2.2.3 Geology, Soils, Seismic, Topography

This section is based on the Preliminary Geotechnical Report prepared for the project (California Department of Transportation [Department], August 2006) and the City General Plan. The Preliminary Geotechnical Report is on file and available for review at the City and the Department offices.

2.2.3.1 Regulatory Setting

This section discusses geology, soils, and seismic concerns as they relate to public safety and project design. Earthquakes are prime considerations in the design and retrofit of structures. The Department's Office of Earthquake Engineering is responsible for assessing the seismic hazard for Department projects. The current policy is to use the anticipated Maximum Credible Earthquake (MCE), from young faults in and near California. The MCE is defined as the largest earthquake that can be expected to occur on a fault over a particular period of time.

City of San Juan Capistrano General Plan

The City is located in the foothills of southern Orange County, near the southwestern edge of the Santa Ana Mountains and north of the San Joaquin Hills. The City General Plan states that due to the City's geographic location in a region that is considered seismically active, the City is subject to several types of geological hazards such as seismic activity, liquefaction, landslides, and erosion. Impacts can be reduced by implementing appropriate land use planning, development engineering, and building construction practices.

The City's General Plan identifies future development regulations for transportation arteries such as SR-74, which is classified as a critical use facility. Thus, detailed field and laboratory testing is required to establish the "survivability design and engineering requirements" for the proposed project. The activities to be undertaken for City projects include:

- Site-detailed geologic mapping and boring to determine that surface faulting and ground breakage has not occurred and is unlikely to occur in the future. Trenching is not an acceptable method for determining geologic conditions because of its adverse environmental effects.
- Adequate boring and field laboratory testing to determine accurately the subsurface profile and the static/dynamic properties of soil and rock materials.

- Calculation of design response spectra, based on repetition and structural properties (damping and ductility).
- Thorough inspection of the construction to ensure that designs are in compliance with the City's General Plan provisions, including a written certification by the contractor that all work has been done in strict accordance with plans and specifications.
- Periodic inspection of all structures and systems to determine that no detrimental modifications have been made, and that proper maintenance has been provided.

2.2.3.2 Affected Environment

Regional Geology

The project area is located in the Peninsular Ranges geomorphic province at the extreme southeastern margin of the Los Angeles Basin and lies between the Santa Ana Mountains and the San Joaquin Hills. The Peninsular Ranges geomorphic province is characterized by northwest to southeast-trending faults that are roughly parallel to the San Andreas Fault Zone. Underlying the project site area are Quaternary alluvium, terrace, and river deposits. Capistrano Formation bedrock is expected to underlie the alluvium and terrace deposits.

Topography

The topography within the Project Limits generally slopes down from the north to the south. The roadway is at a shallow grade and gradually increases in elevation from west to east. The general topographic gradient decreases gradually to the south and rises steeply to the north.

Steep slopes increasing in elevation are located along the north side of SR-74. These slopes are closer to the edge of SR-74 in the eastern portion of the proposed project. Gradual downslopes are located along the south side of SR-74.

Existing cut and fill slopes in the project area typically have slope ratios between 11:1 (horizontal:vertical [H:V]) and 1.2:1 (H:V). The elevation of the roadway increases from the west to the east.

Soil Conditions

The soils underlying the project site are underlain by alluvium, silty sands, and gravels derived from the San Joaquin Hills. The areas underlying the project site in the western portion of the project area are characterized by the Myford association soils. Myford associated soils are nearly level to moderately steep and are moderately well-drained sandy loams that have a strongly developed subsoil. The majority of the

areas south of SR-74 are classified under the Sorrento-Mocho association, which features nearly level to moderately sloping, well-drained sandy loams, loams, or clay loams on alluvial fans and floodplains. Areas within the project area to the north of SR-74 are comprised of the Cieneba-Anaheim-Soper association, which features strongly sloping to very steep, somewhat excessively drained and well-drained sandy loams, loams, clay loams, gravelly loams, and cobbly loams on coastal foothills. The expansion potential of these soil associations generally range from low to moderate, with the exception of a certain type of Myford association, which may have a high potential for expansion.[1] The depth to "bedrock-like" material and the corrosivity of soils at the site are not known at this time and would be determined during the final geotechnical investigation.

Groundwater

San Juan Creek is located south of SR-74 and runs parallel to the project site. The creek is a likely source for groundwater. According to the Preliminary Geotechnical Report, during previous investigations, groundwater was encountered at 111.7 ft below ground surface (bgs). However, groundwater well information obtained from the Prima Deshecha Landfill Site, located 0.6 mi from the eastern boundary of the project site, indicates that depth to groundwater may be encountered at depths as shallow as 8.29 ft bgs.[2]

Regional Faulting and Seismicity

The project is located in a seismically active area, and the geologic processes that have caused earthquakes in the past are expected to continue. A fault is considered active by the State of California if geologic evidence indicates that movement on the fault has occurred in the last 11,000 years, and potentially active if movement is demonstrated to have occurred in the last 2 million years. According to the Revised Preliminary Geotechnical Report, the closest active fault pursuant to the Alquist-Priolo Earthquake Fault Zoning Act (APEFZA) is the Whittier-Elsinore Fault Zone. This fault trends in a northwest-southeast direction. While not considered an active fault, the San Joaquin Hills Fault, located approximately 5.8 mi from the site, serves as the controlling fault for topographical landforms in this area. The San Joaquin Hills

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1 United States Department of Agriculture (USDA) Soil Conservation Service (SCS) and Forest Service, *Soil Survey of Orange County and Western Part of Riverside County, California*, September 1978.

2 Web site geotracker.swrcb.ca.gov/reports Prima Deschecha Sanitary Landfill.

Fault is capable of producing a maximum credible earthquake (MCE) magnitude of 7.0. A magnitude 7.0 event would give a peak bedrock acceleration of about 0.5g and a peak ground acceleration of 0.42g.

Ground Surface Rupture

The closest active fault in the area surrounding the project site that has been zoned active under APEFZA is identified as the Whittier-Elsinore Fault Zone. However, this northwest to southeast trending fault is located approximately 25 mi from the project site. Therefore, the possibility of ground surface rupture at the project site is remote.

Seismic Shaking

Although the San Joaquin Hills fault could produce a magnitude 7.0 event that could cause peak bedrock acceleration of 0.5g and a peak ground acceleration of 0.42g. In addition, design features will be included specifically to address the potential effects of seismic shaking on the project structures.

Liquefaction

Soil liquefaction is a phenomenon that occurs during strong ground shaking, most commonly in generally low- to medium-density, saturated, low-cohesion soils, where the soils experience a temporary loss of strength and behave essentially as a fluid. Areas most susceptible to liquefaction-induced damage are underlain by loose, water-saturated, granular sediment generally within 40 ft of the ground surface. Saturated conditions reduce the effective normal stress, thereby increasing the likelihood of earthquake-induced liquefaction. One of the major types of liquefaction-induced ground failures is lateral spreading of mildly sloping ground. Lateral spreading involves movement of earth materials due to ground shaking and is evidenced by near-vertical cracks with horizontal movement of the soil. Liquefaction-induced ground failure has historically been a major cause of earthquake damage in Southern California. According to Figure S-2, Seismic Hazards dated 1999, in the City's General Plan, within the area of the project limits, SR-74 and areas south of the highway are located in an area identified as a potential liquefaction hazard. The State of California Seismic Hazard Zone map for the San Juan Capistrano Quadrangle (December 21, 2001) indicates historical occurrences of liquefaction along SR-74 and south of SR-74, within the project limits, or local geological, geotechnical, and groundwater conditions that may indicate a potential for permanent ground displacements. Such permanent ground displacements would require mitigation as defined by Public Resources Code (PRC) Section 2693(c).

Slope instability, in the form of landslides and mudslides, is a potential adverse impact associated with seismic shaking. According to the State of California Seismic Hazard Zones map of the San Juan Capistrano Quadrangle, areas north of SR-74 within the project limits have been identified as areas that have a potential for earthquake-induced landslides. This includes areas where previous landslides have occurred, or local topographic, geological, geotechnical, and subsurface water conditions have indicated a potential for permanent ground displacements. Such permanent ground displacement would require mitigation as defined in PRC Section 2693(c).

Tsunami and Seiches Potential

A tsunami is defined as a gravitational sea wave produced by any large-scale disturbance of the sea floor. The Pacific Ocean is located approximately 6 mi from the project site, and the approximate elevation at the project site is 112 ft amsl. Therefore, the probability of a tsunami occurring within the project area is considered remote.

A seiche is defined as a free or standing wave oscillation of the water surface of an enclosed body of water. This phenomenon is not expected at this project site due to the large distance from an enclosed body of water.

Rockfall and Landslide and Slope Instability

According to the Revised Preliminary Geotechnical Report, portions of the project area fall within zones that have been identified as being at an increased risk for rockfall and landslides. In the project area, the low height of existing slopes makes the likelihood of a rockfall minimal.

According to Figure S-1, Geological Hazards, under the Safety Element in the City's General Plan, SR-74 and the areas immediately south of the highway are located in an area of major alluvial valleys where liquefaction is considered potentially high. However, areas immediately north of SR-74 are located in upper drainage areas where liquefaction is considered potentially low.

The majority of the areas further north of the project site are composed of Capistrano and Monterey geological formations with small pockets of terrace deposits. While terrace deposits are considered generally stable, the Capistrano and Monterey formations are considered slide-prone formations.

According to the Safety Element of the City General Plan, the primary cause for nonseismic-related landslides is attributed to the abundance of shales and siltstones underlying the hills of San Juan Capistrano. An abundance of shales and siltstones allows the soils to become highly porous, causing them to not hold together well when saturated and potentially leading to slope instability and landslides. Secondary factors that may result in nonseismic-related slope instability and landslides include rainfall and the City's complex water distribution system.

2.2.3.3 Environmental Consequences

Temporary Impacts

No Build Alternative

The No Build Alternative does not involve construction activities and would not alter existing geologic or soil conditions; therefore, it would not affect geological, or soil resources and no temporary impacts would occur.

Build Alternatives 1 and 2

The project is expected to have a minimal impact on geologic and topographic conditions. However, temporary impacts related to construction activities would occur. Build Alternatives 1 and 2 would alter existing topography due to construction grading and construction of cut-and-fill slopes within the project limits. Given the limited nature of the modifications, potential topographic impacts are considered less than significant.

Temporary erosion effects could occur due to project construction. These effects are discussed in Section 2.2.2, Water Quality and Storm Water Runoff. The Build Alternatives would not increase exposure to geologic hazards such as erosion. Erosion control measures that are discussed in Section 2.2.2, Water Quality and Storm Water Runoff, would minimize the temporary increase in erosion as a result of construction.. As discussed in Section 2.2.2, Water Quality and Storm Water Runoff, with implementation of erosion control Best Management Practices (BMPs) in the Storm Water Pollution Prevention Plan (SWPPP), potential erosion impacts are considered less than significant .

Permanent Impacts

No Build Alternative

The No Build Alternative does not alter the existing facility and would not increase exposure to geologic hazards such as erosion and earthquakes. The proposed project is, however, located in an area that may be subject to liquefaction, with or without

implementation of the proposed project, that could result in damage to the existing facility during a major seismic event. Therefore, the No Build Alternative will have a less than significant impact on geology, soil, seismic and topography.

Build Alternatives 1 and 2

Build Alternatives 1 and 2 are expected to have a minimal impact on geologic and topographic conditions. The primary geologic and geotechnical constraints affecting the design and construction of any of the Build Alternatives include:

- Seismic Hazards.
- Erosion and slope instability.

Seismic Hazards

As previously discussed, the project is located in a seismically active area where, south of the SR-74, liquefaction is considered potentially high. Therefore, the Build Alternatives would be constructed according to seismic design parameters used for the preliminary design of the proposed structures using the California Seismic Hazard Map 1996 (Mualchin 1996) and procedures outlined in the Department's Standard Seismic Design Criteria (SDC), Version 1.4 (2006), and the Department's Guidelines for Foundation Investigations and Reports (GFIR), Version 2.0 (2006).

As previously discussed, areas north of SR-74 within the project limits have been identified as having a potential for earthquake-induced landslides. To address the potential for landslides, a Geotechnical Design Report would be prepared as part of final design that would provide detailed analyses for the various design features, including, but not limited to, retaining walls and noise barriers. The preliminary geotechnical report analyzed four types of retaining walls. The types that were analyzed include: Type 1 retaining wall, soil nail wall, soldier pile wall, and secant/tangent wall. During the design phase, a detailed study would be conducted to finalize the selection for retaining walls. Regardless of the wall type, the walls shall include aesthetic treatment. Under Build Alternative 2, slope cuts are slightly greater due to the improvements on the north side of SR-74 to accommodate the relocated sidewalk.

Furthermore, the project is not located within an APEFZA area, and no well-defined fault traces have been mapped within the project limits. The possibility of surface rupture from an earthquake is considered low. The Build Alternatives are, however, located in an area that may be subject to liquefaction. However, the

Department considers the possibility of seismic activity and includes design standards to minimize and avoid potential adverse impacts from seismic events. In addition, since liquefaction is a factor in certain areas within the project limits, the project design would incorporate deepened foundations and/or increased depth of piles as needed, as outlined in the Preliminary Geotechnical Report. With implementation of the recommendations of the Final Design Report, as identified in Section 2.2.3.5, potential seismic impacts associated with the Build Alternatives are considered less than significant.

Erosion

Permanent erosion impacts can possibly occur from cut slopes. Loose sediment from these slopes may be carried to drainages and streams during a rain event or strong winds. As discussed in Section 2.2.2, only the end of the slope (hillside) would be removed close to the highway on the north side. The south side of SR-74 would be limited. Therefore, the amount of erosion and sediment from the slopes would be . Vegetating the slopes and implementation of permanent BMPs (outlined in Section 2.2.2) would greatly reduce the amount of erosion and siltation as identified in the Landscape Plan. In addition, the natural slopes within the project site are covered with material that is granular in nature (i.e., sand and gravel). Slopes are typically covered with vegetation. Where cuts are proposed, the slope faces will be protected and held in place by retaining walls. Considering that the area impacted is limited and the measures have been incorporated into the project design, potential long-term erosion impacts would be less than significant.

Soils

Expansive and collapsing soils are characterized by their ability to undergo significant volume changes (shrink or swell) due to variations in moisture content even without an increase in external loads. Changes in soil moisture content can result from precipitation, landscape irrigation, utility leakage, roof drainage, perched groundwater, drought, or other factors and may result in unacceptable settlement or heave of structures or concrete slabs supported on grade. As previously discussed, soils underneath the project area generally have only a low to moderate likelihood of expansion. Further testing during the Final Geotechnical Design Report would evaluate soil conditions existing within the project area and identify appropriate remedial actions, as needed. With implementation of the recommendations of the Final Geotechnical Design Report, it is anticipated that Build Alternatives 1 and 2 would have a less than significant impact on soils.

Landslides

Landslides are rock, earth, or debris flows on slopes due to gravity. They can occur on any terrain given the right conditions of the soil, moisture, and angle of slope as result of seismic and/or nonseismic activity. According to Figure S-1, Geological Hazards, referenced in the Safety Element of the San Juan Capistrano General Plan, SR-74 is not located in an area where there confirmed, known, or highly suspected landslides. Therefore, potential landslide impacts associated with Build Alternatives 1 and 2 are considered less than significant.

2.2.3.4 Avoidance, Minimization, and/or Mitigation Measures

The following minimization measure would minimize potential geological, seismic, and soil impacts.

During final design, the Department shall prepare a *Final Geotechnical/Structures Design Report* for the project, refining the existing *Preliminary Design Report*. The *Final Design Report* shall include detailed site testing and design recommendations based on the recommendations in the *Preliminary Design Report*. The recommendations of the *Final Design Report* shall be incorporated into the final design for the project. Since liquefaction is a factor in certain areas within the project limits, the project shall incorporate deepened foundations and/or increased depth of piles as needed.

Implementation of erosion control Best Management Practices (BMPs) in the Storm Water Pollution Prevention Plan (SWPPP) is required, as discussed in Section 2.2.2, Water Quality and Storm Water Runoff.

2.2.3.5 Level of Significance

The No Build Alternative will have no impact associated with liquefaction, landslides, seismic shaking, and erosion.

With implementation of the measure described above, potential temporary, permanent, direct or indirect impacts associated with liquefaction, landslides, seismic shaking, and erosion are less than significant under Build Alternatives 1 and 2.