

IV. Environmental Impact Analysis

D. Geology and Soils

1. Introduction

This section of the Draft EIR provides an analysis of the Project's potential impacts with regard to geology and soils, including ground shaking, ground failure (e.g., liquefaction), and soil stability. The analysis is based, in part, on the *Updated Geotechnical Exploration Report* (Geotechnical Report) prepared for the Project Site by Leighton Consulting, Inc., dated December 2, 2016, which is provided in Appendix H of this Draft EIR. Information from previous geotechnical investigations completed for the Project Site, including the *Supplemental Geotechnical Evaluation* (2010 Geotechnical Evaluation) completed by Ninyo & Moore in October 2010 and the *Geotechnical Investigation Report* (2005 Geotechnical Investigation) completed by Converse Consultants in September 2005, is provided where appropriate. Those reports also are included in Appendix I of this Draft EIR.

2. Environmental Setting

a. Regulatory Framework

(1) State of California

(a) Alquist–Priolo Earthquake Fault Zoning Act

The Alquist–Priolo Earthquake Fault Zoning Act (Public Resources Code Section 2621) was enacted by the State of California in 1972 to address the hazard of surface faulting to structures for human occupancy.¹ The Alquist–Priolo Earthquake Fault Zoning Act was enacted in response to the 1971 San Fernando Earthquake, which was associated with extensive surface fault ruptures that damaged homes, commercial buildings, and other structures. The primary purpose of the Alquist–Priolo Earthquake Fault Zoning Act is to prevent the construction of buildings intended for human occupancy on the surface traces of active faults. The Alquist–Priolo Earthquake Fault Zoning Act is also intended to provide citizens with increased safety and minimize the loss of life during and immediately

¹ *The Act was originally entitled the Alquist–Priolo Geologic Hazards Zone Act.*

following earthquakes by facilitating seismic retrofitting to strengthen buildings against ground shaking.

The Alquist–Priolo Earthquake Fault Zoning Act requires the State Geologist to establish regulatory zones, known as “Earthquake Fault Zones,” around the surface traces of active faults and to issue appropriate maps to assist cities and counties in planning, zoning, and building regulation functions. Maps are distributed to all affected cities and counties for the controlling of new or renewed construction and are required to sufficiently define potential surface rupture or fault creep. The State Geologist is charged with continually reviewing new geologic and seismic data, and revising existing zones and delineating additional earthquake fault zones when warranted by new information.

Local agencies must enforce the Alquist–Priolo Earthquake Fault Zoning Act in the development permit process, where applicable, and may be more restrictive than state law requires. According to the Alquist–Priolo Earthquake Fault Zoning Act, before a project can be permitted, cities and counties shall require a geologic investigation prepared by a licensed geologist to demonstrate that buildings will not be constructed across active faults. If an active fault is found, a structure for human occupancy cannot be placed over the fault trace and must be set back. Although setback distances may vary, a minimum 50-foot setback is required. The Alquist–Priolo Earthquake Fault Zoning Act and its regulations are presented in California Department of Conservation, California Geological Survey, Special Publication 42, *Fault-Rupture Hazard Zones in California*.

(b) Seismic Safety Act

The California Seismic Safety Commission was established by the Seismic Safety Act in 1975 with the intent of providing oversight, review, and recommendations to the Governor and State Legislature regarding seismic issues.² The Commission’s name was changed to Alfred E. Alquist Seismic Safety Commission in 2006. Since then, the Commission has adopted several documents based on recorded earthquakes, including:³

- Research and Implementation Plan for Earthquake Risk Reduction in California 1995 to 2000, report dated December 1994;

² Alfred E. Alquist Seismic Safety Commission, *History and Responsibilities*, www.seismic.ca.gov/about.html, accessed December 19, 2016.

³ Alfred E. Alquist Seismic Safety Commission, *Publications*, www.seismic.ca.gov/pub.html, accessed December 19, 2016.

- Seismic Safety in California’s Schools, “Findings and Recommendations on Seismic Safety Policies and Requirements for Public, Private, and Charter Schools,” report dated December 2004;
- Findings and Recommendations on Hospital Seismic Safety, report dated November 2001; and
- Commercial Property Owner’s Guide to Earthquakes Safety, report dated October 2006.

(c) *Seismic Hazards Mapping Act*

In order to address the effects of strong ground shaking, liquefaction, landslides, and other ground failures due to seismic events, the State of California passed the Seismic Hazards Mapping Act of 1990 (Public Resources Code Sections 2690–2699). Under the Seismic Hazards Mapping Act, the State Geologist is required to delineate “seismic hazard zones.” Cities and counties must regulate certain development projects within these zones until the geologic and soil conditions of the project site are investigated and appropriate mitigation measures, if needed, are incorporated into development plans. The State Mining and Geology Board provides additional regulations and policies to assist municipalities in preparing the Safety Element of their General Plan and encourage land use management policies and regulations to reduce and mitigate those hazards to protect public health and safety. Under Public Resources Code Section 2697, cities and counties shall require, prior to the approval of a project located in a seismic hazard zone, a geotechnical report defining and delineating any seismic hazard. Each city or county shall submit one copy of each geotechnical report, including mitigation measures, to the State Geologist within 30 days of its approval. Public Resources Code Section 2698 does not prevent cities and counties from establishing policies and criteria which are stricter than those established by the Mining and Geology Board.

State publications supporting the requirements of the Seismic Hazards Mapping Act include California Geological Survey Special Publication 117A, *Guidelines for Evaluating and Mitigating Seismic Hazards in California*, and Special Publication 118, *Recommended Criteria for Delineating Seismic Hazard Zones in California*.^{4,5} The objectives of Special Publication 117 are to assist in the evaluation and mitigation of earthquake-related hazards for projects within designated zones of required investigations and to promote uniform and effective statewide implementation of the evaluation and mitigation elements of the Seismic

⁴ California Geological Survey, *Special Publication 117A, Guidelines for Evaluating and Mitigating Seismic Hazards in California*, 2008.

⁵ California Geological Survey, *Special Publication 118, Recommended Criteria for Delineating Seismic Hazard Zones in California*, May 1992 and revised April 2004.

Hazards Mapping Act. Special Publication 118 implements the requirements of the Seismic Hazards Mapping Act in the production of Probabilistic Seismic Hazard Maps for the State.

(d) California Building Standards Code

The California Building Standards Code (California Code of Regulations, Title 24) is a compilation of building standards, including seismic safety standards for new buildings. The California Building Standards Code is based on building standards that have been adopted by state agencies without change from a national model code; building standards based on a national model code that have been changed to address particular California conditions; and building standards authorized by the California legislature but not covered by the national model code.⁶ Given California's susceptibility to seismic events, the seismic standards within the California Building Standards Code are among the strictest in the world. The California Building Standards Code includes provisions for demolition and construction, as well as regulations regarding building foundations and soil types. The California Building Standards Code applies to all occupancies in California, except where stricter standards have been adopted by local agencies. The California Building Standards Code is published on a triennial basis, and supplements and errata can be issued throughout the cycle. The 2016 edition of the California Building Standards Code became effective on January 1, 2017, and incorporates by adoption the 2015 edition of the International Building Code of the International Code Council, with California amendments.⁷ The 2016 California Building Standards Code incorporates the latest seismic design standards for structural loads and materials, as well as provisions from the National Earthquake Hazards Reduction Program to mitigate losses from an earthquake and provide for the latest in earthquake safety.

Specific California Building Standards Code building and seismic safety regulations have been incorporated by reference in the Long Beach Building Code, with local amendments. As such, the California Building Standards Code forms the basis of the Long Beach Building Code.

⁶ *California Building Standards Commission, Information About the Codes, www.bsc.ca.gov/codes.aspx, accessed December 27, 2016.*

⁷ *California Building Standards Code, Title 24, Part 2.*

(2) City of Long Beach

(a) City of Long Beach General Plan Seismic Safety Element

The City of Long Beach General Plan Seismic Safety Element was adopted in October 1988 and provides a comprehensive analysis of seismic factors to reduce loss of life, injuries, damage to property, and social and economic impacts resulting from seismic risk. The Seismic Safety Element also provides goals and recommendations related to seismic safety and maps of designated areas within the City of Long Beach (City) that are considered susceptible to earthquake-induced hazards such as fault rupture and liquefaction. The Seismic Safety Element goals include reducing public exposure to seismic risks; providing an urban environment that is as safe as possible from seismic risk; and providing the maximum feasible level of seismic safety protection services.

(b) Long Beach Building Code

Building and construction activities in the City are subject to Long Beach Municipal Code Title 18, Building Code, which adopts and incorporates by reference the 2016 Edition of the California Building Standards Code. Title 18 includes amendments and modifications to the California Building Standards Code that are specific to the City of Long Beach. The Long Beach Department of Building and Safety is responsible for implementing the provisions of the Long Beach Building Code.

b. Existing Conditions

(1) Regional Geology

The Project Site is located within the Long Beach Plain in the coastal portion of the California Peninsular Ranges geomorphic province that extends northwesterly from Baja California into the Los Angeles Basin and westerly into the offshore area, including Santa Catalina, Santa Barbara, San Clemente, and San Nicolas islands. The northern boundary of the California Peninsular Ranges geomorphic province extends to the Transverse Ranges along the Malibu, Santa Monica, Hollywood, Raymond, Sierra Madre, and Cucamonga Faults. The eastern boundary of the province consists of the Colorado Desert geomorphic province along the San Jacinto fault system. The Peninsular Range is characterized by northwest and southeast trending alignments of mountains and hills and intervening basins, reflecting the influence of northwest trending major faults and folds that control the general geologic structural fabric of the region.

(2) Faulting and Seismicity

The numerous faults in Southern California include active, potentially active, and inactive faults. Based on criteria developed by the California Geological Survey, an active fault is one that has shown evidence of surface displacement within the past 11,000 years (i.e., Holocene-age). A potentially active fault has demonstrated surface displacement within the last 1.6 million years (i.e., Quaternary-age). Inactive faults are those that have not shown evidence of surface displacement within the last 1.6 million years. The Southern California region also includes blind thrust faults, which are faults without a surface expression. Due to the buried nature of these thrust faults, their existence is usually not known until they produce an earthquake. Since the seismic risk of these buried thrust faults in terms of recurrence and maximum potential magnitude is not well established, the potential for earthquakes with magnitude higher than 6.0 occurring on buried thrust faults cannot be precluded. The faults in the vicinity of the Project Site are listed in Table IV.D-1 on page IV.D-7.

As discussed above, the Alquist–Priolo Earthquake Fault Zoning Act requires the State Geologist to establish earthquake fault zones around the surface traces of active faults and to issue appropriate maps to assist cities and counties in planning, zoning, and building regulation functions. These zones, which generally extend from 200 to 500 feet on each side of a known active fault, identify areas where potential surface fault rupture along an active fault could prove hazardous and identify where special studies are required to characterize hazards to habitable structures. The Project Site is not within a currently established Alquist–Priolo Earthquake Fault Zone for surface fault rupture hazards. According to the 2010 Geotechnical Evaluation, the closest active fault zone to the Project Site is the Newport–Inglewood Fault Zone, which is estimated to occur approximately 1,000 feet northeast of the Project Site. The Newport–Inglewood Fault Zone is described as a northwest-trending, right-lateral wrench fault system consisting of a series of fault segments and folds. Although the surface trace of the Newport–Inglewood Fault Zone is discontinuous in the Los Angeles Basin, the fault is expressed at the surface by a series of discontinuous low hills extending from Newport Beach to Beverly Hills, including Signal Hill and Dominguez Hill. South of Signal Hill, the fault roughly parallels the coastline until just south of Newport Bay and heads offshore where it becomes the Newport–Inglewood–Rose Canyon fault zone. According to the Geotechnical Report, the Newport–Inglewood fault itself, which is considered active, is located approximately 0.3 mile northeast of the Project Site. This fault is capable of producing a magnitude 6.9 earthquake.

Based on the Geotechnical Report, the next closest active fault is the Palos Verdes Fault, located approximately 8.1 miles southwest of the Project Site. The Palos Verdes Fault is described as a right-reverse fault. The Palos Verdes Fault lies immediately offshore of the City of Long Beach and is one of several major northwest trending faults in

**Table IV.D-1
Active Faults in Proximity to the Project Site**

Fault Name	Fault Classification	Distance (miles/km)	Approximate Fault Length (miles/km)	Magnitude (Mw)	Estimated Slip Rate (mm/yr)
Newport–Inglewood (L.A. Basin)	Right Lateral	0.5/0.8	44/75	6.9	1.0
Palos Verdes	Right Lateral-Reverse	7.7/12.3	50/80	7.1	3.0
Newport–Inglewood (offshore)	Right Lateral	16.3/26.0	56/90	6.9	1.5
Elsinore–Whittier	Right Lateral	16.8/26.8	112/180	6.8	2.5

Source: *Converse Consultants, 2005 (see Appendix I of this Draft EIR); Southern California Earthquake Data Center (SCEDC), 2014.*

Southern California that are tectonically associated with the northwest trending San Andreas Fault System. The Palos Verdes Fault is capable of producing a magnitude 7.1 earthquake. Other faults in the vicinity include the Puente Hills Blind Thrust fault, located 10.2 miles from the Project Site in the subsurface, and the Elsinore fault, located 16.3 miles from the Project Site.

At the local level, the City of Long Beach General Plan Safety Element designates special fault study zones extending along each side of active and potentially active faults to establish areas of hazard potential due to fault rupture. The Project Site is not within a fault study zone identified in the Safety Element.⁸ However, the Project Site is located in the seismically active Southern California region and could be subjected to moderate to strong ground shaking in the event of an earthquake on one of the many active Southern California faults.

(3) Local Geology

(a) Subsurface Conditions

The Project Site is underlain by artificial fill (soil type Af) and Quaternary-aged young alluvial fan deposits (soil type Qyf). Existing pavement sections consist of 2 to 3 inches of asphalt concrete over 2 to 4 inches of aggregate base. The artificial fill across the Project Site is generally about 2.5 feet thick and consists primarily of silty sand and sandy silt. Deeper fills associated with the construction of the existing buildings and associated improvements exist on-site. One boring completed during the course of the geotechnical

⁸ *City of Long Beach General Plan Safety Element, Plate 2, October 1988.*

investigation encountered up to 6 feet of fill, presumably associated with construction of the water and sewer lines located along the southern edge of the Project Site. Below the artificial fill, Quaternary-aged alluvial fan deposits were encountered in borings drilled to the maximum depth of 81.5 feet. This alluvium generally consisted of interlayered loose to medium dense sand, silty sand, sandy silt, and soft to medium stiff sandy to silty clay. A previous study in 2002 also reported the presence of sumps and mud pits on-site.

Groundwater was encountered at the Project Site at depths of 15 and 18.5 feet below ground surface (bgs). During preparation of the 2005 Geotechnical Investigation, groundwater was encountered at 10 to 15 feet bgs. The historic high groundwater level at the Project Site is on the order of 10 feet bgs. Data from utility potholes by others indicate groundwater at depths between 5 and 11 feet bgs. Due to the proximity to the coastal zone, the depth to groundwater is expected to be influenced by tidal fluctuations. Additionally, fluctuations of the groundwater level, localized zones of perched water, and an increase in soil moisture should be anticipated during and following rainy seasons or periods of locally intense rainfall and stormwater runoff. Irrigation of landscaped areas and introduction of surface water also may cause localized fluctuations of groundwater levels.

(b) 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 with loose (low density), saturated, fine-to-medium grained, cohesionless soils. As the shaking action of an earthquake progresses, the soil grains are rearranged and the soil densifies within a short period of time. Rapid densification of the soil results in a buildup of pore-water pressure. When the pore-water pressure approaches the overburden pressure, the soil reduces greatly in strength and temporarily behaves similarly to a fluid. Effects of liquefaction can include sand boils, settlement, and bearing capacity failures below structural foundations.

According to the Seismic Hazards Zones Maps published by the California Geological Survey and the Long Beach General Plan Seismic Safety Element, the Project Site is located within an area considered susceptible to liquefaction. The liquefaction analysis completed as part of the Geotechnical Report identified layers of liquefiable soils at depths of 5 to 10 feet and 15 to 40 feet bgs. The potential for surface manifestation in the form of sand boils and ground fissures is therefore considered high.

(c) Settlement

Seismically induced settlement or the compaction of dry or moist, cohesionless soils may also occur during a major earthquake. These settlements occur primarily within loose to medium dense sandy soils due to reductions in volume during, and shortly after, an

earthquake. According to the Geotechnical Report and the 2010 Geotechnical Evaluation, there is a potential for liquefaction-induced settlement within the Project Site. In addition, loose alluvial soils or undocumented/poorly compacted fill may be present in some areas of the Project Site. Compressible natural soils and undocumented fills could be susceptible to adverse settlement under static loads imposed by new foundations and structures.

(d) Lateral Spreading

Seismically induced lateral spreading involves primarily lateral movement of earth materials due to ground shaking. For lateral spreading to occur, the liquefiable zone must be continuous, unconstrained laterally, and free to move along gently sloping ground toward an unconfined area. Lateral spreading results in near-vertical cracks with predominantly horizontal movement of the soil mass involved. The Los Alamitos Bay Marina to the west of the Project Site presents a potential unconfined area for lateral spreading to occur. The Geotechnical Report evaluated the potential for lateral spreading considering continuous liquefiable layers and the presence the Los Alamitos Bay Marina, and concluded that the site has an adequate factor of safety against lateral spreading.

(e) Subsidence

Subsidence occurs when a large portion of land is displaced vertically, usually due to the withdrawal of groundwater, oil, or natural gas. Soils that are particularly subject to subsidence include those with high silt or clay content. Based on the City of Long Beach Seismic Safety Element, the Project Site is not located within an area of known ground subsidence. In addition, no large-scale extraction of groundwater, gas, oil, or geothermal energy occurs or is planned at the Project Site. Therefore, there is little to no potential for ground subsidence at the Project Site.

(f) Expansive Soils

Expansive soils are soils that swell when subjected to moisture and shrink when dried. Expansive soils are typically associated with clayey soils. The near-surface soils are mainly sand and, therefore, their expansion potential is considered low. Additionally, previous testing performed as part of the 2005 Geotechnical Investigation concluded the near-surface soils generally exhibit a low expansion potential.

3. Environmental Impacts

a. Methodology

To evaluate potential impacts relative to geology and soils, a Geotechnical Report was prepared for the Project Site. The Geotechnical Report included a review of published

geologic data relevant to the Project Site, a site reconnaissance, field exploration, laboratory testing, and an engineering analysis. Recommendations regarding the design and construction of the Project are based on these results. The Geotechnical Report is provided in Appendix H of this Draft EIR. Supplemental information from the 2010 Geotechnical Evaluation and 2005 Geotechnical Investigation is provided where appropriate; those reports also are included in Appendix I of this Draft EIR.

b. Thresholds of Significance

Appendix G of the CEQA Guidelines provides a set of sample questions that address impacts with regard to geology and soils. These questions are as follows:

Would the project:

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
 - 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? Refer to Division of Mines and Geology⁹ Special Publication 42.
 - Strong seismic ground shaking?
 - Seismic-related ground failure, including liquefaction?
 - Landslides?
- Result in substantial soil erosion or the loss of topsoil?
- 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?
- 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?
- Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?

⁹ Now the California Geological Survey.

With regard to the above questions from CEQA Guidelines Appendix G, as evaluated in the Initial Study prepared for the Project, which is included as Appendix A of this Draft EIR, the Project Site is not within an Alquist–Priolo Earthquake Fault Zone as identified by the California Geological Survey or within the City’s General Plan Seismic Safety Element. In addition, no active or potentially active faults with the potential for surface fault rupture are known to pass directly beneath the Project Site. Therefore, the potential for surface rupture to occur on the Project Site is considered low. As also discussed in the Initial Study, impacts related to the rupture of a known earthquake fault would be less than significant. Additionally, the Project Site and surrounding area are characterized by a relatively flat topography, are not identified by the City as being located within an area of steep slopes, and are not designated as an earthquake-induced landslide area by the California Geological Survey. Therefore, no significant impacts regarding landslides were identified in the Initial Study.

Furthermore, regarding soil erosion or the loss of topsoil, Project-related construction activities would occur in accordance with applicable erosion control requirements, including grading and dust control measures, imposed by the City pursuant to grading permit regulations. As evaluated in the Initial Study, compliance with regulatory requirements that include the implementation of best management practices would ensure impacts related to soil erosion would be less than significant. Lastly, the Project is located within a community served by existing sewage infrastructure and would not require the use of septic tanks or alternative wastewater disposal systems. Therefore, no impact to soils from the use of such systems would occur.

Based on the analysis provided in the Initial Study, as summarized above, no further analysis regarding the impacts related to fault rupture, landslides, soil erosion, and the ability of soils to support septic tanks or alternative wastewater disposal systems is required. The analysis provided below thus focuses on impacts related to seismic ground shaking; seismic-related ground failure, including liquefaction; soil stability, including lateral spreading and subsidence; and expansive soils.

c. Project Design Features

The following project design feature pertaining to geology and soils is required in compliance with regulatory requirements and would be implemented as part of the Project:

Project Design Feature D-1: A final design-level geotechnical report that complies with all applicable state and local code requirements will be prepared for the Project by a qualified geotechnical engineer and certified engineering geologist and submitted to the Long Beach Bureau of Building and Safety, consistent with City of Long Beach Building

Standards Code requirements. The site-specific geotechnical report will be prepared to the written satisfaction of the City of Long Beach Bureau of Building and Safety and will include recommendations for specific building locations and designs, including those pertaining to site preparation, fills and compaction, foundations, etc.

d. Analysis of Project Impacts

(1) Seismic Ground Shaking

As described above, the Project Site is located within the seismically active region of Southern California. The Newport–Inglewood fault and the Palos Verdes fault are the nearest faults to the Project Site, located approximately 0.3 mile northeast and approximately 8.1 miles southwest of the Project Site, respectively. As with other development projects in the Southern California region, the Project would comply with the current seismic design provisions of the California Building Standards Code to minimize seismic impacts. The California Building Standards Code incorporates the latest seismic design standards for structural loads and materials as well as provisions from the National Earthquake Hazards Reduction Program to mitigate losses from an earthquake and provide for the latest in earthquake safety. Additionally, the Project would be required to adhere to the seismic safety requirements contained in the Long Beach Building Code (Title 18), which incorporates by reference the California Building Standards Code, with City amendments for additional requirements. The Project also would be required to comply with the site plan review and permitting requirements of the Long Beach Development Services, including the recommendations provided in a final, site-specific geotechnical report subject to review and approval by the Long Beach Bureau of Building and Safety, as provided in Project Design Feature D-1, above. Through compliance with regulatory requirements and site-specific geotechnical recommendations, the Project would not cause or accelerate geologic hazards related to strong seismic ground shaking, which would result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury. Therefore, impacts related to strong seismic ground shaking would be less than significant.

(2) Seismic-Related Ground Failure and Soil Stability

(a) Liquefaction

As previously discussed, according to the California Geological Survey Seismic Hazards Zones Maps and the Long Beach General Plan Seismic Safety Element, the Project Site is located within an area considered susceptible to liquefaction. Based on the Geotechnical Report and the 2010 Geotechnical Evaluation, the existing soil conditions

within the Project Site are potentially liquefiable during a strong earthquake event. Therefore, impacts associated with liquefaction would be considered potentially significant.

(b) Settlement

Based on the Geotechnical Report and the 2010 Geotechnical Evaluation, due to the Project Site's location within an area susceptible to liquefaction, there is a potential for liquefaction-induced settlement within the Project Site. In addition, potential compressible natural soils and undocumented fills underlying the Project Site could pose a risk of adverse settlement under static loads imposed by new foundations and structures. Therefore, impacts associated with settlement would be potentially significant.

(c) Lateral Spreading

As previously discussed, the soil layers beneath the Project Site were determined to have an adequate factor of safety against lateral spreading. Therefore, impacts associated with lateral spreading would be less than significant.

(d) Subsidence

Based on the City of Long Beach Seismic Safety Element, the Project Site is not located within an area of known ground subsidence. In addition, no large-scale extraction of groundwater, gas, oil, or geothermal energy occurs or is planned at the Project Site. Therefore, there is little to no potential for ground subsidence at the Project Site, and impacts would be less than significant.

(3) Expansive Soils

The near-surface soils are mainly sand and, therefore, their expansion potential is considered low. Additionally, previous testing performed as part of the 2005 Geotechnical Investigation concluded the near-surface soils generally exhibit a low expansion potential. As such, impacts related to expansive soils would be less than significant.

4. Cumulative Impacts

Due to the site-specific nature of geological conditions (i.e., soils, geological features, subsurface features, seismic features, etc.), geology impacts are typically assessed on a project-by-project basis. Nonetheless, cumulative growth in the Project area, inclusive of the six related projects identified in Section III, Environmental Setting, of this Draft EIR, would expose a greater number of people to seismic hazards. However, as with the Project, related projects and other future development projects would be subject to established guidelines and regulations pertaining to building design and seismic safety,

including those set forth in the California Building Standards Code and the Long Beach Building Code, and mitigation would be implemented, as required. With adherence to applicable regulations, Project impacts with regard to geology and soils would not be cumulatively considerable, and cumulative impacts with regard to geology and soils would be less than significant.

5. Mitigation Measures

Mitigation Measure D-1: The Project shall incorporate site-specific ground improvement requirements as a result of liquefaction and liquefaction-induced settlement set forth in a final, site-specific geotechnical report. Such requirements could include, but would not be limited to, stone columns, ramped aggregate piers, or deep soil mixing that would improve the strength of soils and/or provide drainage paths for pore water pressure dissipation. Following ground improvement, the proposed structures may be supported on a conventional shallow foundation system. As an alternative, the proposed structures may be supported on a deep foundation system that extends through liquefiable zones into competent material.

Mitigation Measure D-2: Soils on-site shall be treated according to the recommendations of a final, site-specific geotechnical report to reduce differential settlement to 0.5 inch over a horizontal distance of 30 feet and 1 inch over the entire building footprint. The zone of ground improvement shall cover the structure footprints and extend a minimum horizontal distance of 10 feet beyond the footprints, where feasible, if a mat foundation is used. If a conventional shallow foundation system is used, closely spaced ground improvement shall be incorporated within the footprint of the footings.

6. Level of Significance After Mitigation

Impacts related to subsidence and expansive soils would be less than significant, and no mitigation would be required. With compliance with all applicable regulations, including California Building Standards Code and Long Beach Building Code requirements, as well as implementation of Project Design Feature D-1, Project-level impacts with regard to seismic ground shaking would be less than significant. With implementation of Mitigation Measure D-1 and Mitigation Measure D-2, potential impacts associated with liquefaction and settlement would be reduced to a less than significant level. Cumulative impacts related to geology and soils would be less than significant.