

3E. Geology

3E.1 Introduction

This analysis of geology, soils and seismicity issues relies upon geologic maps and reports available from the City of Pasadena, the California Geological Survey (CGS, formerly California Divisions of Mines and Geology), the US Geologic Survey (USGS), as well as the preliminary geotechnical engineering investigation completed for the proposed project (Preliminary Results of Ongoing Geotechnical Investigation, Proposed Geotechnical Master Plan, performed by Geotechnologies, Inc, and provided in **Appendix E**).

3E.2 Environmental Setting

Located in the northwest portion of San Gabriel Valley, the project area is situated along the border of two geomorphic provinces known as the Transverse Range, which includes the San Gabriel Mountains, and the Peninsular Ranges which include the Los Angeles Basin. The Transverse Range province is characterized by east-west ridges which run oblique to the northwest trending ridges and valleys typical of the Peninsular Ranges province. The Transverse Ranges are created through the north-south compression associated with the San Andreas Fault Zone. The City of Pasadena is located at the foot of (and extends part way into) both the San Gabriel Mountains and the San Rafael Hills, which lie to the north and west of the City, respectively. Most of the populated areas of Pasadena are located within the gently sloping valley floor that becomes the San Gabriel Valley as it extends southward. San Gabriel Valley is filled with the alluvial sediments that have drained off the San Gabriel Mountains.

The project site is located on the eastern slopes of the San Rafael Hills west of the Pasadena City center. The geologic materials that underlie the site include artificial fill, colluvium, and granitic bedrock known as the Wilson Quartz Diorite (Geotechnologies, 2003). The artificial fill is a result of mass grading efforts that were completed in 1974 and 1975 that cut several ridges and used the material to fill in canyons. The fill consists of sand and silty sand with some sand and gravel with thicknesses that range up to at least 92 feet thick (Geotechnologies, 2003).

Seismic Hazards

Seismic hazards include those hazards that could reasonably be expected to occur at the project site during a major earthquake on any of the regional active faults. Some hazards can be more severe than others, depending on the location, underlying materials, and level of ground shaking.

Surface Fault Rupture

The Pasadena area is in close proximity to both active and potentially active faults, and is considered a region of high seismic activity (see **Table 3E-1**)¹. The project site is not located

¹ An “active” fault is defined by the State of California as a fault that has had surface displacement within Holocene time (approximately the last 10,000 years). A “potentially active” fault is defined as a fault that has shown evidence of surface displacement during the Quaternary (last 1.6 million years), unless direct geologic evidence demonstrates

within an Alquist-Priolo Fault Rupture Hazard Zone (discussed below) and is therefore unlikely to experience surface fault rupture. The closest active faults to the project area are the Raymond fault, located 3.5 miles to the south, the Verdugo fault, located 5 miles to the northwest, and the Hollywood fault located 7 miles west (see Table 3E-1) (Jennings, 1994).² Other principle faults (see Table 3E-1) capable of producing significant groundshaking in the project area (based on their proximity) are the San Fernando, Newport-Inglewood, Whittier, San Andreas, Cucamonga, and San Gabriel faults.

**TABLE 3E-1
 ACTIVE FAULTS NEAR THE PROJECT AREA**

Fault (in increasing distance)	Maximum Moment Magnitude Earthquake (Mw)		Slip Rate (mm/yr.)	Distance From Site (Miles)	Direction From Site
Raymond	6.5	RO	0.5	3.5	S
Verdugo	6.8	RO	0.5	5	NW
Sierra Madre Fault Zone	7.0	RO	0.36-.4	5	NE
Hollywood	6.4	RO	1.0	7	W
San Fernando	6.7	RO	2.0	10	N
Newport-Inglewood Zone	6.9	SS	1.0	15	SW
Whittier	6.8	SS	2.5	22	SE
San Andreas (Southern Segment)	7.4	SS	24.0	25	NE
Cucamonga	7.0	RO	5.0	28	E
San Gabriel	7.0	SS	1.0	28	NW

Notes:

- SS Strike Slip: chiefly vertical faults that have shifted rocks on one side of the fault horizontally in relation to the opposite side.
- NO Normal Oblique: faults that have significant components of both strike and dip (faults that have changed the elevation of a rock mass on one side of the fault relative to the opposite mass) slips and the side above the fault is depressed.
- RO Reverse Oblique: faults that have significant components of both strike and dip slips and the side above the fault is elevated.

SOURCE: California Division of Mines and Geology, "Probabilistic Seismic Hazard Assessment for the State of California" *Open File Report 96-08*, 1996, Hart, 1997, and Jennings, 1997.

Several smaller faults have been mapped in the vicinity of the project site, including the Eagle Rock and two unnamed faults that traverse the City of Pasadena (Pasadena, 2004). However, the CGS does not consider these faults to be active, and they are therefore not zoned as Earthquake Fault Zones under the Alquist-Priolo Earthquake Fault Zoning Act.³ Activity on these faults is much less likely to occur than movement on the principal active faults.

inactivity for all of the Holocene or longer. This definition does not, of course, mean that faults lacking evidence of surface displacement are necessarily inactive. "Sufficiently active" is also used to describe a fault if there is some evidence that Holocene displacement occurred on one or more of its segments or branches (Hart, 1997).

- ² Note that although the 1994 Jennings fault activity map considers the Sierra Madre and the Hollywood faults to be active fault segments, neither faults are listed as principal active faults in the Alquist-Priolo Special Publication 42 (Jennings, 1994 and Hart, 1997).
- ³ The Alquist-Priolo Earthquake Fault Zoning Act (formerly the Alquist-Priolo Special Studies Zone Act), signed into law in December 1972, requires the delineation of zones along active faults in California. As previously noted, an *active* fault is a fault that has had surface displacement within approximately the last 11,000 years.

Ground Shaking

The 1997 Uniform Building Code locates the entire Los Angeles Basin within Seismic Risk Zone 4, which represents regions expected to experience maximum magnitudes and damage in the event of an earthquake. The estimated (moment) magnitudes shown in Table 3E-1 represent characteristic earthquakes on particular faults.⁴ While magnitude is a measure of the energy released in an earthquake, intensity is a measure of the ground shaking effects at a particular location. Ground movement during an earthquake can vary depending on the overall magnitude, distance to the fault, focus of earthquake energy, and type of geologic material. The composition of underlying soils, even those relatively distant from faults, can intensify ground shaking. The Modified Mercalli (MM) intensity scale (see **Table 3E-2**) is commonly used to measure earthquake effects due to ground shaking. The MM values for intensity range from I (earthquake not felt) to XII (damage nearly total), and intensities ranging from IV to X could cause moderate to significant structural damage.⁵ At the project site, maximum ground shaking intensity resulting from an earthquake generated on an active Los Angeles Basin fault is anticipated to be very strong to violent (MM VIII to IX) (CGS, 2007).

According to the USGS/CGS Probabilistic Seismic Hazard Assessment Model, peak ground acceleration in the project site region could reach or exceed 0.618 g (CGS, 2007). A probabilistic seismic hazard map represents the severity of ground shaking from earthquakes that geologists and seismologists agree could occur, but has a 90 percent chance of not exceeding in 50 years (an annual probability occurrence of 1 in 475). It is “probabilistic” in the sense that the analysis takes into consideration the uncertainties in the size and location of earthquakes and the resulting ground motions that can affect a particular site, and expresses the probability of exceeding a certain ground motion.⁶

Five moderate earthquakes have impacted the region in the last 60 years, including the Long Beach earthquake of 1933, the San Fernando earthquake of 1971, the Whittier Narrows earthquake of 1987, the Sierra Madre earthquake of 1991 and the recent Northridge earthquake of 1994. These earthquakes caused major damage to structures, largely due to ground shaking liquefaction (see below for more information on liquefaction).

⁴ Moment magnitude is related to the physical size of a fault rupture and movement across a fault. The Richter magnitude scale reflects the maximum amplitude of a particular type of seismic wave. Moment magnitude provides a physically meaningful measure of the size of a faulting event (CGS, 2002). The concept of “characteristic” earthquake means that we can anticipate, with reasonable certainty, the actual earthquake that can occur on a fault.

⁵ The damage level represents the estimated overall level of damage that will occur for various MM intensity levels. The damage, however, will not be uniform. Some buildings will experience substantially more damage than this overall level, and others will experience substantially less damage. Not all buildings perform identically in an earthquake. The age, material, type, method of construction, size, and shape of a building all affect its performance.

⁶ The CGS probabilistic seismic map for 10 percent probability of exceedance in 50 years represents ground motions that geologists and seismologists do not think will be exceeded in the next 50 years. This probability level of ground shaking is used for formulating building codes and designing buildings in highly active seismic areas, allowing engineers to design buildings for larger ground motions that geologists and seismologists think will occur during a 50-year interval, which makes buildings safer than if there were only designed for the ground motions that are expected to occur. Seismic shaking maps are prepared using consensus information on historical earthquakes and faults (Peterson et al., 1996).

**TABLE 3E-2
 MODIFIED MERCALLI INTENSITY SCALE**

Intensity Value	Intensity Description	Average Peak Acceleration
I	Not felt except by a very few persons under especially favorable circumstances.	< 0.0017 g ^a
II	Felt only by a few persons at rest, especially on upper floors on buildings. Delicately suspended objects may swing.	< 0.014 g
III	Felt noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly, vibration similar to a passing truck. Duration estimated.	< 0.014 g
IV	During the day felt indoors by many, outdoors by few. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.	0.014–0.039 g
V	Felt by nearly everyone, many awakened. Some dishes and windows broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles may be noticed. Pendulum clocks may stop.	0.039–0.092 g
VI	Felt by all, many frightened and run outdoors. Some heavy furniture moved; and fallen plaster or damaged chimneys. Damage slight.	0.092–0.18 g
VII	Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars.	0.18–0.34 g
VIII	Damage slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motor cars disturbed.	0.34–0.65 g
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.	0.65–1.24 g
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from riverbanks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.	> 1.24 g
XI	Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.	> 1.24 g
XII	Damage total. Practically all works of construction are damaged greatly or destroyed. Waves seen on ground surface. Lines of sight and level are distorted. Objects are thrown upward into the air.	> 1.24 g

^a g (gravity) = 980 centimeters per second squared. 1.0 g of acceleration is a rate of increase in speed equivalent to a car traveling 328 feet from rest in 4.5 seconds. Source: California Geological Survey (2003).

Liquefaction

Liquefaction can occur as a secondary effect of seismic shaking in areas of saturated, loose, fine-to-medium grained soils where the water table is 50 feet or less below the ground surface. Seismic shaking temporarily eliminates the grain-to-grain support normally provided by the sediment grains. The water between the grains assumes the weight of the overlying material and the sudden increase in pore water pressure results in the soil losing its frictional properties. The

saturated material (with the frictionless properties of a liquid) will fail to support overlying structures. Liquefaction-related effects include loss of bearing strength, ground oscillations, lateral spreading and slumping.

The preliminary data contained in the geotechnical report for the proposed project site did not evaluate the potential for liquefaction. However, the boring logs of the exploratory holes drilled on the project site found little or no seepage to the maximum depth explored, approximately 75 feet below ground surface. The general absence of groundwater to this depth indicates that the potential for liquefaction is likely low. Additionally, the project area is not designated by the CGS as a liquefaction Seismic Hazard Zone, although one is located approximately a half a mile to the east (CGS, 1999).

Landslides and Slope Failure

Slope failures, commonly referred to as landslides, include many phenomena that involve the downslope displacement and movement of material, either triggered by static (i.e., gravity) or dynamic (i.e., earthquake) forces. A slope failure is a mass of rock, soil, and debris displaced downslope by sliding, flowing, or falling. Exposed rock slopes undergo rockfalls, rockslides, or rock avalanches, while soil slopes experience shallow soil slides, rapid debris flows, and deep-seated rotational slides. Landslides may occur on slopes of 15 percent or less; however, the probability is greater on steeper slopes that exhibit old landslide features such as scarps, slanted vegetation, and transverse ridges. Landslide-susceptible areas are characterized by steep slopes and downslope creep of surface materials. Debris flows consist of a loose mass of rocks and other granular material that, if saturated and present on a steep slope, can move downslope. The rate of rock and soil movement can vary from a slow creep over many years to a sudden mass movement. Landslides occur throughout the state of California, but the density of incidents increases in zones of active faulting.

Slope stability can depend on a number of complex variables. The geology, structure, and amount of groundwater in the slope affect slope failure potential, as do external processes (i.e., climate, topography, slope geometry, and human activity). The factors that contribute to slope movements include those that decrease the resistance in the slope materials and those that increase the stresses on the slope. Slope failure under static forces occurs when those forces initiating failure overcome the forces resisting slope movement. For example, a soil slope may be considered stable until it becomes saturated with water (e.g., during heavy rains or due to a broken pipe or sewer line). Under saturated conditions, the water pressure in the individual pores within the soil increases, reducing the strength of the soil. Cutting into the slope and removing the lower portion, or slope toe, can reduce or eliminate the slope support, thereby increasing stress on the slope.

Earthquake motions can induce significant horizontal and vertical dynamic stresses in slopes that can trigger failure. Earthquake-induced landslides can occur in areas with steep slopes that are susceptible to strong ground motion during an earthquake. The 1994 Northridge earthquake triggered over 11,000 landslides over an area of 10,000 square kilometers, primarily in the Santa Susanna Mountains (USGS, 1995). The San Rafael Hills could experience some earthquake-induced rockfalls, slumps, and debris flows during an event on any of the active faults

of the region. The CGS has mapped areas within the San Rafael Hills as having a high potential for seismic-induced landslides. The proposed project elements are not located within a mapped Seismic Hazard Mapping Zone; however, a hazard zone for landslides is shown uphill (west) of the proposed South Parking Structure (CGS, 1999).

Earthquake-Induced Settlement

Settlement of the ground surface can be accelerated and accentuated by earthquakes. During an earthquake, settlement can occur as a result of the relatively rapid rearrangement, compaction, and settling of subsurface materials (particularly loose, non-compacted, and variable sandy sediments). Settlement can occur both uniformly and differentially (i.e., where adjoining areas settle at different rates). Areas most susceptible to earthquake-induced settlement and differential settlement are those that are underlain by compressible sediments, such as poorly engineered artificial fill.

3E.3 Regulatory Framework

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act of 1972 requires that special geologic studies be conducted to locate and assess any active fault traces in and around known active fault areas prior to development of structures for human occupancy. This state law was a direct result of the 1971 San Fernando Earthquake, which was associated with extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures.

The main purpose of the Act is to prevent the construction of buildings used for human occupancy on the surface trace of active faults; the Act only addresses the hazard of surface fault rupture and is not directed toward other earthquake hazards.⁷ The law requires the State Geologist to establish regulatory zones (Earthquake Fault Zones) around the surface traces of active faults and to issue appropriate maps. These maps (Alquist Priolo Maps) are distributed to all affected cities, counties, and state agencies for their use in planning and controlling new or renewed construction. Local cities and counties must regulate certain development projects within the zones, which include withholding permits until geologic investigations demonstrate that development sites are not threatened by future surface displacement. Projects include all land divisions and most structures for human occupancy.

A review of the Alquist-Priolo Fault Hazard maps from the California Department of Conservation (Division of Mines and Geology) indicates that the project area is not located within the Alquist-Priolo Fault zone.

⁷ Human occupancy is defined as any structure that will be used or intended for supporting or sheltering any use by any single person for anything exceeding 2,000 person-hours per year (Hart, 1997).

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act of 1990 addresses non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides, and its purpose is to protect public safety from the effects of strong ground shaking, liquefaction, landslides, or other ground failure, and other hazards caused by earthquakes. This requires the State Geologist to delineate various seismic hazard zones and requires cities, counties, and other local permitting agencies to regulate certain development projects within these zones. Before a development permit is granted for a site within a seismic hazard zone, a geotechnical investigation of the site must be conducted and appropriate mitigation measures incorporated into the project design. Seismic Hazard maps have been completed for much of the Southern California region.

California Building Code

The *California Building Code* is certified in the California Code of Regulations (CCR), Title 24, Part 2, which is a portion of the California Building Standards Code. Title 24 is assigned to the California Building Standards Commission, which, by law, is responsible for coordinating all building standards. Published by the International Conference of Building Officials, the Uniform Building Code (UBC) is a widely adopted model building code in the United States. The California Building Code incorporates by reference the UBC with necessary California amendments. About one-third of the text within the California Building Code has been tailored for California earthquake conditions. Although widely accepted and implemented throughout the United States, local, City and county jurisdictions can adopt the UBC either in whole or in part.

City of Pasadena General Plan: Safety Element

The General Plan for the City of Pasadena contains a variety of recommendations for the prevention of damage and injury or death from seismic related hazards. Ensuring public safety involves establishing goals and policies that consider all types of potential disasters and reducing the risk of personal injury and potential property damage.

The Public Safety Element describes potential hazards and outlines goals and policies aimed at reducing the risks associated with geological hazards in Pasadena. Geologic and seismic issues particularly relevant to the proposed project include the potential for earthquake activity and slope failures. The following goals, policies, and programs would be applicable to the proposed project.

- Goal S-1 Minimize injury and loss of life, property damage, and other impacts caused by seismic shaking, fault rupture, ground failure, earthquake-induced landslides, and other earthquake-induced ground deformation.

- Policy S-1 The City will monitor development or re-development within the Fault Hazard Management zones identified for both the Sierra Madre and Raymond Faults.

Policy S-2 The City will ensure that current geologic knowledge and State-certified professional review are incorporated into the design, planning and construction stages of a project and site specific data are applied to each project.

Program S2-3: The City shall require geological and geotechnical investigations in areas of potential seismic or geologic hazards as part of the environmental and development review process. The City shall not approve proposals and projects for development or redevelopment which do not provide for mitigation of seismic or geologic hazards to the satisfaction of the responsible agencies.

Policy S-3 The City will strive to ensure that the design of new, and the performance of exiting structures address the appropriate earthquake hazards.

Program S3-1: The City shall continue to enforce the seismic design provisions for Seismic Zone 4 of the California Building Code, including near-source seismic conditions.

Goal D-1 Minimize the risk to life or limb, and property damage resulting from soil and slope stability.

Policy G-1 Whenever possible, mitigation of geologic hazards will be conducted without violating the property owners' rights to modify or improve their investment, along with preserving the aesthetic or natural conditions of the area through minimal grading. When these goals are in conflict, protection of life and property will take precedence.

Program G1-1: In the areas of Pasadena susceptible to slope instability, the City will require geotechnical investigations that include engineering analyses of slope stability, provide surface and subsurface drainage specifications, and provide detailed design for fill placement and excavation.

Program G1-2: The City will discourage any grading beyond that which is necessary to create adequate and safe building pads. The City geologist and geotechnical Engineer shall conduct regular inspection of grading operations to maximize site safety and compatibility with community character.

Program G1-3: In the hillside or mountainous areas of Pasadena, the City will discourage excessive grading of slopes greater than 3:1 (horizontal:vertical), and will encourage varied slope ratios on design slopes to reduce the visual impact of grading.

Program G1-4: The City shall prohibit cut or fill slopes steeper than 2:1.

City of Pasadena Municipal Code

The Pasadena Municipal Code, Title 14, Chapter 05 contains requirements for excavation and grading in Hillside Areas. This program regulates excavation and grading within hillside districts and excavation and grading on a slope any portion of which is greater than 15 percent. The program's purpose is to:

- Safeguard life, limb, property and public welfare;
- Protect streams, lakes, reservoirs, and any other water bodies from pollution with chemicals, fuels, lubricants or any other harmful materials associated with construction or grading activities;
- Avoid pollution of the water bodies described above with nutrients, sediment materials, or other earthen or organic materials generated on or caused by surface runoff on or across the permit area;
- Preserve the contours of the natural landscape and land forms; and
- Prevent erosion and control sedimentation.

3E.4 Impacts and Mitigation

3E.4.1 Methodology

The construction of the proposed project could potentially expose people to earthquake, slope instability, subsidence, liquefaction, or other seismic hazards. Mitigation measures to reduce potential impacts will be recommended and assessed for expected effectiveness and potential impacts if implemented.

3E.4.2 Significance Criteria

The criteria used to determine the significance of an impact are based on Appendix G of the *CEQA Guidelines*. For this analysis, implementation of the proposed project may result in significant impacts if it would:

1. Expose people or structures to potential substantial adverse effects, including 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;
 - Strong seismic ground shaking;
 - Seismic-related ground failure, including liquefaction; and/or

- Landslides.
2. 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.
 3. Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code creating substantial risks to life or property.
 4. Result in substantial soil erosion or the loss of topsoil.
 5. 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.

Two of the above issues are not considered relevant to the project based upon the proposed project plans and elements, data research, and the project Initial Study (see Appendix A). These issues are: 1.a) earthquake fault rupture, because the project is not in an earthquake fault rupture zone; and 5) septic tanks, because no such tanks are part of the project, and therefore these two items are not evaluated further in this EIR.

3E.4.3 Project Impacts

Impact 3E.1: The proposed project could expose people or structures to potential substantial adverse effects, including the risk of loss, injury, due to strong seismic ground shaking (less than significant with mitigation).

The project site is located in a very seismically-active region which could subject the proposed project to very strong ground shaking in the event of an earthquake. The primary seismic hazard to the site is strong ground shaking from an earthquake along any of the active faults in the region including the Raymond fault, Verdugo, Sierra Madre-Cucamonga Fault Zone, Hollywood, San Fernando fault, Newport-Inglewood, Whittier, San Andreas fault, and San Gabriel fault. Located within 30 miles of the proposed project area, all of these faults are capable of severe seismic activity that could affect the proposed project area. The City will require that all construction meet the latest standards of the California Building Code for construction. In addition, prior to construction of new development, as is standard practice for the industry, a site specific geotechnical investigation report prepared by a qualified geotechnical engineering firm must be prepared that would include a further evaluation of the existing geologic hazards identified in the preliminary geotechnical investigation and recommend appropriate design measures to reduce seismic hazards within the project area. Whereas the preliminary investigation provided general geologic conditions for the site, the final report can provide design measures specific to each proposed structure. Implementation of **Mitigation Measure 3E.1** would reduce any potential impacts associated with strong ground shaking to a less than significant impact.

Mitigation Measures

Mitigation Measure 3E.1: To minimize the potential effects of groundshaking and to evaluate the potential for other seismic hazards such as earthquake-induced settlement and landslides, the applicant shall have a California certified geotechnical engineer or engineering geologist prepare a site specific soils and geologic engineering report in accordance with California Building Code and Pasadena Neighborhood & Revitalization (BNR) Department requirements. This report must include the findings of the preliminary report and be reviewed, approved, and adhere to all recommendations made by BNR.

Significance After Mitigation: Less than significant.

Impact 3E.2: Development at the project site could subject people and property to slope instability hazards, including landslides and debris flows caused by seismic or nonseismic mechanisms (less than significant with mitigation).

As discussed in the Setting, the project site is located at the foot of some steep terrain, which includes an area considered by the CGS to have a high potential for an earthquake-induced landslide. The existing structures in the project site were constructed after significant cut and fill operations created level building lots. The presence of thick fill layers, colluvium, and sheared bedrock could indicate a potential for slope failure (Geotechnologies, 2003). Landsliding and debris flows could occur over time as a result of rainfall or seismic activity, potentially exposing people and property to injury and damage.

Although most of the proposed construction will occur within previously graded areas, the proposed project would require some earthwork in order to accommodate construction of the Design Research Center. The amount of excavation is proposed to be less than 10,000 cubic yards. However, any alteration of slopes or placement of additional loads could have the potential to create slope instability in the locations of cut and/or fill, but the extent of the potential cannot be known until final design plans are developed and approved. By implementing appropriate slope conditioning measures such as compaction standards, slope terracing, drainage control, and other slope stability measures, any existing potential slope stability hazards can be reduced to less than significant levels through current geotechnical industry standards.

Mitigation Measures

Mitigation Measure 3E.2: A site-specific, design level geotechnical investigation for each building site shall be required as part of the project to reduce the potential for new slope instability from construction grading. The design level geotechnical investigation shall provide individual final design criteria consistent with California Building Code and City of Pasadena BNR requirements. All recommendations provided by the licensed geotechnical engineer shall be included in the final design and be incorporated into the project plans.

Significance After Mitigation: Less than significant.

Impact 3E.3: The proposed project could be located on a geologic unit that would become unstable, and potentially subside or result in failure due to liquefaction (less than significant with mitigation).

According to the CGS, the project area is not located in an area considered to have a high potential for liquefaction (CGS, 1999). Additionally, data included in the preliminary geotechnical report indicates that the depth to groundwater is more than 50 feet below the surface, which would indicate a low potential for liquefaction. However, as described above, a detailed geotechnical investigation report would be prepared by a qualified geotechnical engineering firm which would include an evaluation for liquefaction and subsidence potential as is standard within the industry. As discussed under **Mitigation Measure 3E.1**, the project design would incorporate foundation recommendations of the site-specific geotechnical evaluation, and would be constructed in accordance with applicable California Building Code standards. Considering that the proposed project would be constructed in conformance with the California Building Code and City of Pasadena BNR requirements, the risks of injury and structural damage from unstable soils would be further reduced. Impacts would be less than significant with implementation of **Mitigation Measure 3E.1**.

Mitigation Measures

Implement **Mitigation Measure 3E.1**, above.

Significance After Mitigation: Less than significant.

Impact 3E.4: The proposed project could be located on expansive soils, as defined in Table 18-1-B of the UBC, creating substantial risks to life or property (less than significant with mitigation).

Expansive soils are generally soils that possess a “shrink-swell” behavior. Shrink-swell is the cyclic change in volume (expansion and contraction) that occurs in fine-grained clay sediments from the process of wetting and drying. Structural damage may occur over a long period of time, usually the result of inadequate soil and foundation engineering or the placement of structures directly on expansive soils. The previous grading operations and placement of artificial fill on the project site indicates that these soils are likely nonexpansive or they would have not been used as engineered fill. However, as part of standard geotechnical engineering practices, site-specific geologic and geotechnical investigations evaluate the potential for expansive soils. These investigations would determine whether a given development has expansive solid soils. Furthermore, the investigations will include an assessment of the magnitude of this characteristic, and present recommendations for grading and foundation design to mitigate potentially adverse impacts such as floor and wall cracking. Compliance with the existing routine construction permit requirements and implementation of **Mitigation Measure 3E.1**, above, would reduce potential impacts to less than significant.

Mitigation Measures

Implement **Mitigation Measure 3E.1**, above.

Significance After Mitigation: Less than significant.

Impact 3E.5: The proposed project construction activities could result in substantial soil erosion or the loss of topsoil (less than significant).

The proposed project elements would be constructed on previously developed land with buildings and structures that has been previously graded, indicating that native topsoil is no longer present at the site and that loss of topsoil would not be a significant impact. Construction activity associated with the project components may result in minor wind- and water-driven erosion of soils. This is considered short-term in nature, as the project area would be landscaped and would contain hardscape surfaces and open space upon completion. Furthermore, project construction would involve excavation and hauling materials off-site, in an estimated amount of less than 10,000 cubic yards. These activities could result in soil erosion impacts on off-site areas, such as nearby streets and storm drains. However, implementation of project components would be subject to state codes and City of Pasadena requirements for erosion control. In addition, a National Pollutant Discharge Elimination System (NPDES) General Construction Stormwater Permit is required for the proposed development of the project site and would incorporate specific erosion control measures (also discussed in the section 3.G Hydrology). As part of the NPDES program, a Storm Water Pollution Prevention Plan (SWPPP) would be submitted, as also required as mitigation found in the Hydrology section of this document, for approval by the City of Pasadena. Standard compliance by the project proponent with this program and the conditions of the permit along with the use of standard Best Management Practices (BMPs), such as dust control, hauling all excess soil to safe disposal sites and frequently watering construction site ground soil, erosion impacts would be less than significant.

Mitigation: None required.

3E.4.4 Cumulative Impacts

Impact 3E.6: The proposed project could result in adverse cumulatively considerable geology, soils, and seismicity impact (less than significant).

The project area is located in a seismically active area and future project development could expose additional people and structures to potentially adverse effects associated with earthquakes including seismic ground shaking and seismic related ground failure. However, the site specific geotechnical studies for those future development projects would determine how the projects could be designed to minimize exposure of people to these impacts. Future development would be constructed to standards which could potentially exceed those of older structures within the region, which they may be replacing.

The impact of the proposed project on geology and soils is localized and is incrementally less than significant. Therefore, the proposed project would not affect the immediate vicinity surrounding the proposed project area. The proposed project and the related projects would all be constructed in accordance with the most recent version of the California Building Code seismic safety requirements and recommendations contained in the project's specific geotechnical reports. Therefore, incremental impacts to area geology and soils resulting from construction and operation of the proposed project do not contribute to a cumulatively considerable impact.

Mitigation: None required.