3.8-1. San Vicente Reservoir lies within a broad contact zone between coastal, Tertiary/Eocene-age sedimentary rock formations and late Jurassic- to Cretaceous-age igneous bedrock that is common to the highlands of inland and eastern San Diego County.

Three general geologic formations (or groups) were identified in the SV 100K study area: Peninsular Ranges Batholith, Santiago Peak Volcanics, and the Poway Group. The first two groups are hard, igneous bedrock units, and the third is a sedimentary unit, consisting of pebbles and cobble conglomerates and sandstones. These three general formations and their related units, as well as recent formations are described below, followed by a summary of their distribution within the SV 100K study area.

Pre-Batholithic and Batholithic Granitics

Tan (2002) mapped two igneous rock units of Mesozoic age within the SV 100K study area: a medium- to coarse-grained granite that crops out along the east side of San Vicente Reservoir; and a fine- to medium-grained granodiorite that crops out in part along the northwest and southwest margins of the reservoir. The granitics are included in the following regional units (Figure 3.8-1): grMz (batholithic granite, quartz monzonite, granodiorite, and quartz diorite)
and gr-m (pre-batholithic granite and metamorphic rocks). Granitic rocks of the Peninsular Ranges Batholith underlie most of Riverside County, the eastern and central portions of San Diego County, and the northern two-thirds of the Baja California Peninsula. Based on site-specific geologic studies conducted for the Proposed Action, GEI identified the following local rock units as subsets of the regional units in the study area (Figure 3.8-2):

- **Gneissic Granodiorite** – Late Jurassic/Early Cretaceous-age pre-batholithic granitic rock in the area is typically medium- to fine-grained. The rock typically exhibits a light to olive gray color in an unweathered state. This local unit is a subset of the regional map unit gr-m.

- **Woodson Mountain Granodiorite** – The Late Cretaceous batholithic rock in the study area is fine- to coarse-grained, light to medium gray in color. This local unit is a subset of the regional map unit grMz.

**Santiago Peak Volcanics**

Metasedimentary outcrops of the Santiago Peak Volcanics have been mapped (Tan, 2002) in the area immediately adjacent to, and south of the existing dam. In addition, metavolcanic outcrops of this rock unit have been mapped along the far west shore of the reservoir. The Santiago Peak Volcanics are composed of volcanic and marine sedimentary rocks of presumed late Jurassic to early Cretaceous age. This formation includes the regional unit Mzv (late Jurassic volcanic and metavolcanic rocks) (Figure 3.8-1). Based on site-specific geologic studies conducted for the Proposed Action, GEI identified the following local rock units as subsets of the regional units in the study area (Figure 3.8-2):

- **Metavolcanics** – Metavolcanic rocks in the study area, estimated to be Jurassic in age, consist primarily of metamorphosed strata (i.e., meta-dacites with some hypo-abyssal intrusives, including meta-rhyolites). The color of these rocks varies from pale brown to pale gray to very dark gray. This local unit is a subset of the regional map unit Mzv.

**Poway Group**

Eocene-age sedimentary rocks referred to as the Poway Group have been mapped along the southwest and north-central shores of the reservoir (Tan, 2002). This formation includes the following regional unit (Figure 3.8-1): Ec (Eocene non-marine sandstone, shale and conglomerate). The Poway Group consists of three formations including from oldest to youngest: the Stadium Conglomerate, Mission Valley Formation, and Pomerado Conglomerate (Kennedy, 1975). Both the Stadium Conglomerate and Pomerado Conglomerate have been mapped within the SV 100K study area by Tan (2002). The Mission Valley Formation does not crop out in the vicinity of the Proposed Action. Based on site-specific geologic studies conducted for the Proposed Action, GEI identified the following local rock units as subsets of the regional units in the study area (Figure 3.8-2):
• **Stadium/Pomerado Conglomerate** – The Stadium Conglomerate consists of cobbles within a dark yellowish-brown, coarse-grained sandstone matrix. The clasts are typically of cobble size, but range from gravel to boulders, with maximum size typically increasing with proximity to the contact with underlying hard rock formations. The Pomerado Conglomerate is similar to the underlying Stadium Conglomerate (Kennedy and Peterson, 1975). Regional mapping (Tan, 1992) assigns the conglomerates above 840 feet AMSL as belonging to the Pomerado Conglomerate. In the SV 100K study area, the Pomerado Conglomerate directly overlies the Stadium Conglomerate and the two units cannot be readily distinguished. This local unit is a subset of the regional map unit Ec.

**Debris Flows**

Several deposits of loose materials in the SV 100K study area were identified as resulting from debris flows. Although these deposits are too small to be mapped on a regional scale, they would be a subset of the regional map unit Q (Pleistocene-Holocene alluvium, lake, playa, and terrace deposits). Local debris flow deposits include a relatively small accumulation of cobbles, gravels and sands from the Stadium Conglomerate located in the side-canyon drainage approximately ¼-mile west of the existing marina facility (Figure 3.8-2). Much larger debris flow deposits were observed at the base and on the eastern flanks of the steep hillsides in the southeast corner of the site. Deposits at these locations include numerous boulders, some tens of feet across, derived from the fractured rock formations that comprise the hillside.

**Alluvium (unmapped)**

This local unit is a subset of the regional map unit Q (Pleistocene-Holocene alluvium, lake, playa, and terrace deposits). This Holocene-age alluvium consists primarily of unconsolidated sand, silt, gravels, cobbles and boulders that are present within the San Vicente Creek canyon south of San Vicente Dam (Figures 3.8-2 and 3.8-3). Similar materials are presumed to underlie the bottoms of side canyons and other drainages in the SV 100K study area. Borings indicate that these deposits are up to about 30 feet thick within San Vicente Creek adjacent to the dam. Alluvial thickness is expected to increase farther downstream (south).

**Fill Soils (unmapped)**

Significant thicknesses of fill soils are present in many portions of the SV 100K study area because of past construction activities, including several roadfills, backfill for pipelines, and fill for construction pads. One large remnant construction fill is located above the right abutment of the existing dam (Figures 3.8-2 and 3.8-3). Fill soils typically consist of locally derived silts, sands, gravels, cobbles and boulders.

**Distribution/Occurrence by Component**

Plan and profile views of geologic formations and units in the immediate vicinity of San Vicente Dam are shown in Figures 3.8-3 and 3.8-4, respectively. From west to east across the southern reservoir area, the composition of the geologic rock units within the general formations consist
of sedimentary conglomerates, gneissic granodiorites, metavolcanic rocks, and batholithic granodiorites with units of debris flow, alluvium and fill limited to specific areas as discussed above. The contacts between these units trend to the north-northwest, generally perpendicular to the axis of San Vicente Dam.

Overview

The gneissic granodiorite is exposed primarily in the southwest reservoir area (south and west of the dam) and underlies the right (west) abutment of the dam. This rock type also underlies the area of the Diversion Structure (Terminal Structure) and the western end of the Bypass Pipeline. The metavolcanic rock outcrops in the northwest portion of the reservoir and extends south through the middle portions and left abutment of the dam. The Woodson Mountain Granodiorite underlies the majority of the reservoir basin, the areas to the north, northeast, east and southeast of the reservoir, and also contacts the metavolcanic rocks on the slope that rises to the east of the existing dam.

The Eocene-age Stadium and Pomerado Conglomerates form the tops and sides of hills along the southwest edges of the reservoir. These materials are exposed along the flanks of the side canyon containing the marina and on the hillside west of the marina access road. The majority of the Bypass Pipeline north of the marina is founded in these materials. In the area west of the existing dam, the conglomerate overlies granitic rock. At locations along the northwest portions of the reservoir the conglomerates are directly underlain by the metavolcanic rock units common to the area.

On-Site Quarry Options

The predominant geologic unit underlying the Marina Quarry Option is the Stadium Conglomerate (Figure 3.8-2). The gneissic (foliated) granodiorite underlies the Southwest and Southeast Quarry Options. This unit also outcrops in the southeast part of the Marina Quarry Option.

Dam Foundation

The rock units underlying the dam foundation include metavolcanic rocks and foliated granodiorite (Figures 3.8-3 and 3.8-4). The foliated granodiorite generally underlies the right abutment of the dam. The depth of weathering in the granodiorite is about 5 to 20 feet. The rock exposed in the right abutment exhibits a prominent joint pattern and is crossed by a shear zone (up to 20 feet wide) that adjoins a 3- to 5-foot wide, weathered dike.

The metavolcanic rocks underlie the central part and left abutment of the dam (Figures 3.8-3 and 3.8-4). The contact between the metavolcanic rocks and the foliated granodiorite is a tight, steeply dipping contact extending below the west side (right abutment) of the dam. Alluvium and fill soils cover the metavolcanic rocks downstream (south) of the central part of the dam. The depth to slightly weathered metavolcanic rocks is typically 5 to 30 feet.
The left abutment of the dam is also underlain by a 5-foot wide shear zone and adjacent closely spaced fractures extending across a width of 10 to 15 feet (Figures 3.8-3 and 3.8-4). The left abutment feature required special treatment in the foundation excavation of the existing dam. It is not anticipated that the foundation of the raised dam would extend eastward into the Woodson Mountain Granodiorite.

**Saddle Dam Foundation**

The proposed saddle dams are underlain by the foliated granodiorite. Based on the three borings and seismic refraction profiles performed in the area of the proposed saddle dams, the top of the slightly weathered rock occurs at depths ranging between about 15 and 45 feet below ground surface (GEI, 2007c).

**Tectonic Setting**

The Alquist-Priolo Earthquake Fault Zoning Act (see Section 3.8.1.2) defines active faults as those which have surface displacements in the Holocene, or last 11,000 years. Potentially active faults are those which have displacement within the Quaternary (last 1.6 million years), but no evidence of movement in the Holocene. The DSOD uses a stricter guideline, defining an active fault as one that has ruptured within the last 35,000 years, and a conditionally active fault is one that has ruptured in the Quaternary Age, but whose displacement history in the last 35,000 years is unknown (Fraser, 2001a, 2001b). As discussed below, the nearest known active or conditionally active fault to San Vicente Dam is the La Nacion Fault, located about 13 miles (20 kilometers) to the southwest.

There are no known active or conditionally active faults extending through the San Vicente Dam or the immediate site vicinity. However, two northwest-trending, inactive shear zones transect the area of the dam (Figure 3.8-3). One shear zone crosses through the left abutment foundation, and was treated during the original dam construction by excavation and replacement with concrete and additional grout holes (GEI, 2007c; DSOD, 1981). As shown in Figure 3.8-4, metavolcanic rock is exposed on both sides of this shear zone. The other shear zone lies west of the existing dam, but passes through the right abutment. Recent investigations indicate that this shear zone is 20 feet wide, with granite rock exposed on both sides, and that this not seismogenic. No evidence of late-Quaternary movement was observed along these shear zones during geotechnical investigations for the CSP (GEI, 2007c), and neither shear zone has had an adverse impact on performance of the dam since its construction in 1943.

A number of shear zones are exposed in the access road cut leading to the left abutment of the existing dam. None of these shear zones could be traced beyond the road cut in undisturbed terrain (GEI, 1994).

Other northeast-trending faults of relatively short length and displacement have been recognized in the general area, many of which are contained within the Moreno Valley fault zone described by Edelman (1980).
Seismicity

Earthquake activity, also known as seismicity, is common throughout the southern California region. Most earthquakes in this region occur along active faults.

Southern California lies within a broad zone that constitutes the boundary between the Pacific and North American tectonic plates. In this plate margin area, the potential for large earthquakes is high as the plates slip laterally past each other and movement is distributed among several paralleling, northwest-trending faults. The principal onshore faults are, from east to west, the San Andreas, Imperial, San Jacinto, Elsinore, La Nacion, and Rose Canyon faults. Other offshore faults include, from east to west, the Descanso, Coronado Bank, San Diego Trough-Bahia Soledad, and San Clemente-San Ysidro faults. Most of these offshore faults coalesce south of the international border, where they come onshore as the Agua Blanca Fault, which transects the Baja California peninsula. Also in Mexico, the Calabasas and San Miguel-Vallecitos faults strike towards the San Diego area.

The nearest known active or conditionally active fault to the SV 100K study area is the La Nacion Fault, located about 13 miles (20 kilometers) to the southwest. Other known active faults include the Rose Canyon and Elsinore faults, located 18 miles (29 kilometers) west and 24 miles (36 kilometers) northeast, respectively. These three faults have the greatest likelihood of affecting the SV 100K study area. Estimated maximum magnitude earthquakes ($M_w$) for the La Nacion, Rose Canyon and Elsinore faults are 6.7, 7.1, and 7.5, respectively.

Geologic Hazards

The following geologic hazards are discussed briefly: ground acceleration (ground shaking), fault rupture, liquefaction, landslides, seiches, and reservoir-induced seismicity.

Ground Acceleration (Ground Shaking)

Ground acceleration is an estimation of the peak bedrock or ground motion associated with a specific earthquake. It is expressed in terms of “$g$” forces, where “$g$” equals the acceleration due to gravity. Acceleration can be measured directly from seismic events or calculated from magnitude and fault distance data. Large earthquakes along more extensive faults can produce ground accelerations with longer wavelengths and durations than smaller faults, even thought the latter faults may be closer and thus generate greater peak accelerations. The wavelength, amplitude, and duration of seismic shaking can contribute to the destructive potential of individual earthquakes.

The La Nacion and Rose Canyon faults, as well as the Julian segment of the Elsinore Fault, are the principal contributors to the seismic hazard at the San Vicente Dam site. Moderate ground motion would be induced at the site as a result of a maximum magnitude earthquake on any of these three faults. Specifically, rupture of the La Nacion Fault during an earthquake of $M_w$ 6.7 could produce horizontal ground accelerations at the site of about 0.26g (84th percentile). A $M_w$ 7.1 earthquake on the Rose Canyon Fault, or a $M_w$ 7.5 earthquake on the Julian segment of the
Elsinore Fault, could produce horizontal peak ground accelerations at the site of about 0.21g (84th percentile).

**Fault Rupture**

Fault rupture refers to the physical displacement of surface deposits in direct response to movement along a fault. Other secondary effects related to fault movement, such as ground shaking, liquefaction, and landslides, are discussed elsewhere. As discussed previously, no active or potentially active faults were identified in the SV 100K study area.

**Liquefaction**

Potentially liquefiable soils are located within the natural alluvial deposits of San Vicente Creek and other drainages in the study area. Liquefaction occurs when earthquake vibrations cause loose, granular silts or sands, which are saturated with groundwater, to transform from a solid into a liquid state. As a result, the ground may undergo large permanent displacements that can damage underground utilities and surface structures. This transformation occurs because the intense shaking of the earthquake increases the pore-water pressure and causes the soil materials to lose their shear strength (bearing capacity). Structures on liquefied soils may tilt and sink (subsidence), and buried facilities may rise buoyantly. One type of displacement of major concern associated with liquefaction is lateral spreading because it involves displacement of large blocks of ground down gentle slopes or towards stream channels.

**Landslides**

Woodward-Clyde Consultants (WCC, 1991) and James M. Montgomery (JMM, 1992) reported the possible presence of a landslide block 1.25 miles wide by about 0.5 to 0.7 mile long from crown to toe along the east/northeast side of the reservoir. GEI investigated this feature and another large landform along the northeast rim of the reservoir. These features, which exhibit typical landslide geomorphology, were concluded to be the result of differential erosion rather than from landslide processes. No other indications of deep-seated landslides were observed in the SV 100K study area based on a review of aerial photographs and surface reconnaissance.

Large debris flow/rock fall deposits are present on lower slope areas and at the base of the northwest-facing hillsides in the southeast corner of the SV 100K study area. These deposits originate from the steep fractured rock outcrops located farther up the hillside. During periods of concentrated or above-average amounts of rainfall, and/or during strong ground motion caused by an earthquake, additional rock masses may be dislodged from these and other steep slopes in the area. A significantly smaller debris flow deposit, derived from cobbly sediments of the Stadium Conglomerate, was observed at the base of the south-facing hillsides of the marina (Figure 3.8-2).
Tan (1992) performed regional geologic and landslide hazard mapping in the reservoir area. This study did not indicate the presence of existing landslides at any location along the rim of the reservoir. However, the landslide susceptibility mapping indicates that nearly all reservoir rim slopes be considered as “generally susceptible areas” to landsliding, primarily based on “a combination of weaker materials and steep slopes.” This study indicated that these areas of susceptibility, for the most part, do not currently contain landslide deposits, but “can be expected to fail, locally, if adversely modified.” This could include rockfalls and debris flows in the conglomerates and steep areas underlain by jointed hard rock.

**Seiches**

A seiche is periodic oscillation (i.e., a wave) in the surface of a lake or other confined body of water that is typically induced by strong winds or passage of seismic ground motion from an earthquake.

**Reservoir-Induced Seismicity**

Reservoir-induced seismicity is a phenomenon that can occur when the water pressures induced by filling of a large reservoir triggers a seismic or tectonic event. Reservoir-induced seismicity is empirically related to reservoirs that exhibit the following characteristics:

- Water depths in excess of 300 feet
- Reservoir volumes in excess of one million acre-feet
- Active normal faulting in the reservoir basin
- Sedimentary bedrock in the reservoir basin

**Soils**

The soil associations within the SV 100K study area (Table 3.8-1) are based on survey and map data prepared by the Natural Resources Conservation Service (formerly the Soil Conservation Service) in 1973. Soils in the study area possess a low to high expansion potential, and a slight to severe potential for erosion. Depending on the types of clay minerals present, clay-rich soils are highly expansive. These soils can swell with increase in moisture content and will shrink with decrease in water content. Soils with high shrink-swell potential can cause extensive damage to structures and improvements. In contrast, sandy soils typically possess low expansivity but may possess severe erodability resulting from a lack of cohesive clay minerals. Soils that contain appreciable amounts of both clay and sand may exhibit both moderate to high expansivity and moderate to severe erodability.
Table 3.8-1. Soil Characteristics for the SV 100K Study Area

<table>
<thead>
<tr>
<th>Soil Association</th>
<th>Expansion Potential</th>
<th>Erosion Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Redding-Olivenhain (gravel/sand/silt/clay mixtures)</td>
<td>Moderate to High</td>
<td>Severe</td>
</tr>
<tr>
<td>Cieneba-Fallbrook (sand/silt/clay mixtures)</td>
<td>Low to Moderate</td>
<td>Severe</td>
</tr>
<tr>
<td>Exchequer-San Miguel (silt/clay mixtures)</td>
<td>Low to High</td>
<td>Severe</td>
</tr>
<tr>
<td>Fallbrook-Vista (sand/silt/clay mixtures)</td>
<td>Low to Moderate</td>
<td>Severe</td>
</tr>
<tr>
<td>Diablo-Altamont (clays)</td>
<td>High</td>
<td>Slight to Moderate</td>
</tr>
<tr>
<td>Rock Land (exposed bedrock)</td>
<td>Low</td>
<td>Severe</td>
</tr>
<tr>
<td>Visalia-Tujunga (sand/silt/clay mixtures)</td>
<td>Low</td>
<td>Severe</td>
</tr>
</tbody>
</table>

Source: SCS, 1973

3.8.1.2 Regulatory Setting

The following discussion addresses state regulations relevant to geology, soils and seismic issues of the Proposed Action.

Alquist-Priolo Earthquake Fault Zoning Act

The purpose of the Alquist-Priolo Earthquake Fault Zoning Act of 1972 (renamed in 1994) is “to regulate development near active faults so as to mitigate the hazard of surface fault rupture.” The State Geologist (chief of the then California Division of Mines and Geology [CDMG], now California Geologic Survey [CGS]) is required to delineate Earthquake Fault Zones (formerly known as “Special Studies Zones”) along known active faults in California. Cities and counties affected by the zones must regulate certain development within the zones and not approve development permits for sites within the zones until geologic investigations demonstrate that the sites are not threatened by surface displacement from future faulting. Several of the faults and fault zones in southern California are considered active by the CDMG, and Alquist-Priolo Earthquake Fault Zones (A-P Zones) have been established for the majority of these faults and fault zones (CDMG, 1997). A-P Zones are areas established along and parallel to the traces of active faults. The delineation of A-P Zones on topographic maps is the responsibility of the CGS. The purpose of the A-P zones is to prohibit the location of structures on the traces of active faults, thereby mitigating potential damage from fault surface rupture. In most cases, structures for human occupancy require a 50-foot setback from any known trace of an active fault.

Engineering Standards

The U.S. Army Corps of Engineers (Corps) and the U.S. Bureau of Reclamation (USBR) have developed comprehensive engineering standards that address the geotechnical aspects of dam safety with respect to design and construction. For dams under its jurisdiction, the DSOD is responsible for reviewing proposed designs of new dams (such as Moosa Dam alternative) or the enlargement of existing dams (such as San Vicente Dam). As part of that review, the engineers
at DSOD prepare an independent set of calculations to determine whether the proposed design and construction features will ensure that standard factors of safety are achieved and are consistent with up-to-date standard engineering practices.

### 3.8.2 Project Design Features

General Conditions and Standard Specifications that will be included in the project construction documents to reduce geology/soils impacts associated with construction of the Proposed Action are summarized in Section 1.9.4 (Introduction, Geology and Soils) of this EIR/EIS. In addition, the Proposed Action would include design features to minimize geology/soils impacts. These design and construction features could include, but would not be limited to, the following:

#### Planning and Coordination

- Project plans will be reviewed to ensure compatibility with geotechnical conclusions.
- Applicable field activities (e.g., manufactured slope conditions, excavations, fill placement) will be reviewed and appropriately modified by the geotechnical engineer.
- Design and construction elements, including seismic loading, excavation and grading, fill parameters (e.g., composition and moisture content), foundations and footings, manufactured slopes, and pipelines, will be in conformance with appropriate regulatory guidelines and industry standards.

#### Runoff and Erosion

- Construction activities will comply with existing regulatory requirements related to geology and soils, including applicable elements of the NPDES General Construction Permit, such as implementing a SWPPP and associated sedimentation BMPs. Typical control measures that may be implemented as part of the project SWPPP include:
  - Preparation and implementation of a “weather triggered” action plan during the rainy season to provide enhanced erosion of sediment control measures prior to predicted storm events (i.e., 40 percent or greater chance of rain).
  - Use of erosion control/stabilizing measures in appropriate areas (including disturbed areas and graded slopes with grades of 3:1 [horizontal to vertical] or steeper), such as geotextiles, mats, fiber rolls, soil binders, or temporary hydroseeding established prior to October 1.
  - Use of sediment controls to protect the site perimeter and prevent off-site sediment transport, including measures such as filtration devices (e.g., temporary inlet filters), silt fences, fiber rolls, gravel bags, temporary sediment basins, check dams, street sweeping, energy dissipaters, stabilizing construction access points, (e.g., with temporary graveling or pavement) and sediment stockpiles (e.g., with silt fences and tarps), and use of properly fitted covers for sediment transport vehicles.
- Store BMP materials in applicable on-site areas to provide “standby” capacity adequate to provide complete protection of exposed areas and prevent off-site sediment transport.
- Train personnel responsible for BMP installation and maintenance.
- Implement solid waste management efforts such as proper containment and disposal of construction debris.
- Installation of permanent native vegetation as soon as feasible after grading or construction.
- Implement appropriate monitoring and maintenance efforts (e.g., prior to and after storm events) to ensure proper BMP function and efficiency.
- Implement sampling/analysis, monitoring/reporting and post-construction management programs per NPDES requirements.
- Implement additional BMPs as necessary (and required by appropriate regulatory agencies) to ensure adequate erosion and sediment control.

- Actual BMPs will be determined during the NPDES permitting and SWPPP process, with such measures taking priority over the typical industry standard measures listed above.

**Manufactured Slopes and Retaining Walls**

- Design features will be included to avoid instability of manufactured slopes and retaining walls. These features could include, but are not limited to, the following:
  - Field observation/mapping of manufactured slopes by the geotechnical engineer, and (if applicable) implementation of site-specific design/construction changes.
  - Install adequate drainage for all manufactured slopes and retaining walls, including surface features to prevent runoff on slopes and subdrains, if appropriate, to prevent saturation of surficial materials (including retaining wall backfills).
  - Depending on material, use of maximum grades of 2:1 for fill slopes and 1.5:1 for cut slopes.
  - Use of approved fill materials and application methodologies (e.g., compaction and moisture content) for fill slopes.
  - Use of native and/or drought-tolerant landscaping to reduce irrigation requirements (and/or use of subdrains as noted above).
  - Use of stabilizing techniques (e.g., rock bolts) in applicable cut slopes.
  - Incorporating appropriate placement of slopes and retaining walls (i.e., away from potential saturation sources) and drainage facilities, as well as use of applicable criteria for lateral earth, surcharge and seismic pressures in the design of all retaining walls.
- Evaluate soil/rock conditions encountered during excavation to determine appropriate slope inclinations and stabilizing measures (e.g., shoring) to conform with existing U.S. Occupational Safety and Health Administration (OSHA) and California Occupational Safety and Health Administration (CAL/OSHA) requirements (including 29 CFR Part 1926, Occupational Health Standards-Excavations).

**Differential Settlement**

- Design features will be included to minimize or avoid differential compression or settlement of on-site soils. These features could include, but are not limited to, the following:
  - Perform site-specific settlement analyses in areas deemed appropriate by the geotechnical engineer.
  - Over-excavation of unsuitable materials and replacement with engineered fill, locating foundations and larger utility pipelines outside of cut/fill transition zones, and limited irrigation of landscaped areas.
  - Remove expansive materials and mixture with non-expansive soils and/or placement in deeper fills (at least five feet below finished grade) during grading.
  - Manage oversize material (i.e., rock with maximum dimensions greater than 12 inches) via off-site disposal, use in non-structural fill, or crushing or pre-blasting to generate material with maximum dimensions of less than 12 inches. Oversized material in fills will not exhibit maximum dimensions greater than 4 feet, and will not be placed within 10 feet of finish grade, 10 feet of manufactured slope faces (measured horizontally from the slope face) or 3 feet of the deepest pipeline or other utilities.

**Corrosive Soils**

- Construction activities will conform to applicable industry standards regarding corrosive soils. A site-specific investigation of potential corrosion hazards will be conducted in areas deemed appropriate by a qualified corrosion engineer. The results of this analysis will be checked against the final project design, as appropriate, to address potential corrosion impacts, and may include, but not be limited to:
  - Excavation (or overexcavation) and treatment, and/or removal and replacement (i.e., with engineered fill) of corrosive materials.
  - Use of non-corrosive and/or corrosion-resistant building materials in appropriate locations and installation of cathodic protection.
**Dam Design/Construction**

- The dam raise will be designed and constructed to meet current industry standards and DSOD's rules and regulations to minimize or avoid instability of the dam and its foundation. These features could include, but are not limited to, the following:
  - Construct the base of the raised dam on fresh to slightly weathered bedrock, requiring excavation and removal of overburden and severely to moderately weathered bedrock materials.
  - Perform consolidation grouting across the dam raise footprint to stiffen shallow rock layers. Prior to placement of leveling concrete, zones of localized poor quality rock will be excavated and these localized excavations filled with dental concrete.
  - Install a seepage/leakage control and drainage system to reduce seepage through the dam foundation.
  - Construct the new spillway (stepped portion) concurrently with the placement of RCC lifts.
  - Design the outlet works system in accordance with DSOD requirements regarding evacuation of the reservoir in the event of a dam safety emergency.
  - For the outlet tower and conduit construction, the rock supporting the existing dam will be supported with rock bolts and shotcrete, as needed, to maintain stability of the existing dam when excavation below the base of the existing dam would be performed to construct the base of the tower.
  - Construct the saddle dams using RCC, with a similar cross section as the main dam. The foundation excavations will extend down to competent bedrock and include, as needed, a foundation seepage control system consisting of a grout curtain along the dam axis.
  - Incorporate slope stability measures such as rock bolts or mechanically stabilized earth walls for the marina access road and the left and right abutment access roads, as needed.

**Liquefaction**

- Remove and replace any potentially liquefiable soils that could affect permanent construction will be removed and replaced with fill material that will not have the potential to liquefy.
- For thinner deposits where feasible, remove loose, unconsolidated soils and replace with properly compacted fill soils, or apply other design stabilization features (i.e., excavation of overburden).
- For thicker deposits, implement applicable techniques such as:
  - Dynamic compaction (dropping heavy weights on the land surface);
  - Vibro-compaction (inserting a vibratory device into the liquefiable sand);
- Vibro-replacement (replacing sand by drilling and then vibro-compacting backfill in the bore hole); and,
- Compaction piles (driving piles and densifying surrounding soil).

- Remediation for lateral spreading commonly requires subsurface barrier walls.

**Landslides**

- Stabilization (e.g., retaining walls/other structural support), removal (e.g., over-excavation and recompack) or avoidance (e.g., structural setbacks).

**Soil Erosion and Expansion**

- Identify areas of highly expansive or severely erodable soils will be identified as part of a site-specific geotechnical investigation. The investigations will specifically address foundation and slope stability in expansive or erodable soils proposed for construction. Recommendations made in conjunction with the geotechnical investigations will be implemented during final design and construction.
- Design components to resist damage from expansive soils and other unfavorable soil conditions as the need arises.
- Construct drainage control devices (e.g., storm drains, brow ditches, subdrains, etc.) to direct surface water runoff away from slopes and other graded areas.
- Provide seeding of disturbed and constructed slopes with groundcover vegetation as soon as possible following grading activities.
- Minimize disturbance to existing vegetation and slopes.

### 3.8.3 Direct and Indirect Effects

#### 3.8.3.1 Thresholds of Significance

Thresholds used to evaluate potential geology and soils impacts are based on applicable criteria in the State CEQA Guidelines (CCR §§15000-15387), Appendix G; and the ESP EIR/EIS. A significant geology and soils impact would occur if the Proposed Action would:

1. Expose people, boats, or structures (e.g., dams, docks, waterfront and downstream facilities, etc.) to substantial adverse effects, including the risk of loss, injury, death or property damage, from:
   a. Rupture along 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, such as Division of Mines and Geology Special Publication 42;
   b. Strong seismic ground shaking;
c. Seismic-related ground failure, including liquefaction;
d. Landslides;
e. Seismic-induced waves (seiches) in existing or proposed reservoirs; or
f. Accelerated seismic activity along existing faults due to an increase in stress on the faults caused by the presence of a dam and/or reservoir.

2. Result in substantial soil erosion or the loss of topsoil.

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.

4. Be located on expansive soil, as defined in Table 18-1-B of the UBC (1994), creating substantial risks to life or property.

3.8.3.2 Impact Analysis

Methodology

The methodology for determining impacts related to geology and soils is based on information in the Engineering Summary Report for the Proposed Action (GEI, 2007c). To estimate the ground motions that could be experienced at the San Vicente Dam site should any of the seismic sources in Section 3.8.1.1 rupture, a deterministic seismic hazard analysis was conducted. Deterministic analyses estimate the Horizontal and Vertical Peak Ground Accelerations that could potentially be produced at a site due to a maximum magnitude earthquake occurring on any of the individual active faults known in the region.

Analysis

*Threshold 1a: Expose people, boats, or structures (e.g., dams, docks, waterfront and downstream facilities, etc.) to substantial adverse effects, including the risk of loss, injury, death or property damage, from: rupture along 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, such as Division of Mines and Geology Special Publication 42*

Ground rupture generally occurs along active faults. As discussed in Section 3.8.1.1 above, no active or conditionally active faults underlie the SV 100K footprint. The two shear zones that underlie the existing dam abutments would also transect the proposed footprint of the dam raise section. The two shear zones that transit the footprint the raised dam have been determined to be non-seismogenic. Therefore, ground rupture on these shear zones from a seismic event would be unlikely. In addition, the Proposed Action would implement the Planning and Coordination and Dam Design/Construction project design features (Section 3.8.2 above), and any remedial
measures recommended by further geotechnical investigations associated with final engineering and design. Therefore, impacts of the Proposed Action from ground rupture would be less than significant.

The Proposed Action would not be subject to fault rupture hazard because there are no active or conditionally active faults that underlie the footprint. In addition, the Proposed Action would implement the Planning and Coordination and Dam Design/Construction project design features (Section 3.8.2 above), and any remedial measures recommended by further geotechnical investigations associated with final engineering and design in order to minimize potential exposure of people, boats, or structures to substantial adverse effects from ground rupture, including the risk of loss, injury, death or property damage. Therefore, impacts of the Proposed Action would be less than significant.

**Threshold 1b: Expose people, boats, or structures (e.g., dams, docks, waterfront and downstream facilities, etc.) to substantial adverse effects, including the risk of loss, injury, death or property damage, from: strong seismic ground shaking**

The La Nacion Fault and the Julian segment of the Elsinore Fault are the principal contributors to the seismic hazard at the San Vicente Dam site. Moderate ground motion would be induced at the site as a result of a maximum magnitude earthquake on these faults. The proposed raised dam would be designed to withstand strong ground motions induced by earthquakes. The DSOD has approved the following seismic design criteria (GEI, 2007c):

- Peak horizontal and vertical accelerations equal to 0.26g and 0.22g, respectively, at the San Vicente site caused by a magnitude 6.7 earthquake on the La Nacion Fault, located 20 kilometers from the dam.

- Peak horizontal and vertical accelerations equal to 0.21g and 0.17g, respectively, at the San Vicente site caused by a magnitude 7.5 earthquake on the Julian segment of the Elsinore Fault, located 36 kilometers from the dam.

The Proposed Action would implement the DSOD approved seismic design criteria listed above, and Planning and Coordination and Dam Design/Construction project design features (Section 3.8.2 above) to reduce potential effects from seismic ground shaking. These features would include adherence to DSOD seismic design criteria; to various other regulatory requirements; and to the recommendations of additional site-specific geotechnical investigations associated with final engineering and design. In addition, the results and recommendations of the site-specific geotechnical evaluations for ground shaking would be incorporated into final construction specifications for the Proposed Action. Therefore, impacts would be less than significant.

The Proposed Action would implement the DSOD approved seismic design criteria, the Planning and Coordination and Dam Design/Construction project design features (Section 3.8.2 above), and any remedial measures recommended by further geotechnical investigations associated with final engineering and design in order to minimize potential exposure of people, boats, or
structures to substantial adverse effects from ground shaking, including the risk of loss, injury, death or property damage. Therefore, impacts of the Proposed Action would be less than significant.

**Threshold 1c: Expose people, boats, or structures (e.g., dams, docks, waterfront and downstream facilities, etc.) to substantial adverse effects, including the risk of loss, injury, death or property damage, from: seismic-related ground failure, including liquefaction**

All loose soils (overburden) were removed within the San Vicente dam footprint during original construction. Similarly, all of the loose alluvial soils within the dam foundations will be excavated during foundation preparation such that the entire dam rests on competent bedrock. Therefore, impacts of the Proposed Action from liquefaction at the site construction site would be less than significant.

For other Proposed Action components where data are not sufficient to fully characterize liquefaction potential, site-specific geotechnical studies would be performed during final engineering and design to demonstrate there is no liquefaction hazard, or to mitigate the liquefaction hazard if it were found to exist. The results and recommendations of the site-specific geotechnical evaluations for liquefaction would be incorporated into final construction specifications for the Proposed Action. Therefore, impacts of the Proposed Action from liquefaction at the dam construction and other on-site areas would be less than significant.

The Proposed Action would not be exposed to substantial liquefaction hazard and would implement the Planning and Coordination and Dam Design/Construction project design features (Section 3.8.2 above), and any remedial measures recommended by further geotechnical investigations associated with final engineering and design in order to minimize potential exposure of people, boats, or structures to substantial adverse effects from liquefaction, including the risk of loss, injury, death or property damage. Therefore, impacts of the Proposed Action would be less than significant.

**Threshold 1d: Expose people, boats, or structures (e.g., dams, docks, waterfront and downstream facilities, etc.) to substantial adverse effects, including the risk of loss, injury, death or property damage, from: landslides**

Two large landforms along the northeast perimeter of the San Vicente Reservoir had been suspected of being landslides. An investigation was undertaken that included geologic reconnaissance and analyses, and three deep explorations through the landforms. This investigation concluded that the landforms are not landslide features (GEI, 2007c). No other landslides were observed in the area based on a review of aerial photographs and surface reconnaissance (GEI, 2007c).

The Proposed Action would implement the Planning and Coordination and Dam Design/Construction project design features (Section 3.8.2 above) to reduce potential effects from landslides, including adherence to guidelines from the DSOD and the recommendations of additional site-specific geotechnical investigations associated with final engineering and design.
The results and recommendations of the site-specific geotechnical evaluations for landslides would be incorporated into final construction specifications for the Proposed Action. Therefore, impacts of the Proposed Action from landslides would be less than significant.

The Proposed Action would not be exposed to substantial landslide risk and would implement the Planning and Coordination and Dam Design/Construction project design features (Section 3.8.2 above), and any remedial measures recommended by further geotechnical investigations associated with final engineering and design in order to minimize potential exposure of people, boats, or structures to substantial adverse effects from landslides, including the risk of loss, injury, death or property damage. Therefore, impacts of the Proposed Action would be less than significant.

Threshold 1e: Expose people, boats, or structures (e.g., dams, docks, waterfront and downstream facilities, etc.) to substantial adverse effects, including the risk of loss, injury, death or property damage, from: seismic-induced waves (seiches) in existing or proposed reservoirs

Seiches are produced when seismic ground shaking causes massive wave oscillations of an enclosed water body that continue after the originating force has stopped. The frequency of the oscillation is the same as the natural frequency of the body of water. Seiches can also be formed when faulting causes permanent vertical displacement beneath a body of water. The geotechnical evaluation concluded that because of the irregular shape of the shoreline and the large central island within San Vicente Reservoir, the potential for seiches to overtop the raised dam is considered low (GEI, 2007c). Due to the low potential for this hazard to occur, the impact of seiches would be less than significant.

The Proposed Action would have a low potential for seiches based on the geotechnical evaluation. Therefore, impacts from seiches, including the risk of loss, injury, death or property damage, would be less than significant.

Threshold 1f: Expose people, boats, or structures (e.g., dams, docks, waterfront and downstream facilities, etc.) to substantial adverse effects, including the risk of loss, injury, death or property damage, from: accelerated seismic activity along existing faults due to an increase in stress on the faults caused by the presence of a dam and/or reservoir

Reservoir-induced seismicity is a phenomenon related to reservoirs whose capacity is typically in excess of one million acre feet, and with active normal faulting in the reservoir. Since these features do not exist with the Proposed Action, the potential for reservoir-induced seismicity from filling the raised San Vicente Reservoir was considered low in the geotechnical evaluation (GEI, 2007c). Specifically, the potential for reservoir-induced seismicity for the expanded San Vicente Reservoir is considered to be low for the following reasons:

- The total storage capacity of the expanded reservoir would be 246,994 AF, much less than the one million acre-foot volume that would be needed to substantially contribute to the potential for reservoir-induced seismicity.
- The reservoir basin consists of competent metamorphic and igneous rock, as opposed to sedimentary rock. As discussed in Section 3.8.1.1 above, hard bedrock materials underlie almost the entire reservoir area, with sandstones and conglomerates (underlain by hard rock formations) comprising the tops and sides of hills primarily along the southwestern edges of the reservoir.

- The reservoir basin is not underlain by active or conditionally active faults.

No reservoir-induced seismicity has been associated with any existing reservoir in San Diego County, including San Vicente (in operation since 1943). Due to the low potential for this hazard to occur, impacts from reservoir-induced seismicity would be less than significant.

The Proposed Action would not be exposed to reservoir-induced seismicity hazard because conditions that could result in reservoir-induced seismicity do not exist at the site, according to the Engineering Summary Report (GEI, 2007c). Therefore, impacts from reservoir-induced seismicity, including the risk of loss, injury, death or property damage, would be less than significant.

Threshold 2: Result in substantial soil erosion or the loss of topsoil

As shown in Table 3.8-1, all of the soil associations within the SV 100K study area except Diablo-Altamont (clays) possess severe erosion potential as defined by UBC Standard No. 18-2.

The Proposed Action would implement the Planning and Coordination and Dam Design/Construction project design features (Section 3.8.2 above) to reduce potential effects from soil erosion, including adherence to guidelines from the DSOD and the recommendations of additional site-specific geotechnical investigations associated with final engineering and design. The results and recommendations of the site-specific geotechnical evaluations for soil erosion would be incorporated into final construction specifications for the Proposed Action. Therefore, impacts would be less than significant.

The Proposed Action would not result in substantial erosion or loss of topsoil. The project would implement the Planning and Coordination and Dam Design/Construction project design features (Section 3.8.2 above), and any remedial measures recommended by further geotechnical investigations associated with final engineering and design in order to minimize soil erosion and loss of topsoil. Therefore, impacts of the Proposed Action would be less than significant.

Threshold 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

Landslides and liquefaction impacts are discussed above. Soils in the SV 100K study area have the potential to be unstable because they can contain both clay and sand, and therefore exhibit both moderate to high expansivity and moderate to severe erosion potential. The Proposed Action would implement the Planning and Coordination and Dam Design/Construction project
design features (Section 3.8.2 above) to reduce potential effects from unstable geologic units or soils, including the measures for Manufactured Slopes and Retaining Walls, Differential Settlement, Corrosive Soils, Liquefaction, Landslides, and Soil Erosion and Expansion project design features. The results and recommendations of the site-specific geotechnical evaluations for unstable geologic units or soils would also be incorporated into final construction specifications for the Proposed Action. Therefore, impacts would be less than significant.

The Proposed Action would not 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. The Proposed Action would implement the Planning and Coordination and Dam Design/Construction project design features (Section 3.8.2 above), and any remedial measures recommended by further geotechnical investigations associated with final engineering and design in order to minimize impacts from unstable geologic units or soils. Therefore, impacts of the Proposed Action would be less than significant.

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

As shown in Table 3.8-1, all of the soil associations, except rock land and Visalia-Tujunga san/silt/clay mixtures within the SV 100K study area, possess at least a moderate expansion potential as defined by UBC Standard No. 18-2. The clayey portions of on-site soils are considered moderately expansive. The Proposed Action would implement the Planning and Coordination and Dam Design/Construction project design features (Section 3.8.2 above) to reduce potential effects from expansive soil, including the measures for Manufactured Slopes and Retaining Walls, Differential Settlement, Corrosive Soils, Liquefaction, Landslides, and Soil Erosion and Expansion project design features. The results and recommendations of the site-specific geotechnical evaluations for expansive soil would also be incorporated into final construction specifications for the Proposed Action. Therefore, impacts would be less than significant.

The Proposed Action would not be located on expansive soil that could create substantial risks to life or property. The Proposed Action would implement the Planning and Coordination and Dam Design/Construction project design features (Section 3.8.2 above), and any remedial measures recommended by further geotechnical investigations associated with final engineering and design in order to minimize impacts from soil expansion. Therefore, impacts of the Proposed Action would be less than significant.

3.8.3.3 Mitigation Measures

Impacts related to geology and soils would be less than significant. Therefore, no mitigation measures are required.
3.8.3.4 Residual Impacts after Mitigation

No residual impacts would occur.

3.8.4 Cumulative Effects

3.8.4.1 Other CIP Projects

As described in Section 3.2 (Cumulative Projects) of this EIR/EIS, it was determined that the Slaughterhouse Terminal Reservoir would be the only CIP project with the potential to contribute cumulative impacts when combined with the Proposed Action since they are located within two miles of one another. The PEIR for the Regional Water Facilities Master Plan concluded that the entire San Diego region is susceptible to impacts from seismic activity. Although seismic activity can cause damage to substandard construction, new project designs can significantly reduce the potential for damage. Earthquake-resistant designs employed on new structures minimize the impact to public safety from seismic events to a less-than-significant level. The Proposed Action and the Slaughterhouse Terminal Reservoir may be constructed through geologic formations susceptible to slope failure and soil compaction, as well as at sites with potential shrink and swell soils, or that feature soils with high erosion potential. Project-specific geotechnical investigations would be necessary as part of the design process to address these geologic issues and impacts and all CIP projects throughout the region would be required to utilize standard engineering practices and meet design standards. The above conclusions regarding cumulative geological impacts for the CIP project described above are incorporated into the cumulative geological analyses in Section 3.8.4.3 below.

3.8.4.2 ESP Projects

ESP project components that would be in the vicinity of the Proposed Action would include the San Vicente Pipeline, the San Vicente Pump Station and the San Vicente Surge Control Facility. The ESP EIR/EIS concluded that potentially significant geology/seismicity impacts would be mitigated by implementing standard excavation and construction methods, and cumulative impacts of this issue would not be significant. The above conclusions regarding cumulative public safety and hazardous materials impacts for the three ESP projects described above are incorporated into the cumulative geology and soils analyses in Section 3.8.4.3 below.

3.8.4.3 Other Planned Projects with CIP and ESP Projects

This section evaluates the cumulative geological impacts of the Proposed Action when considered in conjunction with the other planned projects listed in Table 3.2-1 (Cumulative Projects) of this EIR/EIS, and incorporates the cumulative geological impacts associated with the CIP and ESP projects described in the above sections. The following cumulative geology and soils analysis addresses each of the four significance thresholds listed in Section 3.8.3.1 above.
Cumulative Threshold 1: Expose people, boats, or structures (e.g., dams, docks, waterfront and downstream facilities, etc.) to substantial adverse effects, including the risk of loss, injury, death or property damage, from (a) rupture along 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, such as Division of Mines and Geology Special Publication 42; (b) strong seismic ground shaking; (c) seismic-related ground failure, including liquefaction; (d) landslides; (e) seismic-induced waves (seiches) in existing or proposed reservoirs; and (f) accelerated seismic activity along existing faults due to an increase in stress on the faults caused by the presence of a dam and/or reservoir.

Ground Rupture

The Proposed Action would implement the Planning and Coordination and Dam Design/Construction project design features (Section 3.8.2 above), as well as any remedial measures recommended by further geotechnical investigations associated with final engineering and design in order to minimize potential exposure of people, boats, or structures to substantial adverse effects from ground rupture along a known earthquake fault, including the risk of loss, injury, death or property damage.

Other cumulative projects in the vicinity of the Proposed Action primarily include five mining projects and a number of residential subdivisions (refer to Figure 3.2-1 [Cumulative Projects] of this EIR/EIS). These projects either would not have a substantial effect on ground rupture or would be required to comply with mitigation measures or regulations intended to avoid or mitigate significant impacts related to geologic or soil resources. Therefore, ground rupture impacts due to construction and operation of the Proposed Action, when combined with cumulative ground rupture impacts from the CIP, ESP, and other planned cumulative projects listed in Table 3.2-1 (Cumulative Projects) of this EIR/EIS, would not be cumulatively considerable. The cumulative impact would be less than significant.

Ground Shaking

The Proposed Action would implement the measures identified in Section 3.8.3.2 above and the Planning and Coordination and Dam Design/Construction project design features (Section 3.8.2 above) to minimize potential exposure of people, boats, or structures to substantial adverse effects from strong seismic ground shaking, including the risk of loss, injury, death or property damage. Other cumulative projects in the vicinity of the Proposed Action primarily include five mining projects and a number of residential subdivisions (refer to Figure 3.2-1 [Cumulative Projects] of this EIR/EIS). These projects either would not have a substantial effect on seismic ground shaking or would be required to comply with mitigation measures or regulations intended to avoid or mitigate significant impacts related to geologic or soil resources. Therefore, ground shaking impacts due to construction and operation of the Proposed Action, when combined with cumulative ground shaking impacts from the CIP, ESP, and other planned cumulative projects listed in Table 3.2-1 (Cumulative Projects) of this EIR/EIS would not be cumulatively considerable. The cumulative impact would be less than significant.
**Liquefaction**

The Proposed Action would implement the measures identified in Section 3.8.3.2 above, and the Planning and Coordination, Dam Design/Construction, and Liquefaction project design features (Section 3.8.2 above) to minimize potential exposure of people, boats, or structures to substantial adverse effects from liquefaction, including the risk of loss, injury, death, or property damage. Other cumulative projects in the area as described above would not have a substantial effect on liquefaction or would be required to comply with mitigation measures or regulations intended to avoid or mitigate significant impacts related to geologic or soil resources. Therefore, liquefaction impacts due to construction and operation of the Proposed Action, when combined with cumulative liquefaction impacts from the CIP, ESP, and other planned cumulative projects listed in Table 3.2-1 (Cumulative Projects) of this EIR/EIS, would not be cumulatively considerable. The cumulative impact would be less than significant.

**Landslides**

The Proposed Action would implement the measures identified in Section 3.8.3.2 above, and the Planning and Coordination, Dam Design/Construction, and Landslides project design features (Section 3.8.2 above) to minimize potential exposure of people, boats, or structures to substantial adverse effects from landslides, including the risk of loss, injury, death, or property damage. Other cumulative projects in the area as described above are not likely to cause landslides or would be required to comply with mitigation measures or regulations intended to avoid or mitigate significant impacts related to geologic or soil resources. Therefore, landslide impacts due to construction and operation of the Proposed Action, when combined with cumulative landslide impacts from the CIP, ESP and other planned cumulative projects listed in Table 3.2-1 (Cumulative Projects) of this EIR/EIS, would not be cumulatively considerable. The cumulative impact would be less than significant.

**Seiches**

Proposed Action and the other planned cumulative projects described above would have a low potential for seiches. Therefore, geological impacts due to seiches in the Proposed Action project area, when combined with the geological impacts due to seiches found in the CIP, ESP, and other planned cumulative project areas, would not be cumulatively considerable. The cumulative impact would be less than significant.

**Accelerated Seismicity**

The Proposed Action would have a low potential for conditions resulting in reservoir-induced seismicity. In addition, other cumulative projects in the area do not consist of construction of a dam or reservoir that could be subject to reservoir-induced seismicity. Therefore, accelerated seismic activity impacts due to the Proposed Action as a result of the presence of a dam or reservoir would not be cumulatively considerable. The cumulative impact would be less than significant.
Cumulative Threshold 2: Result in substantial soil erosion or the loss of topsoil

The Proposed Action would implement the measures described in Section 3.8.3.2 above and the Runoff and Erosion, Manufactured Slopes and Retaining Walls, and Soil Erosion and Expansion project design features (Section 3.8.2 above) to minimize soil erosion and loss of topsoil. Other cumulative projects in the area as described above would be required to comply with mitigation measures or regulations intended to avoid or mitigate significant impacts related to geologic or soil resources. These projects either would not affect nor be affected by geologic or soil resources or would be required to comply with mitigation measures or regulations intended to avoid or mitigate significant impacts related to geologic or soil resources. Therefore, soil erosion and loss of topsoil due to the Proposed Action, when combined with cumulative soil erosion and loss of topsoil due to the CIP, ESP and other planned cumulative projects listed in Table 3.2-1 (Cumulative Projects) of this EIR/EIS, would not be cumulatively considerable. The cumulative impact would be less than significant.

Cumulative Threshold 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

The Proposed Action would implement the measures described in Section 3.8.3.2 above, and the Manufactured Slopes and Retaining Walls, Differential Settlement, Corrosive Soils, Liquefaction, Landslides, and Soil Erosion and Expansion project design features (Section 3.8.2 above) to minimize impacts from unstable geologic units or soils. Other cumulative projects in the area as described above are not likely to cause landslides or would be required to comply with mitigation measures or regulations intended to avoid or mitigate significant impacts related to geologic or soil resources. These projects either would not be located on a geologic unit or soil that is unstable or would be required to comply with mitigation measures or regulations intended to avoid or mitigate significant impacts related to geologic or soil resources. Therefore, geologic or soils impacts due to the location of the Proposed Action, when combined with cumulative geologic or soils impacts due to the CIP, ESP and other planned cumulative projects listed in Table 3.2-1 (Cumulative Projects) of this EIR/EIS, would not be cumulatively considerable. The cumulative impact would be less than significant.

Cumulative Threshold 4: Be located on expansive soil, as defined in Table 18-1-B of the UBC (1994), creating substantial risks to life or property

The Proposed Action would implement the measures described in Section 3.8.3.2 above, and the Manufactured Slopes and Retaining Walls, Differential Settlement, and Soil Erosion and Expansion project design features (Section 3.8.2 above) to minimize impacts from soil expansion. Therefore, impacts of the Proposed Action would be less than significant. Other cumulative projects in the area as described above would be required to comply with mitigation measures or regulations intended to avoid or mitigate significant impacts related to geologic or soil resources. These projects either would not be located on expansive soil or would be required to comply with mitigation measures or regulations intended to avoid or mitigate significant impacts related to geologic or soil resources. Therefore, geologic or soils impacts due to the
location of the Proposed Action, when combined with cumulative geologic or soils impacts due to the CIP, ESP and other planned cumulative projects listed in Table 3.2-1 (Cumulative Projects) of this EIR/EIS, would not be cumulatively considerable. The cumulative impact would be less than significant.

*The Proposed Action would not be subject to any geologic or soils conditions or hazards that could not be mitigated through implementation of DSOD requirements, Planning and Coordination and Dam Design/Construction project design features, and General Conditions and Standard Specifications, which would minimize potential exposure of people, boats, or structures to substantial adverse effects from ground shaking, ground rupture, ground failure or liquefaction, and landslides, including the risk of loss, injury, death or property damage. The Proposed Action would have a low potential for seiches and for conditions resulting in reservoir-induced seismicity. The Proposed Action would implement measures to minimize substantial soil erosion or the loss of topsoil. The Proposed Action would also implement measures to minimize impacts from unstable geologic units or soils and impacts from soil expansion. The Proposed Action and other cumulative projects would implement measures to minimize impacts on or from geologic and soil resources. Therefore, cumulative geology and soils impacts due to the Proposed Action, when combined geology and soils impacts due to CIP and ESP projects listed above and other cumulative planned projects in the area (Table 3.2-1 [Cumulative Projects] of this EIR/EIS), would be less than significant.*
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Alternative 1: San Vicente 100,000 AF (Proposed Action)
Geology and Soils
LOCAL Bedrock Geology Map in the Vicinity of San Vicente Dam

Figure 3.8-2

San Vicente Creek Canyon

San Vicente Quarry Option Area

Marina Quarry Option Area

San Vicente Reservoir (Existing Spillway El 650)

Not to Scale
FIGURE 3.8-3

DAM SITE GEOLOGY MAP FOR THE PROPOSED ACTION

SOURCE: GEI, 2007c

Not to Scale
GEOLOGIC PROFILE ALONG DAM AXIS

FIGURE 3.8-4

SOURCE: GEI, 2007c