# Chapter 8
# GEOLOGY, SOILS, AND MINERAL RESOURCES

## 8.1 Introduction

This chapter describes existing conditions and regulations related to geology, soils, and mineral resources, including those associated with geologic and seismic hazards, within the study area for the Clearwater Program. It analyzes potential impacts that would result from the implementation of program and project elements; determines the significance of those impacts; and provides mitigation measures, where feasible and if necessary, to reduce or avoid impacts.

Geology and soils issues refer to the compatibility of the physical land with development and include potential hazards associated with earthquake fault rupture, substrate and soil stability, and soil characteristics. This chapter discusses these issues as they pertain to the construction and operation of program and project elements.

Seismic hazard and liquefaction assessments and fault investigations were conducted for the Clearwater Program. The results of these assessments and investigations are documented in studies prepared by Fugro West (refer to Chapter 25) and are incorporated herein by reference.

As discussed in Section 3.6.1, a Preliminary Screening Analysis (Appendix 1-A) was performed to determine impacts associated with the construction and operation of program and project elements by resource area. During preliminary screening, each element was determined to have no impact, a less than significant impact, or a potentially significant impact. Those elements determined to be potentially significant were further analyzed in this environmental impact report/environmental impact statement (EIR/EIS). This EIR/EIS analysis discloses the final impact determination for those elements deemed potentially significant in the Preliminary Screening Analysis. The location of the geology, soils, and mineral resources impact analysis for each program element is summarized by alternative in Table 8-1.

**Table 8-1. Impact Analysis Location of Program Elements by Alternative**

| | Alternative | | | | | | Analysis Location | |
|---|---|---|---|---|---|---|---|---|
| **Program Element** | **1** | **2** | **3** | **4** | **5**[a] | **6**[b] | **PSA** | **EIR/EIS** |
| **Conveyance System** | | | | | | | | |
| Conveyance Improvements | X | X | X | X | X | N/A | C,O | C,O |
| **SJCWRP** | | | | | | | | |
| Plant Expansion | X | X | X | X | X | N/A | C,O | C,O |
| Process Optimization | X | X | X | X | N/A | N/A | C,O | C,O |
| WRP Effluent Management | X | X | X | X | X | N/A | O | - |
| **POWRP** | | | | | | | | |
| Process Optimization | X | X | X | X | N/A | N/A | C,O | C,O |
| WRP Effluent Management | X | X | X | X | X | N/A | O | - |

**Table 8-1 (Continued)**

| Program Element | Alternative 1 | 2 | 3 | 4 | 5[a] | 6[b] | Analysis Location PSA | EIR/EIS |
|---|---|---|---|---|---|---|---|---|
| **LCWRP** | | | | | | | | |
| Process Optimization | X | X | X | X | N/A | N/A | C,O | C,O |
| WRP Effluent Management | X | X | X | X | X | N/A | O | - |
| **LBWRP** | | | | | | | | |
| Process Optimization | X | X | X | X | N/A | N/A | C,O | C,O |
| WRP Effluent Management | X | X | X | X | X | N/A | O | - |
| **WNWRP** | | | | | | | | |
| WRP Effluent Management | X | X | X | X | X | N/A | O | - |
| **JWPCP** | | | | | | | | |
| Solids Processing | X | X | X | X | X | N/A | C,O | C,O |
| Biosolids Management | X | X | X | X | X | N/A | O | O |
| JWPCP Effluent Management | X | X | X | X | N/A | N/A | Evaluated at the project level. See Table 8-2. | |

WRP effluent management and biosolids management do not include construction.
[a] See Section 8.4.7 for a discussion of the No-Project Alternative.
[b] See Section 8.4.8 for a discussion of the No-Federal-Action Alternative.
PSA = Preliminary Screening Analysis
C = construction
O = operation
N/A = not applicable

As discussed in Section 3.2.2, Joint Water Pollution Control Plant (JWPCP) effluent management was the one program element that was carried forward as a project. The location of the geology, soils, and mineral resources impact analysis for each project element is summarized by alternative in Table 8-2.

**Table 8-2. Impact Analysis Location of Project Elements by Alternative**

| Project Element | Alternative 1 | 2 | 3 | 4 | 5[a] | 6[b] | Analysis Location PSA | EIR/EIS |
|---|---|---|---|---|---|---|---|---|
| **Tunnel Alignment** | | | | | | | | |
| Wilmington to SP Shelf (onshore) | X | | | | N/A | N/A | C,O | C,O |
| Wilmington to SP Shelf (offshore) | X | | | | N/A | N/A | C,O | C,O |
| Wilmington to PV Shelf (onshore) | | X | | | N/A | N/A | C,O | C,O |
| Wilmington to PV Shelf (offshore) | | X | | | N/A | N/A | C,O | C,O |
| Figueroa/Gaffey to PV Shelf (onshore) | | | X | | N/A | N/A | C,O | C,O |
| Figueroa/Gaffey to PV Shelf (offshore) | | | X | | N/A | N/A | C,O | C,O |
| Figueroa/Western to Royal Palms (onshore) | | | | X | N/A | N/A | C,O | C,O |
| **Shaft Sites** | | | | | | | | |
| JWPCP East | X | X | | | N/A | N/A | C,O | C,O |
| JWPCP West | | | X | X | N/A | N/A | C,O | C,O |
| TraPac | X | X | | | N/A | N/A | C,O | C,O |
| LAXT | X | X | | | N/A | N/A | C,O | C,O |

**Table 8-2 (Continued)**

| Project Element | Alternative | | | | | | Analysis Location | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5[a] | 6[b] | PSA | EIR/EIS |
| Southwest Marine | X | X | | | N/A | N/A | C,O | C,O |
| Angels Gate | | | X | | N/A | N/A | C,O | C,O |
| Royal Palms | | | | X | N/A | N/A | C,O | C,O |
| **Riser/Diffuser Areas** | | | | | | | | |
| SP Shelf | X | | | | N/A | N/A | C,O | C,O |
| PV Shelf | | X | X | | N/A | N/A | C,O | C,O |
| Existing Ocean Outfalls | X | X | X | X | N/A | N/A | C,O | C,O |

[a] See Section 8.4.7 for a discussion of the No-Project Alternative.
[b] See Section 8.4.8 for a discussion of the No-Federal-Action Alternative.
PSA = Preliminary Screening Analysis
C = construction
O = operation
N/A = not applicable

# 8.2 Environmental Setting

## 8.2.1 Regional Setting

### 8.2.1.1 Geography and Topography

The Joint Outfall System (JOS) provides wastewater conveyance and treatment, solids processing, and biosolids and effluent management for communities within the San Gabriel Valley, the Los Angeles Coastal Plain, and the surrounding mountains and foothills. Geographically, the JOS service area is bound by the San Gabriel Mountains to the north, the Pacific Ocean to the west and south, and the Orange County line and the Puente and San Jose Hills to the east. For purposes of discussion in this chapter, the regional setting is defined by the boundaries of the JOS service area.

Within the region, there are three major rivers – the Los Angeles, the San Gabriel, and the Rio Hondo – that flow southward into the San Pedro Bay. The most significant topographic features are the San Gabriel Valley and the Coastal Plain. The San Gabriel Valley occupies the northeastern portion of the region. This broad, triangular plain descends southward from the San Gabriel Mountains at a slope of roughly 65 feet per mile and covers an area of approximately 170 square miles. The San Gabriel Valley is separated from the Coastal Plain to the south by northwest-trending highlands, including the Puente, Merced, and Repetto Hills. The Whittier Narrows, a hydrologic reference point that is an outlet for the Rio Hondo and the San Gabriel Rivers, lies at the gap between the Puente and Merced Hills.

The Coastal Plain is an alluviated lowland southwest of the Whittier Narrows. The Coastal Plain extends to the Pacific Ocean in all directions, except where interrupted by a few local highlands such as the Baldwin, Dominguez, and Palos Verdes Hills. The Los Angeles, San Gabriel, and Rio Hondo Rivers flow generally southward through the Coastal Plain to the Pacific Ocean along engineered drainage channels.

### 8.2.1.2 Geology

The JOS service area lies within two geomorphic provinces: the Peninsular Ranges geomorphic province and the Transverse Ranges geomorphic province. The Peninsular Ranges geomorphic province extends southward from roughly the southern base of the Santa Monica Mountains and the foothills of the San Gabriel Mountains into Baja California and includes the southern portion of the JOS service area. The Transverse Ranges geomorphic province trends east-west along the northern border of the Peninsular Ranges geomorphic province and includes the northern portion of the JOS service area. The Coastal Plain lies within the Peninsular Ranges geomorphic province, while the San Gabriel Valley lies within a transition zone separating these two geomorphic provinces.

The Coastal Plain is characterized by the geologic features of the Peninsular Ranges geomorphic province and is typified by a succession of northwest-trending highlands and intervening valleys. This regional configuration of parallel highland areas is the direct result of ongoing tectonic activity along a series of northwest-trending, predominantly right-lateral strike-slip faults such as the Palos Verdes, Newport-Inglewood, and Whittier-Elsinore Faults. The geologic units directly underlying this portion of the Coastal Plain primarily are composed of Holocene (approximately 11,000 years old) alluvial and shallow marine sediments that were shed from local highlands. These recent deposits are underlain by a thick sequence of middle to upper Cenozoic-Age (approximately 37 million years ago to recent times) marine sedimentary and volcanic rock units, such as the Monterey, Topanga, Puente, and Fernando Formations, which are exposed in the highlands. The sedimentary bedrock sequence overlies metamorphic bedrock.

The San Gabriel Valley is characterized by geologic features of the Transverse Ranges geomorphic province. The east-west-trending San Gabriel Mountains form the northern boundary of the San Gabriel Valley. The Raymond Hill Fault, the Sierra Madre Fault, and the Repetto Hills Fault (bordered on the south by the Whittier Fault) bound the San Gabriel Valley. The San Gabriel Valley floor is primarily composed of recent alluvial fan and stream deposits derived from the surrounding mountains and hills. These recent deposits are underlain by a thick sequence of late Cretaceous-Age (approximately 98 million years old) to Pleistocene-Age (approximately 1.6 million years old) marine and nonmarine sedimentary rock units that are locally intruded by middle Miocene-Age volcanic rocks. The sedimentary sequence overlies the basement complex that ranges from Miocene-Age (approximately 15 million years old) plutonic rocks in the eastern portion of the San Gabriel Valley to Precambrian-Age (approximately 3.8 billion to 570 million years old) plutonic rocks in the northern San Gabriel Valley.

The offshore San Pedro Shelf (SP Shelf) is the broad, wave-cut platform forming the inner edge of the continental shelf. The offshore stratigraphy underlying the shelf includes folded and faulted Miocene through Pliocene (approximately 5.3 million to 1.6 million years old) sedimentary rocks covered by Quaternary marine sediment. The same sequence of Pliocene through Miocene sedimentary rocks underlies the Palos Verdes Shelf (PV Shelf). Much of this sedimentary sequence was encountered during construction of the Sanitation Districts of Los Angeles County's (Sanitation Districts') existing ocean outfalls.

### 8.2.1.3 Seismicity

The region is seismically active. Seismic risk zones have been developed based on the known distribution of historic earthquakes, evidence of past earthquakes, proximity to earthquake areas and active faults, and frequency of earthquakes in a given area. These zones are generally classified based on peak acceleration from maximum credible earthquakes (Mualchin 1992; Mualchin 1996) or the Uniform Building Code (UBC) Seismic Risk Map of the United States. Because of the number of active faults in Los Angeles County and Southern California, the region is located in the highest risk zone defined by UBC standards (Zone IV).

Potential seismic sources within about a 100-kilometer radius of the region are listed in Table 8-3. Regional faults are shown on Figure 8-1. Locations of significant historical earthquakes are also shown on Figure 8-1.

**Table 8-3. Potential Seismic Sources**

| Fault Zone | Fault Type/ Sense of Movement | Slip Rate (mm per year) | $M_W$ (maximum or range) |
|---|---|---|---|
| Cabrillo | Strike slip/right lateral, normal[a] | 0.2/1.0 | 6.0–6.8 |
| Coronado Banks | Strike slip/right lateral, normal[a] | ~2 | 6.0–7.0 |
| Cleghorn | Strike slip/left lateral | ~4 | N/A |
| Cucamonga | Thrust/reverse | 5.0/14.0 | 6.0–7.0 |
| Elsinore | Strike slip/right lateral | 1.0/5.0 | 6.0–7.5 |
| Hollywood | Strike slip/left lateral, reverse | 1.0/5.0 | 5.8–6.5 |
| Los Alamitos | Uncertain | N/A | N/A |
| Malibu Coast | Reverse slip/reverse | 0.2/1.0 | N/A |
| Newport-Inglewood (including Compton Structure) | Strike slip/right lateral | 1.0/5.0 | 6.0–7.2 |
| Oak Ridge (including Northridge) | Thrust/reverse | 3.5/6.0 | 6.5–7.5 |
| Palos Verdes | Strike slip/right lateral, reverse[a] | 1.0/5.0 | 6.0–7.0 |
| Raymond | Strike slip/left lateral, minor reverse | 0.2/5.0 | 6.0–7.0 |
| Redondo Canyon | Strike slip/right lateral reverse[a] | Uncertain | 5.8–6.5 |
| San Andreas | Strike slip/right lateral | 20/35 | 6.8–8.0 |
| San Cayetano | Thrust/reverse | 1.3/9.0 | 6.5–7.3 |
| San Clemente | Strike slip/right lateral, some vertical | ~1.5 | Uncertain |
| San Gabriel | Strike slip/right lateral | 1.0/5.0 | Uncertain |
| San Jacinto | Strike slip/right lateral, minor reverse | 7/17 | 6.5–7.5 |
| San Jose | Strike slip/left lateral, minor reverse[a] | 0.2/2.0 | 6.0–6.5 (local magnitude) |
| Santa Cruz-Catalina | Strike slip/right lateral, reverse[a] | Unknown | 6.5–7.3 |
| Santa Monica | Left lateral reverse | 0.27/5.0 | 6.0–7.0 |
| Santa Susana | Thrust/reverse | 5.0/7.0 | 6.5–7.3 |
| Sierra Madre (including San Fernando) | Thrust/reverse | 0.36/4.0 | 6.0–7.0[b] |
| Simi-Santa Rosa | Reverse/reverse | Uncertain | N/A |
| Verdugo | Reverse/reverse | ~0.5 | 6.0–6.8 |

[a] Sense of movement is indicated by predominant fault movement sense, followed by minor sense of fault movement, where indicated. A minor sense of fault movement is uncertain.
[b] The maximum magnitude is uncertain.
mm = millimeters
$M_W$ = moment magnitude
N/A = not applicable
Sources: USGS 2010; SCEC 2011; Wills et al. (2008); USGS 2008

Significant historical earthquakes offshore Southern California are described by Fugro West (Fugro 2011). The largest offshore event was the 1927 Lompoc earthquake (local magnitude [$M_L$] 7.3), located about 12 kilometers southwest of Santa Barbara. The Oceanside earthquake ($M_L$ 5.4) of 1986 was perhaps one of the closest offshore earthquakes to the project area. Only far-field earthquakes (i.e., relatively distant earthquakes from the project area) have caused measureable damage in the project area. These events include the Great Fort Tejon earthquake (approximate moment magnitude [$M_W$] 8.0) of 1857 on the San Andreas Fault, the Long Beach earthquake ($M_W$ 6.4) of 1933 on the Newport-Inglewood

Fault, the San Fernando earthquake ($M_W$ 6.6) of 1971 on the San Fernando Fault, the Whittier-Narrows earthquake ($M_W$ 5.9) of 1987 on the Elysian Park Fault, and the Northridge earthquake ($M_W$ 6.7) of 1994 on a previously unmapped blind thrust fault. Although no significant earthquake has been recorded in the Palos Verdes Fault zone, it poses a significant seismic risk due to the project area traversing the fault zone.

### 8.2.1.4 Seismic-Related Geologic Hazards

Injury and damage to buildings during earthquakes can result from surface rupture along an active fault, ground shaking from a nearby or distant earthquake, surface settlement, and liquefaction of soils. These hazards and their potential effects are described in this section.

#### Surface Rupture and Faulting

The hazard of surface rupture is generally limited to land immediately adjacent to an active fault. According to the California Geological Survey (formerly the California Division of Mines and Geology [CDMG]), an active fault is one that has experienced surface displacement within the past 11,000 years (defined geologically as the Holocene epoch). Many of the active faults listed in Table 8-3 cross portions of the JOS service area, and surface rupture along these faults may locally affect JOS facilities. Where the tunnels cross the Palos Verdes and Cabrillo Faults, the tunnels would be susceptible to damage resulting from potential fault rupture displacement (Fugro 2011).

The Palos Verdes Fault is located along the northeast flank of the Palos Verdes Hills approximately 1 to 2 miles southwest of the JWPCP. The fault extends about 62 miles from Santa Monica Bay along the northeastern base of the Palos Verdes Hills, through the Los Angeles Outer Harbor, to the San Pedro Channel south of Newport Beach, and eventually to the Lassuen Knoll, which is a mound on the seafloor about 12 miles offshore of Laguna Beach. The fault offsets Holocene sediments in the Port of Los Angeles and is considered an active fault (Fugro 2011).

Onshore, the Cabrillo Fault appears to be a minor structure subparallel to the Palos Verdes Fault. It intersects the shoreline at Cabrillo Beach and forms a prominent northeast-facing scarp in San Pedro. Little is known of its activity, but the scarp suggests late Pleistocene or Holocene activity. A scarp has been detected on the seafloor suggesting Holocene activity, and the fault has been traced with high-resolution seismic reflection geophysics approximately 6 miles offshore to the southeast from the Palos Verdes Peninsula (Fischer et al. 1987). However, the Cabrillo Fault may represent a bending moment fault, or a splay off the Palos Verdes fault system, that could move concurrently with rupture of the Palos Verdes Fault zone. It is possible that the Cabrillo Fault may represent a non-seismogenic bending moment fault atop the Palos Verdes Anticlinorium. The Cabrillo Fault does not appear to create significant fault rupture hazard. (Fugro 2011.)

#### Ground Shaking

Earthquake-induced ground shaking is a common phenomenon throughout the region. In the recent past, the Los Angeles region has experienced moderate to large earthquakes, such as the October 1, 1987, Whittier Narrows earthquake ($M_W = 5.9$) and the January 17, 1994, Northridge earthquake ($M_W = 6.7$). These, in addition to other seismic events, have produced significant damage from ground shaking, sometimes at locations far distant from the epicenter. In addition, strong ground motions can cause mass movements (e.g., slumps, landslides, debris flows, turbidity currents, liquefaction, and lateral spreading) that could damage JOS facilities.

Potentially damaging ground shaking can occur distant from the event epicenter, depending on several factors, including:

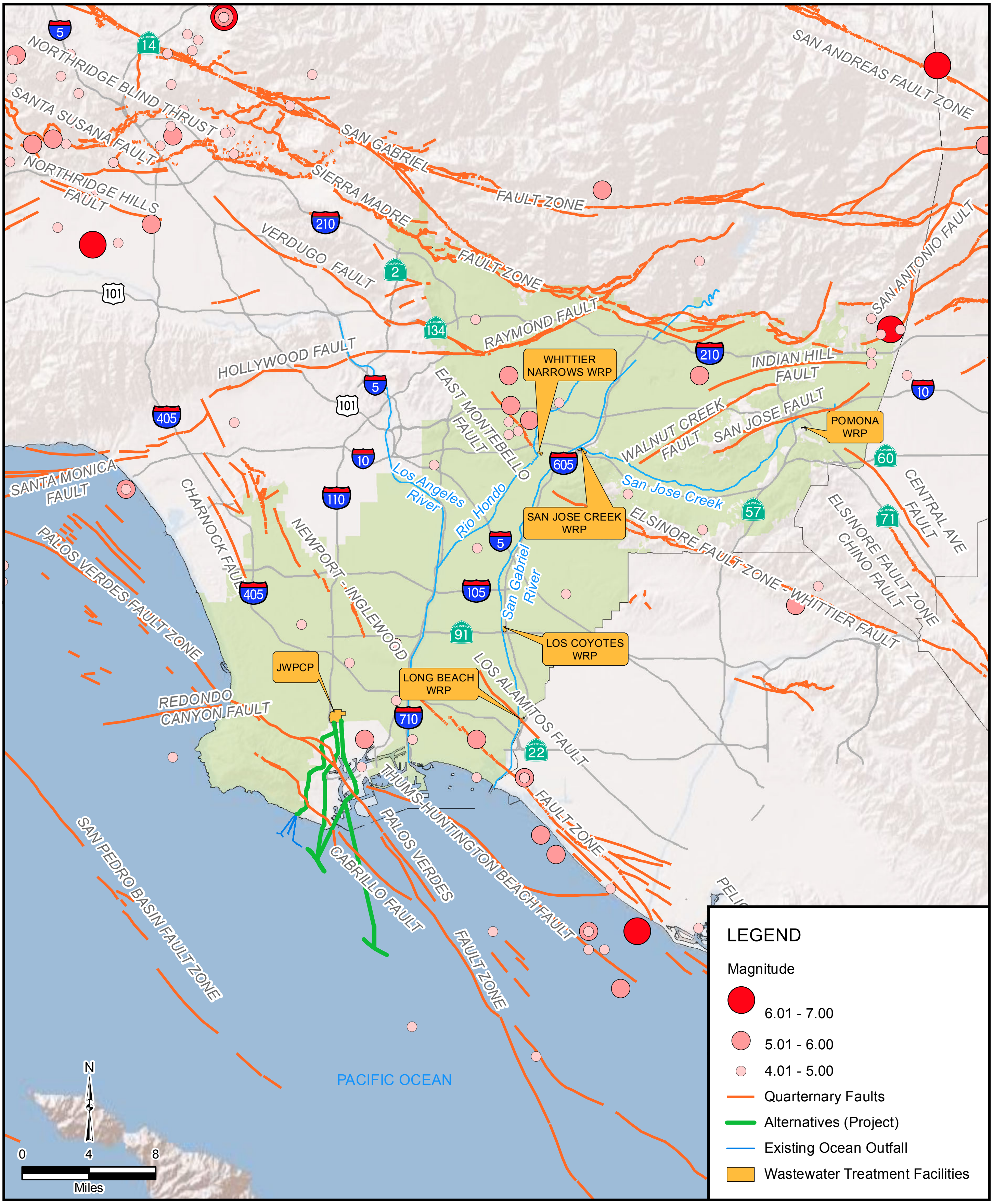



**FIGURE 8-1**

CLEARWATER Program

## Regional Faults and Historical Earthquakes in the JOS Service Area

Source: Sanitation Districts of Los Angeles County 2011, USGS 2010, URS 2011, Thomas Bros. 2011, ESRI 2011

- Earthquake magnitude (i.e., a measure of the total energy released during the fault rupture)
- Epicentral distance (i.e., the source-to-site distance)
- Subsurface geologic conditions between the source and the site
- Subsurface geologic conditions at the site

Wastewater treatment plants, like many other engineered buildings, can be damaged as a result of seismic shaking. Seismic ground shaking recently damaged wastewater facilities and sewers at El Centro and Calexico during the $M_W$ 7.2 April 4, 2010, Mexicali earthquake (El Centro Chamber of Commerce 2010). The 1994 Northridge Earthquake affected water and wastewater facilities (EQE 1994), although Sanitation Districts' facilities within the JOS were not damaged. The September 10, 2010, Christchurch, New Zealand Earthquake ($M_W$ 7.1) damaged the Christchurch wastewater-treatment plant as a result of strong shaking and liquefaction. Large amounts of sand and silt clogged pipes and the plant's primary treatment tanks. The oxidation ponds were also damaged, with cracked and slumped banks (Geotechnical Extreme Events Reconnaissance 2010). The March 11, 2011, Great Tohuku Offshore Earthquake, or Great East Japan Earthquake ($M_W$ 9) triggered tsunami waves that traveled several miles inland damaging at least four wastewater treatment plants (three at Iwate prefecture and one at Sendai city) (Japan Sewer Works Agency 2011). The earthquake produced severe liquefaction resulting in subsidence and shifts in the soil, damaging water, sewer, and gas pipelines (Geotechnical Extreme Events Reconnaissance 2011).

The Palos Verdes Fault zone is perhaps the most significant active fault located within the project area and is capable of generating large-magnitude earthquakes. A large-magnitude earthquake on the Palos Verdes Fault zone would subject the facilities to high levels of strong ground motion. There are numerous other faults near the project area that are also capable of producing high levels of ground motion within the project area, if a significant earthquake were to occur.

Fugro West (Fugro 2011) performed a probabilistic seismic hazards analysis (PSHA) based on a seismotectonic model developed for the project. The modeled seismic sources included all recognized active seismic sources within 62 miles (100 kilometers) of the project area, including the potential sources identified in Table 8-3 based on the geologic, tectonic, and seismological setting of the Southern California region. The PSHA was performed for three return periods (475-, 975- and 2,475-year) at locations specific to project elements. The ranges of estimated peak ground accelerations (PGA) for firm ground at the locations evaluated ranged from:

- 475-year return period: PGA = 0.45 to 0.63g
- 975-year return period: PGA = 0.56 to 0.80g
- 2,475-year return period: PGA = 0.72 to 1.03g

The Palos Verdes Fault zone contributes to the majority of the seismic hazard due to its proximity to the project area (Fugro 2011). The estimated ground motions were found to be highest in the onshore portion of the Palos Verdes Fault and decreased with distance away from the fault. Other seismic sources contribute to the seismic shaking hazard including the Compton Structure, Newport-Inglewood Fault zone, San Pedro Basin Fault system, and the San Pedro Basin Escarpment Fault. The seismogenic characteristics of these sources are described by the Fugro West studies (Fugro 2011).

## Liquefaction

Liquefaction in soils and sediments occurs when granular materials are transformed from a solid state to a liquid state as a result of loss of grain-to-grain contact generated during earthquake shaking.

Earthquake-induced liquefaction most often occurs in areas underlain by unconsolidated, saturated sediments. Liquefaction commonly occurs in Holocene- and late Pleistocene-Age saturated soils.

Liquefaction during seismic shaking can result in lateral spreading and permanent ground deformations, a result of liquefaction-induced settlements. Settlement commonly refers to the subsidence caused by consolidation of liquefiable sediments. Lateral spreading is typically associated with liquefaction-induced horizontal ground deformations on mild sloping ground. Horizontal displacements from lateral spreading can be as much as several tens of feet and can have a significant lateral extent (up to several thousands of feet). Lateral spreading can cause significant damage to both overlying and buried infrastructure, such as pipelines. (Fugro 2011.)

The region is characterized as a large, low-lying, alluvial-filled (unconsolidated granular sediment) basin. Some areas within the basin are susceptible to liquefaction. In particular, areas adjoining rivers, river channels, or areas near the shore may have a higher potential for liquefaction due to a relatively high water table in unconsolidated granular sediments. Although portions of the region are susceptible to liquefaction, no incidents of damage to JOS facilities due to liquefying soils have been reported to date.

The Sanitation Districts' existing ocean outfalls are underlain by Holocene sediments, which could undergo liquefaction due to the seismic setting of the area. Based on the Holocene sediments underlying the PV or SP Shelves, the new outfall alternatives could also be subject to the effects of liquefaction, including settlement and lateral spreading. A diffuser alignment underlain by comparatively favorable sediment conditions where differential settlement is minimal and the risk of lateral spreading is minimized has been recommended. Potential diffuser locations along the SP Shelf are considered to be at less risk of liquefaction than the PV Shelf. (Fugro 2011.)

The proposed shaft sites located in the Port of Los Angeles and nearby onshore areas are located in fills placed over Holocene-Age marine or alluvial deposits. The saturated fill soils and Holocene deposits are susceptible to liquefaction from seismic shaking (Fugro 2011). The lateral spreading potential in the Port of Los Angeles and near shore areas is significant, as evidenced from damage at Pier 300 during the 1994 Northridge earthquake where the ground shaking levels were estimated to be 0.10 to 0.15 g (acceleration due to gravity) (Fugro 2011). The alluvial deposits at the JWPCP shaft sites are also prone to liquefaction, but to a lesser degree than the shaft sites within the Port of Los Angeles.

Liquefaction of the soil around a tunnel results in the loss of shear strength of the material that is providing confinement to the tunnel. If this occurred, the buoyancy of the tunnel and lack of confining stress around the tunnel could lead to uplift due to in-site hydrostatic pressure. None of the tunnel alignments pass thorough liquefiable soil; therefore, the tunnels would not be subject to uplift or settlement as a result of liquefaction (Parsons 2011).

### 8.2.1.5 Nonseismic Geologic Hazards

Geologic hazards independent of seismic activity include landslides and subsidence, which are described herein. Other hazards, including volcanic and geothermal activity, are not discussed because they do not occur in the region.

#### Landslides

Landslides occur in areas with unstable slopes. Unstable slopes result from erosion, improper construction, overwatering, deep weathering, or structural orientation of geologic formations, and can experience rapid earth movement in the form of a landslide with or without a seismic trigger. Landslides can occur as rock falls, mud and debris flow, and creeping slopes. The movement can be sudden or gradual.

Both onshore and submarine offshore landslides have been recognized in the project area (Fugro 2011). The largest onshore landslide complexes are on the south flank of the Palos Verdes Peninsula in seaward-dipping bentonite beds in the Altimira Shale Member of the Miocene Monterey Formation. The deepest slide surface is within the Portuguese Bend Tuff, a bentonitic layer about 60 feet thick. The Portuguese Bend landslide complex is a major translational glide landslide, with its toe below sea level on the inner shelf. The Point Fermin and Abalone Cove landslides are other major slide zones. Due to a number of man-made and geologic factors, these slides have been historically unstable on the southern flank of the Palos Verdes Peninsula. None of the project elements are located in or near the Portuguese Bend landslide or other mapped landslides on the Palos Verdes Peninsula (Dibblee 1999).

The offshore continental slope and shelf edge has been affected by large-scale submarine mass movements (Fugro 2011). The larger submarine slide features have head scarps cutting into the steeply inclined continental slope. The irregularity of the shelf break edge is thought to be an expression of submarine mass movements. On the PV and SP Shelves, the bathymetry appears relatively smooth, and shelves are described as being underlain by Holocene sediments forming flat-lying, well-bedded stratigraphic units that overlie folded and faulted Miocene and Pliocene strata. The potential for liquefaction-induced instability within the Holocene sediments has been analyzed in the Fugro West studies (Fugro 2011). However, based on marine geophysical studies, the SP and PV Shelves apparently have been unaffected by deep-seated submarine landslides because slides have not been mapped in these areas (Saucedo et al. 2003). Additional investigations have been recommended to evaluate seismically induced submarine landslides (Fugro 2011).

#### Subsidence

Measured ground subsidence occurs in areas where groundwater extraction, oil production, or other mining activities have lowered the ground surface. Portions of the southwestern Coastal Plain had significant subsidence problems in the 1940s and 1950s from oil production in the Wilmington Oil Field. Artificial recharge has managed the problem.

### 8.2.1.6 Soils

One soil group is found in the region: the alluvial fans, plans, and the terraces group. This group consists of 17 soil associations (Jones & Stokes 1994). A soils association is composed of two or more soils in a given geographic area that has a distinctive distribution pattern of soils. Normally, a soil association consists of one or more major soils and at least one minor soil. Soil erosion and expansion are described herein.

#### Erodible Soils

Soil associations that have a moderate to high erosion potential include the Oceano, Marina-Carey, steeper slope Augora-Placentia, Oak Glenn-Gorman, steeper slope Altamont-Diablo, and San Andreas-San Benito Associations. The Beaches Association has a very high erosion potential. Generally, land in the region that is developed is not highly susceptible to erosion. Areas that are the most susceptible to erosion include steep, unvegetated slopes with erodible soils, which are concentrated in the Puente and Repetto Hills between the San Gabriel Valley and Coastal Plain, and the Palos Verdes Hills located in the southwest portion of the region. However, a low-lying area in the Coastal Plain located immediately north of the Palos Verdes Hills is composed of wind-eroded soils from the Oceano Association.

### Expansive Soils

Shrink-swell is that quality of the soil that determines its volume change with change in moisture content. Shrink-swell in soils is measured by the volume change resulting from the shrinking soil when it dries and by the expansion of the soil as it takes up moisture (Jones & Stokes 1994). The volume change behavior of soils is influenced by the amount of moisture change, the amount of clay in the soil, and the type of mineral (e.g., montmorillinite) in the clay. In general, the soil with the highest clay content shrinks and swells the most, although the type of clay is an important contributing factor (Jones & Stokes 1994). Damage to buildings, such as cracking of foundations, could result from differential movements and several alternating periods of shrink and swell. Regionally, three soil associations (Cropley, Ramona-Placentia, and Diablo-Altamont) have soils that are considered highly expansive.

## 8.2.2 Program Setting

### 8.2.2.1 Conveyance System

Conveyance system improvements would include numerous trunk sewer relief segments. These sewer improvements are planned throughout the JOS service area and would encounter a wide range of geologic, geotechnical, and soil conditions. Improvements to pipeline segments would be located in low-lying areas, and alluvial conditions would likely predominate most of the geologic settings involved. The primary geologic hazards for many of these locations would include liquefaction, soft or weak soil conditions, and moderate to high levels of ground shaking. Additionally, there may be the potential for crossing localized active faults, such as the Newport-Inglewood Fault zone, and areas susceptible to landslides. Site-specific geotechnical investigations would be needed to characterize the variable conditions along these linear elements, evaluate the potential for geologic hazards, and provide appropriate mitigation.

Soil conditions would vary from site to site and for the entire length of linear elements such as a relief structure. It is anticipated that many of the structures would be built in alluvial areas and that sandy alluvium as well as finer-grained alluvial deposits would be encountered. In the general soils mapping presented by the United States Soil Conservation Service (USSCS), the low-lying alluvial areas are commonly underlain by soils of the Hanford, Chino, and Tujunga-Sobaba Associations (Jones & Stokes 1994). These soils range from fine sand and fine sandy loam to sandy loam to clay loam. Erosion potential for these soils ranges from low to moderate, and the shrink-swell potential ranges from low to moderate.

### 8.2.2.2 Water Reclamation Plants (San Jose Creek, Pomona, Los Coyotes, Long Beach, and Whittier Narrows) and the Joint Water Pollution Control Plant

A description of the locations of the program facilities are summarized in Table 8-4.

**Table 8-4. Geologic Description of Program Locations**

| Program Facility | Description of Location |
|---|---|
| SJCWRP | San Gabriel Valley and the floodplain of the San Gabriel River. The Repetto and Puente Formations form the nearby hills. |
| POWRP | Western portion of the Pomona Valley between the San Jose and Puente Hills. Underlain by alluvium associated with San Jose Creek, which lies to the north of the site. |
| LCWRP | Los Angeles Basin, floodplain of the San Gabriel River. |
| LBWRP | Southern margins of the Los Angeles Basin and adjacent to the channelized Coyote Creek just upstream from its confluence with the San Gabriel River. |
| WNWRP | Puente Hills, Rio Hondo floodplain. |
| JWPCP | Southern margin of the Los Angeles Basin, floodplain of Los Angeles River. |

Geologic hazards that have the potential to affect the program setting are listed by element/location in Table 8-5. Soil associations and geohazard potential for the program are listed by element/location in Table 8-6. The impacts of geologic hazards on program elements are discussed in the environmental analysis for program alternatives, Section 8.4. Details of the program are provided in Chapters 1, 2, and 3.

**Table 8-5. Geologic Inventory for Program Locations**

| Program Element/ Location | Geologic Formation | Nearby Active Fault Zone[a] | Miles From Fault Zone | Depth to Groundwater (feet) | Potential for Liquefaction | Located in a Mapped Landslide Hazard Zone |
|---|---|---|---|---|---|---|
| SJCWRP | 200-foot-thick floodplain alluvium over Repetto and Puente Formation[g] | Raymond Hill | 7 | 3–5[b] | No[a,g] | No[a] |
| | | Whittier-Elsinore | 3.5 | | | |
| POWRP | Holocene to late Pleistocene-Age alluvial deposits; adjacent to Elephant Hills, a bedrock knob underlain by landslide-prone Tertiary-Age deposits[c] | Elsinore | 7–9 | 20–30[c] | Yes[c] | Yes[c] |
| | | Sierra Madre | 5 | | | |
| LCWRP | Holocene alluvial deposits of silty sand and silt[g] | Newport-Inglewood | 8+ | Potentially shallow; can vary up to 35 feet[d] | Yes[d] | No[d] |
| | | Whittier | 8+ | | | |
| LBWRP | Holocene alluvial deposits of silt and clay[e] | Newport-Inglewood | 3 | 20–25[e] | Yes[e] | No[e] |
| | | Palos Verdes | 10 | | | |
| WNWRP | 20–200-foot thick Holocene alluvial deposits of sand and gravel; Oligocene nonmarine sediments are adjacent to and possibly under the Holocene alluvium[g] | Whittier | 3 | Shallow | Yes[b] | No[b] |
| | | Raymond Hill | 7 | | | |

### Table 8-5 (Continued)

| Program Element/ Location | Geologic Formation | Nearby Active Fault Zone[a] | Miles From Fault Zone | Depth to Groundwater (feet) | Potential for Liquefaction | Located in a Mapped Landslide Hazard Zone |
|---|---|---|---|---|---|---|
| JWPCP | Alluvium of sand and thin clay interbeds over Pico, Repetto, and Puente Formations; formations consist of porous sand with sandstone and shale interbeds, which commonly contain oil deposits; Jurassic-Age (approximately 208 to 144 million years old) Catalina Schist forms bedrock[g] | Palos Verdes | 5+ | 35–40[h] | No[f,g] | No[f] |
| | | Cabrillo | 5+ | | | |
| | | Newport-Inglewood | 5+ | | | |

[a] See Figure 8-1 for fault locations in the region.

Sources: [b] CDMG 1998a; [c] CDMG 1998b; [d] CDMG 1998c; [e] CDMG 1998d; [f] CDMG 1998e; [g] Jones & Stokes 1994:Geologic Hazards and Soils; [h] Parsons 2011

### Table 8-6. General Physical Properties of Soils in the Region

| Program Element/ Location | Soil Association | Soil Type | Depth (inches) | Slope (%) | Erosion Potential | Shrink-Swell Potential |
|---|---|---|---|---|---|---|
| WNWRP | Oceano | Sand | 60 | 2–5 | Moderate-high | Low |
| | Marina-Carey | Sand and sandy loam | 60 | 2–15 | High | Low |
| | Tujunga-Sobaba | Fine sand and fine sandy loam | 60 | 0–5 | Low-moderate | Low |
| LCWRP POWRP SJCWRP | Hanford | Sandy loam | 60 | 2.5 | Low | Low |
| LCWRP | Yolo | Silty loam | 60 | 0 | Low | Moderate |
| | Macho-Sorrento | Silty loam | 60 | 2.9 | Low-moderate | Moderate |
| | Cropley | Clay | 60 | 0 | Low | High |
| | Foster | Sandy loam | 60 | 0 | Low | Low |
| WNWRP LBWRP | Chino (with inclusions of the Foster and Grangeville Associations) | Clay loam | 60 | 0 | Low | Moderate |
| JWPCP | Agoura-Placentia | Sandy loam | 18–60 | 2–5 | Low-moderate | High |
| | Agoura-Placentia | Sandy loam | 18–60 | 5–9 | Moderate | High |
| | Ramona-Placentia | Sandy loam | 9–60 | 9–15 | High | High |
| | Perkins-Rincon | Gravelly loam and silty clay loam | 60 | 0–15 | Low-moderate | High |
| | Vista-Amargoss | Sandy loam | 14–38 | 30–50 | High | Low |
| | Oak Glen-Gorman | Sandy loam | 60 | 9–30 | Moderate-high | Low |

**Table 8-6 (Continued)**

| Program Element/ Location | Soil Association | Soil Type | Depth (inches) | Slope (%) | Erosion Potential | Shrink-Swell Potential |
|---|---|---|---|---|---|---|
| | Diablo-Altamont | Clay | 22–51 | 2–9 | Low | High |
| | Altamont-Diablo | Clay | 20–39 | 9–30 | High | High |
| | Altamont-Diablo | Clay | 20–39 | 30–50 | High | High |
| | San Andreas-San Benito | Sandy loam and clay loam | 24–48 | 30–75 | High | Low-moderate |
| | San Benito-Soper | Clay loam | 36–48 | 30–50 | High | Moderate |
| | Beaches | Sand | Very deep | Varies | Very high | Low |
| Source: Jones & Stokes 1994 | | | | | | |

# 8.2.3 Project Setting

## 8.2.3.1 Tunnel Alignment

Figure 8-2 shows the depths of the tunnels for the various alignments. The tunnel alignments would cross the Palos Verdes and Cabrillo Faults. A geologic map of the area with the locations of these faults is shown on Figure 8-3a. The geologic map legend is shown on Figure 8-3b. The descriptions of the geologic units in the project area are shown on Figure 8-3c. The subsurface geology of the Palos Verdes Hills is shown on Figure 8-4. Some portions of the tunnel alignments are anticipated to have subsurface geologic settings similar to the Palos Verdes Hills and would encounter similar formations, as shown on Figure 8-4.

Geologic hazards that have the potential to affect the tunnel alignment for the recommended plan or its alternatives are listed by project element in Table 8-7. The impacts of geologic hazards on tunnel alignments are discussed in the environmental analysis for project alternatives, Section 8.4. Details of the tunnel alignments are presented in Chapter 3.

**Table 8-7. Geologic Inventory of Hazards Along Tunnel Alignments**

| Project Element | Geologic Formation | Active Fault Zone Crossing | Fault Zone Crossing Location | Potential for Liquefaction | Located in a Mapped Landslide Hazard Zone |
|---|---|---|---|---|---|
| Wilmington to SP Shelf Alignment (Onshore) | Pleistocene (Lakewood Formation, San Pedro Sand, and Timms Point Silt) sediment deposits of unconsolidated sand and silt[a] | Palos Verdes | Crosses between LAXT and Southwest Marine shaft sites | No[a] | No[b,c] |
| Wilmington to SP Shelf Alignment (Offshore) | Miocene (Monterey Formation) marine sedimentary rock deposits of mudstone, shale, and fine-grained rock extensively folded and faulted with the offshore Palos Verdes Anticlinorium[a] | Cabrillo | Crosses midway across the SP Shelf | No[a] | No[d,f] |
| Wilmington to PV Shelf Alignment (Onshore) | Pleistocene (Lakewood Formation, San Pedro Sand, and Timms Point Silt) sediment deposits of unconsolidated sand and silt[a] | Palos Verdes | Crosses between LAXT and Southwest Marine shaft sites | No[a] | No[b,c] |

**Table 8-7 (Continued)**

| Project Element | Geologic Formation | Active Fault Zone Crossing | Fault Zone Crossing Location | Potential for Liquefaction | Located in a Mapped Landslide Hazard Zone |
|---|---|---|---|---|---|
| Wilmington to PV Shelf Alignment (Offshore) | Miocene (Monterey Formation) marine sedimentary rock deposits of mudstone, shale, and fine-grained rock extensively folded and faulted with the offshore Palos Verdes Anticlinorium[a] | Cabrillo | Crosses near Point Fermin | No[a] | No[d,f] |
| Figueroa/ Gaffey to PV Shelf Alignment (Onshore) | Pleistocene (Lakewood Formation, San Pedro Sand, and Timms Point Silt) sediment deposits of unconsolidated sand and silt, and Miocene (Monterey Formation) marine sedimentary rock deposits of mudstone, shale, and fine-grained rock[a] | Palos Verdes<br>Cabrillo | Crosses southwest of Figueroa Street and John S. Gibson Boulevard intersection<br>North of Angels Gate Park | No[a] | No[b,c] |
| Figueroa/ Gaffey to PV Shelf Alignment (Offshore) | Miocene (Monterey Formation) marine sedimentary rock deposits of mudstone, shale, and fine-grained rock[a] | No | Does not cross active fault | No[a] | No[b,c] |
| Figueroa/ Western to Royal Palms (Onshore) | Pleistocene (Lakewood Formation, San Pedro Sand, and Timms Point Silt) sediment deposits of unconsolidated sand and silt, and Miocene (Monterey Formation) marine sedimentary rock deposits of mudstone, shale, and fine-grained rock[a,e] | Palos Verdes<br>Cabrillo | South of Harbor Regional Park under North Gaffey Street<br>Intersection of South Dodson Avenue and Western Avenue | No[a] | No[c,e,g] |

Sources: [a] Parsons 2011; [b] CDMG 1998e; [c] CDMG 1998f; [d] Fugro 2011; [e] Dibblee 1999; [f] Saucedo et al. 2003; [g] Appendix 8-A

### 8.2.3.2 Shaft Sites

The shaft site locations are shown on Figure 8-3a in relationship to mapped fault zones and geologic formations. Geologic hazards that have the potential to affect the shaft sites for the recommended plan or its alternatives are listed by project element in Table 8-8. The impacts of geologic hazards on the shaft sites are discussed in the environmental analysis for project alternatives, Section 8.4. Details of the shaft sites are presented in Chapter 3.


**FIGURE 8-2**

CLEARWATER Program

**Tunnel Depths**

Source: Sanitation Districts of Los Angeles County 2011, Thomas Bros. 2011, ESRI 2011

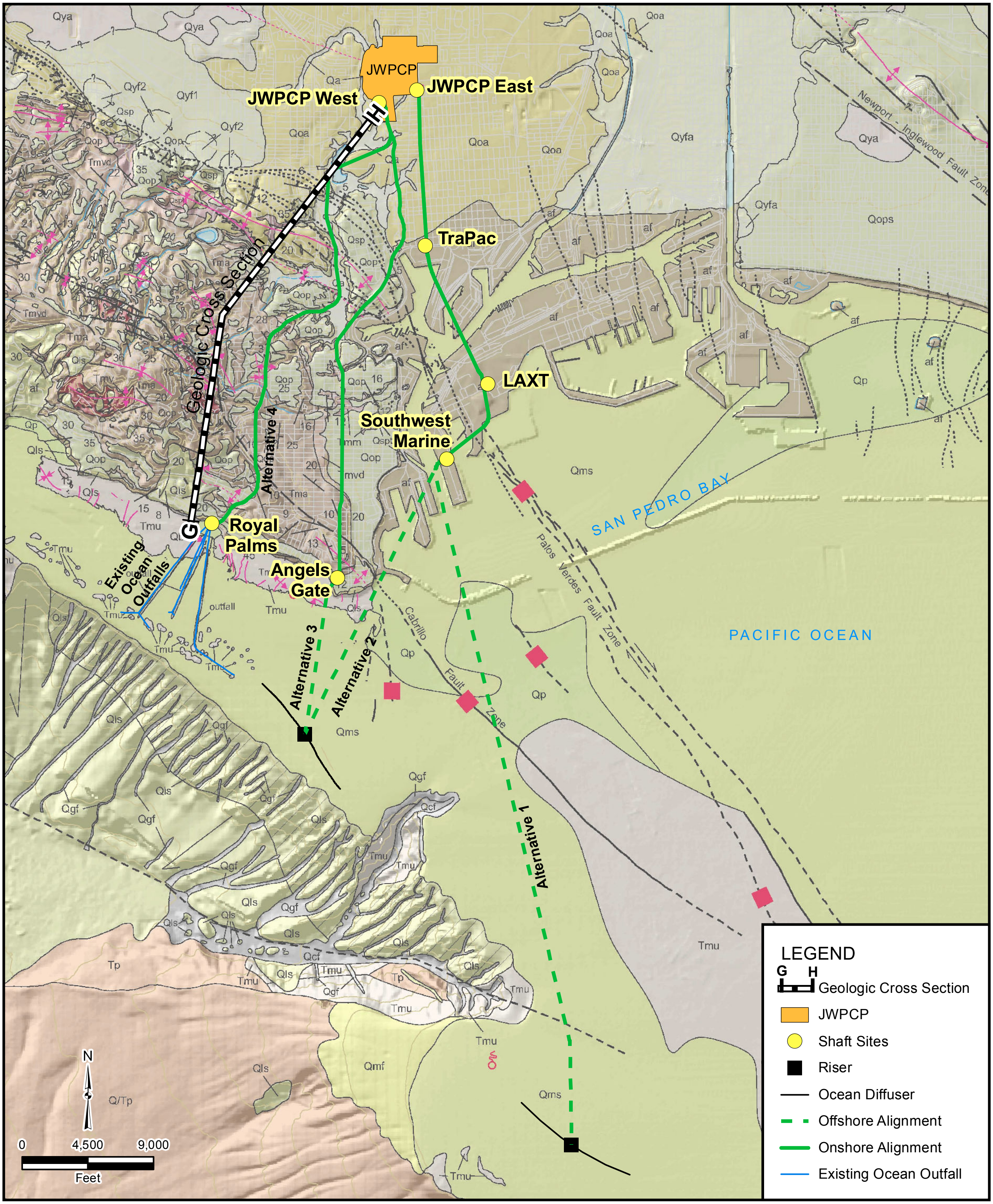



FIGURE 8-3a

**Map of Stratigraphic Relationships for Proposed Tunnel Alignments**

Source: Sanitation Districts of Los Angeles County 2011, URS 2011, CA Geological Survey (Geologic Map Long Beach 30x60) 2003

## ABBREVIATED EXPLANATION

Approximate stratigraphic relationships only: see accompanying Sheet 2 for correlation of map units and more detailed descriptions.

### CENOZOIC

#### QUATERNARY

##### HOLOCENE

| | |
|---|---|
| af | Artificial fill |
| Qw | Active channel and wash deposits |
| Qa | Alluvial flood plain deposits |
| Qls | Landslide deposits |
| Qb | Beach deposits |
| Qe | Eolian deposits |
| Qpe | Paralic estuarine deposits |
| Qyf | Young alluvial fan and valley deposits, undivided a = sand, s = silt, c = clay |
| Qyf2 | Young alluvial fan deposits, unit 2 |
| Qyf1 | Young alluvial fan deposits, unit 1 |

##### PLEISTOCENE

| | |
|---|---|
| Qya | Young alluvial flood plain deposits, unit 1 |
| Qye | Young eolian deposits |
| Qype | Young paralic estuarine deposits |
| Qof | Old alluvial fan and valley deposits, undivided a = sand, s = silt, c = clay |
| Qoa | Old alluvial flood plain deposits, undivided |
| Qoe | Old eolian deposits |
| Qom | Old marine deposits, undivided |
| Qop | Old paralic deposits, undivided, a = sand, s = silt, c = clay |
| Qlh | La Habra Formation |
| | San Pedro Formation |
| Qsp | San Pedro Formation, undivided |
| Qspt | Timms Point Silt Member |
| Qspl | Lomita Marl Member |
| Qi | Inglewood Formation |

#### TERTIARY

##### PLIOCENE

| | |
|---|---|
| | Fernando Formation |
| Tfu | Upper Member |
| Tfl / Tflc | Lower Member, Tflc = conglomerate |
| | Puente Formation |
| Tpsc / Tpscc | Sycamore Canyon Member, Tpscc = conglomerate |

##### MIOCENE

| | |
|---|---|
| Tpy | Yorba Member |
| Tps | Soquel Member |
| Tplv | La Vida Member |
| | Monterey Formation |
| Tmm | Malaga Mudstone Member |
| Tmvd | Valmonte Diatomite Member |
| Tmv | Volcanic rocks within the Monterey Formation |
| Tma | Altamira Shale Member |

### MESOZOIC

#### CRETACEOUS JURASSIC

| | |
|---|---|
| mcs | Catalina Schist |

### Offshore Region

| | |
|---|---|
| Qms | Unconsolidated shelf sediment |
| Qmf | Unconsolidated flank sediment |
| Qmb | Unconsolidated basin sediment |
| Qmr | Unconsolidated ridge sediment |
| Qmc | Unconsolidated canyon sediment |
| Qct | Canyon terrace |
| Qcf | Canyon fill |
| Qgf | Gully fill |
| Qf | Fan deposits |
| Qls | Landslide deposits |
| Qp | Pleistocene sedimentary deposits, undivided |
| QTt | Plio-Pleistocene terrace deposits |
| Tp | Pliocene sedimentary rocks, undivided* |
| Tmp | Mio-Pliocene sedimentary rocks, undivided* |
| Tu | Tertiary sedimentary and volcanic rocks, undivided* |
| Tmu | Miocene sedimentary rocks, undivided* |
| Tmv | Miocene volcanic rocks* |
| ms | Metamorphic rocks of pre- Late Cretaceous age* |

* Q/ = Map unit overlain by more than 3 meters of unconsolidated Quaternary sediment.

### MAP SYMBOLS

Contact - accuracy of location ranges from well located to inferred. All offshore contacts are considered approximately located.

U / D — — ? — ......

Fault - solid where well located; dashed where approximately located or inferred; dotted where concealed; queried where continuation or existence is uncertain. Where age was determined in offshore area, age symbol is shown astride fault and relative offset is shown by U, upthrown side; D, downthrown side (relative or apparent). Age of faults are indicated as follows:

- ■ cuts strata of Holocene age
- □ cuts strata of Pleistocene age
- ◩ cuts strata of Quaternary age
- △ cuts strata of Pliocene age
- ▲ cuts Miocene or older strata

Anticlinal fold - solid where well located; dashed where approximately located or inferred; dotted where concealed. Plunge direction indicated by arrowhead on fold axis.

Synclinal fold - solid where well located; dashed where approximately located or inferred; dotted where concealed. Plunge direction indicated by arrowhead on fold axis.

Strike and dip of stratified rocks. Number indicates dip angle in degrees when known.

- 25 — Inclined beds
- 80 — Overturned beds
- ⊕ — Horizontal beds

Strike and dip of metamorphic and igneous foliation.

- Vertical foliation

Arrows on landslides indicate direction of movement. Hachured where headscarp is mappable.

Oil and/or gas seep.

## FIGURE 8-3b

# Abbreviated Explanation of Stratigraphic Relationships

CLEARWATER Program

Source: California Geological Survey (Geologic Map Long Beach 30x60) 2003

# DESCRIPTION OF MAP UNITS

## (Onshore Region)

**MODERN SURFICIAL DEPOSITS** - Sediment that has been recently transported and deposited in channel and washes, on surfaces of alluvial fans and alluvial plains, and on hill slopes and in artificial fills. Soil-profile development is non-existent. Includes:

af — **Artificial fill (late Holocene) -** Deposits of fill resulting from human construction, mining, or quarrying activities; includes engineered and non engineered fill. Some large deposits are mapped, but in some areas no deposits are shown.

Qw — **Active channel and wash deposits (late Holocene) -** Unconsolidated deposits of silt, sand, and gravel, mostly artificially channelized.

Qa — **Alluvial flood plain deposits (late Holocene) -** Active and recently active alluvial deposits along canyon floors. Consists of unconsolidated sandy, silty, or clay-bearing alluvium.

Qls — **Landslide deposits (Holocene and Pleistocene) -** Highly fragmented to largely coherent landslide deposits. Unconsolidated to moderately well consolidated. Most mapped landslides contain scarp area as well as slide deposit. In some areas scarp is shown separately with hatchers. Many Pleistocene age landslides were reactivated in part or entirely during late Holocene. The preponderance of the landslides in the Capistrano Formation, however, there are many within the Monterey and Santiago Formations as well.

Qb — **Beach deposits (late Holocene) -** Unconsolidated beach deposits consisting mostly of well-sorted fine- to coarse-grained sand. Locally may include talus.

Qe — **Eolian deposits (late Holocene) -** Unconsolidated eolian deposits. Composed mostly of very well-sorted fine- to medium-grained sand. Gradational into older eolian deposits.

Qpe — **Paralic estuarine deposits (late Holocene) -** Unconsolidated estuarine deposits. Composed mostly of loose to moderately dense fine-grained sand, silt, and clay.

**YOUNG SURFICIAL DEPOSITS**—Sedimentary units that are slightly consolidated to cemented and slightly to moderately dissected. Alluvial fan deposits typically have high coarse-fine clast ratios. Young surficial units have upper surfaces that are capped by slight to moderately developed pedogenic-soil profiles. Includes:

Qyf — **Young alluvial fan and valley deposits, undivided (Holocene and late Pleistocene) -** Mostly poorly consolidated and poorly sorted clay, sand, gravel and cobble alluvial fan and valley deposits.

Qyf2 — **Young alluvial fan deposits, unit 2 (Holocene and late Pleistocene) -** Four distinct, gently sloping fan-shaped deposits overlying unit 1. Composed mostly of poorly to moderately consolidated and poorly sorted clay, silty clay and sand.

Qyf1 — **Young alluvial fan deposits, unit 1 (Holocene and late Pleistocene) -** Gently sloping, slightly dissected alluvial fan deposits. Composed mostly of poorly to moderately consolidated and poorly sorted silty clay and sand.

Qya — **Young alluvial flood plain deposits (Holocene and late Pleistocene) -** Mostly poorly consolidated, poorly sorted, permeable alluvial flood plain deposits. Composed mostly of soft clay, silt and loose to moderately dense sand and silty sand.

Qye — **Young eolian deposits (Holocene and late Pleistocene) -** Unconsolidated eolian deposits. Composed mostly of fine- and medium-grained sand.

Qype — **Young paralic estuarine deposits (Holocene and late Pleistocene) -** Unconsolidated estuarine deposits. Composed mostly of fine-grained sand and clay.

**OLD SURFICIAL DEPOSITS** - Sediments that are moderately consolidated and slightly to moderately dissected. Older surficial deposits have upper surfaces that are capped by moderate to well-developed pedogenic soils. Includes:

Qof — **Old alluvial fan and valley deposits, undivided (late to middle Pleistocene) -** Mostly moderately to well-consolidated, moderately sorted sand, clay, and silt.

Qoa — **Old alluvial flood plain deposits, undivided (late to middle Pleistocene) -** Fluvial sediments deposited on canyon floors. Consists of moderately well consolidated, poorly sorted, permeable, commonly slightly dissected gravel, sand, silt, and clay-bearing alluvium. Includes Reddish brown, well-cemented resistant pebbly and gravelly silty sand in the Baldwin Hills and stream terrace deposits in the Torrance quadrangle.

Qoe — **Old eolian deposits (late to middle Pleistocene) -** Poorly consolidated eolian deposits. Composed mostly of dense to very dense well-sorted fine- to coarse-grained sand and silty sand.

Qom — **Old marine deposits, undivided (late to middle Pleistocene) -** Poorly consolidated marine deposits. Composed mostly of fine- to coarse-grained sand.

Qop — **Old paralic deposits, undivided (late to middle Pleistocene) -** Mostly poorly sorted, moderately permeable, reddish-brown, interfingered strandline, beach, estuarine and colluvial deposits composed of siltstone, sandstone, and conglomerate. These deposits rest on the now emergent wave cut abrasion platforms preserved by regional uplift (a = sand, s = silt, c = clay). Locally may include older alluvium.

**SEDIMENTARY AND VOLCANIC BEDROCK UNITS**

Qlh — **La Habra Formation, undivided (late Pleistocene) -** Siltstone, thick-bedded friable sandstone, pebbly sandstone, and pebble-cobble conglomerate; locally abundant clasts of platy white siltstone.

**San Pedro Formation (early Pleistocene) -**

Qsp — **San Pedro Formation, undivided -** Poorly consolidated fine- to coarse-grained sand and silty sand interbedded with thin beds and lenses of gravel. Marine. Also includes fluvial sand and gravel with local beds of clayey-silt in the Baldwin Hills.

Qspt — **Timms Point Silt Member -** Dense sandy silt and silty sand.

Qspl — **Lomita Marl Member -** Marl and calcareous sand and gravel.

Qi — **Inglewood Formation (lower Pleistocene) -** Well-bedded siltstone with interlayered beds of very fine-grained sandstone; locally abundant calcareous and limonitic concretions. Marine.

**Fernando Formation (Pliocene and Pleistocene) -** Consisting of:

Tfu — **Upper Member -** Massive friable silty and pebbly sandstone interbedded with thin beds of siltstone, massive pebble conglomerate at base; locally abundant angular chips of platy white siltstone. Locally contains limy concretions.

Tfl / Tflc — **Lower Member -** Massive silty sandstone with interbedded pebbly sandstone and conglomerate. Basal conglomerate contains locally abundant angular chips of platy white siltstone. Tflc = conglomerate and sandstone interbedded with Tfl. Includes rocks mapped as Repetto in the Torrance quadrangle by Woodring and others, 1946.

**Puente Formation (upper Miocene) -** Consisting of:

Tpsc / Tpscc — **Sycamore Canyon Member -** Sandstone with interbedded pebble-cobble conglomerate and sandy siltstone. Tpscc = pebble-cobble conglomerate and pebbly sandstone interbedded with Tpsc.

Tpy — **Yorba Member -** Platy diatomaceous siltstone with interbeds of sandstone, limestone and marl.

Tps — **Soquel Member -** Thick-bedded to massive graded sandstone and siltstone; local lenses of pebble-cobble conglomerate in upper part.

Tplv — **La Vida Member -** Laminated to platy siltstone with interbedded pebbly sandstone; limestone and altered tuff beds in lower portion.

**Monterey Formation (middle and upper Miocene) -** Constisting of:

Tmm — **Malaga Mudstone Member -** Radiolarian mudstone and diatomite.

Tmvd — **Valmonte Diatomite Member -** Diatomaceous shale, mudstone, and diatomite with beds and lenses of hard, resistant silicified limestone and shale and resistant zones of chert.

Tma — **Altamira Shale Member -** Siliceous shale, silty and sandy shale, cherty shale, chert, siltstone, bituminous shale, diatomaceous shale, diatomite, phosphatic shale, tuffaceous shale, limestone, sandstone, conglomerate , breccia, and silicified limestone and shale.

Tmv — **Volcanic rocks within the Monterey Formation (middle Miocene) -** Consists of basalt, andesite, volcanic breccia, and tuff breccia mainly or completely intrusive.

mcs — **Catalina Schist (pre- late Cretaceous) -** Consists of quartz-chlorite schist, quartz-sericite schist, and quartz-glaucophane schist.

## (Offshore Region)

Qms — **Unconsolidated shelf sediment (late Holocene) -** Deposits of mostly unconsolidated sand and silt on the shelf.

Qmf — **Unconsolidated flank sediment (late Holocene) -** Deposits of mostly mud on the slope.

Qmb — **Unconsolidated basin sediment (late Holocene) -** Deposits of mostly mud on the basin floor.

Qmr — **Unconsolidated ridge sediment (late Holocene) -** Deposits of mostly mud on the ridge.

Qmc — **Unconsolidated canyon sediment (late Holocene) -** Deposits of mostly mud on the canyon walls.

Qct — **Canyon terrace (Holocene and Pleistocene) -** Deposits of mixed gravel, sand, and mud on canyon formed terrace.

Qcf — **Canyon fill (Holocene and Pleistocene) -** Deposits of mixed gravel, sand, and mud on the canyon floor.

Qgf — **Gully fill (late Holocene) -** Deposits of mostly mud in gully.

Qf — **Fan deposits (Holocene and Pleistocene) -** Deposits of gravel, sand, and mud at base of slope at mouths of submarine canyons and gullies.

Qls — **Landslide deposits (Holocene and Pleistocene) -** Highly fragmented to largely coherent landslide deposits. Unconsolidated to moderately well consolidated. Most mapped landslides include scarp area as well as slide deposit. In some areas scarp is shown separately with pattern. Preponderance of landslides found in submarine canyons and on steep slopes.

Qp — **Pleistocene sedimentary deposits, undivided (Pleistocene) -** Deposits of mostly unconsolidated sand in nearshore areas of continental shelf.

QTt — **Plio-Pleistocene terrace deposits (Pliocene and Pleistocene) -** Deposits of unconsolidated gravel and sand on low-stand erosional platforms.

Tp — **Pliocene sedimentary rocks, undivided* (Pliocene) -** Sandstone and siltstone, heavily gullied where mapped on the slope.

Tmp — **Miocene-Pliocene rocks, undivided* -** Plutonic and hypabyssal rocks found on the outer banks.

Tu — **Tertiary sedimentary and volcanic rocks, undivided* (Tertiary) -** Sandstone, mudstone, and volcanic rocks found on the outer banks.

Tmu — **Miocene sedimentary rocks, undivided* (middle and upper Miocene) -** Mostly diatomaceous mudstones of the Monterey Formation.

Tmv — **Miocene volcanic rocks* (middle and upper Miocene) -** Mostly within the Monterey Formation.

ms — **Metamorphic rocks of pre-Late Cretaceous age* (Jurassic - Cretaceous) -** Mainly Franciscan Complex.

* Q/ = Map unit overlain by more than 3 meters of unconsolidated Quaternary sediment.

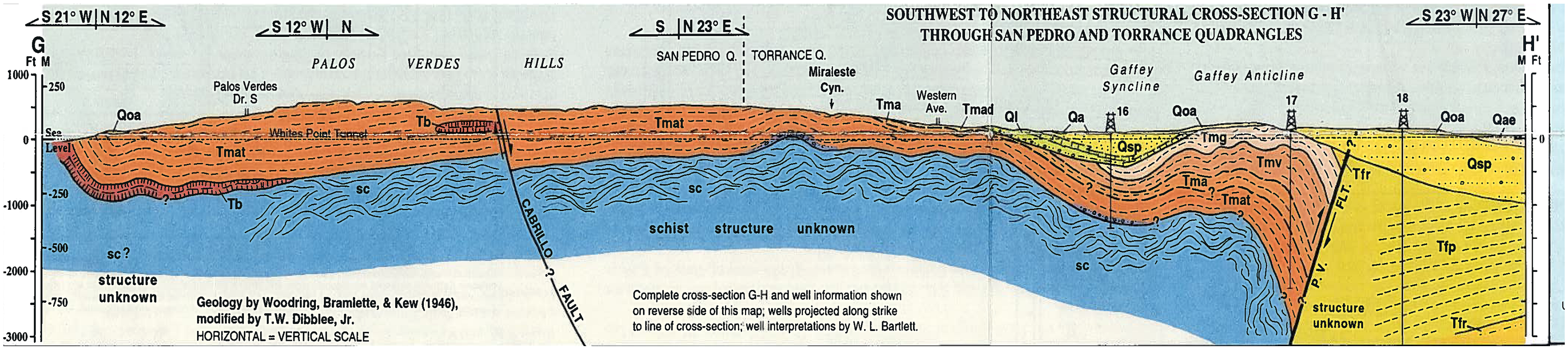
**Prepared in cooperation with the U.S. Geological Survey, Southern California Areal Mapping Project**

**FIGURE 8-3c**

CLEARWATER Program

# Map Unit Descriptions of Stratigraphic Relationships

Source: California Geological Survey (Geologic Map Long Beach 30x60) 2003




## LEGEND

| | | | |
|---|---|---|---|
| **Qya** | YOUNGER ALLUVIUM | **Tma** | MONTEREY FORMATION— ALTIMIRA SHALE |
| **Qoa** | OLDER ALLUVIUM | **Tmat** | MONTEREY FORMATION— ALTIMIRIA SHALE (LOWER PART) |
| **Qal** | ALLUVIUM, ELEVATED | **Tmad** | MONTEREY FORMATION— DIATOMITE |
| **Ql** | LOMITA MARL | **Sc** | CATALINA SCHIST |
| **Qsp** | SAN PEDRO SAND | | |
| **Tfp** | FERNANDO FORMATION— PICO MEMBER | | |
| **Tfr** | FERNANDO FORMATION— SILTSTONE/CLAYSTONE | | |
| **Tb** | BASALT | | |

**FIGURE 8-4**

CLEARWATER Program

## Generalized Geologic Cross Section

Source: Modified from Dibblee 1990

**Table 8-8. Geologic Inventory of Shaft Sites**

| Project Element | Shaft Depth (feet)[a] | Geologic Formation | Nearby Active Fault Zone | Miles From Active Fault Zone (approximate) | Depth to Groundwater in Feet (approximate) | Located in a Mapped Liquefaction Hazard Zone | Located in a Mapped Landslide Hazard Zone |
|---|---|---|---|---|---|---|---|
| JWPCP East | 115 | Surface fill soils over Pleistocene (Lakewood Formation) sediment deposits of alluvial sands, silts, and clays | Palos Verdes | 2 | 35 – 40[d] | Yes; a small portion of the northeast corner[b] | No[b] |
| JWPCP West | 115 (Alt 3)<br>140 (Alt 4) | Same as JWPCP East | Palos Verdes | 1.5 | 35 – 40[d] | No; although area just south is mapped as liquefaction zone[b] | No[b] |
| TraPac | 165 | Artificial fill over alluvial and marine sediments of the Lakewood Formation and San Pedro Sand | Palos Verdes | 0.5 | 15[d] | Yes[b] | No[b] |
| LAXT | 170 | Artificial fill over Holocene (Lakewood Formation) sediment deposits | Palos Verdes | 0.5 | 10[d] | Yes[c] | No[c] |
| Southwest Marine | 170 | Artificial fill over Holocene sediment deposits and Timms Point Silt; Malaga Mudstone and Monterey Formation at depths greater than the shaft | Palos Verdes | 0.5 | 10[d] | Yes[c] | No[c] |
| Angels Gate | 245 | Fluvial sediments of dense sands and hard clays over the Altimira Shale Member of the Monterey Formation | Cabrillo<br>Palos Verdes | 0.5<br>3 | 155 (estimated[d]) | No[c] | No[c] |
| Royal Palms | 50 | Altimira Shale Member of the Monterey Formation | Cabrillo<br>Palos Verdes | 1<br>4 | 25 (estimated[d]) | No[c] | No[c,e] |

[a] Approximate depth from ground surface
Alt = alternative
Sources: [b] CDMG 1998e; [c] CDMG 1998f; [d] Parsons 2011; [e] Appendix 8-A

### 8.2.3.3 Riser/Diffuser Area

The riser and diffuser area would either be located on the SP Shelf or the PV Shelf. The offshore geologic setting and areas of mapped submarine instability are shown on Figure 8-3a, and a geologic map legend is provided as Figure 8-3b.

Geologic hazards that have the potential to affect the riser and diffuser area for the recommended plan or its alternatives are listed by project element in Table 8-9. The impacts of geologic hazards on the riser and diffuser areas are discussed in the environmental analysis for project alternatives, Section 8.4. Details of the riser and diffuser area are presented in Chapter 3.

**Table 8-9. Geologic Inventory of Riser/Diffuser Areas**

| Project Element | Geologic Formation | Nearby Active Fault Zone | Miles From Fault Zone (approximate) | Potential for Liquefaction | Located in a Mapped Landslide Hazard Zone |
|---|---|---|---|---|---|
| Riser/ Diffuser Area – SP Shelf | Quaternary-Age unconsolidated sediment between 35 and 45 feet thick in the diffuser area. The riser would extend into the underlying Late Pleistocene sediment, Fernando Formation, and Monterey Formation.[a] | Palos Verdes | 4.5 | Yes[a] | No[a,b] |
| Riser/ Diffuser Area – PV Shelf | Quaternary-Age unconsolidated sediment between 50 and 80 feet thick in the diffuser area. The riser would extend into the underlying Late Pleistocene sediment, Fernando Formation, and/or Monterey Formation.[a] | Palos Verdes | 4.5 | Yes[a] | No[a,b] |
| Riser/ Diffuser Area – Existing Ocean Outfalls | Quaternary-Age sediment at the seafloor.[a] | Palos Verdes | 5 (from outfall mid point) | Yes[a] | No[a,b] |

Sources: [a] Fugro 2011; [b] Saucedo et al. 2003

# 8.3 Regulatory Setting

## 8.3.1 Federal

There are no pertinent federal regulations for geologic and seismic hazards assessments.

## 8.3.2 State

### 8.3.2.1 Alquist-Priolo Earthquake Fault Zoning Act

The 1972 Alquist-Priolo Earthquake Fault Zoning Act (Alquist-Priolo Act) provided for the delineation of rupture zones along active faults in California. The purpose of the Alquist-Priolo Act is to regulate development on or near fault traces to reduce the hazard of fault rupture and to prohibit the location of most structures for human occupancy across these traces. Cities and counties must regulate certain development projects within the zones, which include withholding permits until geologic investigations demonstrate that development sites are not threatened by future surface displacement. Surface fault rupture is not necessarily restricted to the areas designated as Alquist-Priolo zones.

The Alquist-Priolo Act requires that special geologic studies be conducted to locate and assess the activity level of any fault within a development site. The intent of the law is to minimize damage from fault rupture by avoiding certain types of construction across an active fault. The law requires that some structures, such as private dwellings, be set back at least 50 feet from the mapped trace of an active fault.

#### 8.3.2.2 Seismic Hazards Mapping Act

The California Seismic Hazards Mapping Act, which became law in 1991, was developed to protect the public from the effects of strong ground shaking, liquefaction, landslides, or other ground failure, and from other hazards caused by earthquakes. This act requires the state geologist to delineate various seismic hazard zones and requires cities, counties, and other local permitting agencies to regulate certain development projects within these zones. Before a development permit is granted for a site within a seismic hazard zone, a geotechnical investigation of the site must be conducted and appropriate mitigation measures incorporated into the project design. The California Geological Survey (CGS; formerly the CDMG) has released seismic hazards maps for the Los Angeles area, including the JOS, that include information regarding liquefaction, landslides, and ground shaking.

#### 8.3.2.3 California Building Code

The California Building Standards Code is typically referred to as the California Building Code. California Code of Regulations Title 24 is assigned to the California Building Standards Commission, which, by law, is responsible for coordinating all building standards. The California Building Code incorporates by reference the UBC with necessary California amendments. The UBC is a widely adopted model building code in the United States published by the International Conference of Building Officials. About one-third of the text within the California Building Code has been tailored for California earthquake conditions.

#### 8.3.2.4 Storm Water Pollution Prevention Plan

Dischargers whose projects disturb 1 or more acres of soil or whose projects disturb less than 1 acre but are part of a larger common plan of development that in total disturbs 1 or more acres are required to obtain coverage under the National Pollutant Discharge Elimination System (NPDES) General Permit for Discharges of Storm Water Associated With Construction Activity (Construction General Permit). Construction activity subject to this permit includes clearing, grading, and disturbing the ground such as stockpiling or excavation, but regular maintenance activities performed to restore the original line, grade, or capacity of the facility are not included.

The Construction General Permit requires the development and implementation of a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP must list the best management practices (BMPs) the discharger would use to protect storm water runoff and the placement of those BMPs. BMPs in the SWPPP would include measures such as limiting construction activities to the minimum area necessary, using silt fences or straw bales to filter sediment in runoff, revegetating bare soil areas before onset of the wet season, and locating covered material storage areas away from drainage channels. Additionally, the SWPPP must contain a visual monitoring program, a chemical monitoring program for nonvisible pollutants to be implemented if there is a failure of BMPs, and a sediment monitoring plan if the site discharges directly to a water body.

If a single project traverses more than one Regional Water Quality Control Board (RWQCB) jurisdiction, a complete Notice of Intent package (which includes a site map and fee payment) and Notice of Termination (upon completion of each section) must be filed for each RWQCB.

### 8.3.3 Regional

There are no pertinent regional regulations for geologic and seismic hazards assessments.

### 8.3.4 Local

The safety elements of the general plans for the local cities and the county of Los Angeles contain policies for the avoidance of geologic hazards and/or the protection of unique geologic features. Most municipalities require submittal of construction and operational plans for construction in areas of identified geologic and seismic hazard for review and approval prior to the issuance of permits. County and local grading ordinances establish detailed procedures for excavation and grading required during construction.

## 8.4 Environmental Impacts and Mitigation Measures

### 8.4.1 Methodology and Assumptions

Based on the geology underlying the location of a program or project element, the impact assessment, as described in this chapter, considered the following:

- Intensity of an impact, e.g., the extent or magnitude to which a particular impact would affect a given area
- Duration of an impact, i.e., temporary or permanent
- Probability of an impact, e.g., the relative likelihood of large seismic events would be low within the anticipated time frame of construction activities and would increase over the operational life of a facility
- Acceptable risk level, i.e., the level of injury and material/property loss that could potentially occur would be acceptable in view of the cost/benefit of any mitigation

Geologic information was collected from geotechnical reports prepared for the Sanitation Districts by Fugro West. This includes fault investigations; seismic hazard, slope stability, and liquefaction assessments; and site characterization studies (Fugro 2011; Appendix 8-A). Additionally, a limited review of literature and geologic data was conducted that focused on the identification and evaluation of potential geologic and seismic hazards, as cited in the analysis.

The results of Fugro West's preliminary geologic hazards evaluations and seismic design recommendations were evaluated in a feasibility report prepared by Parsons (Parsons 2011). The feasibility report considered potential geotechnical and seismic issues that could affect the design of the facilities and the integrity of the tunnels, shafts, and riser and diffuser for the ocean outfall alternatives. Geologic and seismic considerations for design and construction of project elements were also included in the feasibility report (Parsons 2011).

Based on the Fugro West geotechnical report and the Parsons feasibility report, program and project elements would be designed to accommodate the anticipated ground accelerations at a given site to minimize damage to structures during future earthquakes.

#### 8.4.1.1 Fault Rupture

Fault ruptures are often accompanied by permanent ground displacements at or below the ground surface. These fault displacements impose stresses on structures crossing the fault. Estimates of potential fault displacement based on probabilistic fault displacement analyses and deterministic fault displacement analyses have been prepared (Fugro 2011). The probabilistic techniques are similar to those used for probabilistic estimates of earthquake ground motions. Deterministic evaluations were based primarily on empirical relations developed by Wells and Coppersmith (1994). Potential fault crossing locations for the proposed tunnel alignment alternatives were evaluated. The estimated fault rupture displacements are highest for the Palos Verdes Fault, while the Cabrillo Fault does not appear to create significant fault rupture hazard (Fugro 2011). The ranges of estimated fault displacement for the locations evaluated are summarized below (Fugro 2011).

- 475-year return period: 0.0 to 0.06 feet
- 975-year return period: 0.0 to 1.3 feet
- 2,475-year return period: 0.3 to 4.9 feet

Fault zone width estimates are important for identifying portions of the tunnel that could be susceptible to damage resulting from potential fault rupture displacement. Within the Palos Verdes Fault zone, a potential broad area of faulting with slip (displacement) occurring on discrete, primary splays within the fault zone was interpreted from the data (Fugro 2011). However, at the depths of the proposed tunnels, a major splay of the Palos Verdes Fault would likely be no more than several feet wide. It may not be possible to identify the master fault splay at all of the proposed tunnel crossings. Therefore, the principal fault displacement should be applied over the entire fault zone width for screening purposes and should not be assigned to a particular fault splay due to the uncertainty in location and activity (Fugro 2011). The estimated fault zone widths of the Palos Verdes Fault zone are summarized below.

- Alternative 1 and 2: 1,310 feet
- Alternative 3: 4,430 feet
- Alternative 4: 6,170 to 7,730 feet

The width of the Cabrillo Fault crossing for Alternative 1 is between 2,000 and 2,100 feet (Fugro 2011). The Cabrillo Fault width at its crossing locations for Alternatives 2, 3, and 4 is currently unknown, but is estimated to be no more than a few hundred feet. The Cabrillo Fault crossing for the selected alternative would be further evaluated during final design.

Fault width is important because it affects the tunnel fault-crossing design strategy for the length of the tunnel to which the design is applied (Parsons 2011). If fault movements can be distributed over a longer distance, it is possible that a more economical and feasible fault crossing can be designed for a given return period. Various fault offset design strategies are discussed in the geotechnical reports (Parsons 2011) because all proposed tunnel alternatives must cross the active Palos Verdes Fault. The fault zone width and style vary with fault crossing location. Depending on the fault crossing location, the fault displacement style ranges from mostly strike-slip (Alternatives 1 and 2) to mostly reverse slip (Alternatives 3 and 4). The orientation of the tunnel-fault zone crossing (i.e., the angle between the tunnel and the fault line) is a key design consideration (Parsons 2011). Depending on the tunnel orientation at the fault crossing location, fault movement could make the tunnel elongate and cause axial tensile strain in the lining, or the tunnel could be shortened and cause axial compressive strain in the lining.

Alternate tunnel fault-crossing design strategies were reviewed, with one-pass and two-pass tunnel lining systems, tunnel diameter, and depth being considered (Parsons 2011). Issues evaluated included allowable fault displacement, shaft locations, tunnel boring machine (TBM) requirements, service interruption, accessibility for repairs after a major earthquake, cost, and other factors. For tunnel alternatives that cross the Palos Verdes Fault zone on Terminal Island (Alternatives 1 and 2), shafts would be required on both sides of the Palos Verdes Fault zone for a tunnel lining system, which would make inspection and any necessary repairs easier along this section of the tunnel following a major seismic event. (Parsons 2011.) A tunnel lining system would also be installed along the portion of the tunnel that crosses the Palos Verdes Fault to minimize the potential for damage due to fault rupture.

Fugro West performed geologic studies of the onshore Palos Verdes Fault zone in the vicinity of Western Avenue, including the areas of Alternatives 3 and 4 tunnel crossings of the Palos Verdes Fault. The width, offset amount, and sense of movement vary along the Palos Verdes Fault zone between Western Avenue and Terminal Island. The onshore portion of the Palos Verdes Fault near Western Avenue (encompassing the Alternative 3 and Alternative 4 tunnel crossings) is characterized by significant vertical and horizontal displacement components. The tunnel crossings of the Palos Verdes Fault below Terminal Island (Alternatives 1 and 2) would be primarily strike slip with lesser dip slip. (Fugro 2011.)

The geology of the tunnel crossings is extremely complex. The geologic strata along the tunnel route have been extensively faulted, folded, and compressed by tectonic forces. Studies indicate that tunnels in the vicinity of Western Avenue would cross two primary splays of the Palos Verdes Fault zone, each with different fault displacement characteristics. The southern splay is primarily a right-slip fault (mostly horizontal movement would occur), and the northern splay is an oblique reverse fault (movement would be mostly vertical wherein the hanging wall of the fault would be thrust over the footwall). The two splays are about 6,000 feet apart, bounding the Gaffey Street anticline. Secondary faults would be expected in the area bound by the two faults, and secondary fault splays may also exist near the two main splays (i.e., splay faults may occur over potentially wider areas beyond the Gaffey Street anticline). (Fugro 2011.)

Onshore tunnel crossings in the vicinity of Western Avenue (Alternatives 3 and 4) would be susceptible to damage from primary fault rupture involving both strike-slip and oblique reverse displacement. Ground deformations resulting from secondary faulting and folding would be anticipated during a fault rupture event (Fugro 2011).

Additional investigations for the selected tunnel alignment are recommended to better constrain the fault zone width, geometry, style, sense, and amount of displacement should the fault rupture during the lifetime of the proposed facilities. (Fugro 2011.)

For this assessment, potential impacts were evaluated considering the information presented in the reports cited herein, experience with development of ocean outfalls and tunnels, and experts' geologic judgment.

### 8.4.1.2 Baseline

#### CEQA Baseline

The California Environmental Quality Act (CEQA) baseline is the existing geologic condition based on review of available geologic and geotechnical literature concerning the geologic setting of the area.

#### NEPA No-Federal-Action Baseline

The National Environmental Policy Act (NEPA) no-federal-action baseline for the Clearwater Program is described in Section 1.7.4.2. The NEPA baseline in general represents the condition of resources at the year 2022 when construction of project elements under the United States (U.S.) Army Corps of Engineers' (Corps') jurisdiction would conclude.

The analysis assumes that the existing condition of geology, soils, and mineral resources would remain in a comparable state through the completion of construction in 2022. Therefore, the NEPA no-federal-action baseline is the same as the CEQA baseline.

Note that the NEPA analysis includes direct and indirect impacts as discussed in Section 3.5.2. Any impact associated with project elements located within the Corps' geographic jurisdiction (i.e., the marine environment) during construction would be the direct result of the Corps permit and considered a direct impact under NEPA. Any impact associated with project elements located outside the Corps' geographic jurisdiction during construction would be the indirect result of the Corps permit and considered an indirect impact under NEPA. Any impact that occurs during operation would be considered an indirect impact under NEPA.

## 8.4.2 Thresholds of Significance

The program and/or project would pose a significant impact if it exceeds any of the following thresholds for geology, soils, and mineral resources (GEO):

GEO-1. Exposes people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure.

GEO-2. Exposes people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving rupture of a known earthquake fault.[1]

GEO-3. Exposes people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking.[1]

GEO-4. Exposes people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking.[1]

GEO-5. Substantially accelerates natural processes of wind and water erosion and sedimentation, resulting in sediment runoff or deposition, which would not be contained or controlled on site.

GEO-6. Results in unstable earth conditions or changes in geologic substructure.

GEO-7. Is located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures.

GEO-8. Destroys, permanently covers, or materially and adversely modifies one or more distinct and prominent geologic or topographic features. Such features may include, but are not limited to, hilltops, ridges, hillslopes, canyons, ravines, rock outcrops, water bodies, streambeds, and wetlands.

GEO-9. Results in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state.

GEO-10. Results in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan.

Program and project elements were analyzed by threshold in the Preliminary Screening Analysis (Appendix 1-A) to identify potentially significant impacts on geology, soils, and mineral resources before mitigation. Table 8-10 identifies which elements were brought forward for further analysis by threshold in this EIR/EIS for Alternatives 1 through 4. If applicable, Table 8-10 also identifies thresholds evaluated

[1] Definition of substantial adverse effects and identification of acceptable risk level (less than significant) should reflect prevailing standard of care for geotechnical engineering and engineering geology.

in this EIR/EIS if an emergency discharge into the various water courses were to occur under the No-Project or No-Federal Action Alternatives, as described in Sections 3.4.1.5 and 3.4.1.6.

**Table 8-10. Thresholds Evaluated**

| | | Threshold | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Alt. | GEO-1 | GEO-2 | GEO-3 | GEO-4 | GEO-5 | GEO-6 | GEO-7 | GEO-8 | GEO-9 | GEO-10 |
| **Program Element** | | | | | | | | | | | |
| Conveyance Improvements | 1–5 | | X | X | X | X | | X | | | |
| SJCWRP Plant Expansion | 1–5 | | X | X | | X | | X | | | |
| SJCWRP Process Optimization | 1–4 | | X | X | | X | | X | | | |
| POWRP Process Optimization | 1–4 | X | X | X | X | X | | X | | | |
| LCWRP Process Optimization | 1–4 | | X | X | X | X | | X | | | |
| LBWRP Process Optimization | 1–4 | | X | X | X | X | | X | | | |
| JWPCP Solids Processing | 1–5 | | X | X | | X | | X | | | |
| JWPCP Biosolids Management | 1–5 | | X | X | | | | | | | |
| **Project Element** | | | | | | | | | | | |
| Wilmington to SP Shelf (onshore tunnel)[a] | 1,2 | X | X | X | X | | X | | | | |
| Wilmington to SP Shelf (offshore tunnel) | 1 | X | X | X | X | | X | | | | |
| Wilmington to PV Shelf (onshore tunnel)[a] | 1,2 | X | X | X | X | | X | | | | |
| Wilmington to PV Shelf (offshore tunnel) | 2 | X | X | X | X | | X | | | | |
| Figueroa/Gaffey to PV Shelf (onshore tunnel) | 3 | X | X | X | X | | X | | | | |
| Figueroa/Gaffey to PV Shelf (offshore tunnel) | 3 | X | X | X | X | | X | | | | |
| Figueroa/Western to Royal Palms (onshore tunnel) | 4 | X | X | X | X | | X | | | | |
| JWPCP East Shaft Site | 1,2 | X | X | X | X | X | X | X | | | |
| TraPac Shaft Site | 1,2 | X | X | X | X | X | X | X | | | |
| LAXT Shaft Site | 1,2 | X | X | X | X | X | X | X | | | |
| Southwest Marine Shaft Site | 1,2 | X | X | X | X | X | X | X | | | |
| JWPCP West Shaft Site | 3,4 | X | X | X | X | X | X | X | | | |
| Angels Gate Shaft Site | 3 | X | X | X | X | X | X | X | X | | |
| Royal Palms Shaft Site | 4 | X | X | X | X | X | X | X | X | | |
| SP Shelf Riser/Diffuser Area | 1 | X | X | X | X | | X | X | X | | |
| PV Shelf Riser/Diffuser Area | 2,3 | X | X | X | X | | X | X | X | | |
| Existing Ocean Outfalls Riser/Diffuser Area | 1–4 | X | X | X | X | | X | X | X | | |
| **Emergency Discharge** | 5,6 | | | | | X | | | | | |

[a] The onshore tunnel alignment for the Wilmington to SP Shelf is the same as the onshore tunnel alignment for the Wilmington to PV Shelf.

Alt. = alternative

In the alternatives analysis that follows, if a program or project element is common to more than one alternative, a detailed discussion is presented only in the first alternative in which it appears. Additionally, in subsequent alternatives where no new elements are introduced under a specific threshold, that threshold is not repeated.

## 8.4.3 Alternative 1

### 8.4.3.1 Program

#### *Impact GEO-1. Would Alternative 1 (Program) expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure?*

Some areas in the JOS service area are bound by slopes that are potentially unstable because of erosion, improper construction, overwatering, deep weathering, or structural orientation of geologic formations. These conditions could result in slope instability or landslide hazards for nearby JOS facilities.

#### Pomona Water Reclamation Plant – Process Optimization

**Construction**

The Pomona Water Reclamation Plant (POWRP) is located near Elephant Hill, which could be susceptible to landslides and mudslides (CDMG 1998b). A landslide has been mapped adjacent to the site, and the slopes above the site are characterized as having an earthquake-induced landslide hazard based on seismic hazard mapping (CDMG 1998b). Landslides do not appear to underlie the site based on the available CDMG map (CDMG 1998b). Construction of new facilities could result in the creation of temporary slopes. During construction of the process optimization facilities at the POWRP, construction workers could be exposed to ground failure in this area. Impacts would be significant before mitigation. Implementation of Mitigation Measure (MM) GEO-1 would reduce impacts during construction to less than significant.

**Operation**

Process optimization would not result in an increase of employees or additional habitable buildings at the POWRP. No impacts would occur during operation.

#### CEQA Impact Determination

Construction of process optimization at the POWRP for Alternative 1 (Program) would expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure. Impacts would be significant before mitigation. Operation of Alternative 1 (Program) would result in less than significant impacts.

Mitigation

**MM GEO-1.** Perform geotechnical investigations and provide site-specific recommendations for stabilization of temporary and permanent slopes and excavations to reduce risks to structures and construction workers associated with landslides, mudslides, or ground failure. The geotechnical investigation will address the requirements of local grading ordinances, as appropriate. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer.

Residual Impacts

Residual impacts would be less than significant.

### *Impact GEO-2. Would Alternative 1 (Program) expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving rupture of a known earthquake fault?*

The proposed conveyance system improvements may involve active fault crossings. None of the water reclamation plants (WRPs), however, are located on or near active faults.

## Conveyance System – Conveyance Improvements

### Construction

Approximately 33 miles of the conveyance system would be improved within the JOS. The relief trunk sewers planned between the JWPCP and the Whittier Narrows Water Reclamation Plant (WNWRP) may cross traces of the active Newport-Inglewood Fault zone (Hart and Bryant 1997). Conveyance pipelines may cross other faults with the potential for fault surface rupture. Fault rupture, if it were to occur, could affect the integrity of a buried pipeline, and the pipeline could be damaged. However, due to the infrequent occurrence of fault rupture and the relatively short duration of construction, the probability that a seismic event would coincide with construction activities is low. Therefore, this hazard is typically considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit analysis of any mitigation. Impacts would be less than significant.

### Operation

The hazard of fault rupture at pipeline/fault crossings would exist during system operation. However, this hazard is typically considered to pose an acceptable level of risk for a sewer conveyance system. That is, the level of material/property loss that could occur from fault rupture of the conveyance system is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

## San Jose Creek Water Reclamation Plant – Plant Expansion and Process Optimization

### Construction

The San Jose Creek Water Reclamation Plant (SJCWRP) expansion site is not near or within a known active fault zone. The Raymond Hill Fault is a potentially active fault located about 7 miles north of the plant, and the Whittier-Elsinore Fault is approximately 3.5 miles south of the site. Neither of these faults crosses the SJCWRP site. Therefore, there would be no risk of fault rupture on site during construction, and there would be no impacts.

### Operation

As discussed under construction, the SJCWRP is not near or within a known active fault zone. There would be no risk of fault rupture on site during operation, and there would be no impacts.

## Pomona Water Reclamation Plant – Process Optimization

### Construction

The POWRP is not near or within a known active fault zone. The Chino and Whittier sections of the Elsinore Fault zone lie to the south and southeast of the site at distances of approximately 7 to 9 miles, respectively. The Sierra Madre Fault zone lies to the north of the site at a distance of approximately 5 miles. Therefore, there would be no risk of fault rupture on site during construction, and there would be no impacts.

### Operation

As discussed under construction, the POWRP is not near or within a known active fault zone. There would be no risk of fault rupture on site during operation, and there would be no impacts.

## Los Coyotes Water Reclamation Plant – Process Optimization

### Construction

The Los Coyotes Water Reclamation Plant (LCWRP) is not near or within a known active fault zone. The Newport-Inglewood and Whittier Faults are the nearest active faults and are 8 miles or more from the LCWRP. Therefore, there would be no risk of fault rupture on site during construction, and there would be no impacts.

### Operation

As discussed under construction, the LCWRP is not near or within a known active fault zone. There would be no risk of fault rupture on site during operation, and there would be no impacts.

## Long Beach Water Reclamation Plant – Process Optimization

### Construction

The Long Beach Water Reclamation Plant (LBWRP) is not near or within a known active fault zone. The nearest active fault zones are the Newport-Inglewood–Rose Canyon and the Palos Verde Faults, located to the southwest of the site at distances of 3 miles and 10 miles, respectively. Therefore, there would be no risk of fault rupture on site during construction, and there would be no impacts.

### Operation

As discussed under construction, the LBWRP is not near or within a known active fault zone. There would be no risk of fault rupture on site during operation, and there would be no impacts.

## Joint Water Pollution Control Plant – Solids Processing

### Construction

The JWPCP is not near or within a known active fault zone. Active faults near the JWPCP include the Palos Verdes, Cabrillo, and Newport-Inglewood Faults, which are located more than 5 miles away. Therefore, there would be no risk of fault rupture on site during construction, and there would be no impacts.

### Operation

As discussed under construction, the JWPCP is not near or within a known active fault zone. There would be no risk of fault rupture on site during operation, and there would be no impacts.

## Joint Water Pollution Control Plant – Biosolids Management

### Operation

Transport of biosolids from the JWPCP would not be significantly affected by fault rupture during operation. There could be some temporary disruption due to fault damage to transportation routes such as roads and bridges, but alternate transportation routes would be available. Therefore, impacts would be less than significant.

## CEQA Impact Determination

Construction and operation of Alternative 1 (Program) would not expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving rupture of a known earthquake fault. Impacts would be less than significant.

#### Mitigation

No mitigation is required.

#### Residual Impacts

Impacts would be less than significant.

## *Impact GEO-3. Would Alternative 1 (Program) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking?*

All Alternative 1 (Program) elements would be potentially subject to strong seismic shaking as a result of earthquakes on nearby or more distant faults. Potential earthquake ground shaking levels are estimated from a regional seismic sources model, as discussed in the seismic hazard zone reports encompassing the WRP locations (e.g., CDMG 1998a). The seismic sources model considers local and regional faults, including those listed in Table 8-5, Table 8-7, Table 8-8, and Table 8-9. Based on the available seismic hazard zone maps (CDMG 1998a, 1998b, 1998c, 1998d), potential seismic shaking levels are shown in Table 8-11. The PGA indicated would be potentially damaging during construction and operation of the proposed facilities.

Estimates of seismic shaking are stated probabilistically in the seismic hazard zone reports for seismic shaking having a 10 percent probability of exceedance in 50 years. This probability approximately corresponds with an average return period of 475 years (i.e., one earthquake every 475 years), and is often used to assess the ground shaking hazard at a given site. Seismic shaking maps such as those included with the California Building Code and seismic shaking maps prepared by the U.S. Geological Survey are based on probabilistic methods.

Site-specific seismic shaking evaluations would be required for earthquake-resistant design and construction, as described for MM GEO-3. The intent of earthquake-resistant design is generally to reduce or minimize earthquake-related damage. Seismic evaluations would consider shaking levels appropriate for site-specific conditions at the various WRPs.

**Table 8-11. Peak Ground Acceleration (Program)**

| WRP | Peak Ground Acceleration (PGA)[a] |
|---|---|
| SJCWRP | 0.49 g to 0.51 g[b] |
| POWRP | 0.54 g[c] |
| LCWRP | 0.43 g[d] |
| LBWRP | 0.45 g[e] |
| JWPCP | 0.52 g[e] |

[a] Calculated for a 10 percent probability of exceedence in 50 years
g = acceleration due to gravity
Sources: [b] CDMG 1998a; [c] CDMG 1998b; [d] CDMG 1998c; [e] CDMG 1998d

## Conveyance System – Conveyance Improvements

### Construction

During seismic shaking, transient loads and deformations are induced on buried pipelines by two components. The first is related to seismic waves in the surrounding soil, and the second is related to the deformation of the pipelines where they connect to other structures. The ability of a buried pipeline to withstand strong ground motions depends upon the intensity and duration of shaking, site-specific geologic conditions, and the material type. Typically, earthquake-induced ground shaking only affects buried pipelines when the shaking induces ground failure, such as settlement or liquefaction, which is addressed under Impact GEO-4. Strong levels of shaking could have adverse effects on people or structures during construction. However, due to the infrequent occurrence of seismic events and the relatively short duration of construction, the probability that a seismic event would coincide with construction activities is low. Therefore, this hazard is typically considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

### Operation

The conveyance system is located in Southern California, which is a seismically active area; therefore, strong seismic shaking could have adverse effects on buried pipelines and/or pipeline connections during operation and would result in significant impacts. However, the conveyance system would be built in compliance with the most up-to-date building codes required by the state of California and the California Building Code, which would minimize potential impacts. The level of material/property loss that could occur due to earth shaking of the conveyance system is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

## San Jose Creek Water Reclamation Plant – Plant Expansion and Process Optimization

### Construction

The SJCWRP is located in Southern California, which is a seismically active area. Estimates of PGA calculated for the hazard level associated with a 10 percent probability of exceedence in 50 years are 0.49 g to 0.51 g, as shown in Table 8-11 (CDMG 1998a). Strong levels of ground shaking could potentially have adverse effects on people or structures during construction. However, due to the infrequent occurrence of seismic events and the relatively short duration of construction, the probability that a seismic event would coincide with construction activities is low. Therefore, this hazard is typically considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

### Operation

The hazard of seismic shaking would exist over the design life of the planned process optimization facilities at the SJCWRP. Strong seismic ground shaking could result in damage to the plant expansion facilities. Impacts would be significant before mitigation. Implementation of MM GEO-3 would reduce the impacts of seismic shaking during operation to less than significant.

## Pomona Water Reclamation Plant – Process Optimization

### Construction

Seismic shaking is a hazard in the site area as a result of the proximity of the site to a number of seismic sources. Estimates of PGA calculated for the hazard level associated with a 10 percent probability of exceedence in 50 years are 0.54 g, for the alluvial conditions at the site as shown in Table 8-11 (CDMG 1998b). Strong levels of shaking could potentially have adverse effects on people or structures during construction. However, due to the infrequent occurrence of seismic events and the relatively short duration of construction, the probability that a seismic event would coincide with construction activities is low. Therefore, this hazard is typically considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

### Operation

The hazard of seismic shaking would exist over the design life of the planned process optimization facilities at the POWRP. Strong seismic shaking could result in damage to the process optimization facilities. Impacts would be significant before mitigation. Implementation of MM GEO-3 would reduce the impacts of seismic shaking during operation to less than significant.

## Los Coyotes Water Reclamation Plant – Process Optimization

### Construction

Seismic shaking due to the distance of the LCWRP from local and regional faults may reach a PGA of 0.43 g when calculated for a 10 percent probability of exceedence in 50 years, as shown in Table 8-11 (CDMG 1998c). Strong levels of shaking could potentially have adverse effects on people or structures during construction. However, due to the infrequent occurrence of seismic events and the relatively short duration of construction, the probability that a seismic event would coincide with construction activities is low. Therefore, this hazard is typically considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

### Operation

The hazard of seismic shaking would exist over the design life of the planned process optimization facilities at the LCWRP. Strong seismic shaking could result in damage to the process optimization facilities. Impacts would be significant before mitigation. Implementation of MM GEO-3 would reduce the impacts of seismic shaking during operation to less than significant.

## Long Beach Water Reclamation Plant – Process Optimization

### Construction

Seismic shaking is a hazard in the LBWRP area as a result of the proximity of the site to a number of seismic sources. Estimates of PGA calculated for the hazard level associated with a 10 percent probability of exceedence in 50 years are 0.45 g, for the alluvial conditions at the site as shown in Table 8-11 (CDMG 1998d). Strong levels of ground shaking could potentially have adverse effects on people or structures during construction. However, due to the infrequent occurrence of seismic events and the relatively short duration of construction, the probability that a seismic event would coincide with construction activities is low. Therefore, this hazard is typically considered to pose an acceptable level of risk. That is, the level of material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit analysis of any mitigation. Impacts would be less than significant.

### Operation

The hazard of seismic shaking would exist over the design life of the planned process optimization facilities at the LBWRP. Strong seismic shaking could result in damage to the process optimization facilities. Impacts would be significant before mitigation. Implementation of MM GEO-3 would reduce the impacts of seismic shaking during operation to less than significant.

## Joint Water Pollution Control Plant – Solids Processing

### Construction

Onsite ground shaking may reach PGA rates of 0.52 g, when calculated for a 10 percent probability of exceedence in 50 years as shown in Table 8-11 (CDMG 1998e). Strong levels of shaking could have adverse effects on people or structures during construction. However, due to the infrequent occurrence of seismic events and the relatively short duration of construction, the probability that a seismic event would coincide with construction activities is low. Therefore, this hazard is typically considered to pose an acceptable level of risk. That is, the level of material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit analysis of any mitigation. Impacts would be less than significant.

### Operation

The hazard of seismic ground shaking would exist over the design life of the solids processing facilities at the JWPCP. Seismic ground shaking levels used for design could be exceeded during operation, which could result in damage to the facilities. Impacts would be significant before mitigation. Implementation of MM GEO-3 would reduce the impacts of seismic shaking during operation to less than significant.

## Joint Water Pollution Control Plant – Biosolids Management

### Operation

Transportation of biosolids from the JWPCP would not likely be affected by seismic ground shaking during operation. Any existing biosolids management facilities being considered for use by the Sanitation Districts have already been assessed and constructed for seismic design. Impacts would be less than significant.

## CEQA Impact Determination

Operation of plant expansion at the SJCWRP; process optimization at the SJCWRP, POWRP, LCWRP, and LBWRP; and solids processing facilities at the JWPCP for Alternative 1 (Program) could expose people or structures to a substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking. Impacts would be significant before mitigation. Construction of Alternative 1 (Program) would result in less than significant impacts.

### Mitigation

**MM GEO-3**. Perform geotechnical investigations and provide site-specific recommendations for reducing the adverse effects of seismic ground shaking on planned facilities. The investigations and recommendations will be conducted in accordance with current California Geological Survey[2] guidelines for evaluating and mitigating seismic hazards in California, and will be in compliance with current building codes, as applicable, to reduce the risk of seismic shaking. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer.

### Residual Impacts

MM GEO-3 would reduce operational impacts at the WRPs and the JWPCP. Residual impacts would be less than significant.

## *Impact GEO-4. Would Alternative 1 (Program) expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking?*

The program element structures for the WRPs discussed in this section are typically located in alluvial conditions with geologic settings susceptible to liquefaction during moderate to high levels of ground shaking. If future systems were constructed over sediments with a high potential for liquefaction, measures such as ground improvement, stone columns, or other feasible options would be implemented to reduce the potential adverse effects of liquefaction such as settlement and lateral spreading. The impact of lateral spreading may also be reduced by shallow burial to limit the lateral and frictional forces on the pipeline. Site-specific geotechnical measures would be implemented to reduce liquefaction risks, as described in MM GEO-4.

[2] Previously known as the California Division of Mines and Geology (CDMG).

## Conveyance System – Conveyance Improvements

### Construction

The conveyance system is located in Southern California, which is a seismically active area. Deposits that are susceptible to liquefaction during strong seismic ground shaking may underlie some reaches of the conveyance system. Liquefaction, if it were to occur, could result in settlement and lateral spreading. These effects could damage buried pipelines and would result in impacts. However, due to the infrequent occurrence of seismic events and the relatively short duration of construction, the probability that a seismic event would coincide with construction activities is low. Therefore, this hazard is typically considered to pose an acceptable level of risk. That is, the level of material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit analysis of any mitigation. Impacts would be less than significant.

### Operation

The hazard of liquefaction would exist over the design life of the conveyance system. However, this hazard is typically considered to pose an acceptable level of risk for a sewer conveyance system. That is, the level of material/property loss that could occur from liquefaction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

## Pomona Water Reclamation Plant – Process Optimization

### Construction

The POWRP area is underlain by Holocene-Age, unconsolidated geologic deposits with relatively shallow groundwater conditions (estimated at 20 to 30 feet below ground surface [bgs]) (CDMG 1998b). The site is within an area mapped as having a liquefaction hazard potential (CDMG 1998b). Liquefaction could occur during construction at the POWRP, which could result in damage as a result of settlement or lateral spreading. However, due to the infrequent occurrence of seismic events causing liquefaction and the relatively short duration of construction, the probability that liquefaction would coincide with construction activities is low. Therefore, this hazard is considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

### Operation

There is a risk of liquefaction that could have an impact on the structure and plant operations if settlement or lateral spreading were not mitigated. Implementation of MM GEO-4 would reduce the impacts of liquefaction during operation to less than significant.

## Los Coyotes Water Reclamation Plant – Process Optimization

### Construction

The LCWRP is in a liquefaction hazard zone (CDMG 1998c). This is due to the expected PGAs and potential for shallow groundwater in the Holocene-Age alluvial deposits underlying the site. Hydrograph data from the region indicate that the groundwater elevations can vary as much as 35 feet seasonally (CDMG 1998c). Liquefaction could occur during construction at the LCWRP, which could result in damage as a result of settlement or lateral spreading. However, due to the infrequent occurrence of seismic events causing liquefaction and the relatively short duration of construction, the probability that liquefaction would coincide with construction activities is low. Therefore, this hazard is considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

#### Operation

There is a risk of liquefaction that could have an impact on the structure and plant operations if settlement or lateral spreading were not mitigated. Implementation of MM GEO-4 would reduce the impacts of liquefaction during operation to less than significant.

### Long Beach Water Reclamation Plant – Process Optimization

#### Construction

The LBWRP is in a liquefaction hazard zone (CDMG 1998c). The potential for strong ground shaking and the presence of Holocene-Age geologic deposits suggests a potential for liquefaction (CDMG 1998d). Groundwater is anticipated at depths of 20 to 25 feet bgs. Liquefaction could occur during construction at the LBWRP, which could result in damage as a result of settlement or lateral spreading. However, due to the infrequent occurrence of seismic events causing liquefaction and the relatively short duration of construction, the probability that liquefaction would coincide with construction activities is low. Therefore, this hazard is considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

#### Operation

The LBWRP is in a liquefaction hazard zone that could have an impact on the plant through settlement or lateral spreading during its operational life. Implementation of MM GEO-4 would reduce the impacts of liquefaction during operation to less than significant.

### CEQA Impact Determination

Operation of process optimization at the POWRP, LCWRP, and LBWRP for Alternative 1 (Program) could expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking. Impacts would be significant before mitigation. Construction of Alternative 1 (Program) would result in less than significant impacts.

#### Mitigation

**MM GEO-4.** Perform geotechnical investigations and provide site-specific recommendations to reduce the impacts of liquefaction on planned facilities. The investigations and recommendations will be conducted in accordance with current California Geological Survey guidelines for evaluating and mitigating seismic hazards in California. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer.

#### Residual Impacts

MM GEO-4 would reduce the impacts of liquefaction during operation of process optimization at the POWRP, LCWRP, and LBWRP. Residual impacts would be less than significant.

### *Impact GEO-5. Would Alternative 1 (Program) substantially accelerate natural processes of wind and water erosion and sedimentation, resulting in sediment runoff or deposition, which would not be contained or controlled on site?*

## Conveyance System – Conveyance Improvements

### Construction

The conveyance system improvements would generally be located within existing public rights-of-way in the streets. The potential for soil erosion would be limited in the existing street areas. Trenching during pipeline installation and repair would result in soil disturbance in a relatively narrow corridor along the pipeline route. The movement and temporary stockpiling of excavated soil could result in short-term erosion and sedimentation if improperly handled and stored. However, it is standard practice of the Sanitation Districts to include in the construction specifications for conveyance system improvements a requirement for contractors to comply with the applicable provisions of the State Water Resources Control Board's NPDES Construction General Permit. In accordance with the Construction General Permit, the contractor is required to provide the Sanitation Districts with a site-specific SWPPP that focuses on managing soil disturbance, non-stormwater discharges, construction materials, and construction wastes by identifiable applicable construction BMPs. Therefore, impacts would be less than significant.

## San Jose Creek Water Reclamation Plant – Plant Expansion

### Construction

The SJCWRP expansion would be adjacent to the San Gabriel River, where existing treatment facilities are located. The area is flat, and the soils are not highly susceptible to erosion. During construction, earth-moving operations could increase short-term erosion. The storage and movement of soil greatly affects the amount of erosion that occurs. If soil is improperly stored or transported, offsite sedimentation could occur. Compliance with the NPDES would require a SWPPP to be developed and implemented prior to construction if the site includes 1 acre or more of disturbed area. Therefore, impacts associated with sediment runoff or deposition would be less than significant.

## San Jose Creek Water Reclamation Plant – Process Optimization

### Construction

Process optimization structures would be located in the existing parking lot and maintained lawn area adjacent to San Jose Creek. The area is flat, and the soils are not highly susceptible to erosion. During construction, earthmoving operations could increase short-term erosion. If soil is improperly handled and stored, offsite sedimentation could occur. Compliance with the NPDES would require a SWPPP to be developed and implemented prior to construction if the site includes 1 acre or more of disturbed area. Therefore, impacts associated with sediment runoff or deposition would be less than significant.

## Pomona Water Reclamation Plant – Process Optimization

### Construction

Process optimization structures would be located on vacant disturbed land. The land around the POWRP is developed, and the soils are not highly susceptible to erosion. During construction, earthmoving operations could increase short-term erosion. If soil is improperly handled and stored, offsite sedimentation could occur. Compliance with the NPDES would require a SWPPP to be developed and implemented prior to construction if the site includes 1 acre or more of disturbed area. Therefore, impacts associated with sediment runoff or deposition would be less than significant.

### Los Coyotes Water Reclamation Plant – Process Optimization

#### Construction

Process optimization structures would be located within the Iron-Wood Nine Golf Course driving range. The land around the LCWRP is developed, and the soils are not highly susceptible to erosion. During construction, earthmoving operations could increase short-term erosion. If soil is improperly handled and stored, offsite sedimentation could occur. Compliance with the NPDES would require a SWPPP to be developed and implemented prior to construction if the site includes 1 acre or more of disturbed area. Therefore, impacts associated with sediment runoff or deposition would be less than significant.

### Long Beach Water Reclamation Plant – Process Optimization

#### Construction

Process optimization structures would be located on vacant disturbed land. The area is flat, and the soils are not highly susceptible to erosion. During construction, earthmoving operations could increase short-term erosion. If soil is improperly handled and stored, offsite sedimentation could occur. Compliance with the NPDES would require a SWPPP to be developed and implemented prior to construction if the site includes 1 acre or more of disturbed area. Therefore, impacts associated with sediment runoff or deposition would be less than significant.

### Joint Water Pollution Control Plant – Solids Processing

#### Construction

The JWPCP has a wide variety of soils with a low-to-high erodibility potential. Construction of the solids processing digesters would involve cut and fill to a depth of approximately 20 to 30 feet below ground. During construction of new facilities, earthmoving operation could increase short-term erosion at the digester sites. The storage and movement of soil greatly affects the amount of erosion that occurs. If soil is improperly stored or transported, offsite sedimentation could occur. Compliance with the NPDES would require a SWPPP to be developed and implemented prior to construction if the site includes 1 acre or more of disturbed area. Therefore, impacts associated with sediment runoff or deposition would be less than significant.

### CEQA Impact Determination

Construction of Alternative 1 (Program) would not substantially accelerate natural processes of wind and water erosion and sedimentation, resulting in sediment runoff or deposition, which would not be contained or controlled on site. Impacts would be less than significant.

#### Mitigation

No mitigation is required.

#### Residual Impacts

Impacts would be less than significant.

### *Impact GEO-7. Would Alternative 1 (Program) be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures?*

## Conveyance System – Conveyance Improvements

### Operation

The conveyance system improvements may be underlain by locally expansive soils, which could deform or damage pipelines during operation. However, during the initial stages of design, it is standard practice of the Sanitation Districts to perform soils borings approximately every 500 feet along proposed sewer alignments prior. The soil borings are analyzed, and the results are used by design engineers to ensure that the appropriate bedding zone and sewer pipe materials are specified to protect against damage caused by expansive soils. Therefore, impacts would be less than significant.

## San Jose Creek Water Reclamation Plant – Plant Expansion; San Jose Creek Water Reclamation Plant, Pomona Water Reclamation Plant, and Los Coyotes Water Reclamation Plant – Process Optimization

### Operation

Naturally occurring soils at the SJCWRP, POWRP, and LCWRP have a low expansion potential (Jones & Stokes 1994) and have been substantially altered by the introduction of artificial fill and grading for construction of onsite facilities. The USSCS Soil Survey maps the Hanford Association beneath the SJCWRP, POWRP, and LCWRP (Jones & Stokes 1994). Soils of the Hanford Association are typically more than 60 inches deep and have an upper 8-inch surface layer of pale brown sandy loam. Below the upper 8 inches, the substratum is likely to consist of sandy loam and gravel. The soils are reported to have low erosion and shrink-swell potential. However, expansive soils, if present, could damage structures, and impacts would be significant. Impacts would be significant before mitigation. Implementation of MM GEO-7 would reduce the impacts of shrink-swell soil behavior during operation to less than significant.

## Long Beach Water Reclamation Plant – Process Optimization

### Operation

Naturally occurring soils at the LBWRP have a moderate expansion potential (Jones & Stokes 1994) and have been substantially altered by the introduction of artificial fill and grading for construction of onsite structures. The USSCS Soil Survey maps the Chino Association beneath the LBWRP (Jones & Stokes 1994). Soils of the Chino Association typically consist of loam, silt loam, or clay loam. Erosion potential is low, and the shrink-swell potential is moderate. Expansive soils, if present, could damage structures, and impacts would be significant before mitigation. Implementation of MM GEO-7 would reduce the impacts of shrink-swell soil behavior during operation to less than significant.

## Joint Water Pollution Control Plant – Solids Processing

### Operation

Naturally occurring soils at the JWPCP have been extensively altered from a number of years of excavation associated with operations, the construction of structures, and the introduction of artificial fill.

Most of the soil consists of clay, silt, and sand, and some artificial fill soils are also present in areas throughout the site. The soils underneath the JWPCP have a moderate expansion potential, although the general area has a high expansion potential affiliated with the Ramona-Placentia Association (Jones & Stokes 1994). Expansive soils, if present, could damage structures, and impacts would be significant before mitigation. Implementation of MM GEO-7 would reduce the impacts of shrink-swell soil behavior during operation to less than significant.

### CEQA Impact Determination

Operation of plant expansion at the SJWRP; process optimization at the SJCWRP, POWRP, LCWRP, and LBWRP; and solids processing facilities at the JWPCP for Alternative 1 (Program) would be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures. Impacts would be significant before mitigation.

#### Mitigation

**MM GEO-7.** Perform geotechnical investigations and provide site-specific recommendations to reduce the risk of adverse effects on structures due to shrink-swell soil behavior. The investigations will include an analysis of soil expansion potential (i.e., American Society for Testing and Materials D-4829). Remediation may include expansive soil removal, reinforced foundations, and/or special pavement design. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer.

#### Residual Impacts

After mitigation, the potential for shrink-swell soils to deform foundations or damage structures during operation would be low. Residual impacts would be less than significant.

## 8.4.3.2 Project

### *Impact GEO-1. Would Alternative 1 (Project) expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure?*

### Tunnel Alignment – Wilmington to San Pedro Shelf (Onshore)

#### Construction

#### CEQA Analysis

The Wilmington to SP Shelf onshore tunnel profile would be at depths between about 100 and 200 feet bgs. Landslides have not been mapped along the onshore tunnel alignment (Dibblee 1999). The tunnel alignment would not cross ancient landslides and would not result in renewed landslide movement during construction. Deep-seated ground failure is considered a low geologic hazard during construction. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

#### Operation

CEQA Analysis

Landslides have not been identified along the onshore tunnel alignment. During operation, the tunnel would not be affected by landslides or result in renewed movement of a landslide. Deep-seated ground failure is considered a low geologic hazard during operation. Impacts would be less than significant.

NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Tunnel Alignment – Wilmington to San Pedro Shelf (Offshore)

#### Construction

CEQA Analysis

The Wilmington to SP Shelf offshore tunnel profile would be at depths between about 100 and 200 feet bgs or below the seafloor. Landslides or indications of deep-seated submarine mass movements have not been mapped along the offshore tunnel alignment (Fugro 2011). The tunnel alignment would not cross below or near known ancient landslides or areas of past submarine mass movements. Deep-seated ground failure is considered a low geologic hazard during tunnel construction. Impacts would be less than significant.

NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

#### Operation

CEQA Analysis

During operation, the offshore tunnel would not be affected by landslides or deep-seated submarine mass movements because areas of major seafloor instability have not been identified along the tunnel alignment. Deep-seated ground failure is considered a low geologic hazard during operation. Impacts would be less than significant.

NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Shaft Sites – JWPCP East, TraPac, LAXT, and Southwest Marine

#### Construction

CEQA Analysis

The JWPCP East, Trans Pacific Container Service Corporation (TraPac), Los Angeles Export Terminal (LAXT), and Southwest Marine shaft sites are not in known landslide areas (CDMG 1998e, 1998f); however, construction of the shafts would be in unconsolidated sedimentary formations below the water table. Excavation instability and/or shaft failure is a construction risk that could result in ground failure in the vicinity of the shaft. Once the shaft is constructed, however, there would be minimal risk of instability during tunnel construction. Impacts would be significant before mitigation. Implementation of MM GEO-1 would reduce impacts to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Operation

#### CEQA Analysis

The JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites are not in known landslide areas (CDMG 1998e, 1998f); therefore, the hazard of ground failure during operation would be low. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Riser/Diffuser Area – San Pedro Shelf

### Construction

#### CEQA Analysis

The riser and diffuser area would not be located in areas of past seafloor instability (Fugro 2011). Design geotechnical investigations would be performed to determine the adequate setback from the edge of the SP Shelf. Therefore, ground failure would be a low geologic hazard during construction. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

### Operation

#### CEQA Analysis

The riser and diffuser area would not be located in areas of past submarine mass movements or seafloor instability (Fugro 2011). Therefore, ground failure would be a low geologic hazard during operation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Riser/Diffuser Area – Existing Ocean Outfalls

The existing ocean outfalls are near the edge of the PV Shelf. Major submarine mass movements have occurred at depths below the shelf (on the continental shelf). The irregular seafloor morphology at the PV Shelf edge is thought to represent submarine slide headscarp features resulting from the Palos Verdes debris avalanche deposits (Fugro 2007c). No areas of past seafloor instability or submarine landsliding were identified during geologic mapping of the shelf (Saucedo et al. 2003).

### Construction

#### CEQA Analysis

The existing ocean outfalls are located between about 0.25 and 0.5 miles away (landward) from the edge of the PV Shelf, and are not located in areas of past seafloor instability (Saucedo et al. 2003). Ground failure is considered a low geologic hazard during rehabilitation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

### Operation

#### CEQA Analysis

The existing ocean outfalls are not located in areas of past submarine mass movements or seafloor instability (Saucedo et al. 2003). Therefore, as under existing conditions, ground failure would continue to be a low geologic hazard during maintenance of the existing ocean outfalls. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## CEQA Impact Determination

Construction at the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites for Alternative 1 (Project) could expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure. Impacts under CEQA would be significant before mitigation. Operation of Alternative 1 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-1.

#### Residual Impacts

MM GEO-1 would reduce impacts during construction at the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites. Residual impacts would be less than significant.

## NEPA Impact Determination

Construction at the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites for Alternative 1 (Project) could expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure. Impacts under NEPA would be significant before mitigation with respect to the No-Federal-Action Alternative (see Section 3.4.1.6). Operation of Alternative 1 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-1.

#### Residual Impacts

Residual impacts would be less than significant, as described under the CEQA impact determination.

### *Impact GEO-2. Would Alternative 1 (Project) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving rupture of a known earthquake fault?*

Although many active faults are mapped near project facilities (see Table 8-7, Table 8-8, and Table 8-9), the potential for fault surface rupture would only exist for project features that are underlain by or extend across an active fault. Fault rupture, if it were to occur, could result in fault movement and associated deformation of the ground near the fault. None of the proposed shafts are underlain by active faults. The tunnel would cross active faults, as described herein.

## Tunnel Alignment – Wilmington to San Pedro Shelf (Onshore)

### Construction

#### CEQA Analysis

The onshore tunnel would not cross a mapped active fault (Hart and Bryant 1997). Therefore, there would be no risk of fault rupture within the alignment during construction, and there would be no impacts.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis. There would be no impacts under NEPA.

### Operation

#### CEQA Analysis

The onshore tunnel would not cross a mapped active fault (Hart and Bryant 1997). Therefore, there would be no risk of fault rupture within the alignment during operation, and there would be no impacts.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis. There would be no impacts under NEPA.

## Tunnel Alignment – Wilmington to San Pedro Shelf (Offshore)

### Construction

#### CEQA Analysis

The offshore tunnel would cross the active Palos Verdes Fault between the LAXT and Southwest Marine shaft sites (Parsons 2011). The offshore tunnel also crosses the Cabrillo Fault on the SP Shelf. The

Cabrillo Fault may also be active, but it would likely move only in response to large earthquakes involving the Palos Verdes Fault (Fugro 2011).

Due to the infrequent occurrence of fault rupture and the relatively short duration of construction, the probability that a fault rupture would coincide with construction activities is low. Therefore, this hazard is typically considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from surface fault rupture during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

### Operation

#### CEQA Analysis

Operation of the offshore tunnel could be affected by fault rupture in the event of a large earthquake along the Palos Verdes Fault. A tunnel liner system would be installed along the portion of the tunnel that crosses the Palos Verdes Fault to minimize the potential for damage due to fault rupture. In the event of fault rupture, there could be some damage to the tunnel, and operation could be affected during system repair. Impacts would be significant before mitigation. Implementation of MM GEO-2 would reduce the risk of tunnel damage and facilitate repair following an earthquake to a less than significant level.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Shaft Sites – JWPCP East, TraPac, LAXT, and Southwest Marine

### Construction

#### CEQA Analysis

The JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites are not near or within an active fault zone (Hart and Bryant 1997). Therefore, there would be no risk of fault rupture on site during construction, and there would be no impacts.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis. There would be no impacts under NEPA.

### Operation

#### CEQA Analysis

The JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites are not near or within an active fault zone. Therefore, there would be no risk of fault rupture during operation, and there would be no impacts.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis. There would be no impacts under NEPA.

## Riser/Diffuser Area – San Pedro Shelf

### Construction

#### CEQA Analysis

The riser and diffuser area would not be located near or within an active fault zone because no faults are mapped in the area (Saucedo et al. 2003). Therefore, there would be no risk of fault rupture on site during construction, and there would be no impacts.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis. There would be no impacts under NEPA.

### Operation

#### CEQA Analysis

As discussed under construction, there would be no risk of fault rupture on site, and there would be no impacts.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis. There would be no impacts under NEPA.

## Riser/Diffuser Area – Existing Ocean Outfalls

### Construction

#### CEQA Analysis

The activities related to rehabilitation of the existing ocean outfalls would not be located near or within an active fault zone because no faults are mapped at the existing ocean outfalls (Saucedo et al. 2003). Therefore, there would be no risk of surface rupture on site during rehabilitation, and there would be no impacts.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis. There would be no impacts under NEPA.

### Operation

#### CEQA Analysis

The existing ocean outfalls are not located near or within an active fault zone. Therefore, there would be no risk of surface rupture during maintenance of the existing ocean outfalls, and there would be no impacts.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis. There would be no impacts under NEPA.

### CEQA Impact Determination

Operation of the offshore tunnel for Alternative 1 (Project) could expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving rupture of a known earthquake fault. Impacts under CEQA would be significant before mitigation. Construction of Alternative 1 (Project) would result in less than significant impacts.

#### Mitigation

**MM GEO-2.** Perform site-specific fault hazard investigations to minimize fault rupture damage and facilitate repair of structures damaged as a result of fault movement. The investigations will be conducted in accordance with current California Geological Survey guidelines for evaluating and mitigating seismic hazards in California. Geologic evaluations of fault crossings will include information to define fault location, fault slip, angle of intersection at the crossing, type of fault slip, width of disturbance, fault dip angle, and design fault displacement. Remediation measures may include engineered backfill, special lining systems, and/or special access provisions for repair. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer.

#### Residual Impacts

Implementation of MM GEO-2 would reduce the risk of offshore tunnel damage and would facilitate repairs. Residual impacts would be less than significant.

### NEPA Impact Determination

Operation of the offshore tunnel for Alternative 1 (Project) could expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving rupture of a known earthquake fault. Impacts under NEPA would be significant before mitigation with respect to the No-Federal-Action Alternative (see Section 3.4.1.6). Construction of Alternative 1 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-2.

#### Residual Impacts

Residual impacts would be less than significant, as described under the CEQA impact determination.

### *Impact GEO-3. Would Alternative 1 (Project) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking?*

Strong ground motions from a significant earthquake could result in considerable damage to the tunnel, shafts, riser and diffuser, and existing ocean outfalls due to seismic wave passage effects (Fugro 2011). Seismic waves can induce transient ground deformations to a tunnel (Parsons 2011). A tunnel's response to ground shaking is usually a combination of compression or extension, longitudinal bending, and ovaling/racking. The tunnel lining would be designed to withstand estimated strains due to seismic shaking so that it can continue to function following a seismic event.

The tunnel, shafts, riser and diffuser, and existing ocean outfalls would potentially be exposed to seismic ground shaking in response to earthquakes on local and regional faults, as shown in Table 8-7, Table 8-8, and Table 8-9. Estimates of PGA for a 475-year return period, 975-year return period, and 2,475-year return period are shown in Table 8-12 (Fugro 2011).

**Table 8-12. Peak Ground Acceleration (Project)**

| Location | Label[b] | Peak Ground Acceleration (PGA)[a] 475-Year Return Period (g) | 975-Year Return Period (g) | 2,475-Year Return Period (g) |
|---|---|---|---|---|
| JWPCP (East and West) | GS-1 | 0.57 | 0.75 | 1.01 |
| TraPac | GS-3 | 0.62 | 0.83 | 1.12 |
| LAXT | GS-6 | 0.61 | 0.82 | 1.11 |
| Southwest Marine | GS-6 | 0.61 (estimated) | 0.82 (estimated) | 1.11 (estimated) |
| Angels Gate | GS-8 | 0.55 | 0.73 | 0.99 |
| Royal Palms | GS-7 | 0.56 | 0.74 | 0.99 |
| Riser (Alternative 1) | GS-17 | 0.49 | 0.69 | 0.97 |
| Riser (Alternatives 2 and 3) | GS-11 | 0.48 | 0.65 | 0.88 |

[a] Calculated for a 10% probability of exceedence in 50 years
[b] Ground shaking evaluation location (Fugro 2011)
g = acceleration due to gravity
Source: Fugro 2011

The PGAs indicated in Table 8-12 could be damaging during construction and operation, as discussed herein.

## Tunnel Alignment – Wilmington to San Pedro Shelf (Onshore)

### <u>Construction</u>

#### CEQA Analysis

The onshore tunnel alignment for Alternative 1 (Project) is in a seismically active area. Strong seismic ground shaking could occur during construction of the tunnel. Seismic ground shaking during construction could damage the tunnel lining and equipment supporting tunnel construction. There is also a risk that earthquake shaking could result in disruption of power, so there would be emergency generators on site to support operation of critical systems such as tunnel ventilation (see Chapter 16 for a discussion of emergency management plans and response). However, due to the infrequent occurrence of seismic events and the relatively short duration of construction, the probability that a seismic event would coincide with construction activities is low. Therefore, this hazard is considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### <u>Operation</u>

#### CEQA Analysis

The hazard of seismic shaking would exist over the design life of the tunnel. The relative likelihood of strong seismic shaking during operation would be greater than that during construction due to the increased time frame of seismic exposure during the design life of Alternative 1 (Project). Buried structure connections can be vulnerable to seismic shaking. Proper seismic design would allow buried structures to withstand seismic ground shaking without significant damage. Impacts would be significant before mitigation. Implementation of MM GEO-3 would reduce the impacts of seismic shaking during operation to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Tunnel Alignment – Wilmington to San Pedro Shelf (Offshore)

### Construction

#### CEQA Analysis

The offshore tunnel alignment for Alternative 1 (Project) is in a seismically active area. Strong seismic ground shaking could occur during construction of the tunnel. Seismic ground shaking during construction could damage the tunnel lining and equipment supporting tunnel construction. There is also a risk that earthquake shaking could result in disruption of power, so there would be emergency generators on site to support operation of critical systems such as tunnel ventilation (see Chapter 16 for a discussion of emergency management plans and response). However, due to the infrequent occurrence of seismic events and the relatively short duration of construction, the probability that a seismic event would coincide with construction activities is low. Therefore, this hazard is considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

### Operation

#### CEQA Analysis

The hazard of seismic shaking would exist over the design life of the tunnel. The relative likelihood of strong seismic shaking during operation would be greater than during construction due to the increased time frame of seismic exposure during the design life of Alternative 1 (Project). Buried structure connections can be vulnerable to seismic shaking. Proper seismic design would allow buried structures to withstand seismic shaking without significant damage. Impacts would be significant before mitigation. Implementation of MM GEO-3 would reduce the impacts of seismic shaking during operation to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Shaft Sites – JWPCP East, TraPac, LAXT, and Southwest Marine

### Construction

#### CEQA Analysis

Strong seismic ground shaking during construction could result in damage to the JWPCP East, TraPac, LAXT, and Southwest Marine shaft excavation temporary support systems. Seismic ground shaking could also damage onsite support facilities such as the TBM cooling water tower, generators and substations, ventilation systems, cranes, and possibly other facilities. However, due to the infrequent occurrence of seismic events and the relatively short duration of construction, the probability that a seismic event would coincide with construction activity is low. Therefore, this hazard is considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Operation

#### CEQA Analysis

Once the permanent access structure is constructed below the ground surface, there would be some potential for damage as a result of seismic shaking. The hazard of seismic shaking would exist over the design life of the buried access structure. The relative likelihood of strong seismic shaking during operation would be greater than that during construction due to the increased time frame of seismic exposure during the design life of Alternative 1 (Project). Buried structure connections can be vulnerable to seismic shaking. Proper seismic design would allow buried structures to withstand seismic ground shaking without significant damage. Impacts would be significant before mitigation. Implementation of MM GEO-3 would reduce the impacts of seismic shaking during operation to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Riser/Diffuser Area – San Pedro Shelf

### Construction

#### CEQA Analysis

Construction of the riser would require a jack-up platform and supporting facilities, such as a crane during installation of the riser casing. Strong seismic ground shaking could affect the platform or supporting facilities on the platform. The riser itself would be driven or hydro-jetted into consolidated materials below the seafloor. Temporary excavation works, such as sheet piling, could be damaged by seismic ground shaking.

The diffuser would be constructed from an anchored derrick barge, which would not be affected by seismic shaking. Some seafloor grading or dredging may be used to construct the diffuser. The dredge materials would be sidecast, if feasible. Significant impacts could result from failure of excavation support, disruption of power, and/or damage to offshore platforms. However, due to the infrequent occurrence of seismic events and the relatively short duration of construction, the probability that a seismic event would coincide with construction activity is low. Therefore, this hazard is considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

### Operation

#### CEQA Analysis

Once the riser is constructed, there would be minimal risk of earthquake damage to the riser itself because construction support facilities would be removed and the permanent riser casing would be in place below the seabed. Strong seismic ground shaking could result in damage at the riser/diffuser connection at the seabed or at the riser/tunnel connection at depth.

The diffuser would be placed on a roadbed base of ballast rock. The roadbed ballast rock could experience settlement during seismic ground shaking. Differential settlement of the ballast rock could result in some deformation of the diffuser pipeline. Impacts would be significant before mitigation. Implementation of MM GEO-3 would reduce the impacts of seismic shaking during operation to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Riser/Diffuser Area – Existing Ocean Outfalls

The potential effects of seismic shaking could produce hoop and axial forces resulting in bending and buckling of the Sanitation District's existing ocean outfalls pipelines. The 60-inch, 72-inch, and 90-inch outfalls were constructed with cast iron joints, which limit the deflection and rotation of the pipeline under differential settlement during a seismic event. The pipe segments for the 120-inch outfall consist of a bell and spigot joint, but were placed relatively tight against each other, which result in nominal gaps between the pipe segments that would not allow any substantial rotation during a seismic event. As a result of seismic ground shaking, these conditions could lead to leakage and eventual undermining of the pipe segments due to scouring of the fine sediments. In general, the survival of the existing 120-inch outfall during an earthquake should be better than that of the other outfalls because the concrete bell and spigot pipes have a stronger mechanical connection. (Parsons 2011.)

Rehabilitation work for Alternative 1 (Project) to the existing ocean outfalls would include joint repairs, lining, and/or re-ballasting. Such work would be designed to decrease the risks associated with seismic hazards.

**Construction**

### CEQA Analysis

The rehabilitation work would be performed from an anchored derrick barge, which would not be affected by seismic shaking. Impacts would be less than significant.

### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

**Operation**

### CEQA Analysis

Once the existing ocean outfalls are rehabilitated, there would be some potential for damage as a result of seismic shaking. However, this hazard is considered to pose an acceptable level of risk for the existing ocean outfalls system. That is, the level of material/property loss that could occur from seismic shaking is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## CEQA Impact Determination

Operation of the onshore and offshore tunnel; the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites; and the riser and diffuser on the SP Shelf for Alternative 1 (Project) could expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking. Impacts under CEQA would be significant before mitigation. Construction of Alternative 1 (Project) would result in less than significant impacts.

### Mitigation

Implement MM GEO-3.

### Residual Impacts

Risks associated with ground shaking during operation of the onshore and offshore tunnel; the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites; and the riser and diffuser on the SP Shelf would be reduced with implementation of MM GEO-3. Residual impacts would be less than significant.

## NEPA Impact Determination

Operation of the onshore and offshore tunnel; the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites; and the riser and diffuser on the SP Shelf for Alternative 1 (Project) could expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking. Impacts under NEPA would be significant before mitigation with respect to the No-Federal-Action Alternative (see Section 3.4.1.6). Construction of Alternative 1 (Project) would result in less than significant impacts.

### Mitigation

Implement MM GEO-3.

#### Residual Impacts

Residual impacts would be less than significant, as described under the CEQA impact determination.

### *Impact GEO-4. Would Alternative 1 (Project) expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking?*

Alternative 1 (Project) elements would be located in a seismically active area and could be exposed to strong, potentially damaging levels of seismic shaking. Based on the geologic setting, the potential for liquefaction exists at the project facilities as summarized in Table 8-7, Table 8-8, and Table 8-9. Liquefaction could result in settlements or lateral spreading. The tunnels, however, would be in sedimentary formations such as the Pleistocene-Age Lakewood Formation or the Miocene-Age Monterey Formation at depths below potentially liquefiable materials (Parsons 2011). The shaft sites located in alluvial and/or filled ground with shallow water table conditions are in geologic settings subject to liquefaction (Fugro 2011; CDMG 1998f). The riser and diffuser area is also underlain by potentially liquefiable sediments (Fugro 2011).

Seismically induced liquefaction settlement could result in downdrag forces along the sides of subsurface structures, such as the shafts and access structures (Fugro 2011). Lateral spreading could produce sustained horizontal loads and reduction of resisting soil pressures that could act on opposite sides of the structures, resulting in structure damage. Liquefaction would also result in reduction of strength of materials, which in turn would lead to reduction in resisting soil pressures surrounding deep founded structures during a large earthquake. The reduction in soil pressure could result in increased stresses and strains, which could be damaging to subsurface structures, such as the shafts and access structures.

Liquefaction, seismically induced settlements, and lateral spreading should be considered for design of shafts, drop structures, and riser and diffuser (Fugro 2011).

## Tunnel Alignment – Wilmington to San Pedro Shelf (Onshore)

### <u>Construction</u>

#### CEQA Analysis

The onshore tunnel would be in Pleistocene sedimentary formations below the regional water table. Pre-Holocene deposits (such as those at the depth of the tunnel) are generally not considered susceptible to liquefaction (CDMG 1997). The liquefaction potential is low and would not present a significant geologic hazard during construction. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### <u>Operation</u>

#### CEQA Analysis

The liquefaction hazard would be low during operation of the tunnel, as described for construction. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Tunnel Alignment – Wilmington to San Pedro Shelf (Offshore)

### Construction

#### CEQA Analysis

The offshore tunnel would be in Pleistocene and Miocene sedimentary formations, which are not liquefiable. Therefore, liquefaction would not present a significant geologic hazard during construction, and impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

### Operation

#### CEQA Analysis

The offshore tunnel would be in Pleistocene and Miocene sedimentary formations, which are not liquefiable. Therefore, liquefaction would not present a significant geologic hazard during operation, and impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Shaft Site – JWPCP East

### Construction

#### CEQA Analysis

The JWPCP East shaft site is underlain by saturated Holocene alluvium, and a small portion of the site is located near a mapped liquefaction zone (CDMG 1998f). The site may have some susceptibility to liquefaction during strong seismic shaking. The shaft site is relatively flat, and the potential for lateral spreading is low; however, liquefaction-induced settlement of unconsolidated alluvium could damage the shaft and support facilities. However, due to the infrequent occurrence of seismic events causing liquefaction and the relatively short duration of construction, the probability that a seismic event would coincide with construction activities is low. Therefore, this hazard is considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit analysis of any mitigation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Operation

#### CEQA Analysis

An access structure from the ground surface to the tunnel would be constructed at this shaft site. During operation, seismic shaking could result in liquefaction. Liquefaction-induced settlements could damage the access structure and the tunnel/access structure connection. This would be a significant impact before mitigation. Implementation of MM GEO-4 would reduce the impacts of liquefaction during operation to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Shaft Site – TraPac

### Construction

#### CEQA Analysis

The shaft site is underlain by saturated Holocene alluvium, which may have susceptibility to liquefaction during strong seismic shaking (CDMG 1998f). The shaft site is relatively flat, and the potential for lateral spreading is low. Liquefaction-induced settlements, however, could damage the shaft and support facilities. However, due to the infrequent occurrence of seismic events causing liquefaction and the relatively short duration of construction, the probability that a seismic event would coincide with construction activities is low. Therefore, this hazard is considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Operation

#### CEQA Analysis

An access structure from the ground surface to the tunnel would be constructed at this shaft site. During operation, seismic shaking could result in liquefaction. Liquefaction-induced settlements could damage the access structure and the tunnel/access structure connection. This would be a significant impact before mitigation. Implementation of MM GEO-4 would reduce the impacts of liquefaction during operation to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Shaft Site – LAXT

### Construction

#### CEQA Analysis

The shaft site is underlain by saturated, hydraulic fill soils, which are susceptible to liquefaction during strong seismic shaking (CDMG 1998f). Although the shaft site is relatively flat, there may be some potential for lateral spreading. Liquefaction-induced settlements and lateral spreading could damage the shaft and onsite support facilities. However, due to the infrequent occurrence of seismic events causing liquefaction and the relatively short duration of construction, the probability that a seismic event would coincide with construction activities is low. Therefore, this hazard is considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Operation

#### CEQA Analysis

An access structure from the ground surface to the tunnel would be constructed at this shaft site. During operation, seismic shaking could result in liquefaction. Liquefaction-induced settlements could damage the access structure and the tunnel/access structure connection. This would be a significant impact before mitigation. Implementation of MM GEO-4 would reduce the impacts of liquefaction during operation to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Shaft Site – Southwest Marine

### Construction

#### CEQA Analysis

The shaft site is underlain by saturated, hydraulic fills which are susceptible to liquefaction during strong seismic shaking (CDMG 1998f). The shaft site is adjacent to harbor shoreline structures, which may be designed to resist liquefaction; however, there may be some potential for lateral spreading. Liquefaction-induced settlements and lateral spreading could damage the shaft and support facilities. However, due to the infrequent occurrence of seismic events causing liquefaction and the relatively short duration of construction, the probability that a seismic event would coincide with construction activities is low. Therefore, this hazard is considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Operation

#### CEQA Analysis

An access structure from the ground surface to the tunnel would be constructed at this shaft site. During operation, seismic shaking could result in liquefaction. Liquefaction-induced settlements and lateral spreading could damage the access structure and the tunnel/access structure connection. This would be a significant impact before mitigation. Implementation of MM GEO-4 would reduce the impacts of liquefaction during operation to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Riser/Diffuser Area – San Pedro Shelf

### Construction

#### CEQA Analysis

The riser and diffuser area is a relatively flat area of the upper slope of the southwest edge of the SP Shelf. To prepare for riser installation, unconsolidated seafloor material would be removed. The jack-up platform legs may be underlain by some thickness of potentially liquefiable material, which could settle if liquefaction were to occur (although typically, the platform could level itself if tilting occurred as a result of liquefaction). There could be some disruption of support facilities on the platform. The riser itself would be driven or hydro-jetted into consolidated materials below the seafloor, which would not be liquefiable. Temporary excavation works, such a sheet piling, could be damaged by liquefaction.

The diffuser may be underlain by a varying thickness of potentially liquefiable Holocene sediment. The diffuser could be impacted by lateral spreading if strong seismic shaking were to occur (Fugro 2011).

The offshore areas where the diffuser would be located are underlain by potentially liquefiable marine sediment (Fugro 2011). Liquefaction can result in lateral spreading on gentle slopes. Lateral spreading hazards exist at the diffuser area (Fugro 2005a, 2005b). However, due to the infrequent occurrence of seismic events causing liquefaction and the relatively short duration of construction, the probability that a seismic event would coincide with construction activities is low. Therefore, this hazard is typically considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from liquefaction during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

### <u>Operation</u>

#### CEQA Analysis

The diffuser may be underlain by a varying thickness of potentially liquefiable Holocene sediment (Fugro 2011). The diffuser could be affected by lateral spreading if strong seismic shaking were to occur (Fugro 2011). Impacts would be significant before mitigation. Implementation of MM GEO-4 would reduce the impacts of liquefaction during operation to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Riser/Diffuser Area – Existing Ocean Outfalls

Holocene sediments, estimated to be 50 to 80 feet thick, underlie the existing ocean outfalls. The thickness decreases towards the edge of the PV Shelf. The seabed slopes below the existing ocean outfalls on the PV Shelf range from 1 to 4 degrees. The Holocene sediments are primarily silts that are susceptible to liquefaction under strong ground shaking from an earthquake. Liquefaction of the sandy silt material could result in settlement and lateral spreading. Vertical settlements are estimated to range between 6 and 18 inches for the 2,475-year event. Lateral spreading may range up to 5 to 7 feet for the 2,475-year event. (Fugro 2011.)

Various construction methods were used to build the existing ocean outfalls, including trenches excavated to varying depths below the seabed (in the nearshore areas, the trenches are in native rock) and placement of the outfall pipe and diffuser directly on the sandy seabed with ballast rock placed up to the pipe spring line. Surveys of the outfall from the 1990s revealed significant losses of small ballast rock, likely the result of storm wave action. A number of outfall repairs implemented in the 1990s helped restore ballast (Parsons 2011). Rehabilitation to the existing ocean outfalls for Alternative 1 (Project) could include joint repairs, lining, and/or re-ballasting.

A concern with placement of outfall pipe sections directly on the ocean floor is the risk of differential settlement during a significant seismic event. The existing ocean outfalls are located in an area of potential high seismicity, and the diffuser locations are underlain by liquefiable soils near the edge of the continental shelf break. Under strong seismic shaking, the sediments underlying the existing ocean outfalls are susceptible to liquefaction. The resulting settlement and lateral spreading is a significant hazard to the existing ocean outfalls and diffuser. (Parsons 2011.)

The main damages associated with seismically induced differential settlement and seismically induced lateral spreading are joint leakage, loss of ballast, and opening or breaking of pipe joints (Parsons 2011). The existing ocean outfalls would be subjected to significant stresses and strains due to differential movements of the seabed as a result of lateral spreading. Differential movements could develop in the lateral spreading mass. The portions of the outfall that are embedded in competent (non-liquefiable) materials in a trench could be subjected to significant lateral forces as the surrounding lateral spreading mass displaces laterally. Therefore, liquefaction-induced settlement and lateral spreading are significant seismic hazards to the existing ocean outfall pipelines and diffusers (Parsons 2011).

### Construction

#### CEQA Analysis

Liquefaction could result in settlement or lateral spreading, which could affect the existing ocean outfalls. However, due to the infrequent occurrence of seismic events and the relatively short duration of construction, the probability that liquefaction would coincide with construction activities is low. Therefore, this hazard is considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

### Operation

#### CEQA Analysis

During operation, liquefaction and lateral spreading could occur as a result of strong seismic shaking. This event could have a number of impacts on the existing ocean outfalls, as previously discussed. However, this hazard is considered to pose an acceptable level of risk for the existing ocean outfalls system. That is, the level of material/property loss that could occur from liquefaction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## CEQA Impact Determination

Operation of the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites and the riser and diffuser on the SP Shelf for Alternative 1 (Project) could expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking. Impacts under CEQA would be significant before mitigation. Construction of Alternative 1 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-4.

#### Residual Impacts

MM GEO-4 would reduce the risk of liquefaction during operation at the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites and the riser and diffuser on the SP Shelf. Residual impacts would be less than significant.

## NEPA Impact Determination

Operation of the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites and the riser and diffuser on the SP Shelf for Alternative 1 (Project) could expose people or structures to a potential substantially adverse effect including the risk of loss, involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking. Impacts under NEPA would be significant before mitigation with respect to the No-Federal-Action Alternative (see Section 3.4.1.6). Construction of Alternative 1 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-4.

#### Residual Impacts

Residual impacts would be less than significant, as described under the CEQA impact determination.

## *Impact GEO-5. Would Alternative 1 (Project) substantially accelerate natural processes of wind and water erosion and sedimentation, resulting in sediment runoff or deposition, which would not be contained or controlled on site?*

### Shaft Site – JWPCP East

#### <u>Construction</u>

#### CEQA Analysis

The shaft construction area is flat. The soils at the JWPCP East shaft site have a low-moderate to high erosion potential (Table 8-6). During construction, earthmoving operations could increase short-term erosion. If soil is improperly handled and stored, sedimentation could occur, resulting in a significant impact. Compliance with the NPDES would require a SWPPP to be developed and implemented prior to construction if the site includes 1 acre or more of disturbed area. Therefore, impacts associated with sediment runoff or deposition would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Shaft Site – TraPac

#### <u>Construction</u>

#### CEQA Analysis

The shaft construction area is flat and is underlain by artificial fill soils (Parsons 2011). During construction, earthmoving operations could increase short-term erosion. If soil is improperly handled and stored, sedimentation could occur, resulting in a significant impact. Compliance with the NPDES would require a SWPPP to be developed and implemented prior to construction if the site includes 1 acre or more of disturbed area. Therefore, impacts associated with sediment runoff or deposition would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Shaft Site – LAXT

### Construction

#### CEQA Analysis

The shaft construction area is flat, and the soils are not highly susceptible to erosion. During construction, earthmoving operations could increase short-term erosion. If soil is improperly handled and stored, sedimentation could occur, resulting in a significant impact. Compliance with the NPDES would require a SWPPP to be developed and implemented prior to construction if the site includes 1 acre or more of disturbed area. Therefore, impacts associated with sediment runoff or deposition would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Shaft Site – Southwest Marine

### Construction

#### CEQA Analysis

The shaft construction area is flat and is underlain by artificial fill soils (Parsons 2011). During construction, earthmoving operations could increase short-term erosion. If soil is improperly handled and stored, sedimentation could occur, resulting in a significant impact. Compliance with the NPDES would require a SWPPP to be developed and implemented prior to construction if the site includes 1 acre or more of disturbed area. Therefore, impacts associated with sediment runoff or deposition would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## CEQA Impact Determination

Construction of Alternative 1 (Project) would not substantially accelerate natural processes of wind and water erosion and sedimentation, resulting in sediment runoff or deposition off site. Impacts under CEQA would be less than significant.

#### Mitigation

No mitigation is required.

#### Residual Impacts

Impacts would be less than significant.

## NEPA Impact Determination

Construction of Alternative 1 (Project) would not substantially accelerate natural processes of wind and water erosion and sedimentation, potentially resulting in sediment runoff or deposition off site. Impacts under NEPA would be less than significant with respect to the No-Federal-Action Alternative (see Section 3.4.1.6).

#### Mitigation

No mitigation is required.

#### Residual Impacts

Impacts would be less than significant.

### *Impact GEO-6. Would Alternative 1 (Project) result in unstable earth conditions or changes in geologic substructure?*

Excavations for project facilities such as tunnels or shafts can potentially cause unstable earth conditions and changes in geologic substructure that can result in collapse or settlement of overlying or adjacent geologic materials (i.e., unconsolidated sediments) and consequent damage to any structures that are constructed upon these materials. The potential for subsidence to develop over a tunnel excavation and its influence on buildings in the settlement zone is an important concern for any tunnel project.

## Tunnel Alignment – Wilmington to San Pedro Shelf (Onshore)

### Construction

#### CEQA Analysis

The onshore tunnel could be constructed in unconsolidated sediments. Ground settlement could occur during tunneling in unconsolidated sedimentary formations, such as the Lakewood Formation or the San Pedro Formation, which would be encountered along the entire length of the onshore tunnel. These formations are prone to raveling and/or flowing ground behavior below the water table (Parsons 2011). Excessive ground loss at the tunnel heading or shield could be manifested in settlement of the surface above the tunnel. Changes in geologic substructure could occur during construction as a result of settlement while tunneling in unconsolidated sedimentary formations.

Settlement potential during tunneling is partly a function of geologic conditions and ground loss at the tunnel heading and shield. The ground loss volume would be dependent on the tunnel contractor’s means and methods, overall workmanship, and subsurface geology encountered. The design intent is to minimize ground surface settlements during tunnel construction to a level that is imperceptible to third parties and agencies (Parsons 2011). Impacts would be significant, but implementation of MM GEO-6a and MM GEO-6b would reduce impacts to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps’ NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Operation

#### CEQA Analysis

Once the tunnel is constructed, there would be minimal risk of instability. Unstable earth conditions or changes in geologic structure would be unlikely. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps’ NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Tunnel Alignment – Wilmington to San Pedro Shelf (Offshore)

### Construction

#### CEQA Analysis

A portion of the offshore tunnel between the TraPac and Southwest Marine shaft sites would be in unconsolidated sedimentary formations where excessive ground losses could occur at the tunnel heading or shield. Ground loss could be reflected in settlement of the surface above the tunnel within the Port of Los Angeles.

Beyond the Southwest Marine shaft, the offshore portion of the tunnel would be mostly in Miocene sedimentary formations. In this formation, it is unlikely that settlement of the seafloor as a result of changes in geologic substructure or unstable earth conditions would occur.

Overall, impacts would be significant, but implementation of MM GEO-6a and MM GEO-6b would reduce impacts to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

### Operation

#### CEQA Analysis

Once the tunnel is constructed, there would be minimal risk of instability. Unstable earth conditions or changes in geologic structure would be unlikely. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Shaft Sites – JWPCP East, TraPac, LAXT, and Southwest Marine

### Construction

#### CEQA Analysis

Shaft construction methods under consideration include water-tight excavation methods such as slurry walls and ground freezing, which are considered suitable for the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites (Parsons 2011). The shaft sites are located in saturated, relatively pervious deposits including fill soils, alluvium, the Lakewood Formation, and the San Pedro Formation (Fugro 2011). Groundwater levels at the shaft sites generally correspond to heads ranging from 70 to 160 feet above the base of the shafts. Groundwater inflows are expected to be a major concern during the excavation of the shafts (Parsons 2011). Key issues for the shaft excavation and support methods include the shaft depth, stability of the soil/rock formation, groundwater levels, and potential for blow out or heave of the bottom of the excavation (Parsons 2011).

Several potential risks associated with the excavation of the shafts have been identified (Parsons 2011). Deep shafts in soil below the groundwater level have the potential for base instability during excavation.

If groundwater seepage paths are not cut off or controlled, or if deep aquifer de-pressurization is not possible, boiling or quicksand conditions could develop during construction. If piping or bottom heave is allowed to develop in a deep shaft, failure of the shaft is a possibility. Leaks in the shaft walls as a result of incomplete ground freezing could result in lowering of the groundwater table that could cause ground settlement. Failures of shafts excavated in saturated soils with slurry walls or frozen ground can result in lost ground (i.e., a cave-in) and structural problems that can affect the entire shaft (i.e., the shaft wall could collapse) (Parsons 2011).

Shaft excavation at the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites would be in unconsolidated sediments (soft ground), which could be prone to instability during construction. Ground surface settlements or other ground movement during shaft construction could result in unstable earth conditions, causing changes in the geologic structure in the vicinity of the shaft. Once the shafts are constructed and during tunnel construction, there would be minimal risk of instability. Impacts during shaft construction would be significant, but implementation of MM GEO-6a and MM GEO-6b would reduce impacts to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Operation

#### CEQA Analysis

An access structure from the ground surface to the tunnel would be constructed at these shaft sites. Once the access structures are constructed, there would be minimal risk of instability. Unstable earth conditions or changes in geologic structure would be unlikely. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Riser/Diffuser Area – San Pedro Shelf

### Construction

#### CEQA Analysis

Seafloor grading and dredging associated with riser and diffuser construction could result in some minor and localized unstable earth conditions. However, seafloor cuts in unconsolidated sediment would likely flatten and become naturally stable over time. Unstable earth conditions would not pose a significant hazard during construction. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

#### Operation

CEQA Analysis
Operation of the riser and diffuser would not result in localized unstable earth conditions or changes in geologic substructure. Impacts would be less than significant.

NEPA Analysis
Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Riser/Diffuser Area – Existing Ocean Outfalls

#### Construction

CEQA Analysis
The rehabilitation work for the existing ocean outfalls would not involve new seafloor excavations or dredging and would not result in unstable earth conditions or changes in geologic substructure. There would be no impacts.

NEPA Analysis
Environmental impacts would be the same as described for the CEQA analysis. There would be no impacts under NEPA.

#### Operation

CEQA Analysis
Operation of the existing ocean outfalls would not result in unstable earth conditions or changes in geologic substructure. There would be no impacts.

NEPA Analysis
Environmental impacts would be the same as described for the CEQA analysis. There would be no impacts under NEPA.

### CEQA Impact Determination

Construction of the onshore and offshore tunnel and at the JWPCP East, TraPac, LAXT, and Southwestern Marine shaft sites for Alternative 1 (Project) could result in unstable earth conditions or changes in geologic substructure. Impacts under CEQA would be significant before mitigation. Operation of Alternative 1 (Project) would result in less than significant impacts.

Mitigation
**MM GEO-6a.** During the final design process, perform geotechnical investigations to provide characterization of the subsurface conditions and anticipated ground behavior along the selected tunnel route and at the shaft sites. The objective of these investigations will be to reduce the potential impacts of shaft excavation instability and ground settlement along the tunnel. The investigation will address facilities at risk of damage due to potential tunneling-induced settlements or shaft instability. An appropriate shaft excavation method that minimizes the risk of excavation instability and ground settlement in the vicinity of the shaft will be recommended. Geotechnical criteria for stabilization of shaft excavations will be incorporated into the project design to ensure the safety and stability of excavations. Recommendations for control and monitoring of the tunnel boring machine excavation and proper

installation of the tunnel lining system to avoid excessive ground loss at the tunnel heading and shield will be made. Project design documents will also specify contingency measures that will be implemented if excessive settlement were to occur during construction.

**MM GEO-6b.** Develop a detailed plan for construction monitoring that will minimize potential ground surface settlements at the shafts and along the onshore tunnel. The objective of the plan will be to reduce the risk of construction instability and to confirm that ground surface settlement is kept to a level that avoids damage to structures above or along the tunnel alignment. The plan will describe the specific monitoring that will be performed before, during, and after construction. Instrumentation (e.g., survey monuments, slope inclinometers, and/or extensometers) may be used to accurately quantify parameters of ground and structure behaviors and to monitor the rate of change. Contingent construction approaches will be implemented if excessive settlement occurs. The plan will address municipality, agency, and third party settlement tolerance requirements as appropriate for the shaft sites and tunnel alignment. Geotechnical inspections will be performed during construction to confirm the encountered subsurface conditions and to provide recommendations for alternate settlement control approaches, if warranted. If the construction monitoring program detects the occurrence of excessive settlement and alternative settlement control measures are inadequate to meet settlement specifications, then further excavation will cease until additional ground support measures are implemented to alleviate the settlement as directed by the project engineer.

#### Residual Impacts

MM GEO-6a and MM GEO-6b would reduce the impacts of unstable earth conditions during construction of the onshore and offshore tunnel and the JWPCP East, TraPac, LAXT, and Southwest Marine shafts. Residual impacts would be less than significant.

### NEPA Impact Determination

Construction of the onshore and offshore tunnel and at the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites for Alternative 1 (Project) could result in unstable earth conditions or changes in geologic substructure. Impacts under NEPA would be significant before mitigation with respect to the No-Federal-Action Alternative (see Section 3.4.1.6). Operation of Alternative 1 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-6a and MM GEO-6b.

#### Residual Impacts

Residual impacts would be less than significant, as described under the CEQA impact determination.

## *Impact GEO-7. Would Alternative 1 (Project) be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures?*

### Shaft Sites – JWPCP East, TraPac, LAXT, and Southwest Marine

#### <u>Construction</u>

#### CEQA Analysis

As shown in Table 8-8, the shaft sites would be located primarily in areas of artificial fill soils at the ground surface where natural topsoils likely have been previously disturbed and/or covered by fill. The existing fill soils in these areas likely have low to negligible expansion potential inasmuch as typical engineering practice is to use granular, non-expansive soil as imported fill material. Surface improvements at the shaft sites would be designed based on the site soil conditions. The expansion potential would be evaluated and expansive soils, if present, would be remediated, as necessary, through implementation of MM GEO-7 to less than significant.

The shafts would be excavated through existing surficial fill soil into the underlying Lakewood Formation deposits. The predominantly granular silty and sandy soils below the fill are likely to have little to no expansion potential. The anticipated shaft excavation and the shaft itself would be mostly below the water table where soils would not be susceptible to shrink-swell soil behavior. The expansion potential of subsurface soils would be evaluated and expansive soils, if present, would be remediated for the shaft and access structure design through implementation of MM GEO-7 to reduce impacts to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Operation

#### CEQA Analysis

An access structure from the ground surface to the tunnel would be constructed at each shaft site. Shrink-swell soils, if encountered, would be remediated during construction with implementation of MM GEO-7. Measures to remediate expansive soils would protect facilities during operation. Therefore, impacts during operation would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Riser/Diffuser Area – San Pedro Shelf

### Construction

#### CEQA Analysis

Expansive soils are typically related to montmorillinite clay, soils containing anhydrous sodium sulfate, and some shales. The unconsolidated marine sediment at the riser and diffuser area is primarily saturated silt and fine sand. The riser would be driven into sedimentary formations such as the Malaga Mudstone, Altimira Shale, and Monterey Formation mudstone and claystone material that have some potential to swell and undergo volumetric change (Fugro 2011). However, there would be no opportunity for swelling to occur because the construction would occur in the ocean environment where there would be no additional water absorption, and the material would not be exposed to alternating drying and wetting cycles. There would be no impacts during construction due to shrink-swell and swelling clay soil behavior.

#### NEPA Analysis

Environmental impacts would be the same as those described for the CEQA analysis. There would be no impacts under NEPA.

#### Operation

CEQA Analysis
As previously described, because the riser and diffuser would be in the ocean environment, there would be no additional water absorption, and the material would not be exposed to alternate drying and wetting cycles during operation. There would be no impacts.

NEPA Analysis
Environmental impacts would be the same as described for the CEQA analysis. There would be no impacts under NEPA.

### Riser/Diffuser Area – Existing Ocean Outfalls

#### Construction

CEQA Analysis
There would be no excavation during construction on the existing ocean outfalls, and they would not be subjected to shrink-swell soil behavior. There would be no impacts during construction.

NEPA Analysis
Environmental impacts would be the same as described for the CEQA analysis. There would be no impacts under NEPA.

#### Operation

CEQA Analysis
The existing ocean outfalls would not be subjected to shrink-swell soil behavior. There would be no impacts during operation.

NEPA Analysis
Environmental impacts would be the same as described for the CEQA analysis. There would be no impacts under NEPA.

## CEQA Impact Determination

Construction at the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites for Alternative 1 (Project) could be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures. Impacts under CEQA would be significant before mitigation. Operation of Alternative 1 (Project) would result in less than significant impacts.

Mitigation
Implement MM GEO-7.

Residual Impacts
Impacts associated with expansive soils at the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites would be remediated with implementation of MM GEO-7 during construction. Residual impacts would be less than significant.

## NEPA Impact Determination

Construction at the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites for Alternative 1 (Project) could be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures. Impacts under NEPA would be significant before mitigation with respect to the No-Federal-Action Alternative (see Section 3.4.1.6). Operation of Alternative 1 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-7.

#### Residual Impacts

Residual impacts would be less than significant, as described under the CEQA impact determination.

### *Impact GEO-8. Would Alternative 1 (Project) destroy, permanently cover, or materially and adversely modify one or more distinct and prominent geologic or topographic features? Such features may include, but are not limited to, hilltops, ridges, hillslopes, canyons, ravines, rock outcrops, water bodies, streambeds, and wetlands?*

## Riser/Diffuser Area – San Pedro Shelf

### Construction

#### CEQA Analysis

The riser and diffuser would cover a seabed area of approximately 5 to 10 acres. The riser would be located in a water depth of approximately 200 feet. Construction of the riser and diffuser would be across a relatively flat seabed surface with nearly flat slopes up to about 2 degrees. The structures would be located at least 1 mile or more from the SP Shelf edge. The shelf edge is locally cut by submarine canyons, which would be avoided by at least 1 mile or more. Naturally occurring bottom features noted in areas of the SP Shelf include rock outcrops, gas vent craters, and mud volcanoes (Fugro 2011). The seabed at the riser and diffuser area, however, is covered by Holocene marine sediment, which is mostly featureless and smooth. In this setting, the riser and diffuser would be obvious human made bottom features over a relatively small area, but they would not be adversely modifying an unusual geologic or topographic feature because the SP Shelf would remain undisturbed over a broad region. Therefore, impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

## Riser/Diffuser Area – Existing Ocean Outfalls

### Construction

#### CEQA Analysis

Rehabilitation of the existing ocean outfalls, which may include re-ballasting and joint repair, would be within the existing footprint. Therefore, there would be no impacts during construction.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

### CEQA Impact Determination

Construction of Alternative 1 (Project) would not destroy, permanently cover, or materially and adversely modify one or more distinct and prominent geologic or topographic features. Such features may include, but are not limited to, hilltops, ridges, hillslopes, canyons, ravines, rock outcrops, water bodies, streambeds, and wetlands. Impacts under CEQA would be less than significant.

#### Mitigation

No mitigation is required.

#### Residual Impacts

Impacts would be less than significant.

### NEPA Impact Determination

Construction of Alternative 1 (Project) would not destroy, permanently cover, or materially and adversely modify one or more distinct and prominent geologic or topographic features. Such features may include, but are not limited to, hilltops, ridges, hillslopes, canyons, ravines, rock outcrops, water bodies, streambeds, and wetlands. Impacts under NEPA would be less than significant with respect to the No-Federal-Action Alternative (see Section 3.4.1.6).

#### Mitigation

No mitigation is required.

#### Residual Impacts

Impacts would be less than significant.

## 8.4.3.3 Impact Summary – Alternative 1

Impacts on geology, soils, and mineral resources analyzed in this EIR/EIS for Alternative 1 are summarized in Table 8-13 and Table 8-14. The proposed mitigation, where feasible, and the significance of the impact before and following mitigation are also listed in the tables.

**Table 8-13. Impact Summary – Alternative 1 (Program)**

| Program Element | Impact Determination Before Mitigation | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|
| Impact GEO-1. Would Alternative 1 (Program) expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure? | | | |
| POWRP | | | |
| Process Optimization | CEQA<br>Significant Impact During Construction | MM GEO-1. Perform geotechnical investigations and provide site-specific recommendations for stabilization of temporary and permanent slopes and excavations to reduce risks to structures and construction workers associated with landslides, mudslides, or ground failure. The geotechnical investigation will address the requirements of local grading ordinances, as appropriate. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA<br>Less Than Significant Impact During Construction |
| | CEQA<br>No Impact During Operation | No mitigation is required. | CEQA<br>No Impact During Operation |

**Table 8-13 (Continued)**

| Program Element | Impact Determination Before Mitigation | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|
| Impact GEO-2. Would Alternative 1 (Program) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving rupture of a known earthquake fault? | | | |
| Conveyance System | | | |
| Conveyance Improvements | CEQA<br>Less Than Significant Impact During Construction | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| SJCWRP | | | |
| Plant Expansion | CEQA<br>No Impact During Construction | No mitigation is required. | CEQA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | No mitigation is required. | CEQA<br>No Impact During Operation |
| Process Optimization | CEQA<br>No Impact During Construction | No mitigation is required. | CEQA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | No mitigation is required. | CEQA<br>No Impact During Operation |
| POWRP | | | |
| Process Optimization | CEQA<br>No Impact During Construction | No mitigation is required. | CEQA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | No mitigation is required. | CEQA<br>No Impact During Operation |
| LCWRP | | | |
| Process Optimization | CEQA<br>No Impact During Construction | No mitigation is required. | CEQA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | No mitigation is required. | CEQA<br>No Impact During Operation |
| LBWRP | | | |
| Process Optimization | CEQA<br>No Impact During Construction | No mitigation is required. | CEQA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | No mitigation is required. | CEQA<br>No Impact During Operation |
| JWPCP | | | |
| Solids Processing | CEQA<br>No Impact During Construction | No mitigation is required. | CEQA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | No mitigation is required. | CEQA<br>No Impact During Operation |
| Biosolids Management | CEQA<br>Less Than Significant Impact During Operation | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |

**Table 8-13 (Continued)**

| Program Element | Impact Determination Before Mitigation | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|
| Impact GEO-3. Would Alternative 1 (Program) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking? | | | |
| Conveyance System | | | |
| Conveyance Improvements | CEQA<br>Less Than Significant Impact During Construction | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| SJCWRP | | | |
| Plant Expansion | CEQA<br>Less Than Significant Impact During Construction | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | MM GEO-3. Perform geotechnical investigations and provide site-specific recommendations for reducing the adverse effects of seismic ground shaking on planned facilities. The investigations and recommendations will be conducted in accordance with current California Geological Survey guidelines for evaluating and mitigating seismic hazards in California, and will be in compliance with current building codes, as applicable, to reduce the risk of seismic shaking. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA<br>Less Than Significant Impact During Operation |
| Process Optimization | CEQA<br>Less Than Significant Impact During Construction | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | MM GEO-3 | CEQA<br>Less Than Significant Impact During Operation |
| POWRP | | | |
| Process Optimization | CEQA<br>Less Than Significant Impact During Construction | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | MM GEO-3 | CEQA<br>Less Than Significant Impact During Operation |
| LCWRP | | | |
| Process Optimization | CEQA<br>Less Than Significant Impact During Construction | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | MM GEO-3 | CEQA<br>Less Than Significant Impact During Operation |
| LBWRP | | | |
| Process Optimization | CEQA<br>Less Than Significant Impact During Construction | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | MM GEO-3 | CEQA<br>Less Than Significant Impact During Operation |

**Table 8-13 (Continued)**

| Program Element | Impact Determination Before Mitigation | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|
| JWPCP | | | |
| Solids Processing | CEQA<br>Less Than Significant Impact During Construction | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | MM GEO-3 | CEQA<br>Less Than Significant Impact During Operation |
| Biosolids Management | CEQA<br>Less Than Significant Impact During Operation | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| Impact GEO-4. Would Alternative 1 (Program) expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking? | | | |
| Conveyance System | | | |
| Conveyance Improvements | CEQA<br>Less Than Significant Impact During Construction | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| POWRP | | | |
| Process Optimization | CEQA<br>Less than Significant Impact During Construction | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | MM GEO-4. Perform geotechnical investigations and provide site-specific recommendations to reduce the impacts of liquefaction on planned facilities. The investigations and recommendations will be conducted in accordance with current California Geological Survey guidelines for evaluating and mitigating seismic hazards in California. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA<br>Less Than Significant Impact During Operation |
| LCWRP | | | |
| Process Optimization | CEQA<br>Less Than Significant Impact During Construction | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | MM GEO-4 | CEQA<br>Less Than Significant Impact During Operation |
| LBWRP | | | |
| Process Optimization | CEQA<br>Less Than Significant Impact During Construction | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | MM GEO-4 | CEQA<br>Less Than Significant Impact During Operation |

**Table 8-13 (Continued)**

| Program Element | Impact Determination Before Mitigation | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|
| Impact GEO-5. Would Alternative 1 (Program) substantially accelerate natural processes of wind and water erosion and sedimentation, resulting in sediment runoff or deposition, which would not be contained or controlled on site? | | | |
| Conveyance System | | | |
| Conveyance Improvements | CEQA<br>Less Than Significant Impact During Construction | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| SJCWRP | | | |
| Plant Expansion | CEQA<br>Less Than Significant Impact During Construction | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| Process Optimization | CEQA<br>Less Than Significant Impact During Construction | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| POWRP | | | |
| Process Optimization | CEQA<br>Less Than Significant Impact During Construction | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| LCWRP | | | |
| Process Optimization | CEQA<br>Less Than Significant Impact During Construction | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| LBWRP | | | |
| Process Optimization | CEQA<br>Less Than Significant Impact During Construction | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| JWPCP | | | |
| Solids Processing | CEQA<br>Less Than Significant Impact During Construction | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| Impact GEO-7. Would Alternative 1 (Program) be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures? | | | |
| Conveyance System | | | |
| Conveyance Improvements | CEQA<br>Less Than Significant Impact During Operation | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| SJCWRP | | | |
| Plant Expansion | CEQA<br>Significant Impact During Operation | MM GEO-7. Perform geotechnical investigations and provide site-specific recommendations to reduce the risk of adverse effects on structures due to shrink-swell soil behavior. The investigations will include an analysis of soil expansion potential (i.e., American Society for Testing and Materials D-4829). Remediation may include expansive soil removal, reinforced foundations, and/or special pavement design. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA<br>Less Than Significant Impact During Operation |
| Process Optimization | CEQA<br>Significant Impact During Operation | MM GEO-7 | CEQA<br>Less Than Significant Impact During Operation |

### Table 8-13 (Continued)

| Program Element | Impact Determination Before Mitigation | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|
| POWRP | | | |
| Process Optimization | CEQA<br>Significant Impact During Operation | MM GEO-7 | CEQA<br>Less Than Significant Impact During Operation |
| LCWRP | | | |
| Process Optimization | CEQA<br>Significant Impact During Operation | MM GEO-7 | CEQA<br>Less Than Significant Impact During Operation |
| LBWRP | | | |
| Process Optimization | CEQA<br>Significant Impact During Operation | MM GEO-7 | CEQA<br>Less Than Significant Impact During Operation |
| JWPCP | | | |
| Solids Processing | CEQA<br>Significant Impact During Operation | MM GEO-7 | CEQA<br>Less Than Significant Impact During Operation |

### Table 8-14. Impact Summary – Alternative 1 (Project)

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| Impact GEO-1. Would Alternative 1 (Project) expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure? | | | | |
| Tunnel Alignment | | | | |
| Wilmington to SP Shelf (Onshore) | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Wilmington to SP Shelf (Offshore) | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |

**Table 8-14 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| Shaft Site | | | | |
| JWPCP East | CEQA<br>Significant Impact During Construction | N/A | MM GEO-1. Perform geotechnical investigations and provide site-specific recommendations for stabilization of temporary and permanent slopes and excavations to reduce risks to structures and construction workers associated with landslides, mudslides, or ground failure. The geotechnical investigation will address the requirements of local grading ordinances, as appropriate. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-1 | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| TraPac | CEQA<br>Significant Impact During Construction | N/A | MM GEO-1 | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-1 | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| LAXT | CEQA<br>Significant Impact During Construction | N/A | MM GEO-1 | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-1 | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |

**Table 8-14 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| Southwest Marine | CEQA<br>Significant Impact During Construction | N/A | MM GEO-1 | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-1 | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Riser/Diffuser Area | | | | |
| SP Shelf | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Existing Ocean Outfalls | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Impact GEO-2. Would Alternative 1 (Project) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving rupture of a known earthquake fault? | | | | |
| Tunnel Alignment | | | | |
| Wilmington to SP Shelf (Onshore) | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |

**Table 8-14 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Wilmington to SP Shelf (Offshore) | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-2. Perform site-specific fault hazard investigations to minimize fault rupture damage and facilitate repair of structures damaged as a result of fault movement. The investigation will be conducted in accordance with current California Geological Survey guidelines for evaluating and mitigating seismic hazards in California. Geologic evaluations of fault crossings will include information to define fault location, fault slip, angle of intersection at the crossing, type of fault slip, width of disturbance, fault dip angle, and design fault displacement. Remediation measures may include engineered backfill, special lining systems, and/or special access provisions for repair. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-2 | NEPA<br>Less Than Significant Impact During Operation |
| Shaft Site | | | | |
| JWPCP East | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |

**Table 8-14 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| TraPac | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| LAXT | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Southwest Marine | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Riser/Diffuser Area | | | | |
| SP Shelf | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Existing Ocean Outfalls | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |

**Table 8-14 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Impact GEO-3. Would Alternative 1 (Project) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking? | | | | |
| Tunnel Alignment | | | | |
| Wilmington to SP Shelf (Onshore) | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-3. Perform geotechnical investigations and provide site-specific recommendations for reducing the adverse effects of seismic ground shaking on planned facilities. The investigations and recommendations will be conducted in accordance with current California Geological Survey guidelines for evaluating and mitigating seismic hazards in California, and will be in compliance with current building codes, as applicable, to reduce the risk of seismic shaking. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-3 | NEPA<br>Less Than Significant Impact During Operation |
| Wilmington to SP Shelf (Offshore) | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-3 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-3 | NEPA<br>Less Than Significant Impact During Operation |

**Table 8-14 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| Shaft Site | | | | |
| JWPCP East | CEQA Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Construction |
| | NEPA Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA Less Than Significant Impact During Construction |
| | CEQA Significant Impact During Operation | N/A | MM GEO-3 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact During Operation | Indirect | MM GEO-3 | NEPA Less Than Significant Impact During Operation |
| TraPac | CEQA Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Construction |
| | NEPA Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA Less Than Significant Impact During Construction |
| | CEQA Significant Impact During Operation | N/A | MM GEO-3 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact During Operation | Indirect | MM GEO-3 | NEPA Less Than Significant Impact During Operation |
| LAXT | CEQA Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Construction |
| | NEPA Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA Less Than Significant Impact During Construction |
| | CEQA Significant Impact During Operation | N/A | MM GEO-3 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact During Operation | Indirect | MM GEO-3 | NEPA Less Than Significant Impact During Operation |
| Southwest Marine | CEQA Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Construction |
| | NEPA Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA Less Than Significant Impact During Construction |

## Table 8-14 (Continued)

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-3 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-3 | NEPA<br>Less Than Significant Impact During Operation |
| Riser/Diffuser Area | | | | |
| SP Shelf | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-3 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-3 | NEPA<br>Less Than Significant Impact During Operation |
| Existing Ocean Outfalls | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Impact GEO-4. Would Alternative 1 (Project) expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking? | | | | |
| Tunnel Alignment | | | | |
| Wilmington to SP Shelf (Onshore) | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |

## Table 8-14 (Continued)

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| Wilmington to SP Shelf (Offshore) | CEQA Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Construction |
| | NEPA Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA Less Than Significant Impact During Construction |
| | CEQA Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Operation |
| | NEPA Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA Less Than Significant Impact During Operation |
| Shaft Site | | | | |
| JWPCP East | CEQA Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Construction |
| | NEPA Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA Less Than Significant Impact During Construction |
| | CEQA Significant Impact During Operation | N/A | MM GEO-4. Perform geotechnical investigations and provide site-specific recommendations to reduce the impacts of liquefaction on planned facilities. The investigations and recommendations will be conducted in accordance with current California Geological Survey guidelines for evaluating and mitigating seismic hazards in California. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact During Operation | Indirect | MM GEO-4 | NEPA Less Than Significant Impact During Operation |
| TraPac | CEQA Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Construction |
| | NEPA Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA Less Than Significant Impact During Construction |
| | CEQA Significant Impact During Operation | N/A | MM GEO-4 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact During Operation | Indirect | MM GEO-4 | NEPA Less Than Significant Impact During Operation |

**Table 8-14 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| LAXT | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-4 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-4 | NEPA<br>Less Than Significant Impact During Operation |
| Southwest Marine | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-4 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-4 | NEPA<br>Less Than Significant Impact During Operation |
| Riser/Diffuser Area | | | | |
| SP Shelf | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-4 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-4 | NEPA<br>Less Than Significant Impact During Operation |
| Existing Ocean Outfalls | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |

**Table 8-14 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Impact GEO-5. Would Alternative 1 (Project) substantially accelerate natural processes of wind and water erosion and sedimentation, resulting in sediment runoff or deposition, which would not be contained or controlled on site? | | | | |
| Shaft Site | | | | |
| JWPCP East | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| TraPac | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| LAXT | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| Southwest Marine | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |

**Table 8-14 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| Impact GEO-6. Would Alternative 1 (Project) result in unstable earth conditions or changes in geologic substructure? | | | | |
| Tunnel Alignment | | | | |
| Wilmington to SP Shelf (Onshore) | CEQA<br>Significant Impact During Construction | N/A | MM GEO-6a. During the final design process, perform geotechnical investigations to provide characterization of the subsurface conditions and anticipated ground behavior along the selected tunnel route and at the shaft sites. The objective of these investigations will be to reduce the potential impacts of shaft excavation instability and ground settlement along the tunnel. The investigation will address facilities at risk of damage due to potential tunneling-induced settlements or shaft instability. An appropriate shaft excavation method that minimizes the risk of excavation instability and ground settlement in the vicinity of the shaft will be recommended. Geotechnical criteria for stabilization of shaft excavations will be incorporated into the project design to ensure the safety and stability of excavations. Recommendations for control and monitoring of the tunnel boring machine excavation and proper installation of the tunnel lining system to avoid excessive ground loss at the tunnel heading and shield will be made. Project design documents will also specify contingency measures that will be implemented if excessive settlement were to occur during construction.<br><br>MM GEO-6b. Develop a detailed plan for construction monitoring that will minimize potential ground surface settlements at the shafts and along the onshore tunnel. The objective of the plan will be to reduce the risk of construction instability and to confirm that ground surface settlement is kept to a level that avoids damage to structures above or along the tunnel alignment. The plan will describe the specific monitoring that will be performed before, during, and after construction. Instrumentation (e.g., survey monuments, slope inclinometers, and/or extensometers) may be used to accurately quantify parameters of ground and structure behaviors and to monitor the rate of change. Contingent construction approaches will be implemented if excessive settlement occurs. The plan will address municipality, agency, and third party settlement tolerance requirements as appropriate for the shaft sites and tunnel alignment. Geotechnical inspections will be performed during | CEQA<br>Less Than Significant Impact During Construction |

**Table 8-14 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | | | construction to confirm the encountered subsurface conditions and to provide recommendations for alternate settlement control approaches, if warranted. If the construction monitoring program detects the occurrence of excessive settlement, and alternative settlement control measures are inadequate to meet settlement specifications, then further excavation will cease until additional ground support measures are implemented to alleviate the settlement as directed by the project engineer. | |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-6a<br>MM GEO-6b | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Wilmington to SP Shelf (Offshore) | CEQA<br>Significant Impact During Construction | N/A | MM GEO-6a<br>MM GEO-6b | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Direct | MM GEO-6a<br>MM GEO-6b | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Shaft Site | | | | |
| JWPCP East | CEQA<br>Significant Impact During Construction | N/A | MM GEO-6a<br>MM GEO-6b | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-6a<br>MM GEO-6b | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |

**Table 8-14 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| TraPac | CEQA<br>Significant Impact During Construction | N/A | MM GEO-6a<br>MM GEO-6b | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-6a<br>MM GEO-6b | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| LAXT | CEQA<br>Significant Impact During Construction | N/A | MM GEO-6a<br>MM GEO-6b | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-6a<br>MM GEO-6b | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Southwest Marine | CEQA<br>Significant Impact During Construction | N/A | MM GEO-6a<br>MM GEO-6b | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-6a<br>MM GEO-6b | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Riser/Diffuser Area | | | | |
| SP Shelf | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |

**Table 8-14 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Existing Ocean Outfalls | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Impact GEO-7. Would Alternative 1 (Project) be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures? | | | | |
| Shaft Site | | | | |
| JWPCP East | CEQA<br>Significant Impact During Construction | N/A | MM GEO-7. Perform geotechnical investigations and provide site-specific recommendations to reduce the risk of adverse effects on structures due to shrink-swell soil behavior. The investigations will include an analysis of soil expansion potential (i.e., American Society for Testing and Materials D-4829). Remediation may include expansive soil removal, reinforced foundations, and/or special pavement design. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-7 | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| TraPac | CEQA<br>Significant Impact During Construction | N/A | MM GEO-7 | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-7 | NEPA<br>Less Than Significant Impact During Construction |

**Table 8-14 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| LAXT | CEQA<br>Significant Impact During Construction | N/A | MM GEO-7 | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-7 | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Southwest Marine | CEQA<br>Significant Impact During Construction | N/A | MM GEO-7 | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-7 | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Riser/Diffuser Area | | | | |
| SP Shelf | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Existing Ocean Outfalls | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |

**Table 8-14 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Impact GEO-8. Would Alternative 1 (Project) destroy, permanently cover, or materially and adversely modify one or more distinct and prominent geologic or topographic features? Such features may include, but are not limited to, hilltops, ridges, hillslopes, canyons, ravines, rock outcrops, water bodies, streambeds, and wetlands? | | | | |
| Riser/Diffuser Area | | | | |
| SP Shelf | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| Existing Ocean Outfalls | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |

## 8.4.4 Alternative 2

### 8.4.4.1 Program

Alternative 2 (Program) is the same as Alternative 1 (Program).

### 8.4.4.2 Project

The impacts for the onshore tunnel; the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites; and the existing ocean outfalls for Alternative 2 (Project) would be the same as for Alternative 1 (Project).

#### *Impact GEO-1. Would Alternative 2 (Project) expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure?*

#### Tunnel Alignment – Wilmington to Palos Verdes Shelf (Offshore)

**Construction**

CEQA Analysis

The Wilmington to PV Shelf offshore tunnel profile would be at depths between about 100 and 250 feet bgs or below the seafloor. Landslides or indications of deep-seated submarine mass movements have not been mapped along the offshore tunnel alignment (Fugro 2011). The tunnel would not cross below or near known ancient landslides or areas of past submarine mass movements. Deep-seated ground failure is considered a low geologic hazard during tunnel construction. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction.  With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

### Operation

#### CEQA Analysis

During operation, the offshore tunnel would not be affected by landslides or deep-seated submarine mass movements because areas of major seafloor instability have not been identified along the tunnel alignment.  Deep-seated ground failure is considered a low geologic hazard during operation.  Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure.  With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Riser/Diffuser Area – Palos Verdes Shelf

### Construction

#### CEQA Analysis

The riser and diffuser area would not be located in areas of past seafloor instability (Fugro 2011).  Design geotechnical investigations would be performed to determine the adequate setback from the edge of the PV Shelf.  Therefore, ground failure would be a low geologic hazard during construction.  Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction.  With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

### Operation

#### CEQA Analysis

Ground failure is considered a low geologic hazard during operation because the riser and diffuser would not be located in areas of past submarine mass movements or seafloor instability (Fugro 2011).  Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure.  With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## CEQA Impact Determination

Construction at the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites for Alternative 2 (Project) could expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure.  Impacts under CEQA would be significant before mitigation.  Operation of Alternative 2 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-1.

#### Residual Impacts

MM GEO-1 would reduce impacts during construction at the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites to less than significant.

### NEPA Impact Determination

Construction at the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites for Alternative 2 (Project) could expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure. Impacts under NEPA would be significant before mitigation with respect to the No-Federal-Action Alternative (see Section 3.4.1.6). Operation of Alternative 2 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-1.

#### Residual Impacts

Residual impacts would be less than significant, as described under the CEQA impact determination.

## *Impact GEO-2. Would Alternative 2 (Project) expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving rupture of a known earthquake fault?*

Although many active faults are mapped near project facilities (see Table 8-7, Table 8-8, and Table 8-9), the potential for fault surface rupture would only exist for project features that are underlain by or extend across an active fault. Fault rupture, if it were to occur, could result in fault movement and associated deformation of the ground near the fault. None of the proposed shafts are underlain by active faults. The tunnel would cross active faults, as described herein.

### Tunnel Alignment – Wilmington to Palos Verdes Shelf (Offshore)

#### <u>Construction</u>

#### CEQA Analysis

The offshore tunnel would cross the active Palos Verdes Fault between the LAXT and Southwest Marine shaft sites (Parsons 2011). The offshore tunnel also crosses the Cabrillo Fault near Point Fermin. The Cabrillo Fault may also be active, but it would likely move only in response to large earthquakes involving the Palos Verdes Fault (Fugro 2011).

Due to the infrequent occurrence of fault rupture and the relatively short duration of construction, the probability that a fault rupture would coincide with construction activities is low. Therefore, this hazard is typically considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from surface fault rupture during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

### Operation

#### CEQA Analysis

Operation of the offshore tunnel could be affected by fault rupture in the event of a large earthquake along the Palos Verdes Fault. A tunnel liner system would be installed along the portion of the tunnel that crosses the Palos Verdes Fault to minimize the potential for damage due to fault rupture. In the event of fault rupture, there could be some damage to the tunnel and operation could be affected during system repair. This would be a significant impact. Implementation of MM GEO-2 would reduce the risk of tunnel damage and facilitate repair following an earthquake to a less than significant level.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Riser/Diffuser Area – Palos Verdes Shelf

### Construction

#### CEQA Analysis

The risers and diffuser area would not be located near or within an active fault zone (Saucedo et al. 2003). Therefore, there would be no risk of fault rupture on site during construction, and there would be no impacts.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis. There would be no impacts under NEPA.

### Operation

#### CEQA Analysis

As discussed under construction, there would be no risk of fault rupture on site during operation, and there would be no impacts.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis. There would be no impacts under NEPA.

## CEQA Impact Determination

Operation of the offshore tunnel for Alternative 2 (Project) could expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving rupture of a known earthquake fault. Impacts under CEQA would be significant before mitigation. Construction of Alternative 2 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-2.

#### Residual Impacts

Implementation of MM GEO-2 would reduce the risk of offshore tunnel damage and would facilitate repairs. Residual impacts would be less than significant.

### NEPA Impact Determination

Operation of the offshore tunnel for Alternative 2 (Project) could expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving rupture of a known earthquake fault. Impacts under NEPA would be significant before mitigation with respect to the No-Federal-Action Alternative (see Section 3.4.1.6). Construction of Alternative 2 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-2.

#### Residual Impacts

Residual impacts would be less than significant, as described under the CEQA impact determination.

## *Impact GEO-3. Would Alternative 2 (Project) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking?*

The tunnel, shafts, riser and diffuser, and existing ocean outfalls would potentially be exposed to seismic ground shaking in response to earthquakes on local and regional faults, as shown in Table 8-7, Table 8-8, and Table 8-9. Strong seismic ground shaking could be damaging during construction and operation of the facilities.

### Tunnel Alignment – Wilmington to Palos Verdes Shelf (Offshore)

#### <u>Construction</u>

#### CEQA Analysis

The offshore tunnel alignment for Alternative 2 (Project) is in a seismically active area. Strong seismic ground shaking could occur during construction of the tunnel. Seismic ground shaking during construction could damage the tunnel lining and equipment supporting tunnel construction. There is also a risk that earthquake shaking could result in disruption of power, so there would be emergency generators on site to support operation of critical systems such as tunnel ventilation (see Chapter 16 for a discussion of emergency management plans and response). However, due to the infrequent occurrence of seismic events and the relatively short duration of construction, the probability that a seismic event would coincide with construction activities is low. Therefore, this hazard is typically considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

#### Operation

##### CEQA Analysis

The hazard of seismic shaking would exist over the design life of the tunnel. The relative likelihood of strong seismic shaking during operation would be greater than during construction due to the increased time frame of seismic exposure during the design life of Alternative 2 (Project). Buried structure connections can be vulnerable to seismic shaking. Proper seismic design would allow buried structures to withstand seismic shaking without significant damage. Impacts would be significant before mitigation. Implementation of MM GEO-3 would reduce the impacts of seismic shaking during operation to less than significant.

##### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Riser/Diffuser Area – Palos Verdes Shelf

#### Construction

##### CEQA Analysis

Construction of the riser would require a jack-up platform and supporting facilities, such as a crane during installation of the riser casing. Strong seismic ground shaking could affect the platform or supporting facilities on the platform. The riser itself would be driven or hydro-jetted into consolidated materials below the seafloor. Temporary excavation works, such as sheet piling, could be damaged by seismic ground shaking.

The diffuser would be constructed from an anchored derrick barge, which would not be affected by seismic shaking. Some seafloor grading or dredging may be used to construct the diffuser. The dredge materials would be sidecast, if feasible. Significant impacts could result from failure of excavation support, disruption of power, and/or damage to offshore platforms. However, due to the infrequent occurrence of seismic events and the relatively short duration of construction, the probability that a seismic event would coincide with construction activities is low. Therefore, this hazard is typically considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

##### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

#### Operation

##### CEQA Analysis

Once the riser is constructed, there would be minimal risk of earthquake damage to the riser itself because construction support facilities would be removed, and the permanent riser casing would be in place below the seabed. Strong seismic ground shaking could result in damage at the riser/diffuser connection at the seabed or at the riser/tunnel connection at depth.

The diffuser would be placed on a roadbed base of ballast rock. The roadbed ballast rock could experience settlement during seismic ground shaking. Differential settlement of the ballast rock could result in some deformation of the diffuser pipeline. Impacts would be significant before mitigation. Implementation of MM GEO-3 would reduce the impacts of seismic shaking during operation to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### CEQA Impact Determination

Operation of the onshore and offshore tunnel; the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites; and the riser and diffuser on the PV Shelf for Alternative 2 (Project) could expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking. Impacts under CEQA would be significant before mitigation. Construction of Alternative 2 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-3.

#### Residual Impacts

Risks associated with ground shaking during operation of the onshore and offshore tunnel; the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites; and the riser and diffuser on the PV Shelf would be reduced with implementation of MM GEO-3. Residual impacts would be less than significant.

### NEPA Impact Determination

Operation of the onshore and offshore tunnel; the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites; and the riser and diffuser on the PV Shelf for Alternative 2 (Project) could expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking. Impacts under NEPA would be significant before mitigation with respect to the No-Federal-Action Alternative (see Section 3.4.1.6). Construction of Alternative 2 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-3.

#### Residual Impacts

Residual impacts would be less than significant, as described under the CEQA impact determination.

### *Impact GEO-4. Would Alternative 2 (Project) expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking?*

Alternative 2 (Project) elements would be located in a seismically active area and could be exposed to strong, potentially damaging levels of seismic shaking. Based on the geologic setting, the potential for liquefaction exists at the project facilities as summarized in Table 8-7, Table 8-8, and Table 8-9. Liquefaction could result in settlements or lateral spreading. The tunnels, however, would be in sedimentary formations such as the Pleistocene-Age Lakewood Formation or the Miocene-Age Monterey

Formation at depths below potentially liquefiable materials (Parsons 2011). The shaft sites located in alluvial and/or filled ground with shallow water table conditions are in geologic settings subject to liquefaction (Fugro 2011; CDMG 1998f). The riser and diffuser area is also underlain by potentially liquefiable sediments (Fugro 2011).

## Tunnel Alignment – Wilmington to Palos Verdes Shelf (Offshore)

### Construction

#### CEQA Analysis

The offshore tunnel would be in Pleistocene and Miocene sedimentary formations, which are not potentially liquefiable. Therefore, liquefaction would not present a significant geologic hazard during construction, and impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

### Operation

#### CEQA Analysis

The offshore tunnel would be in Pleistocene and Miocene sedimentary formations, which are not potentially liquefiable. Therefore, liquefaction would not present a significant geologic hazard during operation, and impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Riser/Diffuser Area – Palos Verdes Shelf

### Construction

#### CEQA Analysis

The riser and diffuser area would be located at the edge of the PV Shelf. To prepare for riser installation, unconsolidated seafloor material would be removed. The jack-up platform legs may be underlain by some thickness of potentially liquefiable material, which could settle if liquefaction were to occur. Typically, the platform could level itself if tilting occurred as a result of liquefaction. However, there could be some disruption of supporting facilities on the platform. The riser would be driven or hydro-jetted into consolidated materials below the seafloor, which would not be liquefiable. Temporary excavation works, such a sheet piling, could be damaged by liquefaction.

The diffuser may be underlain by a varying thickness of potentially liquefiable Holocene sediment. The diffuser could be impacted by lateral spreading if strong seismic shaking were to occur (Fugro 2011).

The offshore areas where the diffuser would be located are underlain by potentially liquefiable marine sediment (Fugro 2011). Liquefaction can result in lateral spreading on gentle slopes. Lateral spreading hazards exist at the diffuser area (Fugro 2005a, 2005b). However, due to the infrequent occurrence of seismic events causing liquefaction and the relatively short duration of construction, the probability that a seismic event would coincide with construction activities is low. Therefore, this hazard is typically considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from liquefaction during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

**Operation**

#### CEQA Analysis

The diffuser may be underlain by a varying thickness of potentially liquefiable Holocene sediment (Fugro 2011). The diffuser could be affected by lateral spreading if strong seismic shaking were to occur (Fugro 2011). This would be considered a significant impact prior to mitigation. Implementation of MM GEO-4 would reduce the impacts of liquefaction during operation to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### CEQA Impact Determination

Operation of the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites and the riser and diffuser on the PV Shelf for Alternative 2 (Project) could expose people or structures to a potential substantially adverse effect including the risk of loss involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking. Impacts under CEQA would be significant before mitigation. Construction of Alternative 2 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-4.

#### Residual Impacts

MM GEO-4 would reduce the risk of liquefaction during operation at the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites and the riser and diffuser area on the PV Shelf. Residual impacts would be less than significant.

### NEPA Impact Determination

Operation of the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites and the riser and diffuser on the PV Shelf for Alternative 2 (Project) could expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking. Impacts under NEPA would be significant before mitigation with respect to the No-Federal-Action Alternative (see Section 3.4.1.6). Construction of Alternative 2 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-4.

#### Residual Impacts

Residual impacts would be less than significant, as described under the CEQA impact determination.

### *Impact GEO-6. Would Alternative 2 (Project) result in unstable earth conditions or changes in geologic substructure?*

Excavations for project facilities such as tunnels or shafts can potentially cause unstable earth conditions and changes in geologic substructure that can result in collapse or settlement of overlying or adjacent geologic materials (i.e., unconsolidated sediments) and consequent damage to any structures that are constructed upon these materials. The potential for subsidence to develop over a tunnel excavation and its influence on buildings in the settlement zone is an important consideration for any tunnel project.

## Tunnel Alignment – Wilmington to Palos Verdes Shelf (Offshore)

### Construction

#### CEQA Analysis

A portion of the tunnel between the TraPac and Southwest Marine shaft sites would be in unconsolidated sedimentary formations where excessive ground losses could occur at the tunnel heading or shield. Ground loss could be reflected in settlement of the land surface above the tunnel within the Port of Los Angeles. Perceptible ground settlement would reflect a change in geologic substructure and would be a significant impact.

Settlement potential during tunneling is partly a function of geologic conditions and ground loss at the tunnel heading and shield. The ground loss volume would be dependent on the tunnel contractor's means and methods, overall workmanship, and subsurface geology encountered. The design intent would be to minimize ground surface settlements during tunnel construction to a level that is imperceptible to third parties and agencies. (Parsons 2011.)

Beyond the Southwest Marine shaft, the offshore portion of the tunnel would be mostly in Miocene sedimentary formations. In this formation, it is unlikely that settlement of the seafloor as a result of changes in geologic substructure or unstable earth conditions would occur.

Overall, impacts would be significant, but implementation of MM GEO-6a and MM GEO-6b would reduce impacts to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

### Operation

#### CEQA Analysis

Once the tunnel is constructed, there would be minimal risk of instability. Unstable earth conditions or changes in geologic structure would be unlikely. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Riser/Diffuser Area – Palos Verdes Shelf

### Construction

#### CEQA Analysis

Seafloor grading and dredging associated with riser and diffuser construction could result in some minor and localized unstable earth conditions. However, seafloor cuts in unconsolidated sediment would likely flatten and become naturally stable over time. Unstable earth conditions would not pose a significant hazard during construction. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

### Operation

#### CEQA Analysis

Operation of the riser and diffuser would not result in localized unstable earth conditions or changes in geologic substructure. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## CEQA Impact Determination

Construction of the onshore and offshore tunnel and at the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites for Alternative 2 (Project) could result in unstable earth conditions or changes in geologic substructure. Impacts under CEQA would be significant before mitigation. Operation of Alternative 2 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-6a and MM GEO-6b.

#### Residual Impacts

MM GEO-6a and MM GEO-6b would reduce the impacts of unstable earth conditions during construction of the onshore and offshore tunnel and the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites to less than significant.

## NEPA Impact Determination

Construction of the onshore and offshore tunnel and at the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites for Alternative 2 (Project) could result in unstable earth conditions or changes in geologic substructure. Impacts under NEPA would be significant before mitigation with respect to the

No-Federal-Action Alternative (see Section 3.4.1.6). Operation of Alternative 2 (Project) would result in less than significant impacts.

Mitigation

Implement MM GEO-6a and MM GEO-6b.

Residual Impacts

Residual impacts would be less than significant, as described under the CEQA impact determination.

### *Impact GEO-7. Would Alternative 2 (Project) be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures?*

## Riser/Diffuser Area – Palos Verdes Shelf

**Construction**

CEQA Analysis

Expansive soils are typically related to montmorillinite clay, soils containing anhydrous sodium sulfate, and some shales. The unconsolidated marine sediment at the riser and diffuser area is primarily saturated silt and fine sand. The riser would be driven into sedimentary formations such as the Malaga Mudstone, Altimira Shale, and Monterey Formation mudstone and claystone material that have some potential to swell and undergo volumetric change (Fugro 2011). However, there would be no opportunity for swelling to occur because the construction would occur in the ocean environment where there would be no additional water absorption, and the material would not be exposed to alternating drying and wetting cycles. There would be no impacts during construction due to shrink-swell and swelling clay soil behavior.

NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

**Operation**

CEQA Analysis

As described under construction, because the riser and diffuser would be in the ocean environment, there would be no additional water absorption, and the material would not be exposed to alternate drying and wetting cycles during operation. There would be no impacts.

NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis. There would be no impacts under NEPA.

## CEQA Impact Determination

Construction at the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites for Alternative 2 (Project) could be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures. Impacts under CEQA would be significant before mitigation. Operation of Alternative 2 (Project) would result in less than significant impacts.

#### Mitigation
Implement MM GEO-7.

#### Residual Impacts
Impacts associated with expansive soils at the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites would be remediated with implementation of MM GEO-7 during construction. Residual impacts would be less than significant.

### NEPA Impact Determination
Construction at the JWPCP East, TraPac, LAXT, and Southwest Marine shaft sites for Alternative 2 (Project) could be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures. Impacts under NEPA would be significant before mitigation with respect to the No-Federal-Action Alternative (see Section 3.4.1.6). Operation of Alternative 2 (Project) would result in less than significant impacts.

#### Mitigation
Implement MM GEO-7.

#### Residual Impacts
Impacts would be less than significant, as discussed under the CEQA impact determination.

### *Impact GEO-8. Would Alternative 2 (Project) destroy, permanently cover, or materially and adversely modify one or more distinct and prominent geologic or topographic features? Such features may include, but are not limited to, hilltops, ridges, hillslopes, canyons, ravines, rock outcrops, water bodies, streambeds, and wetlands?*

### Riser/Diffuser Area – Palos Verdes Shelf

#### Construction

#### CEQA Analysis
The riser and diffuser would cover a seabed area of approximately 5 to 10 acres. The riser would be located in a water depth of approximately 175 feet. There are no distinct or prominent geologic or topographic features at the seabed that would be affected. Construction of the riser and diffuser would be across a relatively flat seabed surface with nearly flat slopes up to about 2 degrees. The structures would be setback from the PV Shelf edge. The seabed at the riser and diffuser area is covered by Holocene marine sediment, which is mostly featureless and smooth. In this setting, the riser and diffuser would be obvious human made bottom features over a relatively small area, but they would not be adversely modifying an unusual geologic or topographic feature because the PV Shelf would remain undisturbed over a broad region. Therefore, impacts would be less than significant.

#### NEPA Analysis
Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

### CEQA Impact Determination
Construction of Alternative 2 (Project) would not destroy, permanently cover, or materially and adversely modify one or more distinct and prominent geologic or topographic features. Such features may include,

but are not limited to, hilltops, ridges, hillslopes, canyons, ravines, rock outcrops, water bodies, streambeds, and wetlands. Impacts under CEQA would be less than significant.

#### Mitigation

No mitigation is required.

#### Residual Impacts

Impacts would be less than significant.

### NEPA Impact Determination

Construction of Alternative 2 (Project) would not destroy, permanently cover, or materially and adversely modify one or more distinct and prominent geologic or topographic features. Such features may include, but are not limited to, hilltops, ridges, hillslopes, canyons, ravines, rock outcrops, water bodies, streambeds, and wetlands before mitigation. Impacts under NEPA would be less than significant with respect to the No-Federal-Action Alternative (see Section 3.4.1.6).

#### Mitigation

No mitigation is required.

#### Residual Impacts

Impacts would be less than significant.

## 8.4.4.3 Impact Summary – Alternative 2

Impacts on geology, soils, and mineral resources for Alternative 2 (Program), which are the same as Alternative 1 (Program), are summarized in Table 8-13. Impacts analyzed in this EIR/EIS for Alternative 2 (Project) are summarized in Table 8-15. The proposed mitigation, where feasible, and the significance of the impact before and following mitigation are also listed in the tables.

**Table 8-15. Impact Summary – Alternative 2 (Project)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| Impact GEO-1. Would Alternative 2 (Project) expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure? | | | | |
| Tunnel Alignment | | | | |
| Wilmington to PV Shelf (Onshore) | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |

**Table 8-15 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| Wilmington to PV Shelf (Offshore) | CEQA Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Construction |
| | NEPA Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA Less Than Significant Impact During Construction |
| | CEQA Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Operation |
| | NEPA Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA Less Than Significant Impact During Operation |
| Shaft Site | | | | |
| JWPCP East | CEQA Significant Impact During Construction | N/A | MM GEO-1. Perform geotechnical investigations and provide site-specific recommendations for stabilization of temporary and permanent slopes and excavations to reduce risks to structures and construction workers associated with landslides, mudslides, or ground failure. The geotechnical investigation will address the requirements of local grading ordinances, as appropriate. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA Less Than Significant Impact During Construction |
| | NEPA Significant Impact During Construction | Indirect | MM GEO-1 | NEPA Less Than Significant Impact During Construction |
| | CEQA Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Operation |
| | NEPA Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA Less Than Significant Impact During Operation |
| TraPac | CEQA Significant Impact During Construction | N/A | MM GEO-1 | CEQA Less Than Significant Impact During Construction |
| | NEPA Significant Impact During Construction | Indirect | MM GEO-1 | NEPA Less Than Significant Impact During Construction |
| | CEQA Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Operation |
| | NEPA Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA Less Than Significant Impact During Operation |

**Table 8-15 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| LAXT | CEQA<br>Significant Impact During Construction | N/A | MM GEO-1 | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-1 | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Southwest Marine | CEQA<br>Significant Impact During Construction | N/A | MM GEO-1 | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-1 | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Riser/Diffuser Area | | | | |
| PV Shelf | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Existing Ocean Outfalls | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |

## Table 8-15 (Continued)

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Impact GEO-2. Would Alternative 2 (Project) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving rupture of a known earthquake fault? | | | | |
| Tunnel Alignment | | | | |
| Wilmington to PV Shelf (Onshore) | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Wilmington to PV Shelf (Offshore) | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-2. Perform site-specific fault hazard investigations to minimize fault rupture damage and facilitate repair of structures damaged as a result of fault movement. The investigations will be conducted in accordance with current California Geological Survey guidelines for evaluating and mitigating seismic hazards in California. Geologic evaluations of fault crossings will include information to define fault location, fault slip, angle of intersection at the crossing, type of fault slip, width of disturbance, fault dip angle, and design fault displacement. Remediation measures may include engineered backfill, special lining systems, and/or special access provisions for repair. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-2 | NEPA<br>Less Than Significant Impact During Operation |

**Table 8-15 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| Shaft Site | | | | |
| JWPCP East | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| TraPac | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| LAXT | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Southwest Marine | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |

**Table 8-15 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| Riser/Diffuser Area | | | | |
| PV Shelf | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Existing Ocean Outfalls | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Impact GEO-3. Would Alternative 2 (Project) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking? | | | | |
| Tunnel Alignment | | | | |
| Wilmington to PV Shelf (Onshore) | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-3. Perform geotechnical investigations and provide site-specific recommendations for reducing the adverse effects of seismic ground shaking on planned facilities. The investigations and recommendations will be conducted in accordance with current California Geological Survey guidelines for evaluating and mitigating seismic hazards in California, and will be in compliance with current building codes, as applicable, to reduce the risk of seismic shaking. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-3 | NEPA<br>Less Than Significant Impact During Operation |

**Table 8-15 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| Wilmington to PV Shelf (Offshore) | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-3 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-3 | NEPA<br>Less Than Significant Impact During Operation |
| Shaft Site | | | | |
| JWPCP East | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-3 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-3 | NEPA<br>Less Than Significant Impact During Operation |
| TraPac | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-3 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-3 | NEPA<br>Less Than Significant Impact During Operation |
| LAXT | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |

**Table 8-15 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-3 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-3 | NEPA<br>Less Than Significant Impact During Operation |
| Southwest Marine | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-3 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-3 | NEPA<br>Less Than Significant Impact During Operation |
| Riser/Diffuser Area | | | | |
| PV Shelf | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-3 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-3 | NEPA<br>Less Than Significant Impact During Operation |
| Existing Ocean Outfalls | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |

**Table 8-15 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| Impact GEO-4. Would Alternative 2 (Project) expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking? | | | | |
| Tunnel Alignment | | | | |
| Wilmington to PV Shelf (Onshore) | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Wilmington to PV Shelf (Offshore) | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Shaft Site | | | | |
| JWPCP East | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-4. Perform geotechnical investigations and provide site-specific recommendations to reduce the impacts of liquefaction on planned facilities. The investigations and recommendations will be conducted in accordance with current California Geological Survey guidelines for evaluating and mitigating seismic hazards in California. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA<br>Less Than Significant Impact During Operation |

**Table 8-15 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-4 | NEPA<br>Less Than Significant Impact During Operation |
| TraPac | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-4 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-4 | NEPA<br>Less Than Significant Impact During Operation |
| LAXT | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-4 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-4 | NEPA<br>Less Than Significant Impact During Operation |
| Southwest Marine | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-4 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-4 | NEPA<br>Less Than Significant Impact During Operation |
| Riser/Diffuser Area | | | | |
| PV Shelf | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |

**Table 8-15 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-4 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-4 | NEPA<br>Less Than Significant Impact During Operation |
| Existing Ocean Outfalls | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Impact GEO-5. Would Alternative 2 (Project) substantially accelerate natural processes of wind and water erosion and sedimentation, resulting in sediment runoff or deposition, which would not be contained or controlled on site? | | | | |
| Shaft Site | | | | |
| JWPCP East | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| TraPac | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| LAXT | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| Southwest Marine | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |

## Table 8-15 (Continued)

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| Impact GEO-6. Would Alternative 2 (Project) result in unstable earth conditions or changes in geologic substructure? | | | | |
| Tunnel Alignment | | | | |
| Wilmington to PV Shelf (Onshore) | CEQA<br>Significant Impact During Construction | N/A | MM GEO-6a. During the final design process, perform geotechnical investigations to provide characterization of the subsurface conditions and anticipated ground behavior along the selected tunnel route and at the shaft sites. The objective of these investigations will be to reduce the potential impacts of shaft excavation instability and ground settlement along the tunnel. The investigation will address facilities at risk of damage due to potential tunneling-induced settlements or shaft instability. An appropriate shaft excavation method that minimizes the risk of excavation instability and ground settlement in the vicinity of the shaft will be recommended. Geotechnical criteria for stabilization of shaft excavations will be incorporated into the project design to ensure the safety and stability of excavations. Recommendations for control and monitoring of the tunnel boring machine excavation and proper installation of the tunnel lining system to avoid excessive ground loss at the tunnel heading and shield will be made. Project design documents will also specify contingency measures that will be implemented if excessive settlement were to occur during construction.<br><br>MM GEO-6b. Develop a detailed plan for construction monitoring that will minimize potential ground surface settlements at the shafts and along the onshore tunnel. The objective of the plan will be to reduce the risk of construction instability and to confirm that ground surface settlement is kept to a level that avoids damage to structures above or along the tunnel alignment. The plan will describe the specific monitoring that will be performed before, during, and after construction. Instrumentation (e.g., survey monuments, slope inclinometers, and/or extensometers) may be used to accurately quantify parameters of ground and structure behaviors and to monitor the rate of change. Contingent construction approaches will be implemented if excessive settlement occurs. The plan will address municipality, agency, and third party settlement tolerance requirements as appropriate for the shaft sites and tunnel alignment. Geotechnical inspections will be performed during | CEQA<br>Less Than Significant Impact During Construction |

**Table 8-15 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | | | construction to confirm the encountered subsurface conditions and to provide recommendations for alternate settlement control approaches, if warranted. If the construction monitoring program detects the occurrence of excessive settlement and alternative settlement control measures are inadequate to meet settlement specifications, then further excavation will cease until additional ground support measures are implemented to alleviate the settlement as directed by the project engineer. | |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-6a<br>MM GEO-6b | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Wilmington to PV Shelf (Offshore) | CEQA<br>Significant Impact During Construction | N/A | MM GEO-6a<br>MM GEO-6b | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Direct | MM GEO-6a<br>MM GEO-6b | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Shaft Site | | | | |
| JWPCP East | CEQA<br>Significant Impact During Construction | N/A | MM GEO-6a<br>MM GEO-6b | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-6a<br>MM GEO-6b | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |

**Table 8-15 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| TraPac | CEQA<br>Significant Impact During Construction | N/A | MM GEO-6a<br>MM GEO-6b | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-6a<br>MM GEO-6b | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| LAXT | CEQA<br>Significant Impact During Construction | N/A | MM GEO-6a<br>MM GEO-6b | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-6a<br>MM GEO-6b | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Southwest Marine | CEQA<br>Significant Impact During Construction | N/A | MM GEO-6a<br>MM GEO-6b | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-6a<br>MM GEO-6b | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Riser/Diffuser Area | | | | |
| PV Shelf | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |

**Table 8-15 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Existing Ocean Outfalls | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Impact GEO-7. Would Alternative 2 (Project) be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures? | | | | |
| Shaft Site | | | | |
| JWPCP East | CEQA<br>Significant Impact During Construction | N/A | MM GEO-7. Perform geotechnical investigations and provide site-specific recommendations to reduce the risk of adverse effects on structures due to shrink-swell soil behavior. The investigations will include an analysis of soil expansion potential (i.e., American Society for Testing and Materials D-4829). Remediation may include expansive soil removal, reinforced foundations, and/or special pavement design. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-7 | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| TraPac | CEQA<br>Significant Impact During Construction | N/A | MM GEO-7 | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-7 | NEPA<br>Less Than Significant Impact During Construction |

**Table 8-15 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| LAXT | CEQA<br>Significant Impact During Construction | N/A | MM GEO-7 | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-7 | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Southwest Marine | CEQA<br>Significant Impact During Construction | N/A | MM GEO-7 | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-7 | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Riser/Diffuser Area | | | | |
| PV Shelf | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Existing Ocean Outfalls | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |

**Table 8-15 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Impact GEO-8. Would Alternative 2 (Project) destroy, permanently cover, or materially and adversely modify one or more distinct and prominent geologic or topographic features? Such features may include, but are not limited to, hilltops, ridges, hillslopes, canyons, ravines, rock outcrops, water bodies, streambeds, and wetlands? | | | | |
| Riser/Diffuser Area | | | | |
| PV Shelf | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| Existing Ocean Outfalls | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |

# 8.4.5 Alternative 3

## 8.4.5.1 Program

Alternative 3 (Program) is the same as Alternative 1 (Program).

## 8.4.5.2 Project

The impacts for the riser and diffuser area on the PV Shelf for Alternative 3 (Project) would be the same as for Alternative 2 (Project). The impacts for the existing ocean outfalls for Alternative 3 (Project) would be the same as for Alternative 1 (Project).

### *Impact GEO-1. Would Alternative 3 (Project) expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure?*

### Tunnel Alignment – Figueroa/Gaffey to Palos Verdes Shelf (Onshore)

**Construction**

CEQA Analysis

The Figueroa/Gaffey to Palos Verdes Shelf onshore tunnel profile would be at depths between about 70 and 370 feet bgs. The tunnel profile would not pass near or below known landslides (Dibblee 1999) and would not result in renewed landslide movement during construction. Deep-seated ground failure is considered a low geologic hazard during construction. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Operation

#### CEQA Analysis

Operation of the tunnel would not result in landslides or ground failure, as the tunnel would be deeper than known landslides along or near the alignment. Deep-seated ground failure is considered a low geologic hazard during operation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Tunnel Alignment – Figueroa/Gaffey to Palos Verdes Shelf (Offshore)

### Construction

#### CEQA Analysis

The Figueroa/Gaffey to Palos Verdes Shelf offshore tunnel profile would be at depths between about 100 and 250 feet bgs or below the seafloor. During construction, the offshore tunnel would not be affected by landslides or deep-seated submarine mass movements because areas of major seafloor instability have not been identified along the tunnel alignment (Fugro 2011). Deep-seated ground failure is considered a low geologic hazard during construction. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

### Operation

#### CEQA Analysis

During operation, the offshore tunnel would not be affected by landslides or deep-seated submarine mass movements because areas of major seafloor instability have not been identified along the tunnel alignment. Deep-seated ground failure is considered a low hazard during operation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Shaft Site – JWPCP West

### Construction

#### CEQA Analysis

The JWPCP West shaft site is not in a known landslide area (CDMG 1998e; Dibblee 1999). However, construction of the JWPCP West shaft would be in unconsolidated sedimentary formations below the water table. Excavation instability and/or shaft failure is a construction risk that could result in ground failure in the vicinity of the shaft. This would represent a significant impact. Once the shaft is constructed, however, there would be minimal risk of instability during tunnel construction. Implementation of MM GEO-1 would reduce impacts to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Operation

#### CEQA Analysis

An access structure from the ground surface to the tunnel would be constructed at the JWPCP West shaft site. The shaft site is not in a known landslide area (CDMG 1998e; Dibblee 1999); therefore, the hazard of ground failure during operation would be low. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Shaft Site – Angels Gate

### Construction

#### CEQA Analysis

The Angels Gate shaft site is not in a known landslide area (CDMG 1998e; Dibblee 1999). Construction of the Angels Gate shaft would be in alluvial deposits at the surface underlain by members of the Monterey Formations. Because the Monterey Formation is not unconsolidated sedimentary material, excavation instability and/or shaft failure is a low construction risk. Impacts would be less than significant. Once the shaft is constructed, there would be minimal risk of instability during tunnel construction.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

**Operation**

CEQA Analysis

An access structure from the ground surface to the tunnel would be constructed at the Angels Gate shaft site. The Angels Gate shaft site is not in a known landslide area (CDMG 1998e; Dibblee 1999); therefore, the hazard of ground failure during operation would be low. Impacts would be less than significant.

NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### CEQA Impact Determination

Construction at the JWPCP West shaft site for Alternative 3 (Project) could expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure. Impacts under CEQA would be significant before mitigation. Operation of Alternative 3 (Project) would result in less than significant impacts.

Mitigation

Implement MM GEO-1.

Residual Impacts

MM GEO-1 would reduce impacts during construction at the JWPCP West shaft site to less than significant.

### NEPA Impact Determination

Construction at the JWPCP West shaft site for Alternative 3 (Project) could expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure. Impacts under NEPA would be significant before mitigation with respect to the No-Federal-Action Alternative (see Section 3.4.1.6). Operation of Alternative 3 (Project) would result in less than significant impacts.

Mitigation

Implement MM GEO-1.

Residual Impacts

Impacts would be less than significant, as described under the CEQA impact determination.

### *Impact GEO-2. Would Alternative 3 (Project) expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving rupture of a known earthquake fault?*

### Tunnel Alignment – Figueroa/Gaffey to Palos Verdes Shelf (Onshore)

**Construction**

CEQA Analysis

The onshore tunnel would cross the active Palos Verdes Fault just southwest of the intersection of Figueroa and John S. Gibson Boulevard (Fugro 2011). The onshore tunnel also crosses the Cabrillo Fault north of Angels Gate Park. The Cabrillo Fault may also be active, but it would likely move only in response to large earthquakes involving the Palos Verdes Fault (Fugro 2011).

Due to the infrequent occurrence of fault rupture on the Palos Verdes and Cabrillo Faults and the relatively short duration of construction, the probability that a fault rupture would coincide with construction activities is low. Therefore, this hazard is typically considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from surface fault rupture during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Operation

#### CEQA Analysis

Operation of the onshore tunnel could be affected by fault rupture in the event of a large earthquake along the Palos Verdes Fault. A tunnel liner system would be installed along the portion of the tunnel that crosses the Palos Verdes Fault to minimize the potential for damage due to fault rupture. In the event of fault rupture, there could be some damage to the tunnel, and operation could be affected during system repair. This would be a significant impact before mitigation. Implementation of MM GEO-2 would reduce impacts if the Palos Verdes Fault were to rupture during operation to a less than significant level.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Tunnel Alignment – Figueroa/Gaffey to Palos Verdes Shelf (Offshore)

### Construction

#### CEQA Analysis

The offshore tunnel does not cross an active fault; no faults are mapped crossing the alignment (Saucedo et al. 1993). There would be no risk of fault rupture within the alignment during construction, and there would be no impacts.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis. There would be no impacts under NEPA.

### Operation

#### CEQA Analysis

The offshore tunnel would not cross a mapped active fault. There would be no risk of fault rupture within the alignment during operation, and there would be no impacts.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis. There would be no impacts under NEPA.

## Shaft Sites – JWPCP West and Angels Gate

### Construction

#### CEQA Analysis

The JWPCP West and Angels Gate shaft sites are not near or within an active fault zone (Hart and Bryant 1997). Therefore, there would be no risk of fault rupture on site during construction, and there would be no impacts.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis. There would be no impacts under NEPA.

### Operation

#### CEQA Analysis

An access structure from the ground surface to the tunnel would be constructed at each shaft site. The JWPCP West and Angels Gate shaft sites are not near or within a mapped active fault zone. Therefore, there would be no risk of fault rupture on site during operation, and there would be no impacts.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis. There would be no impacts under NEPA.

## CEQA Impact Determination

Operation of the onshore tunnel for Alternative 3 (Project) could expose people or structures to a potential substantially adverse effect including the risk of loss involving rupture of a known earthquake fault. Impacts under CEQA would be significant before mitigation. Construction of Alternative 3 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-2.

#### Residual Impacts

Implementation of MM GEO-2 would reduce the risk of onshore tunnel damage and would facilitate repairs. Residual impacts would be less than significant.

## NEPA Impact Determination

Operation of the onshore tunnel for Alternative 3 (Project) could expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving rupture of a known earthquake fault. Impacts under NEPA would be significant before mitigation with respect to the No-Federal-Action Alternative (see Section 3.4.1.6). Construction of Alternative 3 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-2.

#### Residual Impacts
Residual impacts would be less than significant, as described under the CEQA impact determination.

### *Impact GEO-3. Would Alternative 3 (Project) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking?*

The tunnel, shafts, riser and diffuser, and existing ocean outfalls would potentially be exposed to seismic ground shaking in response to earthquakes on local and regional faults, as shown in Table 8-7, Table 8-8, and Table 8-9. Strong seismic shaking could be damaging during construction and operation of the facilities.

## Tunnel Alignment – Figueroa/Gaffey to Palos Verdes Shelf (Onshore and Offshore)

### Construction

#### CEQA Analysis
The onshore and offshore tunnel alignments for Alternative 3 (Project) are in a seismically active area. Strong seismic ground shaking could occur during construction of the tunnel. Seismic ground shaking during construction could damage the tunnel lining and equipment supporting tunnel construction. There is also a risk that earthquake shaking could result in disruption of power, so there would be emergency generators on site to support operation of critical systems such as tunnel ventilation (see Chapter 16 for a discussion of emergency management plans and response). However, due to the infrequent occurrence of seismic events and the relatively short duration of construction, the probability that a seismic event would coincide with construction activities is low. Therefore, this hazard is typically considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

#### NEPA Analysis
Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts for the onshore tunnel would be considered indirect impacts and the environmental impacts for the offshore tunnel would be considered direct impacts.

### Operation

#### CEQA Analysis
The hazard of seismic shaking would exist over the design life of the onshore and offshore tunnel. The relative likelihood of strong seismic shaking during operation would be greater due to the increased time frame of seismic exposure during the design life of Alternative 3 (Project). Buried structure connections can be vulnerable to seismic shaking. Proper seismic design would allow buried structures to withstand seismic shaking without significant damage. Impacts would be significant before mitigation. Implementation of MM GEO-3 would reduce the impacts of seismic shaking during operation to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Shaft Sites – JWPCP West and Angels Gate

### Construction

#### CEQA Analysis

Strong seismic shaking during the time frame of construction could result in damage to the JWPCP West and Angels Gate shaft excavation temporary support systems. Seismic shaking could also damage onsite support facilities such as the TBM cooling water tower, generators and substations, ventilation systems, cranes, and possibly other facilities. However, due to the infrequent occurrence of seismic events and the relatively short duration of construction, the probability that a seismic event would coincide with construction activities is low. Therefore, the hazard of strong seismic shaking is typically considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Operation

#### CEQA Analysis

Once the permanent access structure is constructed below the ground surface, there would be some potential for damage as a result of seismic shaking. The hazard of seismic shaking would exist over the design life of the buried access structure. The relative likelihood of strong seismic shaking during operation would be greater than that during construction due to the increased time frame of seismic exposure during the design life of Alternative 3 (Project). Buried structure connections can be vulnerable to seismic shaking. Proper seismic design would allow buried structures to withstand seismic ground shaking without significant damage. Impacts would be significant before mitigation. Implementation of MM GEO-3 would reduce the impacts of seismic shaking during operation to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## CEQA Impact Determination

Operation of the onshore and offshore tunnel, the JWPCP West and Angels Gate shaft sites, and the riser and diffuser on the PV Shelf for Alternative 3 (Project) could expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking. Impacts under CEQA would be significant before mitigation. Construction of Alternative 3 (Project) would result in less than significant impacts.

#### Mitigation
Implement MM GEO-3.

#### Residual Impacts
Risks associated with ground shaking during operation of the onshore and offshore tunnel, the JWPCP West and Angels Gate shaft sites, and the riser and diffuser on the PV Shelf would be reduced with implementation of MM GEO-3. Residual impacts would be less than significant.

### NEPA Impact Determination
Operation of the onshore and offshore tunnel and the riser, the JWPCP West and Angels Gate shaft sites, and diffuser on the PV Shelf for Alternative 3 (Project) could expose people or structures to a potential substantially adverse effect, including the risk of loss, involving strong seismic ground shaking. Impacts under NEPA would be significant before mitigation with respect to the No-Federal-Action Alternative (see Section 3.4.1.6). Construction of Alternative 3 (Project) would result in less than significant impacts.

#### Mitigation
Implement MM GEO-3.

#### Residual Impacts
Residual impacts would be less than significant, as described under the CEQA impact determination.

## *Impact GEO-4. Would Alternative 3 (Project) expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking?*

Alternative 3 (Project) elements would be located in a seismically active area and could be exposed to strong, potentially damaging levels of seismic shaking. Based on the geologic setting, the potential for liquefaction exists at the project facilities as summarized in Table 8-7, Table 8-8, and Table 8-9.

## Tunnel Alignment – Figueroa/Gaffey to Palos Verdes Shelf (Onshore)

### Construction

#### CEQA Analysis
A limited reach of the tunnel near the JWPCP West shaft site may be in potentially liquefiable Holocene materials due to its relatively shallow depth. The remaining portion of the tunnel would be in Pleistocene and Miocene sedimentary formations, which are not potentially liquefiable. Liquefaction could potentially have adverse effects on people or structures during construction at the north end of the tunnel near the JWPCP. However, due to the infrequent occurrence of seismic ground shaking and the relatively short duration of construction, the probability that a seismic event would coincide with construction activities is low. Therefore, this hazard is typically considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Operation

#### CEQA Analysis

Although during operation of the tunnel the risk of liquefaction hazard would be low, seismic shaking could result in liquefaction along the limited reach of tunnel near the JWPCP that may be in potentially liquefiable Holocene materials. This would be a significant impact before mitigation. Implementation of MM GEO-4 would reduce the impacts of liquefaction during operation to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Tunnel Alignment – Figueroa/Gaffey to Palos Verdes Shelf (Offshore)

### Construction

#### CEQA Analysis

The offshore tunnel would be in Miocene sedimentary formations, which are not potentially liquefiable. Therefore, liquefaction would not present a significant geologic hazard during construction. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

### Operation

#### CEQA Analysis

The offshore tunnel would be in Miocene sedimentary formations, which are not potentially liquefiable. Therefore, liquefaction would not present a significant geologic hazard during operation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Shaft Site – JWPCP West

### Construction

#### CEQA Analysis

The JWPCP West shaft site is underlain by saturated Holocene alluvium, which may have some susceptibility to liquefaction during strong seismic shaking. The shaft site is relatively flat, and the potential for lateral spreading is low. If liquefaction-induced settlement occurred during construction, it could potentially damage the shaft and support facilities. However, due to the infrequent occurrence of liquefaction events and the relatively short duration of construction, the probability that a liquefaction event would coincide with construction activity is low. Therefore, the hazard of liquefaction is typically considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from liquefaction during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Operation

#### CEQA Analysis

An access structure from the ground surface to the tunnel would be constructed at the JWPCP West shaft site. During operation, seismic shaking could result in liquefaction. Liquefaction-induced settlements could damage the access structure and the tunnel/access structure connection. This would be a significant impact before mitigation. Implementation of MM GEO-4 would reduce impacts to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Shaft Site – Angels Gate

### Construction

#### CEQA Analysis

The Angels Gate shaft site would be in members of the Monterey Formation, which are not subject to liquefaction. Therefore, liquefaction would not present a significant geologic hazard during construction. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Operation

#### CEQA Analysis

An access structure from the ground surface to the tunnel would be constructed at the Angels Gate shaft site. The Angels Gate access structure would be in members of the Monterey Formation, which are not subject to liquefaction. Therefore, liquefaction would not present a significant geologic hazard during operation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### CEQA Impact Determination

Operation of the onshore tunnel, the JWPCP West shaft site, and the riser and diffuser on the PV Shelf for Alternative 3 (Project) could expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking. Impacts under CEQA would be significant before mitigation. Construction of Alternative 3 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-4.

#### Residual Impacts

MM GEO-4 would reduce the risk of liquefaction during operation of the onshore tunnel, the JWPCP West shaft site, and the riser and diffuser area on the PV Shelf. Residual impacts would be less than significant.

### NEPA Impact Determination

Operation of the onshore tunnel, the JWPCP West shaft site, and the riser and diffuser area on the PV Shelf for Alternative 3 (Project) could expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking. Impacts under NEPA would be significant before mitigation with respect to the No-Federal-Action Alternative (see Section 3.4.1.6). Construction of Alternative 3 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-4.

#### Residual Impacts

Residual impacts would be less than significant, as described under the CEQA impact determination.

## *Impact GEO-5. Would Alternative 3 (Project) substantially accelerate natural processes of wind and water erosion and sedimentation, resulting in sediment runoff or deposition, which would not be contained or controlled on site?*

### Shaft Site – JWPCP West

#### <u>Construction</u>

#### CEQA Analysis

The shaft construction area is flat. The soils at the JWPCP West shaft site have a low-moderate to high erosion potential (Table 8-6). During construction, earthmoving operations could increase short-term erosion. If soil is improperly handled and stored, sedimentation could occur, resulting in a significant impact. However, as described in Section 8.3.2.4, a SWPPP would be prepared prior to construction. Therefore, impacts associated with sediment runoff or deposition would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Shaft Site – Angels Gate

#### Construction

#### CEQA Analysis

The shaft construction area is generally flat and the potential for soil erosion and sediment runoff exists. During construction, earthmoving operations could increase short-term erosion. If soil is improperly handled and stored, sedimentation could occur, resulting in a significant impact. However, as described in Section 8.3.2.4, a SWPPP would be prepared prior to construction. Therefore, impacts associated with sediment runoff or deposition would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### CEQA Impact Determination

Construction of Alternative 3 (Project) would not substantially accelerate natural processes of wind and water erosion and sedimentation, resulting in sediment runoff or deposition, which would not be contained or controlled on site. Impacts under CEQA would be less than significant.

#### Mitigation

No mitigation is required.

#### Residual Impacts

Residual impacts would be less than significant.

### NEPA Impact Determination

Construction of Alternative 3 (Project) would not substantially accelerate natural processes of wind and water erosion and sedimentation, resulting in sediment runoff or deposition, which would not be contained or controlled on site. Impacts under NEPA would be less than significant with respect to the No-Federal-Action Alternative (see Section 3.4.1.6).

#### Mitigation

No mitigation is required.

#### Residual Impacts

Residual impacts would be less than significant.

### *Impact GEO-6. Would Alternative 3 (Project) result in unstable earth conditions or changes in geologic substructure?*

Excavations for project facilities such as tunnels or shafts can potentially cause unstable earth conditions and changes in geologic substructure that can result in collapse or settlement of overlying or adjacent geologic materials (i.e., unconsolidated sediments) and consequent damage to any structures that are constructed upon these materials. The potential for subsidence to develop over a tunnel excavation and its influence on buildings in the settlement zone is an important concern for any tunnel project.

## Tunnel Alignment – Figueroa/Gaffey to Palos Verdes Shelf (Onshore)

### Construction

#### CEQA Analysis

A portion of the onshore tunnel would be in soft ground where ground losses could occur at the tunnel heading or shield. Settlement of the land surface above the tunnel could have adverse effects along Figueroa Boulevard and, less likely, along Gaffey Street, where the tunnel would be in Miocene sedimentary formations. Changes in geologic substructure could occur during construction as a result of settlement while tunneling in unconsolidated sedimentary formations.

Settlement potential during tunneling is partly a function of geologic conditions and ground loss at the tunnel heading and shield. The ground loss volume would be dependent on the tunnel contractor's means and methods, overall workmanship, and subsurface geology encountered. The design intent is to minimize ground surface settlements during tunnel construction to a level that is imperceptible to third parties and agencies (Parsons 2011). Impacts would be significant, but implementation of MM GEO-6a and MM GEO-6b would reduce impacts to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Operation

#### CEQA Analysis

Once the tunnel is constructed, there would be minimal risk of instability. Unstable earth conditions or changes in geologic structure would be unlikely. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Tunnel Alignment – Figueroa/Gaffey to Palos Verdes Shelf (Offshore)

### Construction

#### CEQA Analysis

The offshore tunnel would be in Miocene sedimentary formations, which have a low likelihood of ground losses during tunneling. It is unlikely that settlement of the seafloor as a result of changes in geologic substructure or unstable earth conditions would occur. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered direct impacts.

### Operation

#### CEQA Analysis

Once the tunnel is constructed, there would be minimal risk of instability. Unstable earth conditions or changes in geologic structure would be unlikely. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Shaft Site – JWPCP West

### Construction

#### CEQA Analysis

Shaft excavation at the JWPCP West shaft site would be in unconsolidated sediments (soft ground), which could be prone to instability during construction. Dewatering or groundwater leakage into the shaft could be reflected in ground settlement and/or surface cracking at the shaft. Ground surface settlements, cracking, trench collapse, or other indications of ground failure could result from unstable earth conditions, causing changes in the geologic structure in the vicinity of the shaft. Once the shaft is constructed and during tunnel construction, there would be minimal risk of instability. Impacts during shaft construction would be significant, but implementation of MM GEO-6a and MM GEO-6b would reduce impacts to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Operation

#### CEQA Analysis

An access structure from the ground surface to the tunnel would be constructed at the JWPCP West shaft site. Once the access structure is constructed, there would be minimal risk of instability. Unstable earth conditions or changes in geologic structure would be unlikely. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Shaft Site – Angels Gate

### Construction

#### CEQA Analysis

Construction of the shaft at Angels Gate could result in unstable earth conditions in the vicinity of the shaft, although this would be less likely in relatively strong sedimentary formations such as Altimira Shale. If weak bedding layers were exposed in cut slopes, localized slope instability could occur. Slope movements could affect nearby natural slopes. Once the shaft is constructed and during tunnel drilling, there would be minimal risk of instability. Impacts during shaft construction would be significant, but implementation of MM GEO-6a and MM GEO-6b would reduce impacts to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

**Operation**

#### CEQA Analysis

An access structure from the ground surface to the tunnel would be constructed at the Angels Gate shaft site. Once the access structure is constructed, there would be minimal risk of instability. Unstable earth conditions or changes in geologic structure would be unlikely. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### CEQA Impact Determination

Construction of the onshore tunnel and the JWPCP West and Angels Gate shaft sites for Alternative 3 (Project) would result in unstable earth conditions or changes in geologic substructure. Impacts under CEQA would be significant before mitigation. Operation of Alternative 3 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-6a and MM GEO-6b.

#### Residual Impacts

MM GEO-6a and MM GEO-6b would reduce the impacts of unstable earth conditions during construction of the onshore tunnel and the JWPCP West and Angels Gate shaft sites to less than significant.

### NEPA Impact Determination

Construction of the onshore tunnel and the JWPCP West and Angels Gate shaft sites for Alternative 3 (Project) would result in unstable earth conditions or changes in geologic substructure. Impacts under NEPA would be significant before mitigation with respect to the No-Federal-Action Alternative (see Section 3.4.1.6). Operation of Alternative 3 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-6a and MM GEO-6b.

#### Residual Impacts

Residual impacts would be less than significant, as described under the CEQA impact determination.

### *Impact GEO-7. Would Alternative 3 (Project) be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures?*

## Shaft Site – JWPCP West

**Construction**

CEQA Analysis

As shown in Table 8-6, the JWPCP West shaft site would be located primarily in areas of artificial fill soils at the ground surface where natural topsoils likely have been previously disturbed and/or covered by fill. The existing fill soils in these areas likely have low to negligible expansion potential inasmuch as typical engineering practice is to use granular, non-expansive soil as imported fill material. Surface improvements at the shaft site would be designed based on the site soil conditions. The expansion potential would be evaluated and expansive soils, if present, would be remediated, as necessary, through implementation of MM GEO-7 to less than significant.

The shafts would be excavated through existing surficial fill soil into the underlying Lakewood Formation deposits. The predominantly granular silty and sandy soils below the fill are likely to have little to no expansion potential. The anticipated shaft excavation and the shaft itself would be mostly below the water table where soils would not be susceptible to shrink-swell soil behavior. The expansion potential of subsurface soils would be evaluated and expansive soils, if present, would be remediated for the shaft and access structure design through implementation of MM GEO-7 to reduce impacts to less than significant.

NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

**Operation**

CEQA Analysis

An access structure from the ground surface to the tunnel would be constructed at the shaft site. Shrink-swell soils, if encountered, would be remediated during construction with implementation of MM GEO-7. Measures to remediate expansive soils would protect facilities during operation. Therefore, impacts during operation would be less than significant.

NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Shaft Site – Angels Gate

**Construction**

CEQA Analysis

Portions of Altimira Shale or other sedimentary formations within the shaft excavation are predominantly clayey and could contain swelling clay with shrink-swell behavior. The anticipated shaft excavation and the shaft itself would be mostly below the water table where soils would not be susceptible to shrink-swell soil behavior. The shaft support system, retaining walls, and access structure would be designed to withstand earth pressures, including potential adverse effects of swelling clay soils, if present. Expansive soils would be identified and remediated through implementation of MM GEO-7 to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

**Operation**

#### CEQA Analysis

An access structure from the ground surface to the tunnel would be constructed at the shaft site. Shrink-swell soils, if encountered, would be remediated during construction with implementation of MM GEO-7. Measures to remediate expansive soils would protect facilities during operation. Therefore, impacts during operation would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### CEQA Impact Determination

Construction at the JWPCP West and Angels Gate shaft sites for Alternative 3 (Project) could be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures. Impacts under CEQA would be significant before mitigation. Operation of Alternative 3 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-7.

#### Residual Impacts

Impacts associated with expansive soils at the JWPCP West and Angels Gate shaft sites would be remediated with implementation of MM GEO-7 during construction. Residual impacts would be less than significant.

### NEPA Impact Determination

Construction at the JWPCP West and Angels Gate shaft sites for Alternative 3 (Project) could be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures. Impacts under NEPA would be significant before mitigation with respect to the No-Federal-Action Alternative (see Section 3.4.1.6). Operation of Alternative 3 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-7.

#### Residual Impacts

Residual impacts would be less than significant, as described under the CEQA impact determination.

### *Impact GEO-8. Would Alternative 3 (Project) destroy, permanently cover, or materially and adversely modify one or more distinct and prominent geologic or topographic features? Such features may include, but are not limited to, hilltops, ridges, hillslopes, canyons, ravines, rock outcrops, water bodies, streambeds, and wetlands?*

## Shaft Site – Angels Gate

Marine terraces represent wave-cut platforms that subsequently become covered with sediment from subaerial erosion processes. The seaward edges of the wave-cut platforms become modified by the natural processes of wind, rain, and runoff, which form coastal bluffs. Coastal bluffs are often windy and dry, with shallow, salty soil. The bluffs typically support a specialized community of plants and animals that have adapted to them. Coastal bluffs may be considered prominent natural landforms. Coastal developments are typically sited to minimize alteration of natural landforms, such as coastal bluffs. The shaft at Angels Gate would be located at the toe of the coastal bluff separating the first and second emergent marine terraces at Point Fermin (Woodring et al. 1946).

### Construction

#### CEQA Analysis

The sloping hillside areas of the shaft site are part of a broader coastal bluff below Angels Gate Park. Coastal bluffs are considered prominent geologic and topographic features created in response to marine and subaerial (non-marine) erosion. The shape and form of the coastal bluff reflects the strength and erosion resistance of the geologic materials comprising the bluff. Extensive urban development has taken place on marine terraces throughout Palos Verdes and San Pedro. The coastal bluff along Paseo Del Mar may have been previously modified by grading. Site preparation and construction at the shaft site would not involve making significant new cuts into the slope and would not further modify the form and shape of the coastal bluff. Ample level ground area exists at the site such that the construction staging area would not require grading significant new cut slopes. Therefore, construction at the Angels Gate shaft site would not result in modification of a prominent geologic or topographic feature. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## CEQA Impact Determination

Construction of Alternative 3 (Project) would not destroy, permanently cover, or materially and adversely modify one or more distinct and prominent geologic or topographic features. Such features may include, but are not limited to, hilltops, ridges, hillslopes, canyons, ravines, rock outcrops, water bodies, streambeds, and wetlands. Impacts under CEQA would be less than significant.

#### Mitigation

No mitigation is required.

#### Residual Impacts

Impacts would be less than significant.

### NEPA Impact Determination

Construction of Alternative 3 (Project) would not destroy, permanently cover, or materially and adversely modify one or more distinct and prominent geologic or topographic features. Such features may include, but are not limited to, hilltops, ridges, hillslopes, canyons, ravines, rock outcrops, water bodies, streambeds, and wetlands. Impacts under NEPA would be less than significant with respect to the No-Federal-Action Alternative (see Section 3.4.1.6).

#### Mitigation

No mitigation is required.

#### Residual Impacts

Impacts would be less than significant.

## 8.4.5.3 Impact Summary – Alternative 3

Impacts on geology, soils, and mineral resources for Alternative 3 (Program), which are the same as Alternative 1 (Program), are summarized in Table 8-13. Impacts analyzed in this EIR/EIS for Alternative 3 (Project) are summarized in Table 8-16. The proposed mitigation, where feasible, and the significance of the impact before and following mitigation are also listed in the tables.

**Table 8-16. Impact Summary – Alternative 3 (Project)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| Impact GEO-1. Would Alternative 3 (Project) expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure? | | | | |
| Tunnel Alignment | | | | |
| Figueroa/ Gaffey to PV Shelf (Onshore) | CEQA Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Construction |
| | NEPA Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA Less Than Significant Impact During Construction |
| | CEQA Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Operation |
| | NEPA Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA Less Than Significant Impact During Operation |
| Figueroa/ Gaffey to PV Shelf (Offshore) | CEQA Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Construction |
| | NEPA Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA Less Than Significant Impact During Construction |
| | CEQA Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Operation |
| | NEPA Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA Less Than Significant Impact During Operation |

**Table 8-16 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| Shaft Site | | | | |
| JWPCP West | CEQA<br>Significant Impact During Construction | N/A | MM GEO-1. Perform geotechnical investigations and provide site-specific recommendations for stabilization of temporary and permanent slopes and excavations to reduce risks to structures and construction workers associated with landslides, mudslides, or ground failure. The geotechnical investigation will address the requirements of local grading ordinances, as appropriate. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-1 | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Angels Gate | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Riser/Diffuser Area | | | | |
| PV Shelf | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |

## Table 8-16 (Continued)

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| Existing Ocean Outfalls | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Impact GEO-2. Would Alternative 3 (Project) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving rupture of a known earthquake fault? | | | | |
| Tunnel Alignment | | | | |
| Figueroa/ Gaffey to PV Shelf (Onshore) | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-2. Perform site-specific fault hazard investigations to minimize fault rupture damage and facilitate repair of structures damaged as a result of fault movement. The investigations will be conducted in accordance with current California Geological Survey guidelines for evaluating and mitigating seismic hazards in California. Geologic evaluations of fault crossings will include information to define fault location, fault slip, angle of intersection at the crossing, type of fault slip, width of disturbance, fault dip angle, and design fault displacement. Remediation measures may include engineered backfill, special lining systems, and/or special access provisions for repair. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-2 | NEPA<br>Less Than Significant Impact During Operation |
| Figueroa/ Gaffey to PV Shelf (Offshore) | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |

**Table 8-16 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Shaft Site | | | | |
| JWPCP West | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Angels Gate | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Riser/Diffuser Area | | | | |
| PV Shelf | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Existing Ocean Outfalls | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |

**Table 8-16 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Impact GEO-3. Would Alternative 3 (Project) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking? | | | | |
| Tunnel Alignment | | | | |
| Figueroa/ Gaffey to PV Shelf (Onshore) | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-3. Perform geotechnical investigations and provide site-specific recommendations for reducing the adverse effects of seismic ground shaking on planned facilities. The investigations and recommendations will be conducted in accordance with current California Geological Survey guidelines for evaluating and mitigating seismic hazards in California, and will be in compliance with current building codes, as applicable, to reduce the risk of seismic shaking. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-3 | NEPA<br>Less Than Significant Impact During Operation |
| Figueroa/ Gaffey to PV Shelf (Offshore) | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-3 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-3 | NEPA<br>Less Than Significant Impact During Operation |

## Table 8-16 (Continued)

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| Shaft Site | | | | |
| JWPCP West | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-3 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-3 | NEPA<br>Less Than Significant Impact During Operation |
| Angels Gate | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-3 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-3 | NEPA<br>Less Than Significant Impact During Operation |
| Riser/Diffuser Area | | | | |
| PV Shelf | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-3 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-3 | NEPA<br>Less Than Significant Impact During Operation |
| Existing Ocean Outfalls | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |

## Table 8-16 (Continued)

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Impact GEO-4. Would Alternative 3 (Project) expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking? | | | | |
| Tunnel Alignment | | | | |
| Figueroa/ Gaffey to PV Shelf (Onshore) | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-4. Perform geotechnical investigations and provide site-specific recommendations to reduce the impacts of liquefaction on planned facilities. The investigations and recommendations will be conducted in accordance with current California Geological Survey guidelines for evaluating and mitigating seismic hazards in California. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-4 | NEPA<br>Less Than Significant Impact During Operation |
| Figueroa/ Gaffey to PV Shelf (Offshore) | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |

**Table 8-16 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| Shaft Site | | | | |
| JWPCP West | CEQA Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Construction |
| | NEPA Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA Less Than Significant Impact During Construction |
| | CEQA Significant Impact During Operation | N/A | MM GEO-4 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact During Operation | Indirect | MM GEO-4 | NEPA Less Than Significant Impact During Operation |
| Angels Gate | CEQA Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Construction |
| | NEPA Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA Less Than Significant Impact During Construction |
| | CEQA Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Operation |
| | NEPA Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA Less Than Significant Impact During Operation |
| Riser/Diffuser Area | | | | |
| PV Shelf | CEQA Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Construction |
| | NEPA Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA Less Than Significant Impact During Construction |
| | CEQA Significant Impact During Operation | N/A | MM GEO-4 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact During Operation | Indirect | MM GEO-4 | NEPA Less Than Significant Impact During Operation |
| Existing Ocean Outfalls | CEQA Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Construction |
| | NEPA Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA Less Than Significant Impact During Construction |
| | CEQA Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Operation |

## Table 8-16 (Continued)

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Impact GEO-5. Would Alternative 3 (Project) substantially accelerate natural processes of wind and water erosion and sedimentation, resulting in sediment runoff or deposition, which would not be contained or controlled on site? | | | | |
| Shaft Site | | | | |
| JWPCP West | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| Angels Gate | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| Impact GEO-6. Would Alternative 3 (Project) result in unstable earth conditions or changes in geologic substructure? | | | | |
| Tunnel Alignment | | | | |
| Figueroa/ Gaffey to PV Shelf (Onshore) | CEQA<br>Significant Impact During Construction | N/A | MM GEO-6a. During the final design process, perform geotechnical investigations to provide characterization of the subsurface conditions and anticipated ground behavior along the selected tunnel route and at the shaft sites. The objective of these investigations will be to reduce the potential impacts of shaft excavation instability and ground settlement along the tunnel. The investigation will address facilities at risk of damage due to potential tunneling-induced settlements or shaft instability. An appropriate shaft excavation method that minimizes the risk of excavation instability and ground settlement in the vicinity of the shaft will be recommended. Geotechnical criteria for stabilization of shaft excavations will be incorporated into the project design to ensure the safety and stability of excavations. Recommendations for control and monitoring of the tunnel boring machine excavation and proper installation of the tunnel lining system to avoid excessive ground loss at the tunnel heading and shield will be made. Project design documents will also specify contingency measures that will be implemented if excessive settlement were to occur during construction. | CEQA<br>Less Than Significant Impact During Construction |

**Table 8-16 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | | | MM GEO-6b. Develop a detailed plan for construction monitoring that will minimize potential ground surface settlements at the shafts and along the onshore tunnel. The objective of the plan will be to reduce the risk of construction instability and to confirm that ground surface settlement is kept to a level that avoids damage to structures above or along the tunnel alignment. The plan will describe the specific monitoring that will be performed before, during, and after construction. Instrumentation (e.g., survey monuments, slope inclinometers, and/or extensometers) may be used to accurately quantify parameters of ground and structure behaviors and to monitor the rate of change. Contingent construction approaches will be implemented if excessive settlement occurs. The plan will address municipality, agency, and third party settlement tolerance requirements as appropriate for the shaft sites and tunnel alignment. Geotechnical inspections will be performed during construction to confirm the encountered subsurface conditions and to provide recommendations for alternate settlement control approaches, if warranted. If the construction monitoring program detects the occurrence of excessive settlement and alternative settlement control measures are inadequate to meet settlement specifications, then further excavation will cease until additional ground support measures are implemented to alleviate the settlement as directed by the project engineer. | |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-6a<br>MM GEO-6b | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Figueroa/ Gaffey to PV Shelf (Offshore) | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |

**Table 8-16 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Shaft Site | | | | |
| JWPCP West | CEQA<br>Significant Impact During Construction | N/A | MM GEO-6a<br>MM GEO-6b | CEQA<br>Less Than Significant impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-6a<br>MM GEO-6b | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Angels Gate | CEQA<br>Significant Impact During Construction | N/A | MM GEO-6a<br>MM GEO-6b | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-6a<br>MM GEO-6b | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Riser/Diffuser Area | | | | |
| PV Shelf | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Existing Ocean Outfalls | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |

## Table 8-16 (Continued)

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Impact GEO-7. Would Alternative 3 (Project) be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures? | | | | |
| Shaft Site | | | | |
| JWPCP West | CEQA<br>Significant Impact During Construction | N/A | MM GEO-7. Perform geotechnical investigations and provide site-specific recommendations to reduce the risk of adverse effects on structures due to shrink-swell soil behavior. The investigations will include an analysis of soil expansion potential (i.e., American Society for Testing and Materials D-4829). Remediation may include expansive soil removal, reinforced foundations, and/or special pavement design. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-7 | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Angels Gate | CEQA<br>Significant Impact During Construction | N/A | MM GEO-7 | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-7 | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Riser/Diffuser Area | | | | |
| PV Shelf | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |

**Table 8-16 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Existing Ocean Outfalls | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Impact GEO-8. Would Alternative 3 (Project) destroy, permanently cover, or materially and adversely modify one or more distinct and prominent geologic or topographic features? Such features may include, but are not limited to, hilltops, ridges, hillslopes, canyons, ravines, rock outcrops, water bodies, streambeds, and wetlands? | | | | |
| Shaft Site | | | | |
| Angels Gate | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| Riser/Diffuser Area | | | | |
| PV Shelf | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| Existing Ocean Outfalls | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |

## 8.4.6 Alternative 4 (Recommended Alternative)

### 8.4.6.1 Program

Alternative 4 (Program) is the same as Alternative 1 (Program).

### 8.4.6.2 Project

The impacts for the JWPCP West shaft site for Alternative 4 (Project) would be the same as for Alternative 3 (Project), except tunnel construction would occur over a period of 4 years instead of 5 years. The construction impacts for the rehabilitation of the existing ocean outfalls for Alternative 4 (Project) would be the same as for Alternative 1 (Project). Operational impacts would be the same as baseline conditions; therefore, there would be no operational impacts for the existing ocean outfalls under Alternative 4 (Project).

#### *Impact GEO-1. Would Alternative 4 (Project) expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure?*

#### Tunnel Alignment – Figueroa/Western to Royal Palms (Onshore)

**<u>Construction</u>**

CEQA Analysis

The Figueroa/Western to Royal Palms onshore tunnel profile would be at depths between about 70 and 450 feet bgs, with the exception of Royal Palms Beach, which would be approximately 50 feet bgs. The tunnel profile would not pass below or near known landslides (Dibblee 1999) and would not result in renewed landslide movement during construction. Landslide activity in 2011 on Paseo Del Mar near White Point County Beach has raised questions about the potential for proposed tunneling activities to affect the stability of the existing slopes in the area. The onshore tunnel alignment would be located about 2,000 feet west of the landslide activity near White Point County Beach. This landslide activity is likely due to weak bedding planes in areas where the bedrock dips unfavorably (out of slope). These slope instabilities are less likely to occur to the west where the onshore tunnel alignment would be located along favorably oriented geologic bedding such as what has been mapped by Dibblee in the project area (Appendix 8-A). Therefore, deep-seated ground failure is considered a low geologic hazard during construction. Impacts would be less than significant.

NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

**<u>Operation</u>**

CEQA Analysis

Operation of the onshore tunnel would not result in landslides or ground failure because the tunnel would not be near known landslides along or near the alignment. Deep-seated ground failure is considered a low geologic hazard during operation. Impacts would be less than significant.

NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Shaft Site – Royal Palms

#### Construction

CEQA Analysis

The Royal Palms shaft site is not in a mapped landslide area (Dibblee 1999). However, construction of the shaft would be in Altimira Shale that could contain weak layers below the water table. Excavation instability is a construction risk that could result in ground failure in the vicinity of the shaft. This would represent a significant impact. Once the shaft is constructed, there would be minimal risk of instability during tunnel construction. Implementation of MM GEO-1 would reduce impacts to less than significant.

NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

#### Operation

CEQA Analysis

An access structure from the ground surface to the tunnel would be constructed at the Royal Palms shaft site. The Royal Palms shaft site is not in a known landslide areas (Dibblee 1999); therefore, the hazard of ground failure during operation would be low. Impacts would be less than significant.

NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### CEQA Impact Determination

Construction at the JWPCP West and Royal Palms shaft sites for Alternative 4 (Project) could expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure. Impacts under CEQA would be significant before mitigation. Operation of Alternative 4 (Project) would result in less than significant impacts.

Mitigation

Implement MM GEO-1.

Residual Impacts

MM GEO-1 would reduce impacts during construction at the JWPCP West and Royal Palms shaft sites to less than significant.

### NEPA Impact Determination

Construction at the JWPCP West and Royal Palms shaft sites for Alternative 4 (Project) could expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure. Impacts under NEPA would be significant before mitigation with respect to the No-Federal-Action Alternative (see Section 3.4.1.6). Operation of Alternative 4 (Project) would result in less than significant impacts.

Mitigation

Implement MM GEO-1.

#### Residual Impacts

Residual impacts would be less than significant, as described under the CEQA impact determination.

### *Impact GEO-2. Would Alternative 4 (Project) expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving rupture of a known earthquake fault?*

## Tunnel Alignment – Figueroa/Western to Royal Palms (Onshore)

### Construction

#### CEQA Analysis

The onshore tunnel would cross the active Palos Verdes Fault just south of Harbor Regional Park under North Gaffey Street (Fugro 2011). The onshore tunnel also crosses the Cabrillo Fault at the intersection of South Dodson Avenue and Western Avenue. The Cabrillo Fault may also be active, but it would likely move only in response to large earthquakes involving the Palos Verdes Fault (Fugro 2011).

Due to the infrequent occurrence of fault rupture on the Palos Verdes and Cabrillo Faults and the relatively short duration of construction, the probability that a fault rupture would coincide with construction activities is low. Therefore, this hazard is typically considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from surface fault rupture during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Operation

#### CEQA Analysis

Operation of the onshore tunnel could be affected by fault rupture in the event of a large earthquake along the Palos Verdes Fault. A tunnel liner system would be installed along the portion of the tunnel that crosses the Palos Verdes Fault to minimize the potential for damage due to fault rupture. In the event of fault rupture, there could be some damage to the tunnel, and operation could be affected during system repair. Impacts would be a significant before mitigation. Implementation of MM GEO-2 would reduce the risk of tunnel damage and facilitate repair following an earthquake to a less than significant level.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Shaft Site – Royal Palms

**Construction**

CEQA Analysis

The shaft site is not near or within an active fault zone (Hart and Bryant 1997). Therefore, there would be no risk of fault rupture on site during construction, and there would be no impacts.

NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis. There would be no impacts under NEPA.

**Operation**

CEQA Analysis

An access structure from the ground surface to the tunnel would be constructed at the shaft site. The shaft site is not near or within a mapped active fault zone. Therefore, there would be no risk of fault rupture on site during operation, and there would be no impacts.

NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis. There would be no impacts under NEPA.

### CEQA Impact Determination

Operation of the onshore tunnel for Alternative 4 (Project) could expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving rupture of a known earthquake fault. Impacts under CEQA would be significant before mitigation. Construction of Alternative 4 (Project) would result in less than significant impacts.

Mitigation

Implement MM GEO-2.

Residual Impacts

Implementation of MM GEO-2 would reduce the risk of onshore tunnel damage and would facilitate repairs. Residual impacts would be less than significant.

### NEPA Impact Determination

Operation of the onshore tunnel for Alternative 4 (Project) could expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving rupture of a known earthquake fault. Impacts under NEPA would be significant before mitigation with respect to the No-Federal-Action Alternative (see Section 3.4.1.6). Construction of Alternative 4 (Project) would result in less than significant impacts.

Mitigation

Implement MM GEO-2.

Residual Impacts

Residual impacts would be less than significant, as described under CEQA.

### *Impact GEO-3. Would Alternative 4 (Project) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking?*

The tunnel, shafts, riser and diffuser, and existing ocean outfalls would be potentially exposed to seismic ground shaking in response to earthquakes on local and regional faults, as shown in Table 8-7, Table 8-8, and Table 8-9. Strong seismic shaking could cause damage during construction and operation of the facilities.

## Tunnel Alignment – Figueroa/Western to Royal Palms (Onshore)

### Construction

#### CEQA Analysis

The onshore tunnel alignment for Alternative 4 (Project) is in a seismically active area. Strong seismic ground shaking could occur during construction of the tunnel. Seismic ground shaking during construction could damage the tunnel lining and equipment supporting tunnel construction. There is also a risk that earthquake shaking could result in disruption of power, so there would be emergency generators on site to support operation of critical systems such as tunnel ventilation (see Chapter 16 for a discussion of emergency management plans and response). However, due to the infrequent occurrence of seismic events and the relatively short duration of construction, the probability that a seismic event would coincide with construction activities is low. Therefore, this hazard is typically considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Operation

#### CEQA Analysis

The hazard of seismic shaking would exist over the design life of the tunnel. The relative likelihood of strong seismic shaking during operation would be greater than during construction due to the increased time frame of seismic exposure during the design life of Alternative 4 (Project). Buried structure connections can be vulnerable to seismic ground shaking. Proper seismic design would allow buried structures to withstand seismic shaking without significant damage. Impacts would be significant before mitigation. Implementation of MM GEO-3 would reduce the impacts of seismic shaking during operation to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Shaft Site – Royal Palms

**Construction**

CEQA Analysis

Strong seismic shaking during the time frame of construction could result in damage to the shaft excavation temporary support system. Seismic shaking could also damage onsite support facilities such as generators and substations, ventilation systems, cranes and possibly other facilities. However, due to the infrequent occurrence of seismic events and the relatively short duration of construction, the probability that a seismic event would coincide with construction activity is low. Therefore, this hazard is considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

**Operation**

CEQA Analysis

Once the permanent access structure is constructed below the ground surface, there would be some potential for damage as a result of seismic shaking. The hazard of seismic shaking would exist over the design life of the buried access structure. The relative likelihood of strong seismic shaking during operation would be greater than that during construction due to the increased time frame of seismic exposure during the design life of Alternative 4 (Project). Buried structure connections can be vulnerable to seismic shaking. Proper seismic design would allow buried structures to withstand seismic ground shaking without significant damage. Impacts would be significant before mitigation. Implementation of MM GEO-3 would reduce the impacts of seismic shaking during operation to less than significant.

NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### CEQA Impact Determination

Operation of the onshore tunnel and the JWPCP West and Royal Palms shaft sites for Alternative 4 (Project) could expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking. Impacts under CEQA would be significant before mitigation. Construction of Alternative 4 (Project) would result in less than significant impacts.

Mitigation

Implement MM GEO-3.

Residual Impacts

Risks associated with ground shaking during operation of the onshore tunnel and the JWPCP West and Royal Palms shaft sites would be reduced with implementation of MM GEO-3. Residual impacts would be less than significant.

## NEPA Impact Determination

Operation of the onshore tunnel and the JWPCP West and Royal Palms shaft sites for Alternative 4 (Project) could expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking. Impacts under NEPA would be significant before mitigation with respect to the No-Federal-Action Alternative (see Section 3.4.1.6). Construction of Alternative 4 (Project) would result in less than significant impacts.

### Mitigation

Implement MM GEO-3.

### Residual Impacts

Residual impacts would be less than significant, as described under the CEQA impact determination.

## *Impact GEO-4. Would Alternative 4 (Project) expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking?*

Alternative 4 (Project) elements would be located in a seismically active area and could be exposed to strong, potentially damaging levels of seismic shaking. Based on the geologic setting, the potential for liquefaction exists at the project facilities as summarized in Table 8-7, Table 8-8, and Table 8-9.

## Tunnel Alignment – Figueroa/Western to Royal Palms (Onshore)

### <u>Construction</u>

### CEQA Analysis

The onshore tunnel would be between70 and 450 feet bgs, with the exception at Royal Palms Beach, where the tunnel would be approximately 50 feet bgs. A limited reach of the tunnel near the JWPCP West shaft site may be in potentially liquefiable Holocene materials due to its relatively shallow depth. The remaining portion of the tunnel would be in Pleistocene and Miocene sedimentary formations, which are not potentially liquefiable. Liquefaction could potentially have adverse effects on people or structures during construction at the north end of the tunnel near the JWPCP. However, due to the infrequent occurrence of seismic ground shaking and the relatively short duration of construction, the probability that a seismic event would coincide with construction activities is low. Therefore, this hazard is typically considered to pose an acceptable level of risk. That is, the level of injury and material/property loss that could potentially occur from seismic activity during construction is considered to be acceptable in view of the cost/benefit of any mitigation. Impacts would be less than significant.

### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### <u>Operation</u>

### CEQA Analysis

Although during operation of the tunnel the risk of liquefaction hazard would be low, seismic shaking could result in liquefaction along the limited reach of tunnel near the JWPCP that may be in potentially liquefiable Holocene materials. This would be a significant impact before mitigation. Implementation of MM GEO-4 would reduce the impacts of liquefaction during operation to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## Shaft Site – Royal Palms

### Construction

#### CEQA Analysis

The shaft site would be in Miocene sedimentary formations, which are not subject to liquefaction. Therefore, liquefaction would not present a significant geologic hazard during construction. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Operation

#### CEQA Analysis

An access structure from the ground surface to the tunnel would be constructed at this shaft site. The Royal Palms access structure would be in Miocene sedimentary formations, which are not subject to liquefaction. Therefore, liquefaction would not present a significant geologic hazard during operation. Impacts would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

## CEQA Impact Determination

Operation of the onshore tunnel and the JWPCP West shaft site for Alternative 4 (Project) could expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking. Impacts under CEQA would be significant before mitigation. Construction of Alternative 4 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-4.

#### Residual Impacts

MM GEO-4 would reduce the risk of liquefaction during operation of the onshore tunnel and the JWPCP West shaft site. Residual impacts would be less than significant.

### NEPA Impact Determination

Operation of the onshore tunnel and the JWPCP West shaft site for Alternative 4 (Project) could expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking. Impacts under NEPA would be significant before mitigation with respect to the No-Federal-Action Alternative (see Section 3.4.1.6). Construction of Alternative 4 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-4.

#### Residual Impacts

Residual impacts would be less than significant, as described under the CEQA impact determination.

## *Impact GEO-5. Would Alternative 4 (Project) substantially accelerate natural processes of wind and water erosion and sedimentation, resulting in sediment runoff or deposition, which would not be contained or controlled on site?*

### Shaft Site – Royal Palms

**Construction**

#### CEQA Analysis

The shaft construction area is sloped, and the potential for soil erosion and sediment runoff exists. During construction, earthmoving operations could increase short-term erosion. If soil is improperly handled and stored, sedimentation could occur, resulting in a significant impact. However, as described in Section 8.3.2.4, a SWPPP would be prepared prior to construction. Therefore, impacts associated with sediment runoff or deposition would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### CEQA Impact Determination

Construction of Alternative 4 (Project) would not substantially accelerate natural processes of wind and water erosion and sedimentation, resulting in sediment runoff or deposition, which would not be contained or controlled on site. Impacts under CEQA would be less than significant.

#### Mitigation

No mitigation is required.

#### Residual Impacts

Impacts would be less than significant.

### NEPA Impact Determination

Construction of Alternative 4 (Project) would not substantially accelerate natural processes of wind and water erosion and sedimentation, resulting in sediment runoff or deposition, which would not be contained or controlled on site. Impacts under NEPA would be less than significant with respect to the No-Federal-Action Alternative (see Section 3.4.1.6).

#### Mitigation
No mitigation is required.

#### Residual Impacts
Impacts would be less than significant.

## *Impact GEO-6. Would Alternative 4 (Project) result in unstable earth conditions or changes in geologic substructure?*

### Tunnel Alignment – Figueroa/Western to Royal Palms (Onshore)
Excavations for project facilities such as tunnels or shafts can potentially cause unstable earth conditions and changes in geologic substructure that can result in collapse or settlement of overlying or adjacent geologic materials (i.e., unconsolidated sediments) and consequent damage to any structures that are constructed upon these materials. The potential for subsidence to develop over a tunnel excavation and its influence on buildings in the settlement zone is an important concern for any tunnel project.

**Construction**

#### CEQA Analysis
A portion of the tunnel would be in soft ground where ground losses could occur at the tunnel heading or shield. Settlement of the land surface above the tunnel could have adverse effects along Figueroa Boulevard. Settlement along Western Avenue, where the tunnel would be in Miocene sedimentary formations, is less likely. Changes in geologic substructure could occur during construction as a result of settlement while tunneling in unconsolidated sedimentary formations.

Settlement potential during tunneling is partly a function of geologic conditions and ground loss at the tunnel heading and shield. The ground loss volume would be dependent on the tunnel contractor's means and methods, overall workmanship, and subsurface geology encountered. The design intent is to minimize ground surface settlements during tunnel construction to a level that is imperceptible to third parties and agencies (Parsons 2011). Impacts would be significant, but implementation of MM GEO-6a and MM GEO-6b would reduce impacts to less than significant.

#### NEPA Analysis
Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

**Operation**

#### CEQA Analysis
Once the tunnel is constructed, there would be minimal risk of instability. Unstable earth conditions or changes in geologic structure would be unlikely. Impacts would be less than significant.

#### NEPA Analysis
Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### Shaft Site – Royal Palms

#### Construction

CEQA Analysis

Construction of the shaft at Royal Palms could result in unstable earth conditions in the vicinity of the shaft. For example, weak layers in Altimira Shale could be exposed in construction cuts. Slope instability could create slope movement. If the nearby natural slopes were affected, an unstable earth condition could occur over a broader area than the shaft. Once the shaft is constructed and during tunnel drilling, there would be minimal risk of instability. Impacts during shaft construction would be significant, but implementation of MM GEO-6a and MM GEO-6b would reduce impacts to less than significant.

NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

#### Operation

CEQA Analysis

An access structure from the ground surface to the tunnel would be constructed at the Royal Palms shaft site. Once the access structure is constructed, there would be minimal risk of instability. Unstable earth conditions or changes in geologic structure would be unlikely. Impacts would be less than significant.

NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### CEQA Impact Determination

Construction of the onshore tunnel and the JWPCP West and Royal Palms shaft sites for Alternative 4 (Project) would result in unstable earth conditions or changes in geologic substructure. Impacts under CEQA would be significant before mitigation. Operation of Alternative 4 (Project) would result in less than significant impacts.

Mitigation

Implement MM GEO-6a and MM GEO-6b.

Residual Impacts

MM GEO-6a and MM GEO-6b would reduce the impacts of unstable earth conditions during construction of the onshore tunnel and the JWPCP West and Royal Palms shaft sites. Residual impacts would be less than significant.

### NEPA Impact Determination

Construction of the onshore tunnel and the JWPCP West and Royal Palms shaft sites for Alternative 4 (Project) would result in unstable earth conditions or changes in geologic substructure. Impacts under NEPA would be significant before mitigation with respect to the No-Federal-Action Alternative (see Section 3.4.1.6). Operation of Alternative 4 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-6a and MM GEO-6b.

#### Residual Impacts

Residual impacts would be less than significant, as described under the CEQA impact determination.

## *Impact GEO-7. Would Alternative 4 (Project) be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures?*

### Shaft Site – Royal Palms

**<u>Construction</u>**

#### CEQA Analysis

Portions of Altimira Shale or other sedimentary formations within the shaft excavation are predominantly clayey and could contain swelling clay with shrink-swell behavior. The shaft support system, retaining walls, and access structure would be designed to withstand earth pressures, including potential adverse effects of swelling clay soils, if present. Expansive soils would be identified and remediated through implementation of MM GEO-7 to reduce impacts to less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

**<u>Operation</u>**

#### CEQA Analysis

An access structure from the ground surface to the tunnel would be constructed at the shaft site. Shrink-swell soils, if encountered, would be remediated during construction with implementation of MM GEO-7. Measures to remediate expansive soils would protect facilities during operation. Therefore, impacts during operation would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the operational life of the structure. With respect to the Corps' NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### CEQA Impact Determination

Construction at the JWPCP West and Royal Palms shaft sites for Alternative 4 (Project) could be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures. Impacts under CEQA would be significant before mitigation. Operation of Alternative 4 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-7.

#### Residual Impacts

Impacts associated with expansive soils at the JWPCP West and Royal Palms shaft sites would be remediated with implementation of MM GEO-7 during construction. Residual impacts would be less than significant.

### NEPA Impact Determination

Construction at the JWPCP West and Royal Palms shaft sites for Alternative 4 (Project) could be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures. Impacts under NEPA would be significant before mitigation with respect to the No-Federal-Action Alternative (see Section 3.4.1.6). Operation of Alternative 4 (Project) would result in less than significant impacts.

#### Mitigation

Implement MM GEO-7.

#### Residual Impacts

Residual impacts would be less than significant, as described under the CEQA impact determination.

## *Impact GEO-8. Would Alternative 4 (Project) destroy, permanently cover, or materially and adversely modify one or more distinct and prominent geologic or topographic features? Such features may include, but are not limited to, hilltops, ridges, hillslopes, canyons, ravines, rock outcrops, water bodies, streambeds, and wetlands?*

### Shaft Site – Royal Palms

Marine terraces represent wave-cut platforms that subsequently become covered with sediment from subaerial erosion processes. Marine terraces are striking geologic features in the Palos Verdes Hills, as noted by Woodring et al. (1946). At least 13 uplifted marine terraces are present at Palos Verdes, ranging in altitude between about 100 and 1,300 feet. The lower terraces are better preserved and more conspicuous in form and shape. The Sanitation District’s existing ocean outfalls manifold structure is within the first emergent marine terrace.

#### Construction

#### CEQA Analysis

The majority of the construction at Royal Palms would be located within the fenced area around the existing manifold structure. To the extent possible, final ground conditions at ground level would not appear substantially different than current conditions (Parsons 2011). Impacts on the marine terrace landform or other distinct or prominent geologic or topographic features would be less than significant.

#### NEPA Analysis

Environmental impacts would be the same as described for the CEQA analysis, and would occur for the duration of construction. With respect to the Corps’ NEPA scope of analysis described in Section 3.5, the environmental impacts would be considered indirect impacts.

### CEQA Impact Determination

Construction of Alternative 4 (Project) would not destroy, permanently cover, or materially and adversely modify one or more distinct and prominent geologic or topographic features. Such features may include, but are not limited to, hilltops, ridges, hillslopes, canyons, ravines, rock outcrops, water bodies, streambeds, and wetlands. Impacts under CEQA would be less than significant.

#### Mitigation

No mitigation is required.

#### Residual Impacts

Impacts would be less than significant.

### NEPA Impact Determination

Construction of Alternative 4 (Project) would not destroy, permanently cover, or materially and adversely modify one or more distinct and prominent geologic or topographic features. Such features may include, but are not limited to, hilltops, ridges, hillslopes, canyons, ravines, rock outcrops, water bodies, streambeds, and wetlands. Impacts under NEPA would be less than significant with respect to the No-Federal-Action Alternative (see Section 3.4.1.6).

#### Mitigation

No mitigation is required.

#### Residual Impacts

Impacts would be less than significant.

## 8.4.6.3 Impact Summary – Alternative 4

Impacts on geology, soils, and mineral resources for Alternative 4 (Program), which are the same as Alternative 1 (Program), are summarized in Table 8-13. Impacts analyzed in this EIR/EIS for Alternative 4 (Project) are summarized in Table 8-17. The proposed mitigation, where feasible, and the significance of the impact before and following mitigation are also listed in the tables.

**Table 8-17. Impact Summary – Alternative 4 (Project)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| Impact GEO-1. Would Alternative 4 (Project) expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure? | | | | |
| Tunnel Alignment | | | | |
| Figueroa/ Western to Royal Palms (Onshore) | CEQA Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Construction |
| | NEPA Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA Less Than Significant Impact During Construction |
| | CEQA Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA Less Than Significant or Significant Impact During Operation |
| | NEPA Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA Less Than Significant Impact During Operation |

**Table 8-17 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| Shaft Site | | | | |
| JWPCP West | CEQA<br>Significant Impact During Construction | N/A | MM GEO-1. Perform geotechnical investigations and provide site-specific recommendations for stabilization of temporary and permanent slopes and excavations to reduce risks to structures and construction workers associated with landslides, mudslides, or ground failure. The geotechnical investigation will address the requirements of local grading ordinances, as appropriate. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-1 | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Royal Palms | CEQA<br>Significant Impact During Construction | N/A | MM GEO-1 | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-1 | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Riser/Diffuser Area | | | | |
| Existing Ocean Outfalls | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |

### Table 8-17 (Continued)

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| Impact GEO-2. Would Alternative 4 (Project) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving rupture of a known earthquake fault? | | | | |
| Tunnel Alignment | | | | |
| Figueroa/ Western to Royal Palms (Onshore) | CEQA Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Construction |
| | NEPA Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA Less Than Significant Impact During Construction |
| | CEQA Significant Impact During Operation | N/A | MM GEO-2. Perform site-specific fault hazard investigations to minimize fault rupture damage and facilitate repair of structures damaged as a result of fault movement. The investigations will be conducted in accordance with current California Geological Survey guidelines for evaluating and mitigating seismic hazards in California. Geologic evaluations of fault crossings will include information to define fault location, fault slip, angle of intersection at the crossing, type of fault slip, width of disturbance, fault dip angle, and design fault displacement. Remediation measures may include engineered backfill, special lining systems, and/or special access provisions for repair. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact During Operation | Indirect | MM GEO-2 | NEPA Less Than Significant Impact During Operation |
| Shaft Site | | | | |
| JWPCP West | CEQA No Impact During Construction | N/A | No mitigation is required. | CEQA No Impact During Construction |
| | NEPA No Impact During Construction | N/A | No mitigation is required. | NEPA No Impact During Construction |
| | CEQA No Impact During Operation | N/A | No mitigation is required. | CEQA No Impact During Operation |
| | NEPA No Impact During Operation | N/A | No mitigation is required. | NEPA No Impact During Operation |
| Royal Palms | CEQA No Impact During Construction | N/A | No mitigation is required. | CEQA No Impact During Construction |
| | NEPA No Impact During Construction | N/A | No mitigation is required. | NEPA No Impact During Construction |

**Table 8-17 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | CEQA<br>No Impact During Operation | N/A | No mitigation is required. | CEQA<br>No Impact During Operation |
| | NEPA<br>No Impact During Operation | N/A | No mitigation is required. | NEPA<br>No Impact During Operation |
| Riser/Diffuser Area | | | | |
| Existing Ocean Outfalls | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |
| Impact GEO-3. Would Alternative 4 (Project) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking? | | | | |
| Tunnel Alignment | | | | |
| Figueroa/ Western to Royal Palms (Onshore) | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-3. Perform geotechnical investigations and provide site-specific recommendations for reducing the adverse effects of seismic ground shaking on planned facilities. The investigations and recommendations will be conducted in accordance with current California Geological Survey guidelines for evaluating and mitigating seismic hazards in California, and will be in compliance with current building codes, as applicable, to reduce the risk of seismic shaking. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-3 | NEPA<br>Less Than Significant Impact During Operation |
| Shaft Site | | | | |
| JWPCP West | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |

## Table 8-17 (Continued)

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-3 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-3 | NEPA<br>Less Than Significant Impact During Operation |
| Royal Palms | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-3 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-3 | NEPA<br>Less Than Significant Impact During Operation |
| Riser/Diffuser Area | | | | |
| Existing Ocean Outfalls | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| Impact GEO-4. Would Alternative 4 (Project) expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking? | | | | |
| Tunnel Alignment | | | | |
| Figueroa/ Western to Royal Palms (Onshore) | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-4. Perform geotechnical investigations and provide site-specific recommendations to reduce the impacts of liquefaction on planned facilities. The investigations and recommendations will be conducted in accordance with current California Geological Survey guidelines for evaluating and mitigating seismic hazards in California. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA<br>Less Than Significant Impact During Operation |

**Table 8-17 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-4 | NEPA<br>Less Than Significant Impact During Operation |
| Shaft Site | | | | |
| JWPCP West | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Significant Impact During Operation | N/A | MM GEO-4 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact During Operation | Indirect | MM GEO-4 | NEPA<br>Less Than Significant Impact During Operation |
| Royal Palms | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Riser/Diffuser Area | | | | |
| Existing Ocean Outfalls | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Direct | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| Impact GEO-5. Would Alternative 4 (Project) substantially accelerate natural processes of wind and water erosion and sedimentation, resulting in sediment runoff or deposition, which would not be contained or controlled on site? | | | | |
| Shaft Site | | | | |
| JWPCP West | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |

## Table 8-17 (Continued)

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| Royal Palms | CEQA<br>Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Construction |
| Impact GEO-6. Would Alternative 4 (Project) result in unstable earth conditions or changes in geologic substructure? | | | | |
| Tunnel Alignment | | | | |
| Figueroa/ Western to Royal Palms (Onshore) | CEQA<br>Significant Impact During Construction | N/A | MM GEO-6a. During the final design process, perform geotechnical investigations to provide characterization of the subsurface conditions and anticipated ground behavior along the selected tunnel route and at the shaft sites. The objective of these investigations will be to reduce the potential impacts of shaft excavation instability and ground settlement along the tunnel. The investigation will address facilities at risk of damage due to potential tunneling-induced settlements or shaft instability. An appropriate shaft excavation method that minimizes the risk of excavation instability and ground settlement in the vicinity of the shaft will be recommended. Geotechnical criteria for stabilization of shaft excavations will be incorporated into the project design to ensure the safety and stability of excavations. Recommendations for control and monitoring of the tunnel boring machine excavation and proper installation of the tunnel lining system to avoid excessive ground loss at the tunnel heading and shield will be made. Project design documents will also specify contingency measures that will be implemented if excessive settlement were to occur during construction.<br><br>MM GEO-6b. Develop a detailed plan for construction monitoring that will minimize potential ground surface settlements at the shafts and along the onshore tunnel. The objective of the plan will be to reduce the risk of construction instability and to confirm that ground surface settlement is kept to a level that avoids damage to structures above or along the tunnel alignment. The plan will describe the specific monitoring that will be performed before, during, and after construction. Instrumentation (e.g., survey monuments, slope inclinometers, and/or extensometers) may be used to accurately quantify parameters of ground and structure behaviors and to | CEQA<br>Less Than Significant Impact During Construction |

## Table 8-17 (Continued)

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | | | monitor the rate of change. Contingent construction approaches will be implemented if excessive settlement occurs. The plan will address municipality, agency, and third party settlement tolerance requirements as appropriate for the shaft sites and tunnel alignment. Geotechnical inspections will be performed during construction to confirm the encountered subsurface conditions and to provide recommendations for alternate settlement control approaches, if warranted. If the construction monitoring program detects the occurrence of excessive settlement and alternative settlement control measures are inadequate to meet settlement specifications, then further excavation will cease until additional ground support measures are implemented to alleviate the settlement as directed by the project engineer. | |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-6a<br>MM GEO-6b | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Shaft Site | | | | |
| JWPCP West | CEQA<br>Significant Impact During Construction | N/A | MM GEO-6a<br>MM GEO-6b | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-6a<br>MM GEO-6b | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Royal Palms | CEQA<br>Significant Impact During Construction | N/A | MM GEO-6a<br>MM GEO-6b | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-6a<br>MM GEO-6b | NEPA<br>Less Than Significant Impact During Construction |

**Table 8-17 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Riser/Diffuser Area | | | | |
| Existing Ocean Outfalls | CEQA<br>No Impact During Construction | N/A | No mitigation is required. | CEQA<br>No Impact During Construction |
| | NEPA<br>No Impact During Construction | N/A | No mitigation is required. | NEPA<br>No Impact During Construction |
| Impact GEO-7. Would Alternative 4 (Project) be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures? | | | | |
| Shaft Site | | | | |
| JWPCP West | CEQA<br>Significant Impact During Construction | N/A | MM GEO-7. Perform geotechnical investigations and provide site-specific recommendations to reduce the risk of adverse effects on structures due to shrink-swell soil behavior. The investigations will include an analysis of soil expansion potential (i.e., American Society for Testing and Materials D-4829). Remediation may include expansive soil removal, reinforced foundations, and/or special pavement design. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-7 | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |
| Royal Palms | CEQA<br>Significant Impact During Construction | N/A | MM GEO-7 | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact During Construction | Indirect | MM GEO-7 | NEPA<br>Less Than Significant Impact During Construction |
| | CEQA<br>Less Than Significant Impact During Operation | N/A | No mitigation is required. | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Less Than Significant Impact During Operation | Indirect | No mitigation is required. | NEPA<br>Less Than Significant Impact During Operation |

**Table 8-17 (Continued)**

| Project Element | Impact Determination Before Mitigation | NEPA Direct or Indirect | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|---|
| Riser/Diffuser Area | | | | |
| Existing Ocean Outfalls | CEQA No Impact During Construction | N/A | No mitigation is required. | CEQA No Impact During Construction |
| | NEPA No Impact During Construction | N/A | No mitigation is required. | NEPA No Impact During Construction |
| Impact GEO-8. Would Alternative 4 (Project) destroy, permanently cover, or materially and adversely modify one or more distinct and prominent geologic or topographic features? Such features may include, but are not limited to, hilltops, ridges, hillslopes, canyons, ravines, rock outcrops, water bodies, streambeds, and wetlands? | | | | |
| Shaft Site | | | | |
| Royal Palms | CEQA Less Than Significant Impact During Construction | N/A | No mitigation is required. | CEQA Less Than Significant Impact During Construction |
| | NEPA Less Than Significant Impact During Construction | Indirect | No mitigation is required. | NEPA Less Than Significant Impact During Construction |
| Riser/Diffuser Area | | | | |
| Existing Ocean Outfalls | CEQA No Impact During Construction | N/A | No mitigation is required. | CEQA No Impact During Construction |
| | NEPA No Impact During Construction | Direct | No mitigation is required. | NEPA No Impact During Construction |

## 8.4.7 Alternative 5 (No-Project Alternative)

Pursuant to CEQA, an environmental impact report (EIR) must evaluate a no-project alternative. A no-project alternative describes the no-build scenario and what reasonably would be expected to occur in the foreseeable future if the project were not approved. Under the No-Project Alternative for the Clearwater Program, the Sanitation Districts would continue to expand, upgrade, and operate the JOS in accordance with the JOS 2010 Master Facilities Plan (2010 Plan) (Sanitation Districts 1994), which includes all program elements proposed under the Clearwater Program, excluding process optimization at the WRPs, as described in Section 3.4.1.5. A new or modified ocean discharge system would not be constructed. As a result, there would be a greater potential for an emergency discharge into various water courses, as described in Section 3.4.1.5.

Because there would be no construction of a new or modified JWPCP ocean discharge system, the Corps would not make any significance determinations under NEPA and would not issue any permits or discretionary approvals for dredge or fill actions or for transport or ocean disposal of dredged material.

### 8.4.7.1 Program

Alternative 5 (Program) would consist of the implementation of the 2010 Plan. The impacts for conveyance improvements, plant expansion at the SJCWRP, WRP effluent management, JWPCP solids processing, and JWPCP biosolids management for Alternative 5 (Program) would be the same as for Alternative 1 (Program) and would be subject to mitigation in accordance with the EIR prepared for the 2010 Plan (Jones & Stokes 1994).

### 8.4.7.2 Project

Alternative 5 does not include a project; therefore, a new or modified ocean discharge system would not be constructed. As a consequence of taking no action, there would be a greater potential for emergency discharges into the Wilmington Drain. The Wilmington Drain is a flood control structure extending from I-110 to the north side of Pacific Coast Highway. South of Pacific Coast Highway, the drain merges with the riparian woodland of Machado Lake (also known as Harbor Lake).

An emergency discharge into the Wilmington Drain would not expose people, structures, or property to landslides or ground failure. It would not cause or involve a rupture of a known earthquake fault or expose people or structures to seismic ground shaking because the discharge of effluent would not be affected by fault rupture. An emergency discharge would not deform the foundations or cause damage to structures because of shrink-swell potential because structures do not exist in the Wilmington Drain. The loss of important state, regional, or local mineral resources would not occur during an emergency discharge because no important mineral resources exist in the Wilmington Drain.

However, an emergency discharge during a wet-weather event could exceed the capacity of the Wilmington Drain. If sufficient capacity were not available in the Wilmington Drain, the sewers tributary to the JWPCP could overflow and untreated wastewater could enter various water courses, such as the Dominguez Channel and the Los Angeles River. The Dominguez Channel extends from the city of Carson and discharges into the Consolidated Slip of the Los Angeles Harbor just south of Anaheim Street. The south end of the Los Angeles River traverses the I-710 and discharges into the easterly end of the Los Angeles Harbor. Untreated wastewater overflowing out of the sewers would likely enter adjacent stormdrains tributary to the Dominguez Channel and the Los Angeles River. A sewer overflow would not cause or involve a rupture of a known earthquake fault or expose people or structures to seismic ground shaking because the sewer overflow would not be affected by fault rupture. The loss of important state, regional, or local mineral resources would not occur during an emergency discharge because no important mineral resources exist in either the Dominguez Channel or the Los Angeles River. The Dominguez Channel and the Los Angeles River are both fully lined concrete channels and, therefore, would not sustain any significant erosion or siltation.

However, an exceedance could result in mudslides, ground failure, and unstable earth conditions in the unlined portions of the Wilmington Drain, the various low-lying areas along the JOS where flooding would most likely occur, and possibly around Machado Lake. The Wilmington Drain, Machado Lake, and the various areas along the JOS where flooding may occur could be adversely modified during a wet-weather event and an emergency discharge. Therefore, impacts associated with these geologic resources would be significant. There is no feasible mitigation to reduce these impacts; therefore, impacts would be significant and unavoidable.

The Wilmington Drain is underlain by unconsolidated Holocene-Age alluvium (Dibblee 1999) and fill, likely with relatively high erosion potential. There are existing gabions along the drain margins upstream of the Pacific Coast Highway overpass, but the channel banks are mostly vegetated and unlined. Depending on the duration and volume, the emergency discharge into the drain could increase short-term erosion and sedimentation. The existing gabions at Pacific Coast Highway suggest the channel banks in the area may be vulnerable to scouring at least locally, requiring the additional erosion protection at the road crossing. However, increased sedimentation as a result of emergency discharge could have offsite water quality impacts and other issues.

Impacts under CEQA would be significant. While a SWPPP would reduce the impacts associated with erosion, a SWPPP would not be prepared for an emergency discharge. Therefore, there is no feasible mitigation, and impacts would remain significant and unavoidable.

#### 8.4.7.3 Impact Summary – Alternative 5

Impacts on geology, soils, and mineral resources for Alternative 5 (Program) would be the same as those summarized for Alternative 1 (Program) in Table 8-13, excluding process optimization. Note that the mitigation measures for Alternatives 1 through 4 (Program) are not applicable to Alternative 5 (Program). Significant impacts for Alternative 5 (Project) are summarized in Table 8-18.

**Table 8-18. Impact Summary – Alternative 5 (Project)**

| Project Element | Impact Determination Before Mitigation | Mitigation | Residual Impact After Mitigation |
|---|---|---|---|
| Impact GEO-5. Would Alternative 5 (Project) substantially accelerate natural processes of wind and water erosion and sedimentation, resulting in sediment runoff or deposition, which would not be contained or controlled on site? | | | |
| Emergency Discharge | CEQA<br>Significant Impact During Operation | No mitigation is feasible. | CEQA<br>Significant and Unavoidable Impact During Operation |

### 8.4.8 Alternative 6 (No-Federal-Action Alternative)

Pursuant to NEPA, an environmental impact statement (EIS) must evaluate a no-federal-action alternative. The No-Federal-Action Alternative for the Clearwater Program consists of the activities that the Sanitation Districts would perform without the issuance of the Corps' permits. The Corps' permits would be required for the construction of the offshore tunnel, construction of the riser and diffuser, the rehabilitation of the existing ocean outfalls, and the ocean disposal of dredged material. Without a Corps permit to work on the aforementioned facilities, the Sanitation Districts would not construct the onshore tunnel and shaft sites. Therefore, none of the project elements would be constructed under the No-Federal-Action Alternative. The Sanitation Districts would continue to use the existing ocean discharge system, which could result in emergency discharges into various water courses, as described in Sections 3.4.1.6 and 8.4.7.2. The program elements for the recommended alternative would be implemented in accordance with CEQA requirements. However, based on the NEPA scope of analysis established in Sections 1.4.2 and 3.5, these elements would not be subject to NEPA because the Corps would not make any significance determinations and would not issue any permits or discretionary approvals.

#### 8.4.8.1 Program

The program elements are beyond the NEPA scope of analysis.

#### 8.4.8.2 Project

The impact analysis for Alternative 6 (Project) is the same as described for Alternative 5 (Project).

#### 8.4.8.3 Impact Summary – Alternative 6

The program is not analyzed under Alternative 6. Significant impacts for Alternative 6 would be the same as summarized in Table 8-18 for Alternative 5 (Project).

## 8.4.9 Comparison of Significant Impacts and Mitigation for All Alternatives

A summary of significant impacts on geology, soils, and mineral resources resulting from the construction and/or operation of program and/or project elements is provided in Table 8-19. Impacts are compared by alternative. Proposed mitigation, where feasible, and the significance of the impact before and following mitigation under CEQA and NEPA are also listed in the table.

**Table 8-19. Comparison of Significant Impacts and Mitigation for Geology, Soils, and Mineral Resources for All Alternatives**

| Element | Impact Before Mitigation | Mitigation Measure | Residual Impact After Mitigation |
|---|---|---|---|
| **Alternatives 1, 2, 3, 4, and 5[a] (Program)** | | | |
| Impact GEO-1. Would Alternatives 1, 2, 3, 4, and 5 (Program) expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure? | | | |
| POWRP – Process Optimization | CEQA Significant Impact During Construction | MM GEO-1. Perform geotechnical investigations and provide site-specific recommendations for stabilization of temporary and permanent slopes and excavations to reduce risks to structures and construction workers associated with landslides, mudslides, or ground failure. The geotechnical investigation will address the requirements of local grading ordinances, as appropriate. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA Less Than Significant Impact During Construction |
| Impact GEO-3. Would Alternatives 1, 2, 3, 4, and 5 (Program) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking? | | | |
| SJCWRP – Plant Expansion and Process Optimization; POWRP, LCWRP, LBWRP – Process Optimization; JWPCP – Solids Processing | CEQA Significant Impact During Operation | MM GEO-3. Perform geotechnical investigations and provide site-specific recommendations for reducing the adverse effects of seismic ground shaking on planned facilities. The investigations and recommendations will be conducted in accordance with current California Geological Survey guidelines for evaluating and mitigating seismic hazards in California, and will be in compliance with current building codes, as applicable, to reduce the risk of seismic shaking. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA Less Than Significant Impact During Operation |
| Impact GEO-4. Would Alternatives 1, 2, 3, 4, and 5 (Program) expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking? | | | |
| POWRP, LCWRP, LBWRP – Process Optimization | CEQA Significant Impact During Operation | MM GEO-4. Perform geotechnical investigations and provide site-specific recommendations to reduce the impacts of liquefaction on planned facilities. The investigations and recommendations will be conducted in accordance with current California Geological Survey guidelines for evaluating and mitigating seismic hazards in California. The geotechnical recommendations will be incorporated into the final design and construction of new facilities, as deemed appropriate by the project engineer. | CEQA Less Than Significant Impact During Operation |

## Table 8-19 (Continued)

| Element | Impact Before Mitigation | Mitigation Measure | Residual Impact After Mitigation |
|---|---|---|---|
| Impact GEO-7. Would Alternatives 1, 2, 3, 4, and 5 (Program) be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures? | | | |
| SJCWRP – Plant Expansion and Process Optimization; POWRP, LCWRP, LBWRP – Process Optimization; JWPCP – Solids Processing | CEQA Significant Impact During Operation | MM GEO-7. Perform geotechnical investigations and provide site-specific recommendations to reduce the risk of adverse effects on structures due to shrink-swell soil behavior. The investigations will include an analysis of soil expansion potential (i.e., American Society for Testing and Materials D-4829). Remediation may include expansive soil removal, reinforced foundations, and/or special pavement design. The geotechnical recommendations will be incorporated into the final design and construction of new facilities. | CEQA Less Than Significant Impact During Operation |

[a] Process optimization would not apply to Alternative 5 (Program). Additionally, all mitigation measures and residual impacts would not apply to Alternative 5 (Program).

| Element | Impact Before Mitigation | Mitigation Measure | Residual Impact After Mitigation |
|---|---|---|---|
| **Alternative 1 (Project)** | | | |
| Impact GEO-1. Would Alternative 1 (Project) expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure? | | | |
| Shaft Sites – JWPCP East, TraPac, LAXT, Southwest Marine | CEQA Significant Impact During Construction | MM GEO-1 | CEQA Less Than Significant Impact During Construction |
| | NEPA Significant Impact (Indirect) During Construction | MM GEO-1 | NEPA Less Than Significant Impact (Indirect) During Construction |
| Impact GEO-2. Would Alternative 1 (Project) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving rupture of a known earthquake fault? | | | |
| Tunnel Alignment – Wilmington to SP Shelf (Offshore) | CEQA Significant Impact During Operation | MM GEO-2. Perform site-specific fault hazard investigations to minimize fault rupture damage and facilitate repair of structures damaged as a result of fault movement. The investigations will be conducted in accordance with current California Geological Survey guidelines for evaluating and mitigating seismic hazards in California. Geologic evaluations of fault crossings will include information to define fault location, fault slip, angle of intersection at the crossing, type of fault slip, width of disturbance, fault dip angle, and design fault displacement. Remediation measures may include engineered backfill, special lining systems, and/or special access provisions for repair. The geotechnical recommendations will be incorporated into the final design and construction of new facilities. | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-2 | NEPA Less Than Significant Impact (Indirect) During Operation |

**Table 8-19 (Continued)**

| Element | Impact Before Mitigation | Mitigation Measure | Residual Impact After Mitigation |
|---|---|---|---|
| Impact GEO-3. Would Alternative 1 (Project) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking? | | | |
| Tunnel Alignment – Wilmington to SP Shelf (Onshore) | CEQA Significant Impact During Operation | MM GEO-3 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-3 | NEPA Less Than Significant Impact (Indirect) During Operation |
| Tunnel Alignment – Wilmington to SP Shelf (Offshore) | CEQA Significant Impact During Operation | MM GEO-3 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-3 | NEPA Less Than Significant Impact (Indirect) During Operation |
| Shaft Sites – JWPCP East, TraPac, LAXT, Southwest Marine | CEQA Significant Impact During Operation | MM GEO-3 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-3 | NEPA Less Than Significant Impact (Indirect) During Operation |
| Riser/Diffuser Area – SP Shelf | CEQA Significant Impact During Operation | MM GEO-3 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-3 | NEPA Less Than Significant Impact (Indirect) During Operation |
| Impact GEO-4. Would Alternative 1 (Project) expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking? | | | |
| Shaft Sites – JWPCP East, TraPac, LAXT, Southwest Marine | CEQA Significant Impact During Operation | MM GEO-4 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-4 | NEPA Less Than Significant Impact (Indirect) During Operation |
| Riser/Diffuser Area – SP Shelf | CEQA Significant Impact During Operation | MM GEO-4 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-4 | NEPA Less Than Significant Impact (Indirect) During Operation |

## Table 8-19 (Continued)

| Element | Impact Before Mitigation | Mitigation Measure | Residual Impact After Mitigation |
|---|---|---|---|
| Impact GEO-6. Would Alternative 1 (Project) result in unstable earth conditions or changes in geologic substructure? | | | |
| Tunnel Alignment – Wilmington to SP Shelf (Onshore) | CEQA Significant Impact During Construction | MM GEO-6a. During the final design process, perform geotechnical investigations to provide characterization of the subsurface conditions and anticipated ground behavior along the selected tunnel route and at the shaft sites. The objective of these investigations will be to reduce the potential impacts of shaft excavation instability and ground settlement along the tunnel. The investigation will address facilities at risk of damage due to potential tunneling-induced settlements or shaft instability. An appropriate shaft excavation method that minimizes the risk of excavation instability and ground settlement in the vicinity of the shaft will be recommended. Geotechnical criteria for stabilization of shaft excavations will be incorporated into the project design to ensure the safety and stability of excavations. Recommendations for control and monitoring of the tunnel boring machine excavation and proper installation of the tunnel lining system to avoid excessive ground loss at the tunnel heading and shield will be made. Project design documents will also specify contingency measures that will be implemented if excessive settlement were to occur during construction.<br><br>MM GEO-6b. Develop a detailed plan for construction monitoring that will minimize potential ground surface settlements at the shafts and along the onshore tunnel. The objective of the plan will be to reduce the risk of construction instability and to confirm that ground surface settlement is kept to a level that avoids damage to structures above or along the tunnel alignment. The plan will describe the specific monitoring that will be performed before, during, and after construction. Instrumentation (e.g., survey monuments, slope inclinometers, and/or extensometers) may be used to accurately quantify parameters of ground and structure behaviors and to monitor the rate of change. Contingent construction approaches will be implemented if excessive settlement occurs. The plan will address municipality, agency, and third party settlement tolerance requirements as appropriate for the shaft sites and tunnel alignment. Geotechnical inspections will be performed during construction to confirm the encountered subsurface conditions and to provide recommendations for alternate settlement control approaches, if warranted. If the construction monitoring program detects the occurrence of excessive settlement, and alternative settlement control measures are inadequate to meet settlement specifications, then further excavation will cease until additional ground support measures are implemented to arrest the settlement as directed by the project engineer. | CEQA Less Than Significant Impact During Construction |
| | NEPA Significant Impact (Indirect) During Construction | MM GEO-6a<br>MM GEO-6b | NEPA Less Than Significant Impact (Indirect) During Construction |
| Tunnel Alignment – Wilmington to SP Shelf (Offshore) | CEQA Significant Impact During Construction | MM GEO-6a<br>MM GEO-6b | CEQA Less Than Significant Impact During Construction |
| | NEPA Significant Impact (Direct) During Construction | MM GEO-6a<br>MM GEO-6b | NEPA Less Than Significant Impact (Indirect) During Construction |

**Table 8-19 (Continued)**

| Element | Impact Before Mitigation | Mitigation Measure | Residual Impact After Mitigation |
|---|---|---|---|
| Shaft Sites – JWPCP East, TraPac, LAXT, Southwest Marine | CEQA<br>Significant Impact During Construction | MM GEO-6a<br>MM GEO-6b | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact (Indirect) During Construction | MM GEO-6a<br>MM GEO-6b | NEPA<br>Less Than Significant Impact (Indirect) During Construction |
| Impact GEO-7. Would Alternative 1 (Project) be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures? | | | |
| Shaft Sites – JWPCP East, TraPac, LAXT, Southwest Marine | CEQA<br>Significant Impact During Construction | MM GEO-7 | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact (Indirect) During Construction | MM GEO-7 | NEPA<br>Less Than Significant Impact (Indirect) During Construction |
| **Alternative 2 (Project)** | | | |
| Impact GEO-1. Would Alternative 2 (Project) expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure? | | | |
| Shaft Sites – JWPCP East, TraPac, LAXT, Southwest Marine | CEQA<br>Significant Impact During Construction | MM GEO-1 | CEQA<br>Less Than Significant Impact During Construction |
| | NEPA<br>Significant Impact (Indirect) During Construction | MM GEO-1 | NEPA<br>Less Than Significant Impact (Indirect) During Construction |
| Impact GEO-2. Would Alternative 2 (Project) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving rupture of a known earthquake fault? | | | |
| Tunnel Alignment – Wilmington to PV Shelf (Offshore) | CEQA<br>Significant Impact During Operation | MM GEO-2 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact (Indirect) During Operation | MM GEO-2 | NEPA<br>Less Than Significant Impact (Indirect) During Operation |
| Impact GEO-3. Would Alternative 2 (Project) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking? | | | |
| Tunnel Alignment – Wilmington to PV Shelf (Onshore) | CEQA<br>Significant Impact During Operation | MM GEO-3 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact (Indirect) During Operation | MM GEO-3 | NEPA<br>Less Than Significant Impact (Indirect) During Operation |
| Tunnel Alignment – Wilmington to PV Shelf (Offshore) | CEQA<br>Significant Impact During Operation | MM GEO-3 | CEQA<br>Less Than Significant Impact During Operation |
| | NEPA<br>Significant Impact (Indirect) During Operation | MM GEO-3 | NEPA<br>Less Than Significant Impact (Indirect) During Operation |

**Table 8-19 (Continued)**

| Element | Impact Before Mitigation | Mitigation Measure | Residual Impact After Mitigation |
|---|---|---|---|
| Shaft Sites – JWPCP East, TraPac, LAXT, Southwest Marine | CEQA Significant Impact During Operation | MM GEO-3 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-3 | NEPA Less Than Significant Impact (Indirect) During Operation |
| Riser/Diffuser Area – PV Shelf | CEQA Significant Impact During Operation | MM GEO-3 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-3 | NEPA Less Than Significant Impact (Indirect) During Operation |
| Impact GEO-4. Would Alternative 2 (Project) expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking? | | | |
| Shaft Sites – JWPCP East, TraPac, LAXT, Southwest Marine | CEQA Significant Impact During Operation | MM GEO-4 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-4 | NEPA Less Than Significant Impact (Indirect) During Operation |
| Riser/Diffuser Area – PV Shelf | CEQA Significant Impact During Operation | MM GEO-4 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-4 | NEPA Less Than Significant Impact (Indirect) During Operation |
| Impact GEO-6. Would Alternative 2 (Project) result in unstable earth conditions or changes in geologic substructure? | | | |
| Tunnel Alignment – Wilmington to PV Shelf (Onshore) | CEQA Significant Impact During Construction | MM GEO-6a<br>MM GEO-6b | CEQA Less Than Significant Impact During Construction |
| | NEPA Significant Impact (Indirect) During Construction | MM GEO-6a<br>MM GEO-6b | NEPA Less Than Significant Impact (Indirect) During Construction |
| Tunnel Alignment – Wilmington to PV Shelf (Offshore) | CEQA Significant Impact During Construction | MM GEO-6a<br>MM GEO-6b | CEQA Less Than Significant Impact During Construction |
| | NEPA Significant Impact (Direct) During Construction | MM GEO-6a<br>MM GEO-6b | NEPA Less Than Significant Impact (Indirect) During Construction |

## Table 8-19 (Continued)

| Element | Impact Before Mitigation | Mitigation Measure | Residual Impact After Mitigation |
|---|---|---|---|
| Shaft Sites – JWPCP East, TraPac, LAXT, Southwest Marine | CEQA Significant Impact During Construction | MM GEO-6a MM GEO-6b | CEQA Less Than Significant Impact During Construction |
| | NEPA Significant Impact (Indirect) During Construction | MM GEO-6a MM GEO-6b | NEPA Less Than Significant Impact (Indirect) During Construction |
| Impact GEO-7. Would Alternative 2 (Project) be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures? | | | |
| Shaft Sites – JWPCP East, TraPac, LAXT, Southwest Marine | CEQA Significant Impact During Construction | MM GEO-7 | CEQA Less Than Significant Impact During Construction |
| | NEPA Significant Impact (Indirect) During Construction | MM GEO-7 | NEPA Less Than Significant Impact (Indirect) During Construction |
| **Alternative 3 (Project)** | | | |
| Impact GEO-1. Would Alternative 3 (Project) expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure? | | | |
| Shaft Site – JWPCP West | CEQA Significant Impact During Construction | MM GEO-1 | CEQA Less Than Significant Impact During Construction |
| | NEPA Significant Impact (Indirect) During Construction | MM GEO-1 | NEPA Less Than Significant Impact (Indirect) During Construction |
| Impact GEO-2. Would Alternative 3 (Project) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving rupture of a known earthquake fault? | | | |
| Tunnel Alignment – Figueroa/ Gaffey to PV Shelf (Onshore) | CEQA Significant Impact During Operation | MM GEO-2 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-2 | NEPA Less Than Significant Impact (Indirect) During Operation |
| Impact GEO-3. Would Alternative 3 (Project) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking? | | | |
| Tunnel Alignment – Figueroa/ Gaffey to PV Shelf (Onshore) | CEQA Significant Impact During Operation | MM GEO-3 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-3 | NEPA Less Than Significant Impact (Indirect) During Operation |
| Tunnel Alignment – Figueroa/ Gaffey to PV Shelf (Offshore) | CEQA Significant Impact During Operation | MM GEO-3 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-3 | NEPA Less Than Significant Impact (Indirect) During Operation |

**Table 8-19 (Continued)**

| Element | Impact Before Mitigation | Mitigation Measure | Residual Impact After Mitigation |
|---|---|---|---|
| Shaft Sites – JWPCP West, Angels Gate | CEQA Significant Impact During Operation | MM GEO-3 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-3 | NEPA Less Than Significant Impact (Indirect) During Operation |
| Riser/Diffuser Area – PV Shelf | CEQA Significant Impact During Operation | MM GEO-3 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-3 | NEPA Less Than Significant Impact (Indirect) During Operation |
| Impact GEO-4. Would Alternative 3 (Project) expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking? | | | |
| Tunnel Alignment – Figueroa/ Gaffey to PV Shelf (Onshore) | CEQA Significant Impact During Operation | MM GEO-4 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-4 | NEPA Less Than Significant Impact (Indirect) During Operation |
| Shaft Site – JWPCP West | CEQA Significant Impact During Operation | MM GEO-4 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-4 | NEPA Less Than Significant Impact (Indirect) During Operation |
| Riser/Diffuser Area – PV Shelf | CEQA Significant Impact During Operation | MM GEO-4 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-4 | NEPA Less Than Significant Impact (Indirect) During Operation |
| Impact GEO-6. Would Alternative 3 (Project) result in unstable earth conditions or changes in geologic substructure? | | | |
| Tunnel Alignment – Figueroa/ Gaffey to PV Shelf (Onshore) | CEQA Significant Impact During Construction | MM GEO-6a<br>MM GEO-6b | CEQA Less Than Significant Impact During Construction |
| | NEPA Significant Impact (Indirect) During Construction | MM GEO-6a<br>MM GEO-6b | NEPA Less Than Significant Impact (Indirect) During Construction |
| Shaft Sites – JWPCP West, Angels Gate | CEQA Significant Impact During Construction | MM GEO-6a<br>MM GEO-6b | CEQA Less Than Significant Impact During Construction |

## Table 8-19 (Continued)

| Element | Impact Before Mitigation | Mitigation Measure | Residual Impact After Mitigation |
|---|---|---|---|
| | NEPA Significant Impact (Indirect) During Construction | MM GEO-6a MM GEO-6b | NEPA Less Than Significant Impact (Indirect) During Construction |
| Impact GEO-7. Would Alternative 3 (Project) be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures? | | | |
| Shaft Sites – JWPCP West, Angels Gate | CEQA Significant Impact During Construction | MM GEO-7 | CEQA Less Than Significant Impact During Construction |
| | NEPA Significant Impact (Indirect) During Construction | MM GEO-7 | NEPA Less Than Significant Impact (Indirect) During Construction |
| **Alternative 4 (Project)** | | | |
| Impact GEO-1. Would Alternative 4 (Project) expose people, structures, or property to major geologic hazards such as landslides, mudslides, or ground failure? | | | |
| Shaft Site – JWPCP West, Royal Palms | CEQA Significant Impact During Construction | MM GEO-1 | CEQA Less Than Significant Impact During Construction |
| | NEPA Significant Impact (Indirect) During Construction | MM GEO-1 | NEPA Less Than Significant Impact (Indirect) During Construction |
| Impact GEO-2. Would Alternative 4 (Project) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving rupture of a known earthquake fault? | | | |
| Tunnel Alignment – Figueroa/ Western to Royal Palms (Onshore) | CEQA Significant Impact During Operation | MM GEO-2 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-2 | NEPA Less Than Significant Impact (Indirect) During Operation |
| Impact GEO-3. Would Alternative 4 (Project) expose people or structures to a potential substantially adverse effect, including the risk of loss, injury, or death involving strong seismic ground shaking? | | | |
| Tunnel Alignment – Figueroa/ Western to Royal Palms (Onshore) | CEQA Significant Impact During Operation | MM GEO-3 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-3 | NEPA Less Than Significant Impact (Indirect) During Operation |
| Shaft Sites – JWPCP West, Royal Palms | CEQA Significant Impact During Operation | MM GEO-3 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-3 | NEPA Less Than Significant Impact (Indirect) During Operation |

**Table 8-19 (Continued)**

| Element | Impact Before Mitigation | Mitigation Measure | Residual Impact After Mitigation |
|---|---|---|---|
| Impact GEO-4. Would Alternative 4 (Project) expose people or structures to a potential substantially adverse effect including the risk of loss, injury, or death involving substrate consisting of material that is subject to liquefaction or other secondary seismic hazards in the event of ground shaking? | | | |
| Tunnel Alignment – Figueroa/ Western to Royal Palms (Onshore) | CEQA Significant Impact During Operation | MM GEO-4 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-4 | NEPA Less Than Significant Impact (Indirect) During Operation |
| Shaft Site – JWPCP West | CEQA Significant Impact During Operation | MM GEO-4 | CEQA Less Than Significant Impact During Operation |
| | NEPA Significant Impact (Indirect) During Operation | MM GEO-4 | NEPA Less Than Significant Impact (Indirect) During Operation |
| Impact GEO-6. Would Alternative 4 (Project) result in unstable earth conditions or changes in geologic substructure? | | | |
| Tunnel Alignment – Figueroa/ Western to Royal Palms (Onshore) | CEQA Significant Impact During Construction | MM GEO-6a<br>MM GEO-6b | CEQA Less Than Significant Impact During Construction |
| | NEPA Significant Impact (Indirect) During Construction | MM GEO-6a<br>MM GEO-6b | NEPA Less Than Significant Impact (Indirect) During Construction |
| Shaft Sites – JWPCP West, Royal Palms | CEQA Significant Impact During Construction | MM GEO-6a<br>MM GEO-6b | CEQA Less Than Significant Impact During Construction |
| | NEPA Significant Impact (Indirect) During Construction | MM GEO-6a<br>MM GEO-6b | NEPA Less Than Significant Impact (Indirect) During Construction |
| Impact GEO-7. Would Alternative 4 (Project) be located in soil characterized by shrink-swell potential that might result in deformation of foundations or damage to structures? | | | |
| Shaft Sites – JWPCP West, Royal Palms | CEQA Significant Impact During Construction | MM GEO-7 | CEQA Less Than Significant Impact During Construction |
| | NEPA Significant Impact (Indirect) During Construction | MM GEO-7 | NEPA Less Than Significant Impact (Indirect) During Construction |
| **Alternatives 5 (Project)** | | | |
| Impact GEO-5. Would Alternative 5 (Project) substantially accelerate natural processes of wind and water erosion and sedimentation, resulting in sediment runoff or deposition, which would not be contained or controlled on site? | | | |
| Emergency Discharge | CEQA Significant Impact During Operation | No mitigation is feasible. | CEQA Significant and Unavoidable Impact During Operation |

**Table 8-19 (Continued)**

| Element | Impact Before Mitigation | Mitigation Measure | Residual Impact After Mitigation |
|---|---|---|---|
| **Alternatives 6 (Project)** | | | |
| Impact GEO-5. Would Alternative 6 (Project) substantially accelerate natural processes of wind and water erosion and sedimentation, resulting in sediment runoff or deposition, which would not be contained or controlled on site? | | | |
| Emergency Discharge | NEPA<br>Significant Impact During Operation | No mitigation is feasible. | NEPA<br>Significant and Unavoidable Impact During Operation |