4.4 GEOLOGY

This section addresses impacts related to geologic hazards. Impacts related to seismic ground shaking, liquefaction, subsidence, and lateral spreading.

4.4.1 Setting

a. Regional Geology. The project site is located along the southern edge of the Transverse Ranges Geomorphic Province, immediately adjacent to the northern end of the Los Angeles Basin. The Los Angeles Basin is a lowland coastal plain 80 kilometers (50 miles) long by 32 kilometers (20 miles) wide that slopes gradually southward and westward toward the Pacific Ocean. The coastal plain overlies a structural trough filled with a thick sequence of early Cenozoic[1] through Holocene marine and nonmarine sediments deposited as the basin subsided. Youngest sediments include alluvium deposited by the Los Angeles River.

The Los Angeles Basin occupies the intersection of the north-northwest trending Peninsular Ranges Geomorphic Province and the east-west trending Transverse Ranges Geomorphic Province. The Peninsular Ranges are characterized by a series of mountain ranges and intervening valleys that extend from Los Angeles to Baja California. The Transverse Ranges, which form the northern boundary of the Los Angeles Basin, extend from Point Arguello eastward to the Joshua Tree National Monument, where they merge with the Mojave and Colorado deserts.

Southern California seismicity is dominated by the intersection of the north-northwest trending San Andreas fault system and the east-west trending Transverse Ranges fault system. The orientation and activity of both fault systems have resulted from strain that is produced by the relative motions of the Pacific and North American Tectonic Plates. This strain is relieved by right-lateral[2] strike-slip faulting on the San Andreas and related faults and by vertical, reverse-slip or left-lateral strike-slip displacement on faults in the Transverse Ranges. Effects of this structural deformation include mountain building, basin development, widespread regional uplift, and earthquake generation.

The faulting and seismicity of Southern California is dominated by the compressionary regime associated with the "Big Bend" of the San Andreas Fault Zone. The San Andreas Fault Zone separates two of the major tectonic plates that comprise the Earth's crust. West of the San Andreas Fault Zone lies the Pacific Plate, which is moving in a northwesterly direction relative to the North American Plate, which is east of the San Andreas Fault Zone. This relative movement between the two plates is the driving force of fault ruptures in western California. The San Andreas Fault generally trends northwest-southeast. However, north of the Transverse Ranges Province, the fault trends more in an east-west direction (the Big Bend),

[1] The Cenozoic era spans the time from 66 to 1.6 million years ago. The Quaternary period spans the time from 1.6 million years ago to the present. The Holocene, or Recent, epoch spans the end of the Quaternary period, from 11,000 years ago to the present.
[2] A strike-slip fault is a fault separating blocks of rock that slide past each other horizontally. A right-lateral strike-slip fault is a strike-slip fault on which the displacement of the more distant block is to the right when viewed from either side. On a left-lateral fault the displacement is in the opposite direction. A reverse-slip fault is a fault that dips at an angle below the surface on which the overhanging block of rock slides upward over the underlying block.

causing the fault's right-lateral strike-slip movement to produce north-south compression between the two plates. This compression has produced rapid uplift of many of the mountain ranges in Southern California. North-south compression in southern California has been estimated to be 5 to 20 millimeters per year (SCEC, 1995).

Associated with the rapid uplift of the mountains surrounding the Coastal Plain of the Los Angeles Basin is rapid sedimentation of the basin. Quaternary age (within the last 1.6 million years) unconsolidated and semi-consolidated sediments are over 1,000 feet thick in some localities of the Coastal Plain. The Quaternary sediments are underlain by Tertiary (1.6 to 65 million years old) age rocks. The Tertiary material is principally composed of marine sediments of the Pico, Repetto, Monterey, and Topanga formations that filled the basin when it was below sea level.

b. Site Geology. The project site is situated approximately one mile west of the Los Angeles River. The river flows through a narrow floodplain between the Elysian Park and Repetto hills, and continues southward across the basin. Approximately 1.5 miles northeast of the project area, the Arroyo Seco joins the river at the base of Elysian Park Hills, near Glendale Junction.

The project site is relatively flat. The site slopes very gently in an east-southeasterly direction toward the Los Angeles River, at a less than 1% slope gradient. Surface elevation is about 280 feet above mean sea level. The project site is located within the Transverse Ranges Geomorphic Region of California, characterized by east-west trending Santa Monica Mountains/Puente Hills ranges. The foothills, referred to in geologic references as Elysian Park and Repetto hills, are comprised predominately of Pliocene Fernando and Upper Miocene Puente marine sedimentary formations. The Transverse Ranges Region is also characterized by a series of northeast-southwest trending faults associated with the San Andreas Fault system.

Local geology of the site vicinity consists of Quaternary alluvium associated with the river narrows and floodplain. The river plain is approximately two miles wide in the project area. The river is flanked on the east and west by terraces and low rolling hills (Elysian Park and Repetto hills) of the Puente and Fernando bedrock formations. Alluvial sediments consist primarily of river sand (generally well sorted, with little or no fines), with lenses of gravel and cobbles.

Underlying bedrock is moderately cemented siltstone of marine origin. According to California Department of Water Resources Bulletin 104, bedrock lies beneath alluvium at a depth of approximately 80 to 100 feet. Union Station Oil Field is immediately south or west of project site components. Therefore, bedrock in the area could be petroliferous, exhibiting a natural oily stain and odor.

Most, if not all, soils within the project area have been modified and disturbed by grading and earthmoving associated with previous land uses. Therefore, it is unlikely that undisturbed native soils are present on the project site. The site consists of varying thickness of artificial fill underlain by mainly sands, with varying amounts of silts, gravels, and cobbles that overlie bedrock of marine origin. Soil contamination is discussed in Section 4.5, *Hazards and Hazardous Materials*.

Groundwater in the site vicinity is present within alluvial sediments. Groundwater in the Los Angeles River floodplain is recharged from percolating precipitation and from the river itself (where the river bed is not completely lined with concrete) flowing into Quaternary alluvial fan deposits (consisting mostly of sand). Urban development covers most land surface within the site vicinity with structures and pavement, limiting recharge from precipitation.

Given the coarse-grained texture of river sediments (i.e., sand, gravel, and cobbles), large water volumes could be released when alluvial deposits are penetrated. Groundwater quality in the project area may contain organic contaminants from solvent and petroleum hydrocarbon pollution associated with industrial activities in the area. Underlying bedrock is considered essentially nonwater bearing, but is likely saturated and may yield small quantities of poor water quality.

The project site is northeast of Union Station Oil Field. Union Station Oil Field was discovered in 1967. This field is represented by a generally east-west trending anticline, a structural feature (elongated dome) that traps petroleum and related compounds (i.e., crude oil and natural gas).

Surface locations of most wells (directionally drilled wells) are along Garvey Street, south of 1st Street. Since operating well sites are outside the project site, recovery of natural resources would not be affected.

Potential geologic hazards in the site vicinity include seismic ground motion and associated ground failures. Seismic ground failures may include liquefaction, lateral spreading, and ground oscillations. In addition, a minor potential for regional subsidence may be associated with extracting oil and natural gas from Union Station Oil Field.

Specific geologic hazards are discussed below.

c. Seismic Hazards. The project site is located within the seismically active area of Southern California, but is not located in an Alquist-Priolo Earthquake hazard zone as delineated by the State of California Special Studies Zones (Los Angeles Quadrangle), effective January 1, 1977. Seismic hazards can be divided into two general categories: hazards due to surface rupture and hazards associated with ground shaking.

Potential for Surface Rupture. In general terms, an earthquake is caused when strain energy in rocks is suddenly released by movement along a plane of weakness. In some cases, fault movement propagates upward through the subsurface materials and causes displacement at the ground surface as a result of differential movement. Surface rupture usually occurs along traces of known or potentially active faults, although many historic events have occurred on faults not previously known to be active.

The California Geologic Survey (CGS) establishes criteria for faults as active, potentially active or inactive. Active faults are those that show evidence of surface displacement within the last 11,000 years (Holocene age). Potentially active faults are those that demonstrate displacement within the past 1.6 million years (Quaternary age). Faults showing no evidence of displacement within the last 1.6 million years may be considered inactive for most structures, except for critical or certain life structures. In 1972, the Alquist-Priolo Special Studies Zone Act (now known as the Alquist-Priolo Earthquake Fault Zone Act, 1994, or APEHA) was passed into law, requiring studies within 500 feet of mapped faults within a mapped Alquist-Priolo fault zone.

Surface rupture caused by movement along a fault could likely result in catastrophic structural damage to buildings constructed along the fault trace. Consequently, the State of California via the APEHA prohibits the construction of occupied "habitable" structures within the designated fault zone and it must be demonstrated that the structure does not encroach on a 50-foot setback from the fault trace. Per the Alquist-Priolo legislation, no structure for human occupancy is permitted on the trace of an active fault. The term "structure for human occupancy" is defined as any structure used or intended for supporting or sheltering any use or occupancy, which is expected to have a human occupancy rate of more than 2,000 person-hours per year. Unless proven otherwise, an area within 50 feet of an active fault is presumed to be underlain by active branches of the fault. Local government agencies may identify additional faults, in addition to those faults mandated by the State, for which minimum construction setback requirements must be maintained. The project site is not located within an Alquist-Priolo zone.

<u>Potential for Ground Shaking</u>. The energy released during an earthquake propagates from its rupture surface in the form of seismic waves. The resulting strong ground motion from the seismic wave propagation can cause significant damage to structures. At any location, the intensity of the ground motion is a function of the distance to the fault rupture, the local soil/bedrock conditions, and the earthquake magnitude. Intensity is usually greater in areas underlain by unconsolidated material than in areas underlain by more competent rock.

Earthquakes are characterized by a moment magnitude, which is a quantitative measure of the strength of the earthquake based on strain energy released during the event. The magnitude is independent of the site, but is dependent on several factors, including the type of fault, rock-type, and stored energy. Moderate to severe ground shaking will be experienced in the project area if a large magnitude earthquake occurs on one of the nearby faults.

Ground shaking is primarily a function of the distance between an area and the seismic source, the type of materials underlying the site and the motion of fault displacement. In addition, the Northridge (1994) earthquake showed how peculiarities in basin effects could play a significant role in ground accelerations at particular areas. For instance, ground accelerations exceeding 1.0 g were recorded at areas far from the epicenter of the Northridge earthquake. It is possible that accelerations near or over the upper bound earthquake ground motion could occur anywhere within or adjacent to the City of Los Angeles, including the project site.

The number or frequency of large magnitude earthquakes that may occur during the life of the project cannot be reliably predicted. However, it is probable the project site will experience at least one major earthquake during the next 50 years.

The potential hazards or adverse effects of groundshaking would depend on several factors, including: the severity of ground shaking; the nature, depth, and extent of the seismic event; the type of structures involved; and the local topography. Southern California is located in an active seismic region. As such, development that occurs within the geographical boundaries of southern California has the potential of exposing people and structures to potentially substantial adverse effects involving the rupture of a known earthquake fault, strong seismic ground shaking and seismic-related ground failure. Therefore, there is potential for ground shaking on the project site.

Several active and potentially active faults are located in the greater Los Angeles region, as shown on Figure 4.4-1. Table 4.4-1 illustrates the faults nearest to the site and the maximum magnitude of those faults.

Table 4.4-1
Major Faults in the Project Site Vicinity

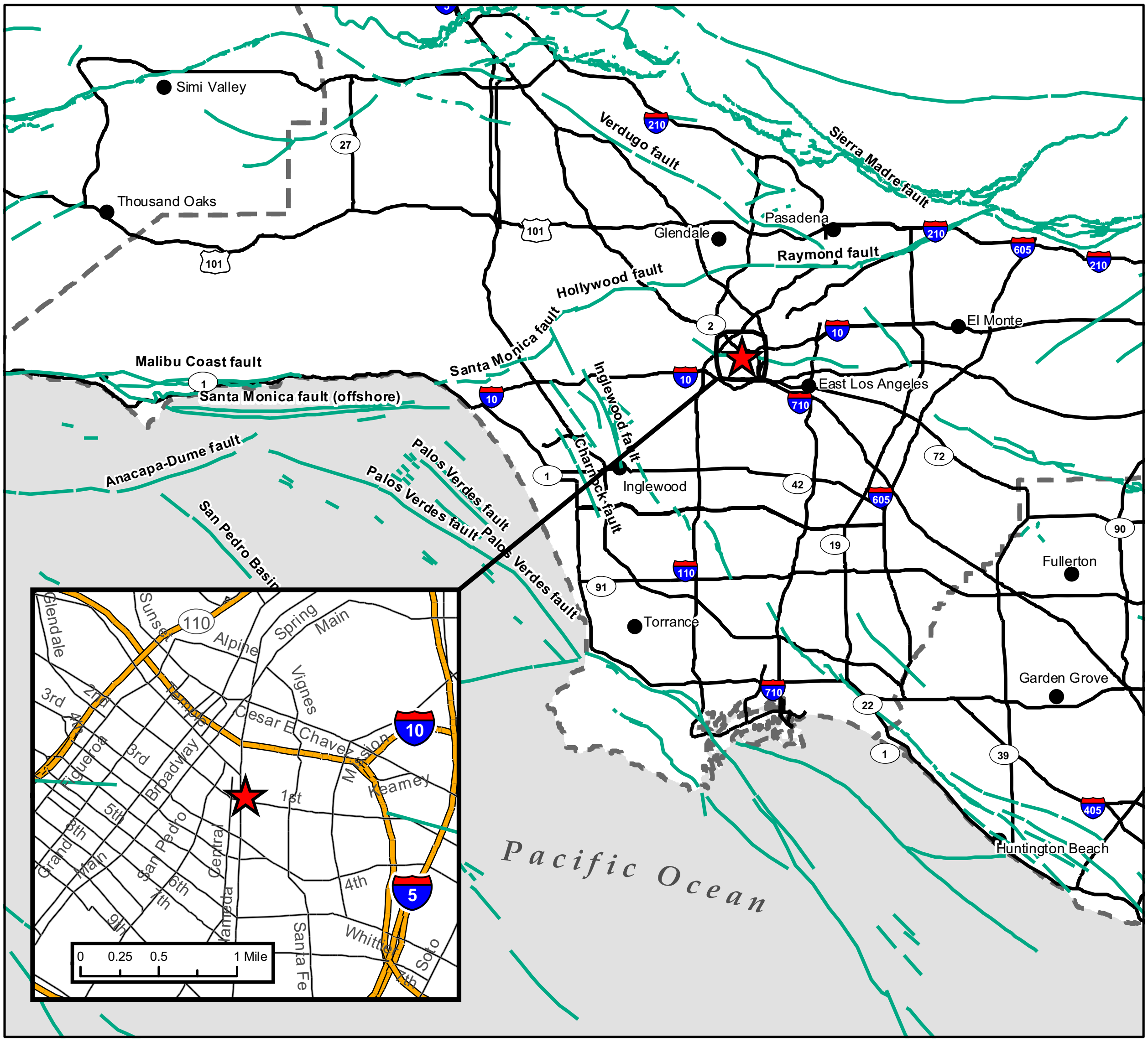
Fault	Approximate Distance (Mile)	Type of Fault	Maximum Earthquake
Hollywood	5	Reverse Oblique	6.4
Raymond	7	Reverse Oblique	6.5
Newport-Inglewood (LA Basin)	10	Strike slip	6.9
Sierra Madre	15	Reverse	7.0
Santa Monica	20	Reverse oblique	6.6

Source: Diaz-Yourman & Associates, 2003

In addition to the faults listed in Table 4.4-1, other large faults in the Southern California area have the potential to affect the site. These include the San Andreas Fault, San Gabriel Fault and other undefined large blind thrust faults.

d. Secondary Seismic Hazards from Groundshaking. Potential hazards resulting from the secondary effects of groundshaking include: liquefaction, lateral spreading, seismic settlement, and earthquake induced landslides.

Liquefaction. Soil liquefaction results from the temporary buildup of excess pore pressures, which can result in a condition of near zero effective stress and temporary loss of strength. Several factors influence a soil's potential for liquefaction during an earthquake. These factors include: magnitude and proximity of the earthquake; duration of shaking; soil types; grain size distribution; clay fraction content; density; angularity; effective overburden; location of groundwater table; cyclic loading; soil stress history; and many others. Liquefaction is more likely in poorly-graded, saturated, low-density sands. With increasing overburden, density and increasing clay-content, the likelihood of liquefaction decreases. Soils on the project site are composed of unconsolidated alluvium, which contains deposits of silt, sand, and gravel. Because liquefaction is more likely in sands, the project site could be subject to liquefaction hazards. According to the California Department of Conservation, a small portion of the project site is located within a liquefaction zone (California Department of Conservation, Divisions of Mines and Geology, 1999), as shown on Figure 4.4-2.



Source: Bryant, W.A. (compiler), 2005, Digital Database of Quaternary and Younger Faults from the Fault Activity Map of California, version 2.0: California Geological Survey Web Page, <http://www.consrv.ca.gov/CGS/information/publications/QuaternaryFaults_ver2.htm>; (1/31/07).

Regional Fault Map

Figure 4.4-1

Aerial source: Google Earth Pro, 2009.

Liquefaction Potential

Figure 4.4-2

Lateral Spreading. Lateral spreading, closely related to liquefaction, occurs when a soil mass slides laterally on a liquefied layer, and gravitational and inertial forces cause the layer, and the overlying non-liquefied material to move. The magnitude of lateral spreading movements depends on earthquake magnitude, distance between the site and the seismic event, thickness of the liquefied layer, ground slope or ratio of free-face height to distance between the free face and structure, fines content, average particle size of the materials comprising the liquefied layer, and the standard penetration rates of the materials.

Widespread lateral spreading is generally not applicable to fine-grained soils or to sandy soils where:

1) *Standard penetration values are greater than 15; and,*
2) *The standard penetration rates are less than 15 and the potentially vulnerable layer is less than 1 meter thick.*

The project site is a flat site underlain by alluvial soils consisting of deposits of silt, sand, and gravel (Dibblee, 1993). Because the project site is located on a flat site that does not contain a slope, there is no potential for lateral spreading. Therefore, impacts related to lateral spreading are less than significant.

Seismic Settlement and Lurching. Seismic settlement occurs when cohesionless materials (sands) densify as a result of ground shaking. Settlement of medium-dense sands could result from a strong earthquake even if groundwater did not rise and groundshaking did not induce liquefaction. Uniform settlement beneath a given structure would cause minimal damage; however, because of variations in distribution, density, and confining conditions of the soils, seismic-induced settlement is generally non-uniform and can cause serious structural damage. Dry and partially saturated soils as well as saturated granular soils are subject to seismic-induced settlement.

Lurch cracking is the development of ground fractures, cracks, and fissures produced by groundshaking, settlement, compaction, and sliding that can occur due to seismic ground acceleration. These features can occur if high ground accelerations affect an area. Because the project site is located in a seismically active region and because soils on the project site are composed of sand, seismic settlement and ground lurching could potentially affect the project site.

Earthquake Induced Landslides. Landslides occur when slopes become unstable and masses of earth material move downslope. The project site is flat and located within a highly urbanized area. It is not located on or adjacent to landslide-prone hillsides. Therefore, landslide hazards are not a significant concern onsite.

e. Geotechnical Hazards.

Expansive Soils. Expansive soils swell or heave with increases in moisture content and shrink with decreases in moisture content. Foundations for structures constructed on expansive soils require special design considerations (CBC, 2008). Because expansive soils can expand when wet and shrink when dry, they can cause foundations, basement walls and floors to crack, causing substantial structural damage. As such, impacts related structural failure due to the expansive soils near the ground surface would be potentially significant.

Hydroconsolidation. Hydroconsolidation occurs when soil layers collapse (settle) as water is added under loads. Natural deposits susceptible to hydroconsolidation are typically aeolian, alluvial, or colluvial materials, with high apparent strength when dry. The dry strength of the materials may be attributed to the clay and silt constituents in the soil and the presence of cementing agents (i.e., salts). Capillary tension may tend to act to bond soil grains. Once these soils are subjected to excessive moisture and foundation loads, the constituency including soluble salts or bonding agents is weakened or dissolved, capillary tensions are reduced and collapse occurs resulting in settlement. The existing alluvium may be susceptible to collapse and excessive settlements. Therefore, onsite hydroconsolidation could potentially occur.

Subsidence and Settlement. Subsidence is the sinking of the ground surface caused by the compression of soil layers. The causes range from groundwater, oil and gas withdrawal, oxidation of organics, or the placement of additional fill over compressible layers.

Subsidence involves deep seated settlement caused by the compression of soil layers due to the withdrawal of fluid (e.g. oil, natural gas, water, etc.). The settlement can be exacerbated by increased loading, such as from the construction of onsite buildings or the placement of additional fill over compressible layers. Settlement can also result solely from human activities including improperly placed artificial fill, and structures built on soils or bedrock materials with differential settlement rates. The alluvium in the project site vicinity consists of deposits of silt, sand, and gravel. Because onsite development would involve the construction of buildings, the project site could be subject to subsidence.

Existing Fill. Uncontrolled artificial fills are considered to be unsuitable for support of structures and other improvements. This is typically due to any number of reasons, which include but are not limited to: high voids that may collapse or consolidate upon loading; high organics, which decay leaving additional voids or high moisture soils which compress; inconsistent mixtures of fills that may perform differently; changes in consistency over short spans which leads to differential settlement; uneven expansion potential, which may result in differential movement of foundation elements; and lack of proper benching, which may lead to fill creep. Older controlled fills tend to be prone to hydroconsolidation, excessive settlements or creep. This is a result in the change of compaction methods and efforts (i.e., the three-layer method versus the five layer method for maximum density determinations), experience in keyways, subdrains, benching and other factors. In addition, older fills may tend to lose integrity due to several factors, including bioturbation, organic material decay, shrink swell cycles and other mechanisms that adversely affect the fills. Therefore, the custom and practice in the industry typically dictates that these types of fills not be relied on for structural support of foundations or slabs. The project site currently contains an office building and a surface parking lot. Therefore, because a soil sample has not been analyzed from the project site, the existing fill on the project site could potentially vary in thickness, density, and composition. If the project site varies in thickness, density, and composition, it may not be suitable for support of structures.

f. Regulatory Framework.

Uniform Building Code. The Uniform Building Code (UBC) is a model building code that provides the basis for the California Building Code (CBC). The UBC defines different regions of the United States and ranks them according to their seismic hazard potential (Seismic Zones 1 through 4). Zone 1 has the least seismic potential and Zone 4 has the highest. The project site is located in Seismic Zone 4.

California Building Code. California law provides a minimum standard for building design through the California Building Code (CBC). Chapter 23 contains specific requirements for seismic safety. Chapter 29 regulates excavation, foundations, and retaining walls. Chapter 33 contains specific requirements pertaining to site demolition, excavation, and construction to protect people and property from hazards associated with excavation cave-ins and falling debris or construction materials. Chapter 70 regulates grading activities, including drainage and erosion control. Construction activities are subject to occupational safety standards for excavation, shoring, and trenching as specified in California Division of Occupational Safety and Health (Cal/OSHA) regulations (Title 8 of the California Code of Regulations [CCR]) and in Section A33 of the CBC.

Alquist-Priolo Earthquake Fault Zoning Act. The Alquist-Priolo Earthquake Fault Zoning Act was signed into law in 1972. The purpose of this Act is to prohibit the location of most structures for human occupancy across the traces of active faults and to thereby mitigate the hazard of fault rupture. Under the Act, the State Geologist is required to delineate "Earthquake Fault Zones" along known active faults in California. Cities and counties affected by the zones must regulate certain development projects within the zones. They must withhold development permits for sites within the zones until geologic investigations demonstrate that the sites are not threatened by surface displacement from future faulting.

Seismic Hazards Mapping Act. The California Geologic Survey, formerly the California Department of Conservation, Division of Mines and Geology (CDMG), provides guidance with regard to seismic hazards. Under CDMG's Seismic Hazards Mapping Act (1990), seismic hazard zones are to be identified and mapped to assist local governments in land use planning. The intent of this publication is to protect the public from the effects of strong ground shaking, liquefaction, landslides, ground failure, or other hazards caused by earthquakes. In addition, CDMG's Special Publications 117, "Guidelines for Evaluating and Mitigating Seismic Hazards in California," provides guidance for the evaluation and mitigation of earthquake-related hazards for projects within designated zones of required investigations.

4.4.2 Environmental Impact Analysis

a. Methodology and Significance Thresholds. To analyze geological conditions on the project site, geological information was collected from the City of Los Angeles General Plan, geologic maps, the U.S. Geological Survey, the California Building Code, the California Geologic Survey, and the Southern California Earthquake Center. Information was compared to CEQA and City of Los Angeles thresholds to determine impacts related to groundshaking, ground failure, unstable soil, and expansive soil.

In accordance with Appendix G of the *CEQA Guidelines*, onsite development would have a significant geological impact if it would cause any of the following:

- *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;*
- *Landslides;*
- *Result in substantial soil erosion or the loss of topsoil;*
- *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.*
- *Strong seismic ground shaking*
- *Seismic-related ground failure, including liquefaction;*
- *Located on a geologic unit or soil that is 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 1-B of the Uniform Building Code, creating substantial risks to life or property.*

To determine whether a proposed project would have a significant impact to the geology of the project area, the *City of Los Angeles CEQA Thresholds Guide* provides the following threshold guidance.

- *A project would normally have a significant geologic hazard impact if it would cause or accelerate geologic hazards, which would result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury*

Impacts related to the following issues were found to be less than significant in the Initial Study (see Appendix A) prepared for the project:

- *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;*
- *Landslides;*
- *Result in substantial soil erosion or the loss of topsoil;*
- *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.*

Because the Initial Study did not identify potentially significant impacts for the issues listed above, further discussion of these issues in the EIR is not warranted. Therefore, this EIR analysis focuses on potential impacts related to:

- *Strong seismic ground shaking*
- *Seismic-related ground failure, including liquefaction;*
- *Located on a geologic unit or soil that is unstable as a result of the project, and potentially result in subsidence, liquefaction, or collapse;*

- *Be located on expansive soil, as defined in Table 1-B of the Uniform Building Code, creating substantial risks to life or property.*

b. Project Impacts and Mitigation Measures.

Impact GEO-1 **Strong to severe groundshaking could result in liquefaction, subsidence, and/or collapse, which could potentially damage onsite development, resulting in loss of property or risk to human health and safety. However, with implementation of mitigation measures GEO-1(a-b), impacts would be *significant but mitigable*.**

As discussed in the *Setting*, the project site is located on unconsolidated alluvium. Therefore, because the project site is composed of sand, silt, and gravel, the project site could be subject to liquefaction hazards. According to the California Department of Conservation, a small portion of the project site is located within a liquefaction zone (California Department of Conservation, Divisions of Mines and Geology, 1999), as shown on Figure 4.4-2.

Settlement can be exacerbated by increased loading, such as from the construction of onsite buildings or the placement of additional fill over compressible layers. Because onsite development would involve the construction of buildings, the project site could be subject to subsidence. Hydroconsolidation occurs when soil layers collapse (settle) as water is added under loads. Natural deposits susceptible to hydroconsolidation are typically aeolian, alluvial, or colluvial materials, with high apparent strength when dry. The existing alluvium may be susceptible to collapse and excessive settlements. Therefore, onsite hydroconsolidation could potentially occur.

Because there is potential for liquefaction, subsidence, and collapse during a strong to severe groundshaking event, damage to onsite structures and infrastructure could occur on the project site. Damage to structures and infrastructure could result in loss of property or risk to human health and safety. Therefore, impacts related to grading of the site and construction of onsite development are potentially significant.

Mitigation Measures. Standard City mitigation measures are required to reduce impacts to a less than significant level.

GEO-1(a) **Standard Liquefaction Requirements.** The project shall comply with the Uniform Building Code Chapter 18, Division 1, Section 1804.5, *Liquefaction Potential and Soil Strength Loss,* which requires the preparation of a geotechnical report by a registered civil engineer to the written satisfaction of the Department of Building and Safety. The geotechnical report shall assess potential consequences of any liquefaction and soil strength loss, estimation of settlement, or reduction in foundation soil-bearing capacity, and discuss mitigation measures that may include building design consideration.

Building design considerations shall include, but are not limited to: ground stabilization, selection of appropriate foundation type and depths, selection of appropriate structural systems to accommodate anticipated displacements and lateral/vertical loads, removal of unsuitable soil, or any combination of these measures.

GEO-1(b) **Subsidence**. Prior to the issuance of building or grading permits, the applicant shall submit a geotechnical report prepared by a registered civil engineer or certified engineering geologist to the written satisfaction of the Department of Building and Safety. The geotechnical report shall assess potential consequences of subsidence and include ways to avoid subsidence related impacts, such as the removal and recompaction of and loose soils that may be prone to subsidence as determined by a State of California Registered Civil Engineer.

Significance after Mitigation. Impacts related to liquefaction, subsidence, and collapse would be less than significant with the above mitigation measures.

Impact GEO-2 **Onsite soils have the potential to be expansive. However, mandatory compliance with UBC requirements, which include proper fill selection, moisture control, and compaction during construction, would reduce impacts related to expansive soils to a *less than significant level*.**

Onsite alluvium consists of silt, sand, and gravel. Expansive soils are those that are high in expansive clays or silts. Therefore, the onsite deposits that have high silt contents have the potential to be expansive.

Expansive soils are soils that swell and shrink with wetting and drying, respectively. Shrinking and swelling can cause damage to foundations, concrete slabs, flatwork, and pavement. However, onsite development would be required to comply with the current UBC, which includes provisions for construction on expansive soils. The UBC requirements include proper fill selection, moisture control, and compaction during construction, which prevent expansive soils from causing substantial damage. Expansive soils can be treated by removal (typically the upper three feet below finish grade) and replacement with low expansive soils, lime-treatment, and moisture conditioning. Mandatory compliance with UBC requirements would ensure that impacts related to expansive soils would be less than significant.

Mitigation Measures. Mitigation Measure GEO-1 in addition to mandatory compliance with UBC requirements, which require proper fill selection, moisture control, and compaction during construction, would reduce impacts related to expansive soils to a less than significant level.

Impact GEO-3 **Seismically-induced ground shaking can cause damage to structures, potentially resulting in loss of property or risk to human health and safety. Onsite development would be required to comply with UBC requirements, which address seismically-induced groundshaking. Mandatory compliance with UBC requirements would reduce impacts related to seismically-induced groundshaking to a *less than significant* level.**

The estimated maximum peak ground accelerations are on the order of 0.7g for the site from the nearby faults, based on the design level ground acceleration (10% probability of exceedance in 50 years). Earthquakes of this magnitude could potentially damage buildings and pose risks to human health and safety.

As discussed above, the project site is located within Seismic Zone 4 of the Uniform Building Code (UBC). UBC Seismic Zones are based on the probability of expected intensity of ground shaking due to an earthquake. Seismic Zone 4 corresponds to regions where expected Peak Ground Acceleration (PGA) (as a fraction of gravity, (g) is greater than 0.3g).

The probabilistic approach to forecasting future ground motion at the site determines the expected peak ground acceleration level that has a 10% probability of exceedance over the approximate lifetime of the project (typically 50 years). This approach takes into account historical seismicity, the geological slip rate of faults within 100 kilometers (62 miles) of the property, and the site-specific response characteristics.

The CGS conducted a probabilistic seismic hazard analysis for general soil and rock conditions which correspond to site categories defined by the UBC which are commonly found in California. The project site is located in Quaternary alluvium. The results of the analysis performed by the CGS for alluvium conditions at a sample location suggest a 10% probability of exceedance in 50 years ground acceleration of 0.72g (CGS, 2003).

The faults listed in Table 4.4-1 are not the only faults in the area that can produce earthquakes; however, they are the faults most likely to affect the project site. Earthquakes along these faults have the potential to produce potentially significant impacts to the proposed structure, including damage to buildings or collapse of buildings. Proper engineering, including mandatory compliance with the seismic design requirements set forth by the UBC, would minimize the risk to life and property due to seismically-induced groundshaking. Mandatory compliance would reduce impacts related to seismically-induced groundshaking to a less than significant level. Nonetheless, standard City mitigation is required.

Mitigation Measures. Mandatory compliance with UBC requirements would reduce groundshaking impacts to a less than significant level. Compliance would be assured through implementation of Measure GEO-3.

GEO-3 **Seismic Standards.** The design and construction of the project shall conform to Uniform Building Code seismic standards, which address seismically-induced groundshaking, as approved by the Department of Building and Safety.

Significance after Mitigation. Impacts related to seismic groundshaking would be less than significant with mandatory compliance of seismic design requirements set forth by the CBC.

c. Cumulative Impacts. Onsite development, in conjunction with other cumulative projects proposed in the City of Los Angeles, would expose additional people and property to seismically related hazards that are present throughout the region. If all of the development indicated in Table 3-2 (Section 3.0, *Environmental Setting*) were to proceed, individual construction projects located throughout the City and the surrounding area would add approximately 2.7 million square feet (sf) of commercial/retail, 1.8 million sf of office, 20,000 residential dwelling units, 400,000 sf of restaurant, 2,000 hotel rooms, and 200,000 sf (900 students) of institutional development. Cumulative impacts related to slope stability, destabilization of hillsides due to excavation, landsliding, seismically induced ground shaking, liquefaction, soil settlement and expansive soils would be similar to what is described for project-specific impacts, and would be addressed on a project-by-project basis through compliance with existing building codes, standard City mitigation and regulations, and any site-specific mitigation measures for individual projects. Compliance with applicable code requirements and the recommendations of site-specific geotechnical evaluations on a case-by-case basis would reduce cumulative impacts relating to geologic hazards to a less than significant level.

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