5.4 GEOLOGY AND SOILS

This section of the Draft Environmental Impact Report (DEIR) evaluates the potential for implementation of the Beach Boulevard Specific Plan (Proposed Project) to impact geological and soil resources in the City of Anaheim.

5.4.1 Environmental Setting

Regulatory Setting

California Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was signed into state law in 1972. Its primary purpose is to mitigate the hazard of fault rupture by prohibiting the location of structures for human occupancy across the trace of an active fault. The act delineates "Earthquake Fault Zones" along faults that are "sufficiently active" and "well defined." The act also requires that cities and counties withhold development permits for sites within an earthquake fault zone until geologic investigations demonstrate that the sites are not threatened by surface displacement from future faulting. Pursuant to this act, structures for human occupancy are not allowed within 50 feet of the trace of an active fault.

Seismic Hazard Mapping Act

The Seismic Hazard Mapping Act (SHMA) was adopted by the state in 1990 to protect the public from the effects of nonsurface fault rupture earthquake hazards, including strong ground shaking, liquefaction, seismically induced landslides, or other ground failure caused by earthquakes. The goal of the act is to minimize loss of life and property by identifying and mitigating seismic hazards. The California Geological Survey (CGS) prepares and provides local governments with seismic hazard zone maps that identify areas susceptible to amplified shaking, liquefaction, earthquake-induced landslides, and other ground failures. SHMA requires responsible agencies to only approve projects within seismic hazard zones following a site-specific investigation to determine if the hazard is present, and if so, the inclusion of appropriate mitigation. In addition, the SHMA requires real estate sellers and agents at the time of sale to disclose whether a property is within one of the designated seismic hazard zones

California Building Code

Current law states that every local agency enforcing building regulations, such as cities and counties, must adopt the provisions of the California Building Code (CBC) within 180 days of its publication. The publication date of the CBC is established by the California Building Standards Commission, and the code is also known as Title 24, Part 2 of the California Code of Regulations. The most recent building standard adopted by the legislature and used throughout the state is the 2016 version of the CBC (effective January 1, 2017), often with local, more restrictive amendments that are based on local geographic, topographic, or climatic conditions. These codes provide minimum standards to protect property and public safety by regulating the design and construction of excavations, foundations, building frames, retaining walls, and other building elements to mitigate the effects of seismic shaking and adverse soil conditions. The CBC contains

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provisions for earthquake safety based on factors including occupancy type, the types of soil and rock onsite, and the strength of ground shaking with specified probability of occurring at a site.

Natural Hazards Disclosure Act

The Natural Hazards Disclosure Act requires that sellers of real property and their agents provide prospective buyers with a "Natural Hazard Disclosure Statement" when the property being sold lies within one or more state-mapped hazard areas, including a Seismic Hazard Zone. California law also requires that when houses built before 1960 are sold, the seller must give the buyer a completed earthquake hazards disclosure report and a booklet titled "The Homeowners Guide to Earthquake Safety." This publication was written and adopted by the California Seismic Safety Commission.

Soils Investigation Requirements

Requirements for soils investigations for subdivisions requiring tentative and final maps and for other specified types of structures are in California Health and Safety Code, Sections 17953 to 17955, and in Section 1802 of the CBC. Testing of samples from subsurface investigations is required, such as from borings or test pits. Studies must be done as needed to evaluate slope stability, soil strength, position and adequacy of load-bearing soils, the effect of moisture variation on load-bearing capacity, compressibility, liquefaction, differential settlement, and expansiveness.

Regional Geologic Setting

The City of Anaheim is situated in the Peninsular Ranges Geomorphic Province. This geomorphic province encompasses an area that extends approximately 900 miles from the Transverse Ranges and the Los Angeles Basin in the north to the southern tip of Baja California (Norris and Webb 1990). The province varies in width, from approximately 30 to 100 miles. In general, the province consists of a northwest-southeast-oriented complex of blocks separated by similarly trending faults. The basement bedrock complex includes Jurassic age metavolcanic and metasedimentary rocks, and Cretaceous age igneous rocks of the Southern California batholith.

The Project Area is on the Downey Plain within the Coastal Plain of Orange County. The general cross-section of the Coastal Plain of Orange County consists of a broad, deep, alluvial basin bounded by hills and mountains to the north and east and by the Pacific Ocean to the south and southwest (CDWR 1967). In general, Holocene and late Pleistocene alluvia are encountered beneath the Project Area.

Faulting and Seismicity

The City of Anaheim is in an area considered seismically active, as is most of southern California. Major active fault zones are southwest and northeast of the City. Based on review of the referenced geologic and seismic literature, there are no known Alquist-Priolo Earthquake Fault Zones in the City limits.

Active and potentially active faults are close to Anaheim (see Figure 5.4-1, *Regional Fault Location Map*). The Peninsular Ranges Province is traversed by a group of almost-parallel fault zones trending roughly northwest. Major fault systems include the active San Andreas, San Jacinto, Whittier-Elsinore, and Newport-Inglewood fault zones, which form a regional tectonic framework of primarily right-lateral, strike-slip movement. The City of Anaheim is situated between two major, active fault zones: the Newport-Inglewood Fault Zone to the southwest and the Whittier-Elsinore Fault Zone to the northeast. Another potentially active fault in close proximity to the study area is the Norwalk fault. A brief description of these local faults is presented below.

Newport-Inglewood Fault Zone

The Newport-Inglewood Fault Zone, source of the 1933 Long Beach earthquake (magnitude 6.3), consists of a series of disconnected, northwest-trending fault segments that extend from Los Angeles through Long Beach and Torrance to Newport Beach (Bilodeau et al. 2007; CDWR 1967). From Newport Beach, the fault zone continues offshore southeasterly past Oceanside. The Newport-Inglewood Fault Zone is the closest major fault and passes within seven miles southwest of the Project Area. No historical (1769 to present) evidence exists for tectonic fault rupture along fault traces in the Newport-Inglewood Fault Zone in Orange County (Jennings and Bryant 2010). The most recent evidence for near-surface movement during Holocene time is displacement of the Holocene Bolsa aquifer in the vicinity of Bolsa Chica Gap (CDWR 1967). Borehole evidence combined with groundwater pumping tests, piezometric levels, and geophysical data indicate that the North Branch and the Bolsa-Fairview traces of the Newport-Inglewood Fault Zone offset the base of the Bolsa aquifer by 20 feet and 10 feet (vertical separation) respectively (Ninyo & Moore 2001). Although no onshore surface fault rupture has taken place in historical time (since 1769), the fault zone is considered capable of generating an earthquake of magnitude 6.9.

Whittier-Elsinore Fault

The Whittier-Elsinore Fault Zone is one of the largest major fault systems in Southern California. The Elsinore Fault Zone extends from near the United States-Mexico border northwest to the northern Santa Ana Mountains just east of the City limits. At the northern end, the zone of mapped faults branches into two segments west and east, the Whittier Fault and the Chino-Central Avenue Fault.

The northern portion of the Elsinore Fault Zone is also referred to as the Glen Ivy segment (CDMG 1998). The Glen Ivy segment is zoned under the Alquist-Priolo Earthquake Fault Zone Act. Dominant movement along the fault is right-lateral strike-slip. The Glen Ivy segment could produce a maximum moment magnitude 6.8 earthquake (CDMG 1998). From the northern end of the Glen Ivy segment, the mapped zone of faulting is fragmented into a zone of discontinuous northwestern-trending faults along the eastern side of the Santa Ana Mountains in Riverside. The faults branch into the Whittier and Chino-Central Avenue faults near the Santa Ana River.

The Whittier Fault Zone extends approximately 24 miles from Whittier Narrows in Los Angeles County, southeast to Santa Ana Canyon, where it merges with the Elsinore Fault Zone. The Whittier Fault Zone averages 1,000 to 2,000 feet in width and is made up of many fault splays that merge and branch along their courses. The Whittier Fault Zone does not extend inside the City boundaries, but approaches to within less than a mile of the northeastern corner of the City. Available information indicates that the Whittier Fault

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Zone is active and may be capable of generating an earthquake of magnitude 6.8 accompanied by surface rupture along one or more of its fault traces. The Whittier Fault is zoned under the Alquist-Priolo Earthquake Fault Zone Act north of the City.

The Chino-Central Avenue Fault branches away from the Elsinore (Glen Ivy) Fault and extends northwest for approximately 13 miles through the Prado Basin and into the Puente Hills. Dominant movement along the fault is right-reverse oblique slip. The Chino Fault could produce a maximum moment magnitude 6.7 earthquake (CDMG 1998).

Norwalk Fault

The Norwalk Fault is buried beneath Holocene alluvial deposits, but has been recognized from subsurface oil- and water-well data. The Norwalk Fault extends from Norwalk in Los Angeles County to the south edge of the West Coyote Hills just north of the City limits (CDWR 1967). The "Whittier" earthquake of 1929 was attributed to the Norwalk Fault by Charles Richter. The offset of Holocene deposits or the presence of geomorphic features, which would suggest the fault is active, have not been established (Ninyo & Moore 2001). It should be noted that because the fault is buried, data regarding its location is approximate and in some areas inconclusive. The Norwalk Fault is not currently zoned under the Alquist-Priolo Earthquake Fault Zone Act.

Strong Ground Motion

Seismic activity along nearby or more-distant fault zones is likely to cause ground shaking in the City. The distances to active faults within 30 miles of the Project Area are shown in Table 5.4-1. These distances represent the closest part of the listed fault to the closest geographic part of the Project Area (Jennings and Bryant 2010).

Table 5.4-1 Principal Active Faults

Fault	Approximate Distance to Project Area (miles)	Maximum Moment Magnitude Earthquake
Puente Hills Blind Thrust	6.6	7.1
Newport-Inglewood (L.A. Basin)	7.2	6.5
Elsinore – Whittier	9.0	6.8
Newport-Inglewood (offshore)	15.1	7.1
San Jose	15.3	6.9
Elsinore – Glen Ivy	18.8	6.7
Chino-Central Avenue	18.9	6.9
Palos Verdes	19.0	7.0
Sierra Madre (central)	21.4	6.5
Raymond	22.0	6.7
Verdugo	23.0	6.5
Clamshell – Sawpit	23.5	6.5
Hollywood	25.0	6.7
Cucamonga	27.7	7.0

Source: Jennings and Bryant 2010.

Figure 5.4-1 - Regional Fault Location Map

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Beach Boulevard Specific Plan

Fault Line

County Boundaries

City of Anaheim

County Boundaries

Note: All fault locations and dimensions are approximate and not all faults are shown.

0 20
Scale (Miles)

Source: California Department of Mines and Geology. Preliminary fault activity map of California, 1994.

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Geologic Hazards

Expansive Soils

Expansive soils shrink or swell as the moisture content decreases or increases. Structures built on these soils may experience shifting, cracking, and breaking damage as soils shrink and subside or expand. Based on the presence of alluvial materials in the City, there is little potential for expansive soils. Soils observed in the Project Area are classified in the "low" range (Morton et al. 1976).

Corrosive Soils

Corrosive soils contain chemical constituents that may damage construction materials such as concrete and ferrous metals. One such constituent is water-soluble sulfate, which can react with and damage concrete. Electrical resistivity, chloride content, and pH level are all indicators of the soil's tendency to corrode ferrous metals. Based on the classification of near-surface soils as Metz loamy sand (USDA 1978), corrosive soils are not expected to be a significant potential hazard on the Project Area.

Subsidence

The phenomenon of widespread land sinking, or subsidence, is generally related to substantial overdraft of groundwater or petroleum reserves from underground reservoirs (Bawden et al. 2001). The Project Area is not in an oil field, although drinking-water wells are in the Project vicinity. Based on the lack of oil fields in the Project vicinity and the management of groundwater in the basin, subsidence is not considered to be a significant potential hazard on the Project Area.

Seismic Hazards

Historical Earthquakes

Historically, the City of Anaheim has not experienced a major destructive earthquake. However, based on a search of earthquake databases of the United States Geological Survey's National Earthquake Information Center, several major earthquakes (magnitude 5.8 or more) have been recorded within approximately 60 miles of the Project Area since 1769; the latest was the Northridge earthquake in 1994, over 45 miles from the Project Area. Table 5.4-2 summarizes the approximate magnitudes of and distances to these seismic events.

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Table 5.4-2 Historical Earthquakes

Date	Location	Maximum Magnitude (M)*	Approximate Epicentral Distance (miles)
7/28/1769	Los Angeles Basin	6.0	10
11/22/1800	San Diego Basin	6.5	52
12/8/1812	Wrightwood	7.0	41
7/11/1855	Los Angeles Region	6.0	40
12/16/1858	San Bernardino Region	6.0	23
7/30/1894	Lytle Creek Region	6.0	37
4/21/1918	San Jacinto	6.9	43
7/23/1923	San Bernardino Region	6.0	56
3/11/1933	Long Beach	6.3	16
2/9/1971	San Fernando	6.5	51
10/1/1987	Whittier Narrows	5.8	20
1/17/1994	Northridge	6.7	45

* Magnitudes listed are "summary magnitudes." Prior to 1898, these are adjusted intensity magnitudes and after 1898, are surface wave magnitudes (http://pasadena.wr.usgs.gov/info/cahist_eqs.html).

Surface (Fault) Rupture

The potential for ground rupture due to fault movement is generally related to the seismic activity of known fault zones. Recognized active fault zones are generally located outside the City of Anaheim. Earthquake fault zones (formerly known as special study zones) have been established along known active faults in California in accordance with the Alquist-Priolo Earthquake Fault Zoning Act. No active surface faults are mapped or known to cross the Project Area, and the Project Area is not in an Alquist-Priolo Earthquake Fault Zone. The potential for ground rupture due to seismic activity in the City is considered low.

Strong Seismic Ground Shaking

Earthquakes are common to southern California, and geologic evidence is used to determine the likelihood of future ruptures along a fault. The amplitudes of earthquake waves are measured on the Richter Scale. Each one-point increase in magnitude represents a tenfold increase in wave amplitude and a 32-fold increase in energy. That is, a Magnitude (M) 7 earthquake produces 100 times (10 x 10) the ground motion amplitude of an M 5 earthquake and releases over 1,000 times (32 x 32) more energy.

Peak horizontal ground acceleration (PHGA) values that could be expected at this location are based on types and characteristics of fault sources, distances and estimated maximum earthquake magnitude, and subsurface site geology. The accuracy of the PHGA estimate depends on the method used to estimate it. The maximum magnitude earthquake (M_{max}) is the largest earthquake that is expected along a fault under the current tectonic framework and is based in part on various fault characteristics (length, style of faulting, and historic seismicity). The Puente Hills Blind Thrust Fault is the dominant active fault that could be expected to significantly impact the Project Area (USGS 2008).

Amplification or deamplification of the ground motion would likely occur as it passes from the bedrock and through the softer, deep alluvial deposits of the Project Area to the ground surface. The actual estimated PHGA at surface of the Project Area would depend upon site amplification/deamplification effects, which depend substantially on the thickness of sedimentary deposits beneath the Project Area, and these are not presently known with certainty. Based on US Geological Survey amplification estimates for the Orange County area, based on a 1.0-second spectral acceleration (Field 2001), effects from the geologic units underlying the Project Area may be over three times the effect of crystalline bedrock at the same location.

The seismic design of buildings in the Project Area is governed by the requirements of the most recent CBC. All site-specific seismic design parameters must be determined based on the subsurface soil conditions encountered during a geotechnical/engineering geologic investigation.

Slope Failure (Landslides)

Landslides are perceptible downward movements of a mass of earth (soil and/or debris), rock, or combination of the two under the influence of gravity. Landslide materials are commonly porous and very weathered in the upper portions and along the margins of the slide. They may also have open fractures or joints. Slope failures can occur during or after intense rainfall or in response to strong seismic shaking. Areas of high topographic relief, such as steep canyon walls, are most likely to be impacted by slope failure. As shown in the State of California Seismic Hazard Zones, Anaheim Quadrangle map, the Project Area is not in an area likely to have earthquake-induced landslides (CGS 1998).

Liquefaction and Related Ground Failure

Liquefaction is a process whereby strong earthquake shaking causes sediment layers that are saturated with groundwater to lose strength and behave as a fluid (CGS 2008). This subsurface process can lead to near-surface or surface ground failure that can result in property damage and structural failure. If surface ground failure does occur, it is usually expressed as lateral spreading, flow failures, ground oscillation, and/or general loss of bearing strength. Sand boils (injections of fluidized sediment) commonly accompany these different types of failure. In order to determine a region's susceptibility to liquefaction, the following three factors must be analyzed:

- **The intensity and duration of ground shaking.**
- **The age and textural characteristic of the alluvial sediments.** Generally, the younger, less compact sediments tend to have a higher susceptibility to liquefaction. Textural characteristics also play a dominant role in determining liquefaction susceptibility. Sand and silty sands deposited in river channels and floodplains tend to be more susceptible to liquefaction than coarser or finer grained alluvial materials.
- **The depth to the groundwater.** Groundwater saturation of sediments is necessary for earthquake-induced liquefaction. In general, groundwater shallower than 10 feet to the surface cause the highest liquefaction susceptibility.

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Research and historical data indicate that loose, granular materials at depths of less than 50 feet, with silt and clay contents of less than 30 percent, and saturated by relatively shallow groundwater are most susceptible to liquefaction (CGS 2008). These geological conditions are typical in parts of southern California, including Anaheim, and in valley regions and alluvial floodplains. Based on a review of a CGS seismic hazard map, there is a potential for liquefaction in the Project Area (CGS 1998).

Hazardous Buildings

The principal threat in an earthquake is not limited to ground shaking, fault rupture, or liquefaction, but includes the damage to buildings that house people or an essential function. Continuing advances in engineering design and building code standards over the past decades have greatly reduced the potential for collapse during an earthquake in most new buildings. However, many buildings were built before some of the earthquake design standards were incorporated into the building code. Several specific building types are a particular concern in this regard.

- **Unreinforced Masonry Buildings:** In the late 1800s and early 1900s, unreinforced masonry was the most common type of construction for larger downtown commercial structures and for multi-story apartment and hotel buildings. These were recognized as a collapse hazard following the San Francisco earthquake of 1906, the Santa Barbara earthquake of 1925, and again in the aftermath of the Long Beach earthquake of 1933. These buildings are recognized as the most hazardous buildings in an earthquake. Per Senate Bill 547, local jurisdictions are required to enact structural hazard reduction programs by (a) inventorying pre-1943 unreinforced masonry buildings, and (b) developing mitigation programs to correct the structural hazards.

- **Precast Concrete Tilt-up Buildings:** This building type was introduced following World War II and gained popularity in light industrial buildings during the late 1950s and 1960s. Extensive damage to concrete tilt-up buildings in the 1971 San Fernando earthquake revealed the need for better anchoring of walls to the roof, floor, and foundation elements of the building and for stronger roof diaphragms.[1] In the typical damage to these buildings, the concrete wall panels would fall outward and the roof would collapse.

- **Soft-Story Buildings:** Soft-story buildings are those in which at least one story, commonly the ground floor, has significantly less rigidity and/or strength than the rest of the structure. This can form a weak link in the structure unless special design features are incorporated to give the building adequate structural integrity. Typical examples of soft-story construction are buildings with glass curtain walls on the first floor only, or buildings placed on stilts or columns, leaving the first story open for landscaping, street-friendly building entry, parking, or other purposes. From the early 1950s to early 1970s, soft-story buildings were a popular construction style for low- and midrise concrete frame structures.

- **Nonductile Concrete Frame Buildings:** The brittle behavior of nonductile concrete frame buildings can create major damage and even collapse under strong ground shaking. This type of construction,

1 A roof diaphragm is a structural roof deck that is capable of resisting shear that is produced by lateral forces, such as wind or seismic loads.

which generally lacks masonry shear walls, was common in the very early days of reinforced concrete buildings, and they continued to be built until the codes were changed in 1973 to require ductility in the moment-resisting frame. Large numbers of these buildings were built for commercial and light industrial use in California's older, densely populated cities. Although many of these buildings have four to eight stories, there are many in the lower height range. This category also includes one-story parking garages with heavy concrete roof systems supported by nonductile concrete columns.

5.4.2 Thresholds of Significance

According to Appendix G of the CEQA Guidelines, a project would normally have a significant effect on the environment if the project would:

G-1 Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

i) 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 Geology Special Publication 42.)

ii) Strong seismic ground shaking.

iii) Seismic-related ground failure, including liquefaction.

iv) Landslides.

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

G-3 Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse.

G-4 Be located on expansive soil, as defined in Section 1803.5.3 of the California Building Code (2016), creating substantial risks to life or property.

G-5 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.

The Initial Study, included as Appendix A, substantiates that impacts associated with the following thresholds would be less than significant:

- Threshold G5

This impact will not be addressed in the following analysis.

5.4.3 Environmental Impacts

The following impact analysis addresses thresholds of significance. The applicable thresholds are identified in brackets after the impact statement.

Impact 5.4-1: Buildings and people in the Project Area would be subjected to potential seismic-related hazards. [Thresholds G-1 and G-3]

Impact Analysis: The intensity of ground shaking at a given location depends on several factors, but primarily on the earthquake magnitude, the distance from the epicenter to the site of interest, and the response characteristics of the soils or bedrock units underlying the site. The Whittier–Elsinore and Newport–Inglewood faults are potentially capable of producing the most intense ground accelerations at the Project Area, given that they are the closest faults. In southern California, there is no way to avoid earthquake hazards. However, appropriate measures to mitigate and minimize the effects of earthquakes are in the 2016 CBC, with specific provisions for seismic design. The CBC has been accepted as the basic design standard in the City of Anaheim and Orange County. The design of structures in accordance with the CBC is expected to minimize the effects of ground shaking to the greatest degree feasible and to less than significant levels except for a catastrophic seismic event.

Secondary effects of earthquakes are nontectonic processes such as ground deformation, including fissures; settlement; displacement; and loss of bearing strength, and these are the leading causes of damage to structures during a moderate to large earthquake. Secondary effects leading to ground deformation include liquefaction, lateral spreading, seismically induced landslides, and ground lurching.

Liquefaction

Research and historical data indicate that loose, granular materials at depths of less than 50 feet, with silt and clay contents of less than 30 percent, and saturated by relatively shallow groundwater table are most susceptible to liquefaction. These geological conditions are typical in parts of southern California, including Anaheim (Anaheim GP 2004), and in valley regions and alluvial floodplains. Groundwater was observed in 1997 to be less than 10 feet below ground surface throughout the Project Area (OC Water District 2015). All of the Project Area is expected to be susceptible to liquefaction.

The Project Area is in a Zone of Required Investigation for Liquefaction, as shown on the State of California Seismic Hazard Zones, Anaheim Quadrangle map, reissued in April 1998. Although liquefaction is expected, because of mandatory compliance with SHMA that requires a site-specific investigation and compliance with existing regulations, liquefaction impacts to any new developments in the Project Area would be reduced to a less than significant level.

Landslides

Marginally stable slopes (including existing landslides) may be subject to landslides caused by earthquakes. The landslide hazard depends on many factors, including existing slope stability, shaking potential, and presence of existing landslides. The terrain of the Project Area is relatively flat. Therefore, landslides are not expected to impact the Project Area.

Lateral Spreading

Lateral spreading is a phenomenon where large blocks of intact, nonliquefied soil move downslope on a liquefied substratum. The mass moves toward an unconfined area, such as a descending slope or stream-cut bluff, and has been known to move on slope gradients as little as one degree. Although a liquefaction-induced lateral spread landslide is unlikely because there does not appear to be a "free-face" adjacent to the Project Area, this should be evaluated on a site-specific basis. Site-specific mass grading and compaction that would occur as part of development in the Project Area would mitigate any potential impacts from seismically induced lateral spreading.

Settlement, Subsidence, and/or Collapse

The potential hazard posed by seismic settlement and/or collapse in the Project Area is considered moderate based on the compressibility of the underlying alluvial soils and the presence of shallow groundwater. Strong ground shaking can cause settlement of alluvial soils underlying the site by allowing sediment particles to become more tightly packed. Alluvial deposits are especially susceptible to this phenomenon. Artificial fills, if not adequately compacted, may also experience seismically induced settlement. Because unconsolidated soils and undocumented fill material are present in the Project Area, seismically induced settlement and/or collapse are potential impacts.

Subsidence of basins attributed to overdraft of groundwater aquifers or overpumping of petroleum reserves has been reported in various parts of southern California. Although groundwater withdrawal in the Project vicinity has led to lowered groundwater levels, it has not been excessive. Dewatering may be necessary during grading and construction of new developments in the Project Area, although this would not result in overpumping of the groundwater system.

Site-specific mass grading and compaction that would occur as part of future development in the Project Area would mitigate any potential impacts of seismically induced settlement and/or collapse.

Ground Lurching

Seismically induced ground lurching occurs when soil or rock masses move at right angles to a cliff or steep slope in response to seismic waves. Structures built on these masses can experience significant lateral and vertical deformation from ground lurching. The Project Area is on relatively flat terrain, and the potential for ground lurching is considered low. Therefore, no significant adverse impact related to ground lurching is anticipated.

Impact 5.4-2: Unstable geologic unit or soils conditions, including soil erosion, could result due to development of the Proposed Project. [Thresholds G-2 and G-3]

Impact Analysis: Soils in the Project Area have already been disturbed by development. Therefore, the loss of topsoil is not a potential impact. Soils in the Project Area are particularly prone to erosion during the grading phase of development, especially during heavy rains. Reduction of the erosion potential can be accomplished through a Storm Water Pollution Prevention Plan, which specifies best management practices for temporary erosion controls. Such measures typically include temporary catchment basins and/or sandbagging to control runoff and contain sediment transport within the Project Area. A comprehensive discussion of erosion can be found in Section 5.7, *Hydrology and Water Quality*. As identified in Section 5.7, all construction projects that involve the disturbance of one or more acres of land are subject to requirements for implementation of individual Storm Water Pollution Prevention Plans. Compliance with these requirements would reduce potential erosion impacts to a level that is less than significant.

Impact 5.4-3: Soil conditions could result in risks to life or property. [Thresholds G-1iii and iv, G-2, G-3 and G-4]

Impact Analysis: Highly expansive soils swell when they absorb water and shrink as they dry and can cause structural damage to building foundations and roads. Thus, they are less suitable for development than nonexpansive soils. The Project Area is known to have a low potential for expansive soils. The presence of expansive soils in areas proposed for construction would be considered a potentially significant impact. Construction techniques that address expansive soils include deepened foundations, post-tension foundations, and moisture conditioning. Anaheim implements a number of codes and policies that mitigate the impacts of development in areas with expansive soils. Current codes and regulations relating to geology and soils are in the Anaheim Municipal Code, Title 17, Land Development and Resources. These codes address grading, excavation, fills, and water courses as well as applicable geotechnical report preparation and submittal. Application of the existing regulations in the Municipal Code, CBC, and grading regulations would minimize the risk associated with any development proposed in areas with expansive soils. Compliance with the current codes and policies would reduce potential impacts associated with expansive soils to a less than significant level.

5.4.4 Cumulative Impacts

Geology and soils impacts related to future development in the Project Area would involve hazards related to site-specific soil conditions, erosion, and ground-shaking during earthquakes. The impacts on each site would be specific to that site and its users and would not be common or contribute to the impacts (or shared with, in an additive sense) on other sites. In addition, development on each site would be subject to existing regulations and standards that are designed to protect public safety. Therefore, cumulative geology and soils impacts would be less than significant.

5.4.5 Existing Regulations and Standard Conditions

- Alquist-Priolo Earthquake Fault Zoning Act (California Public Resources Code Sections 2621 et seq.)
- Seismic Hazards Mapping Act (California Public Resources Code Section 2695)
- California Building Code (CBC; Title 24, California Code of Regulations [CCR], Part 2)

- Unreinforced Masonry Law (California Government Code Sections 8875 et seq.)
- Natural Hazards Disclosure Act (California Civil Code Sections 1103 et seq.; California Public Resources Code Section 2694)
- National Pollutant Discharge Elimination System (NPDES) General Permit for Discharges of Storm Water Associated with Construction Activity (Order 2009-0009-DWQ, State Water Resources Control Board)
- California Health and Safety Code Sections 17953 to 17955 and CBC Section 1802: Requirements for Geotechnical Investigation
- California Code of Regulations Title 24 Part 5: California Plumbing Code
- South Coast Air Quality Management District Rules 403 and 403.2: Fugitive Dust Control
- Anaheim Municipal Code, Title 17, Land Development and Resources: Requirements for grading operations.

5.4.6 Level of Significance Before Mitigation

Upon implementation of regulatory requirements and standard conditions of approval, the following impacts would be less than significant: 5.4-1, 5.4-2, and 5.4-3.

5.4.7 Mitigation Measures

No mitigation measures are necessary.

5.4.8 Level of Significance After Mitigation

No significant impacts related to geology and soils have been identified. No significant and unavoidable impacts are anticipated.

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