4.2 GEOLOGY, SOILS, AND SEISMICITY

The purpose of this section is to describe the geologic, seismic and slope stability setting of the project area, identify potential impacts associated with the proposed project, and recommend mitigation measures to reduce the significance of such impacts. Information in this section is based on the Preliminary Geotechnical Investigation, Proposed Carbon Canyon Sewer and Pump Station Replacement Project for Orange County Sanitation District, Near Carbon Canyon Road and Rose Drive, City of Brea and Unincorporated Orange County, California (dated June 30, 2003; prepared by Leighton Consulting Inc.), Seismic Hazard Zone Report for the Yorba Linda 7.5-Minute Quadrangle, Los Angeles and Orange Counties, California prepared by the California Geological Survey (Formerly California Division of Mines and Geology), 1997 (revised 2001), and the City of Brea General Plan have been reviewed and incorporated into this section (see Section 9, Bibliography).

EXISTING CONDITIONS

LANDFORM AND TOPOGRAPHY

The project site is located in the Los Angeles Basin in the northern portion of the Peninsular Range geomorphic province of California. This is an area of complex geology as the relatively northwestward moving Peninsular Range province collides with the Transverse Ranges (San Gabriel Mountains) to the north. Numerous faults are present within the basin and are believed to accommodate compression associated with the collision. The Puente Hills are a structurally uplifted feature along the north side of the Whittier (Puente Hills) Fault system. This fault system is considered active by the California Geological Survey (CGS) and produced the magnitude 5.9 Whittier Narrows earthquake on October 1, 1987.

The project area is situated within the Chino/ Puente Hills, just west of the Carbon Canyon State Park. The topography of the project site is characterized by a steep northeast-southwest trending ridgeline that creates the southwest abutment for the Carbon Canyon Dam. Typical slope gradients within the project site range from 1:1 to 2:1 horizontal to vertical. Elevations within the project site range from 420 to 525 feet above mean sea level. The northeastern segment of the proposed pipeline route is located within a previously graded road along the northern side of the ridgeline. The southwestern segment of the pipeline crosses a large gully and terrace that abut the southern portion of the ridgeline.

EARTH MATERIALS

BEDROCK

Bedrock found at the project site and vicinity has been assigned to the Miocene age Puente Formation and the Pliocene age Fernando Formation. The Puente Formation has been divided into four members, from oldest to youngest: La Vida, Soquel, Yorba, and Sycamore Canyon. The Fernando Formation has been divided into two members from oldest to youngest: lower and upper, which are separated by a regional erosional unconformity. The eastern portion of the site displays bedding orientations that dip at moderate angles to the northeast. Bedding in the northwestern portion of the site dips predominantly to the north at shallow to moderate angles. The southwestern portion of the site displays numerous northwesterly trending fold axes. No active faults have been identified on-site during surveys. Inactive faults have been mapped near the existing City water reservoir.

The Fernando Formation was identified within the alignment of the proposed pipeline and is the bedrock material that would typically be encountered during grading activities. Included below is a description of the Fernando Formation encountered during Leighton Consulting Inc's (LCI) geotechnical investigation:

Fernando Formation Bedrock (Tf): Fernando Formation bedrock was encountered in Borings B-3, B-4/4A, and B-5 at depths ranging from 0 to 22 feet. The bedrock generally consisted of very stiff/very dense, to hard, silty sandstone to siltstone. The bedrock encountered was generally slightly moist to moist with moisture contents ranging from 2.5 to 17 percent.

In 1999 Pacific Soils and Engineering Inc (PSE, 1999), identified a queried landslide on their geotechnical map, in the vicinity of LCI's Boring B-5. Based on the material encountered within this boring (approximately 22 feet of alluvium overlying very dense to hard sandstone and siltstone) and the lack of topographic evidence, it is LCI's opinion that this landslide is not present as mapped.

SOILS

In addition to the bedrock that is identified within the project site and vicinity, LCI encountered soils onsite that would be considered relatively young, geologically speaking. These soils were typically located at the base of the hills located within the project site. Included below is a description of the soils encountered during LCI's geotechnical investigation:

Alluvium (Qal): The onsite alluvial soils encountered during our investigation were variable, consisting of both fine- and coarse-grained materials. The fine-grained material was generally comprised of medium-stiff to hard, sandy silt to sandy clay. The coarse-grained material was generally comprised of loose to very-dense, clayey sand, and silty sand. Occasional fine roots were encountered within the excavations. Local gravel-rich and porous areas were also observed during our excavation. The alluvial soils encountered were generally slightly moist to moist with moisture contents ranging from 3.6 to 18.7 percent.

EARTH MATERIALS CHARACTERISTICS

Based on LCI's field investigation:

- The upper alluvial soil deposits are considered to be moderately compressible and are generally considered to have negligible hydrocollapse potential.
- Onsite alluvial soil is in good working order; oversized material was not encountered.
- The onsite alluvial soil and bedrock deposits are expected to exhibit a low to medium expansion potential.
- Seven representative samples of the subsurface soil were tested for water-soluble sulfates. The results of these tests indicate a soluble sulfate content of 0.03 percent or less by weight, indicating negligible sulfate exposure.
- As a screening for potentially corrosive soil, two representative soil samples were tested during LCI's investigation to determine minimum resistivity, chloride content, and pH level. The minimum soil resistivity of the samples ranged from 1,195 to 2,200 ohm-cm, the chloride content ranged from approximately 73 to 112 ppm, and the pH level ranged from 7.9 to 8.1. The soil resistivity test results indicate that the onsite soils are corrosive to ferrous metal.

GROUNDWATER

Groundwater was not encountered in any of the borings excavated during the geotechnical investigation. A study conducted by the California Geological Survey (formerly California Department of Mines and Geology CDMG, 2001) estimates that the historically highest groundwater level at the site was approximately 10 feet below the ground surface in the low-lying areas of the site (ranging from approximately 5 feet below to 10 feet above the proposed sewer invert). Boring B-3 of the PSE (1999) investigation encountered groundwater at a depth of 51 feet below the existing ground surface. This boring was located approximately 600 feet due east of the intersection of Rose Drive and Vesuvius Drive. Based on a review of the California Department of Water Resources data (CDWR, 2003) current groundwater levels in the general site vicinity are expected to be on the order of 50 feet below the ground surface in the low-lying areas of the site (ranging from approximately 30 to 45 feet below the proposed sewer invert). The local groundwater flow is generally to the southwest.

LANDSLIDES

Landslides are mass movements of the ground that include rock falls, relatively shallow slumping and sliding of soil, and deeper rotational or transitional movement of soil or rock. According to the CGS, there are no identified landslides mapped within the project boundary. However, there is a potential for Earthquake Induced Landslides as indicated on the Seismic Zones Hazard Map for the Yorba Linda Quadrangle. This map indicates that within the project site there are areas that may have the potential for landslide movement during a seismic event due to local topographic, geological, geotechnical and subsurface water conditions that indicate a potential for permanent ground displacements.

SEISMICITY

SURFACE RUPTURE

No major active faults have been mapped within the project site. The project however is located within 0.25 miles from the active Whittier Fault Zone, which has been identified on the Alquist-Priolo Special Study Zones Map for the Yorba Linda Quadrangle. In addition, the Elysian Park Thrust Fault (Puente Hills Thrust) is located beneath the City of Brea and is therefore considered a seismic threat. Regarding surface rupture though, it is difficult to ascertain whether or not a rupture will occur due to the depth of the fault and the magnitude of the earthquake. There can be surface deformation after an earthquake occurs; however the probability of occurrence and location of this type of deformation is unknown and difficult to determine.

SEISMICALLY INDUCED SETTLEMENT

During a strong seismic event, seismically induced settlement can occur within loose to moderately dense, dry or saturated granular soils. LCI performed an analysis of seismically induced settlement. Their analysis indicated that the seismically induced settlement along the proposed alignment is considered negligible, except for the location near boring B-6 where the potentially liquefiable soil was encountered. Assuming the historic high groundwater levels and a peak ground acceleration of 0.47g, the maximum seismically induced settlement was estimated to be on the order of 3.5 inches.

GROUND SHAKING

There are several faults in the region that could produce earthquakes resulting in seismic impacts on project facilities. The San Andreas and San Jacinto Fault Zones are within forty-eight miles of the City and the Cucamonga and Sierra Madre Fault Zones are within twenty-four miles of the City

of Brea. Although the project area is not located within an Alquist-Priolo Earthquake Fault Zone (formerly referred to as Special Study Zones) as designated by the California Geological Survey (Formerly CDMG)[1], as stated above, the site is approximately 0.25 miles south of the Whittier Fault, which is located within an Alquist-Priolo Earthquake Fault Zone. According to the *Brea General Plan*, the Whittier Fault is capable of a Maximum Credible Earthquake magnitude of 7.3. The Whittier fault is a right lateral strike slip fault with a reverse slip component of movement. The fault extends approximately 20 miles from Turnbull Canyon near Whittier (northwest of the project) to the horseshoe bend of the Santa Ana River near Prado Dam (southeast of the project).

The Elysian Park Thrust Fault (Puente Hills Blind Thrust) is also located beneath the City of Brea. According to the *Brea General Plan*, the Elysian Park Thrust Fault is capable of a MCE magnitude of 6.7. The exact location of this fault in relation to the project site is currently unknown. It is believed that the 1987 Whittier Narrows earthquake with an epicenter located approximately 10 miles west of the project resulted from movement along the Elysian Park thrust fault.

LIQUEFACTION

Liquefaction is the loss of soil strength or stiffness due to a buildup of pore-water pressure during severe ground shaking. Liquefaction is associated primarily with loose (low density), saturated, fine- to medium-grained, cohesionless soil. Bedrock and certain fine-grained soils (i.e. silt and clay) are not considered susceptible to liquefaction. Effects of severe liquefaction can include sand boils, excessive settlement, bearing capacity failures, and lateral spreading. The western half of the site is identified as potentially liquefiable on the Seismic Hazards Zone Map for the Yorba Linda Quadrangle (CDMG, 1998). This zoning is based on upon historic shallow groundwater levels and regional soil conditions.

LCI evaluated the liquefaction potential of the alluvial soil encountered in their borings. The parameters utilized in the analysis to characterize the in situ soil include corrected Modified California sample blow count results from the hollow-stem auger borings and visual descriptions of soil samples retrieved. Based on their analysis, the soil encountered during the investigation is not considered susceptible to liquefaction, with the exception of one location. Soil potentially susceptible to liquefaction was observed at Boring B-6 (adjacent to the existing pump house) within a depth of 8 and 18 feet below existing ground up to approximately 10 feet below the invert. However, liquefaction could only occur in this area if the groundwater levels rise to historic levels.

IMPACTS

SIGNIFICANCE CRITERIA

The significance criteria for this analysis was developed from Appendix G of the State *CEQA Guidelines* and professional standards. The proposed project would be considered to have a significant impact on geological resources if it would:

- Expose people and property to substantial geological hazards, such as landslides, mudslides, ground failure, or similar hazards, or soil and/or seismic conditions so unfavorable that they could not be overcome by design using reasonable construction and/or maintenance practices;
- Locate a structure within a mapped hazard area or within a structural setback zone;

[1] *Alquist-Priolo Earthquake Fault Zone Map*, issued by the State Geologist, 1986; California Division of Mines and Geology Special Publication 42 (1997).

- Locate a structure within an Alquist-Priolo earthquake fault zone, a known active fault zone, or an area characterized by surface rupture that might be related to a fault;
- Trigger or accelerating geologic processes, such as landslides or erosion, that could result in slope failure;
- Cause substantial irreversible disturbance of soil materials at the site or adjacent sites, such that their use is compromised;
- Modify the surface soils such that abnormal amounts of windborne or waterborne soils are removed from the site; or
- Cause the deformation of foundations by expansive soils (those characterized by shrink/swell potential);
- Cause the modification of on-site soils (e.g., grading) in a manner that results in decreased stability for adjacent developments.

Potential impacts associated with the project area=s topography, soils, and the region=s seismic activity are identified below. Mitigation measures are provided to reduce the significance of impacts.

IMPACT DISCUSSION

WOULD THE PROJECT?

FAULT RUPTURE.

Expose people or structures to potential substantial adverse effects, including the risk of loss, injury or death involving:

(a) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? ***Less Than Significant Impact.***

The project site is located within the seismically active southern California region and would likely be subjected to ground shaking, thus exposing the proposed facilities to seismic hazards. However, no faults are known to traverse the proposed pipeline alignment. As such, impacts in regard to fault rupture are not anticipated to be significant.

SEISMICITY AND GROUND FAILURE

Expose people or structures to potential substantial adverse effects, including the risk of loss, injury or death involving:

(b) Strong seismic ground shaking? ***Less Than Significant Impact.***

The proposed project would be subjected to strong seismic ground shaking over its lifetime. However, as proposed, the project consists of the installation of a gravity feed sewer pipeline. This pipeline would be designed to accommodate total and differential settlement, and would be constructed in conformance with the latest version of the Uniform Building Code. As proposed the only structures that would be impacted by seismic shaking would be the pipeline itself, which would not be considered significant. There are no other habitable structures proposed with this project.

(c) Seismic-related ground failure, including liquefaction? ***Less Than Significant Impact With Mitigation Incorporated.***

As indicated by the geotechnical investigation, total and differential settlement would be within tolerable limits for the proposed gravity fed sewer main. Regarding seismically induced settlement, the preliminary geotechnical investigation identified a potentially liquefiable soil layer adjacent to the existing pump station. This is a potentially significant impact that would require mitigation. Estimated settlement of 3.5 inches could occur if groundwater levels rose 40 feet at the same time as a seismic event; the likelihood of this is quite low. The following three alternatives were recommended in the geotechnical report:

i. Design the sewer line to allow for ½ of the total estimated settlement (approximately 2 inches of differential settlement.)
ii. Completely remove the potentially liquefiable materials (a depth of 8 to 18 feet below existing ground in the vicinity of the pump station.)
iii. Take no remedial action with the understanding that repair of the sewer line could be required in the event of a strong earthquake.

In addition, groundwater was not encountered within any of the borings within the geotechnical investigation. Since groundwater was not encountered and borings within the vicinity indicate that the depth to groundwater is approximately 51 feet, it is not expected to pose a significant constraint to construction of the project.

(d) Landslides? ***Less Than Significant Impact.***

There are no identified landslides located within the project site. In addition, the proposed project involves the construction of a gravity fed sewer pipeline, which would be below existing ground. The occurrence of landslide may impact this pipeline, however the likelihood of this is low and the rock units that the pipeline would be located within are not very susceptible to earth movements of this type. Based on these conditions, impacts associated with landslides would be considered less than significant.

SOILS AND EARTH MATERIALS

(e) Result in substantial soil erosion or the loss of topsoil? ***Less Than Significant Impact With Mitigation Incorporated.***

Ongoing project operations of a gravity fed sewer line are not anticipated to result in soil erosion or the loss of topsoil. Areas graded for the pipeline would either be revegetated (if native), landscaped, and/or repaved with decomposed granite. The operational phase of the proposed project is anticipated to result in less than significant impacts. However, construction of the proposed project would require the temporary removal of vegetation and excavation of subgrade soils, which would temporarily increase the potential for soil loss due to wind and water erosion. This is a potentially significant impact that would require mitigation measures.

(f) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse? ***Less Than Significant Impact With Mitigation Incorporated.***

Regarding seismically induced settlement, the preliminary geotechnical investigation identified a potentially liquefiable soil layer adjacent to the existing pump station. This is a potentially significant impact that would require mitigation. Estimated settlement of 3.5 inches could occur if groundwater levels rose 40 feet at the same time as a seismic event; the likelihood of this is quite low. The following three alternatives were recommended in the geotechnical report:

i. Design the sewer line to allow for ½ of the total estimated settlement (approximately 2 inches of differential settlement.)
ii. Completely remove the potentially liquefiable materials (a depth of 8 to 18 feet below existing ground in the vicinity of the pump station.)
iii. Take no remedial action with the understanding that repair of the sewer line could be required in the event of a strong earthquake.

In addition, construction of the proposed pipeline would involve standard construction techniques, including trenching, overexcavation, and micro–tunneling. The utilization of standard construction measures and design-engineering practices contained within the UBC would reduce impacts to less than significant levels.

(g) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property? ***Less Than Significant Impact.***

As indicated in the preliminary geotechnical report, the onsite alluvial soil and bedrock deposits are expected to exhibit a low to medium expansion potential. Potential impacts regarding expansive soils are considered to be less than significant with regard to the proposed project.

(h) Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater? ***No Impact.***

The Project proposes the construction of a gravity fed sewer pipeline. The use of septic tanks and alternative wastewater disposal systems are not proposed as part of this project. Therefore, no impacts would occur in this regard.

EXPANDED SERVICE AREA OPTION

Note: The impacts of the new pipelines associated with the Expanded Service Area Option are being analyzed in a separate Environmental Impact Report that is available for review at the County of Los Angeles.

MITIGATION MEASURES

FAULT RUPTURE

No mitigation is required.

SEISMICITY AND GROUND FAILURE

GEO-1 The proposed sewer main shall be designed to accommodate up to two inches of vertical differential settlement in the vicinity of the Pump Station, through the use of flexible joints. These joints shall provide the pipeline with at least two inches of differential settlement over a horizontal distance of forty-feet (40').

SOILS AND EARTH MATERIALS

GEO-2 Concurrent with grading permit application, the Applicant shall submit an Erosion Control Plan for review and approval by the Orange County Sanitation District. The Erosion Control

Plan shall reflect applicable Specific Plan policies and OCSD requirements, as well as current County of Orange NPDES permit requirements. The Erosion Control Plan shall include, but not be limited to, the following:

- Erosion potential within graded areas shall be reduced and controlled by utilizing rapid development planting techniques (e.g. hydro seeding) slope terracing, replacement with cohesive soils not subject to erosion, and/or the construction of slope drainage improvements;

- Interim erosion control measures during construction, including temporary desilting basins and interceptor dikes shall be implemented to minimize sedimentation;

- All landscape and/or grading plans shall include provisions for temporary erosion control on all graded sites which are scheduled to remain unimproved during the winter/rainy months; and

- County of Orange NPDES, SWPPP, and BMP requirements.

GEO-3 The following mitigation measures shall be adhered to during project implementation:

- The proposed sewer main shall be designed to accommodate up to two inches of vertical differential settlement in the vicinity of the Pump Station, through the use of flexible joints. These joints shall provide the pipeline with at least two inches of differential settlement over a horizontal distance of forty-feet (40').

- Utility trenches can be backfilled with the onsite material, provided it is free of debris and/or significant organic material.

- Underlying subgrade soils must be prepared in such a manner that a uniform response to the applied loads is achieved.

- All temporary excavations should be performed in accordance with project plans, specifications, and all OSHA requirements.

UNAVOIDABLE SIGNIFICANT IMPACTS

No unavoidable significant impacts have been identified.