
4.5 - Geology, Soils, and Seismicity

4.5.1 - Introduction

This section describes the existing geology and soils setting and potential effects from project implementation on the site and its surrounding area. Descriptions and analysis in this section are based on information contained in the various geotechnical reports prepared for this project or on this site by GeoMat Testing Laboratories, Inc. (GeoMat 2007), Gary Rasmussen & Associates, Inc. (GRA 1990), and CHJ Incorporated (CHJ 1989)(CHJ 2006)(CHJ 2007). These various studies are included in this EIR in Appendix E.

As explained in Section 1, *Introduction*, where applicable, this project-level DEIR incorporates by reference information and analysis contained in the City of San Bernardino General Plan EIR and the Paradise Hills Specific Plan EIR, certified by the San Bernardino City Mayor and Common Council in 2005 and 1993, respectively. The General Plan EIR contemplated buildout of the General Plan at a programmatic level and concluded that all impacts on geology, soils, and seismicity were less than significant after mitigation. The Paradise Hills EIR provided project-level analysis of the smaller Paradise Hills project and concluded that all impacts related to geology, soils, and seismicity were less than significant and did not require mitigation.

This DEIR accounts for modifications to the baseline conditions that have occurred since certification of the previous EIRs and changes that have increased the size and intensity of the Proposed Project. Accordingly, not all of the conclusions in the previous EIRs are applicable to the Proposed Project, and new analysis is provided for potential impacts not previously considered in those documents.

4.5.2 - Environmental Setting

Regional Setting

The site is located at the north end of the San Bernardino Valley, in the southern foothills of the San Bernardino Mountains. This area is at the eastern end of the California "Transverse Ranges" geomorphic province, which is an east-west trending series of steep mountain ranges and valleys. The east-west structure of the Transverse Ranges is oblique to the normal northwest trend of coastal California, hence the name "Transverse." The province extends offshore to include San Miguel, Santa Rosa, and Santa Cruz islands. Its eastern extension, the San Bernardino Mountains, has been displaced to the south along the San Andreas Fault. Intense north-south compression is squeezing the Transverse Ranges. As a result, this is one of the most rapidly rising regions on earth.

Southern California contains numerous regional earthquake faults, the most prominent of which is the San Andreas Fault Zone (SAFZ). This zone represents the contact boundary between the continental North American tectonic plate and the oceanic Pacific tectonic plate. Along this margin, the two plates are slowly moving past each other. Large earthquakes and lateral ground offsets have been recorded along this very active seismic zone. Southern California has experienced many strong earthquakes in the past, a number of them involving the SAFZ or related faults.

The SAFZ passes through the central and northern portions of the project site. As a result, the site has been studied extensively in terms of onsite faulting. Exhibit 4.5-1 shows the locations of major regional faults in relation to the project site.

In order to classify faults by their relative hazards, geologists have found they can recognize faults that have been active since the last ice age (during the “Holocene,” about the last 11,000 years). Faults that have ruptured to the ground surface in Holocene time, such as the SAFZ, are classified as “active” and are included in Alquist-Priolo earthquake fault zones. There are several other definitions of activity, used for other purposes, such as the siting and design of large dams, power plants and other facilities. Another commonly used designation is for faults that have offset geologic units from the Quaternary period (the last 1.8 million years). Faults that offset Quaternary units are sometimes called “potentially active.” Determining if a fault is “active” or “potentially active” depends on geologic evidence, which may not be available for every fault. Although there are probably still some unrecognized active faults, nearly all the movement between the two crustal plates, and, therefore, the majority of the seismic hazards, are on the well-known active faults. Furthermore, the San Andreas is considered one of the most active faults in California.

Seismicity

The term seismicity describes the effects of seismic waves that radiate from an earthquake as it occurs. While most of the energy released during an earthquake results in the permanent displacement of the ground, as much as 10 percent of the energy may dissipate immediately in the form of seismic waves. To understand the implications of seismic events, a discussion of faulting and seismic hazards is provided below.

Faulting

Faults form in rocks when stresses overcome the internal strength of the rock, resulting in a fracture. Large faults develop in response to large regional stresses operating over a long time, such as those stresses caused by the relative displacement between tectonic plates. According to the elastic rebound theory, these stresses cause strain to build up in the earth’s crust until enough strain has built up to exceed the strength along a fault and cause a brittle failure. The slip between the two stuck plates or coherent blocks generates an earthquake. Following an earthquake, strain will build once again until the occurrence of another earthquake. The magnitude of slip is related to the maximum allowable strain that can be built up along a particular fault segment. The greatest buildup in strain due to the largest relative motion between tectonic plates or fault blocks over the longest period will generally produce the largest earthquakes. The distribution of these earthquakes is a study of much interest for both hazard prediction and the study of active deformation of the earth’s crust. Deformation is a complex process and strain caused by tectonic forces is not only accommodated through faulting, but also by folding, uplift, and subsidence, which can be gradual or in direct response to earthquakes.



Source: University Hills Specific Plan.



Michael Brandman Associates

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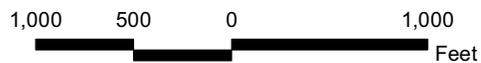


Exhibit 4.5-1 Local Seismic Hazards

UNIVERSITY HILLS SPECIFIC PLAN EIR

Faults are mapped to determine earthquake hazards, since they occur where earthquakes tend to recur. A historic plane of weakness is more likely to fail under stress and strain than a previously unbroken block of crust. Faults are, therefore, a prime indicator of past seismic activity, and faults with recent activity are presumed to be the best candidates for future earthquakes. However, since slip is not always accommodated by faults that intersect the surface along traces, and since the orientation of stress and strain in the crust can shift, predicting the location of future earthquakes is complicated. Earthquakes sometimes occur in areas with previously undetected faults or along faults previously thought inactive.

Local Faulting

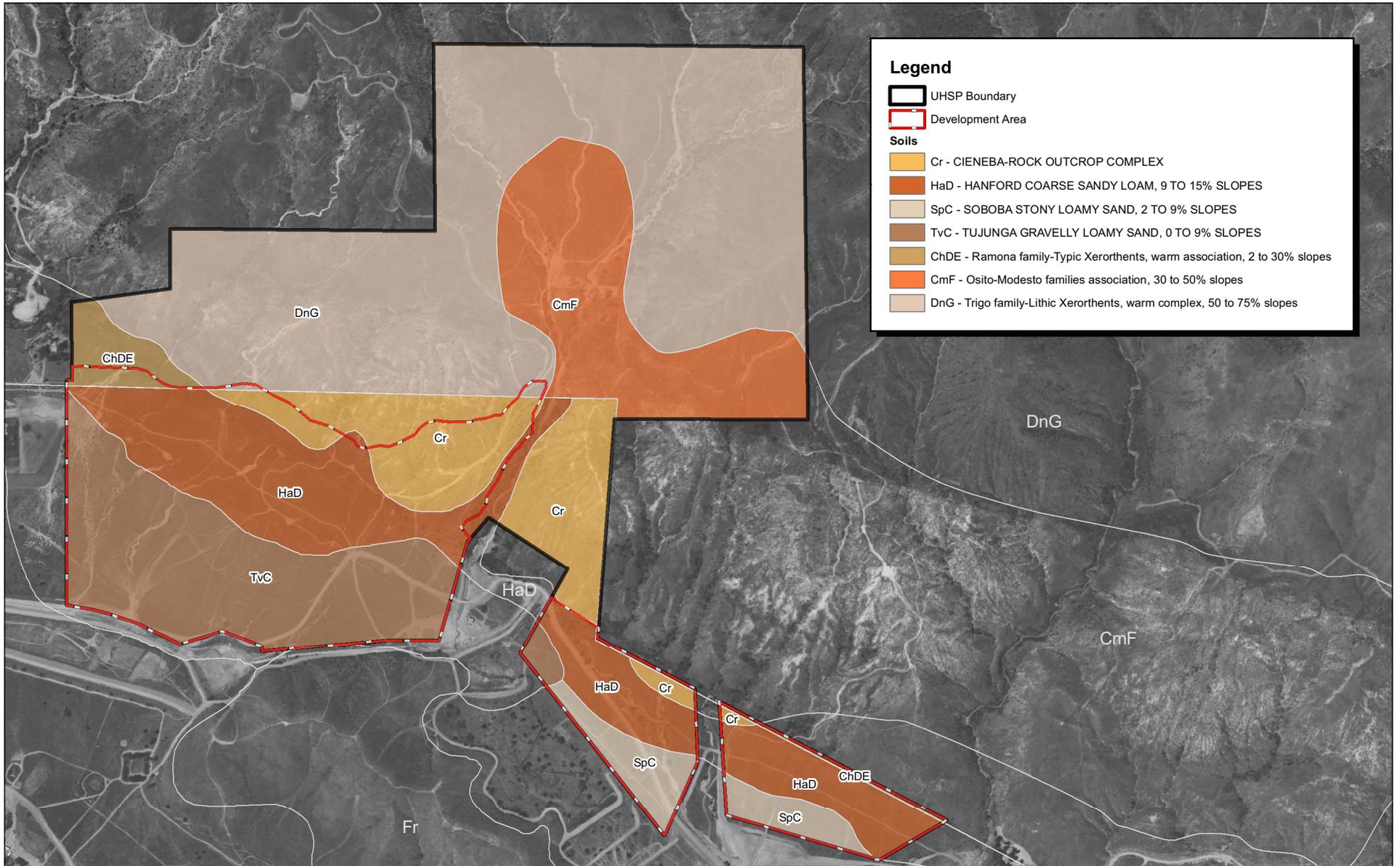
There are several active faults in the immediate and surrounding areas that could affect the project site. The SAFZ is the most well known major active fault in California, and two branches or splays of the fault pass through the project site.

The California Legislature established the Alquist-Priolo Earthquake Fault Zoning Act in 1972. This act established an Alquist-Priolo Earthquake Fault Zone along the San Andreas Fault, requiring detailed studies of rupture hazards prior to construction. While the project site is located within the SAFZ, this location may represent an actual risk greater from ground rupture rather than from strong ground movement during an earthquake, which can often be experienced to a greater degree at some distance away from the actual event, depending on the soil and bedrock conditions of a particular location.

In addition to the SAFZ, there are several other major faults in the general area, including the Mill Creek Fault (onsite and considered a part of the SAFZ complex), the very active San Jacinto Fault 4 miles southwest of the site, the Glen Helen Fault approximately 4 miles west of the site, and the Cucamonga Fault about 7 miles west of the site. Peak ground acceleration is a measure of earthquake acceleration, and how hard the earth shakes in a given geographic area. Peak ground acceleration is measured in g (the acceleration due to gravity). The geotechnical studies for the Paradise Hills project determined that the maximum horizontal acceleration that would be experienced on the project site from regional faults would be 0.66 g (about two-thirds of the vertical force of gravity) in areas of the site underlain by alluvial soils, while the site would experience 0.71 g in areas underlain by bedrock (GRA 1990)(CHJ 2007). All of the areas planned for development within the UHSP project will be underlain by alluvium.

Seismic Hazards

Seismic hazards pose a substantial danger to property and human safety and are present because of the risk of naturally occurring geologic events and processes impacting human development. Therefore, the hazard is as influenced by the conditions of human development as by the frequency and distribution of major geologic events. Seismic hazards present in California include ground rupture along faults, strong seismic shaking, liquefaction, ground failure, landsliding, and slope failure. Exhibit 4.5-2 shows local seismic hazards in the surrounding area.



Source: National Agriculture Imagery Program for Riverside County (2005& USDA).



Michael Brandman Associates

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Exhibit 4.5-2 USDA Soils Map

UNIVERSITY HILLS SPECIFIC PLAN EIR

Fault Rupture

Fault rupture is a seismic hazard that affects structures sited above an active fault. The hazard from fault rupture is the movement of the ground surface along a fault during an earthquake. Typically, this movement takes place during the short time of an earthquake, but can also occur slowly over many years in a process known as creep. Most structures and underground utilities cannot accommodate the surface displacements of several inches to several feet commonly associated with fault rupture or creep. The potential for fault rupture on the project site is high due to the location of two branches of the SAFZ on the project site.

Ground Shaking

The severity of ground shaking depends on several variables such as earthquake magnitude, epicenter distance, local geology, thickness, and seismic wave-propagation properties of unconsolidated materials, groundwater conditions, and topographic setting. Ground shaking hazards are most pronounced in areas near faults or with unconsolidated alluvium.

The most common type of damage from ground shaking is structural damage to buildings, which can range from cosmetic stucco cracks to total collapse. The overall level of structural damage from a nearby large earthquake would likely be moderate to heavy, depending on the characteristics of the earthquake, the type of ground, and the condition of the building. Besides damage to buildings, strong ground shaking can cause severe damage from falling objects or broken utility lines. Fire and explosions are also hazards associated with strong ground shaking. Previous geotechnical evaluations of the project site indicated that a Richter 7.5-magnitude earthquake could be expected on this portion of the San Andreas Fault within the lifetime of the project (GRA 1990)(CHJ 2007).

While Richter magnitude provides a useful measure of comparison between earthquakes, the moment magnitude is more widely used for scientific comparison, since it accounts for the actual slip that generated the earthquake. Actual damage is due to the propagation of seismic or ground waves as a result of initial failure, and the intensity of shaking is related as much to earthquake magnitude as to the condition of underlying materials. Loose materials tend to amplify ground waves, while hard rock can quickly attenuate them, causing little damage to overlying structures.

Ground Failure

Ground failure includes liquefaction and the liquefaction-induced phenomena of lateral spreading, and lurching.

Liquefaction is a process by which sediments below the water table temporarily lose strength during an earthquake and behave as a viscous liquid rather than a solid. Liquefaction is restricted to certain geologic and hydrologic environments, primarily recently deposited sand and silt in areas with high groundwater levels. The process of liquefaction involves seismic waves passing through saturated granular layers, distorting the granular structure, and causing the particles to collapse. This causes the granular layer to behave temporarily as a viscous liquid rather than a solid, resulting in liquefaction.

Liquefaction can cause the soil beneath a structure to lose strength, which may result in the loss of foundation-bearing capacity. This loss of strength commonly causes the structure to settle or tip. Loss of bearing strength can also cause light buildings with basements, buried tanks, and foundation piles to rise buoyantly through the liquefied soil.

Lateral spreading is lateral ground movement, with some vertical component, as a result of liquefaction. In effect, the soil rides on top of the liquefied layer. Lateral spreading can occur on relatively flat sites with slopes less than 2 percent, under certain circumstances, and can cause ground cracking and settlement. Lurching is the movement of the ground surface toward an open face when the soil liquefies. An open face could be a graded slope, stream bank, canal face, gully, or other similar feature.

The San Bernardino General Plan indicates the potential for liquefaction on the project site is relatively low, mainly due to the depth to groundwater and the types of soils onsite (Figure S-9, CSB Safety Element 2005).

Landslides and Slope Failure

Landslides and other forms of slope failure form in response to the long-term geologic cycle of uplift, mass wasting, and disturbance of slopes. Mass wasting refers to a variety of erosional processes from gradual downhill soil creep to mudslides, debris flows, landslides and rock fall—processes that are commonly triggered by intense precipitation, which varies according to climactic shifts. Often, various forms of mass wasting are grouped together as landslides, which are generally used to describe the downhill movement of rock and soil.

Geologists classify landslides into several different types that reflect differences in the type of material and type of movement. The four most common types of landslides are translational, rotational, earth flow, and rock fall. Debris flows are another common type of landslide similar to earth flows, except that the soil and rock particles are coarser. Mudslide is a term that appears in non-technical literature to describe a variety of shallow, rapidly moving earth flows.

Available geotechnical data indicates the north-central portion of the site, west of Badger Canyon (Planning Areas 15), may contain one or more ancient landslides and thus characterizes this area as potentially hazardous (Figure S-9 CSB Safety Element 2005).

Springs and Seeps

The central portion of the project site, just north of the south branch of the San Andreas Fault, contains several springs that have been noted in repeated hydrology studies as well as the many biological surveys on the site (see Section 4.3, *Biological Resources*). These seeps are caused by the location of the San Andreas Fault. Development near these seeps must be designed to carry excess water away to protect improved structures.

Project Site

Onsite Geology/Seismicity

The flatter southern and central portions of the UHSP site are comprised of deep alluvial fan deposits of Quaternary age from materials washed down out of the mountains to the north. In the northern portions of the site (i.e., planned open space), bedrock outcroppings of granitic material are found on the steeper slopes, while the drainage courses associated with Badger Creek and its tributaries contain recent alluvium washed down out of the Santa Ana Mountains to the north.

As previously stated, the SAFZ passes through the central and northern portions of the project site. Two main splays or branches of the fault have been identified, the Southern Branch which passes through the central portion of the site, and the Northern Branch which passes through the north end of the site. In addition, the Mill Creek Fault is located in the northern portion of the project site, between the north and south branches of the SAFZ. Because of this, the site has been studied extensively in terms of onsite faulting. The previous Exhibit 4.5-2 shows the alignment of the SAFZ and other local faults in the project vicinity.

Onsite Soils

Previous geotechnical studies on the site have found deep alluvial soils of silty sand in the terrace portions of the site (i.e., the areas planned for development) (CHJ 1989). Gravel, cobbles, and occasional boulders were also found at greater depths in these areas (GeoMat 2007). The project site contains seven individual soil types, based on the classifications used by the Natural Resource Conservation Service (NRCS) formerly known as the Soil Conservation Service (SCS). Most of these soils have relatively high permeability due to their sandy nature, and are moderately to highly erodible when exposed to wind or water.

Seven different soil types were found on the project site. The characteristics of onsite soils are summarized in Table 4.5-1 and their locations shown in Exhibit 4.5-2. As shown in the table, soils onsite have low or moderate erosion potentials and moderate to very slow infiltration rates. Soils are relatively sandy and have a low clay content as a result of their sand content and their low to moderate permeability. Therefore, they have a low shrink-swell potential and are not considered expansive soils (CHJ 2006).

Groundwater

Groundwater levels, determined from previous borings, varied from 121 to 142 feet below ground surface. Groundwater is discussed further in Section 4.7, *Hydrology and Water Quality*.

Table 4.5-1: Onsite Soil Properties

SCS	Soil Unit	Slopes	Class	Acres	Percent	Runoff	Erosion
Development Area							
ChDE	Ramona Family – Typic Xerothents, Warm Association	2-30%	IV	6.2	1.5	Slow	Slight
CmF	Osito-Modesto Families Association	30-50%	V	9.4	2.3	Medium to Rapid	Moderate-High
Cr	Cieneba-Rock Outcrop Complex	--	VII-e1	12.1	3.0	Rapid	Moderate
DnG	Trigo Family-Lithic Xerothents, warm complex	--	IV	5.0	1.2	Medium to Rapid	Moderate-High
HaD	Hanford Course Sandy Loam	9-15%	IIIe-1	64.2	15.9	Medium	Moderate-High
SpC	Soboba Stony Loamy Sand	2-9%	VI-s1	19.0	4.7	Slow	Slight
TvC	Tujunga Gravelly Loamy Sand	0-9%	IV-s4	53.5	13.3	Very Slow-Slow	Slight
Subtotal Development Area		0-50%	III-VII	169.4	41.9	--	--
Open Space Area							
CmF	Osito-Modesto Families Association	30-50%	V	70.4	17.4	Medium to Rapid	Moderate-High
Cr	Cieneba-Rock Outcrop Complex	--	VII-e1	32.5	8.0	Rapid	Moderate
DnG	Trigo Family-Lithic Xerothents, warm complex	--	IV	131.9	32.7	Medium to Rapid	Moderate-High
Subtotal Open Space Area		0-50%	IV-VII	234.8	58.1	--	--
Total		0-50%	III-VII	404.2	100.0	--	--
Source: Natural Resources Conservation Service Website. 2007.							

Regulatory Framework

Federal Clean Water Act § 402

Clean Water Act (CWA) § 402 mandates that certain types of construction activity comply with the requirements of Environmental Protection Agency’s NPDES stormwater program. Construction activities that disturb one or more acres of land must obtain coverage under the NPDES general construction activity stormwater permit, which is issued by San Francisco RWQCB. Obtaining coverage under the NPDES general construction activity stormwater permit generally requires that the project applicant complete the following steps:

- File a Notice of Intent with RWQCB that describes the proposed construction activity before construction begins;

- Prepare a Storm Water Pollution Prevention Plan (SWPPP) that describes Best Management Practices (BMPs) that will be implemented to control accelerated erosion, sedimentation, and other pollutants during and after project construction; and
- File a notice of termination with RWQCB when construction is complete and the construction area has been permanently stabilized.

State Alquist-Priolo Earthquake Fault Zoning Act

In response to the severe fault rupture damage of structures by the 1971 San Fernando earthquake, the State of California enacted the Alquist-Priolo Earthquake Fault Zoning Act in 1972. This act required the State Geologist to delineate Earthquake Fault Zones (EFZs) along known active faults that have a relatively high potential for ground rupture. Faults that are zoned under the Alquist-Priolo Act must meet the strict definition of being “sufficiently active” and “well-defined” for inclusion as an EFZ. The EFZs are revised periodically, and they extend 200 to 500 feet on either side of identified fault traces. No structures for human occupancy may be built across an identified active fault trace. An area of 50 feet on either side of an active fault trace is assumed to be underlain by the fault, unless proven otherwise. Proposed construction in an EFZ is permitted only following the completion of a fault location report prepared by a California Professional Geologist.

California Building Standards Code

Title 24 of the California Code of Regulations, also known as the California Building Standards Code, sets forth minimum requirements for building design and construction. The California Building Standards Code is a compilation of three types of building standards from three different origins:

- Building standards that have been adopted by State agencies without change from building standards contained in national model codes;
- Building standards that have been adopted and adapted from the national model code standards to meet California conditions; and
- Building standards, authorized by the California legislature, that constitute extensive additions not covered by the model codes that have been adopted to address particular California concerns.

In the context of earthquake hazards, the California Building Standards Code’s design standards have a primary objective of assuring public safety and a secondary goal of minimizing property damage and maintaining function during and following seismic events. Recognizing that the risk of severe seismic ground motion varies from place to place, the California Building Standards Code seismic code provisions will vary depending on location (Seismic Zones 0, 1, 2, 3, and 4; with 0 being the least stringent and 4 being the most stringent).

Regional Water Quality Control Board

The Santa Ana Region of the RWQCB regulates State water quality standards in the San Bernardino area. Beneficial uses and water quality objectives for surface water and groundwater resources in the

project area are established in the water quality control plans (basin plans) of each RWQCB as mandated by the State Porter-Cologne Act and the Clean Water Act (CWA). The RWQCBs also implement CWA § 303(d) total maximum daily load (TMDL) process, which consists of identifying candidate water bodies where water quality is impaired by the presence of pollutants. The TMDL process is implemented to determine the assimilative capacity of the water body for the pollutants of concern and to establish equitable allocation of allowable pollutant loading within the watershed. Section 401 of the CWA requires an applicant pursuing a federal permit to conduct any activity that may result in a discharge of a pollutant to obtain a water quality certification (or waiver) from the applicable RWQCB.

The RWQCBs primarily implement basin plan policies through issuing waste discharge requirements for waste discharges to land and water. The RWQCBs are also responsible for administering the NPDES permit program, which is designed to manage and monitor point and non-point source pollution. NPDES stormwater permits for general construction activity are required for projects that disturb more than one acre of land. Municipal NPDES stormwater permits are required for urban areas with populations greater than 100,000. The City Public Works Department administers municipal NPDES permitting in San Bernardino. The City must comply with the provisions of the permit by ensuring that, among other things, new development and redevelopment projects mitigate, to the maximum extent practicable, water quality impacts to stormwater runoff during the project's construction and operational periods.

The general NPDES stormwater permits for general construction activities require the applicant to file a Notice of Intent (NOI) to discharge stormwater with the RWQCB and to prepare and implement an SWPPP. The SWPPP would include a site map, description of stormwater discharge activities, and a list of BMPs that would be employed to prevent water pollution. It must describe BMPs that would be used to control soil erosion and discharges of other construction-related pollutants (e.g., petroleum products, solvents, paints, cement) that could contaminate nearby water resources. It must demonstrate compliance with local and regional erosion and sediment control standards, identify responsible parties, provide a detailed construction timeline, and implement a BMP monitoring and maintenance schedule. For additional information, see Section 4.7, *Hydrology and Water Quality*.

Local - City of San Bernardino General Plan

The Safety Element of the City's General Plan establishes the following goals and policies related to geology, soils, and seismicity:

Goal 10.7: "Protect life, essential lifelines, and property from damage resulting from seismic activity."

- **Policy 10.7.1:** Minimize the risk to life and property through the identification of potentially hazardous areas, establishment of proper construction design criteria, and provision of public information.

- **Policy 10.7.2:** Require geologic and geotechnical investigations for new development in areas adjacent to known fault locations and approximate fault locations (Figure S-3) as part of the environmental and/or development review process and enforce structural setbacks from faults identified through those investigations. (LU-1)
- **Policy 10.7.3:** Enforce the requirements of the California Seismic Hazards Mapping and Alquist-Priolo Earthquake Fault Zoning Acts when siting, evaluating, and constructing new projects within the City. (LU-1)
- **Policy 10.7.4:** Determine the liquefaction potential at a site prior to development, and require that specific measures be taken, as necessary, to prevent or reduce damage in an earthquake.
- **Policy 10.7.5:** Evaluate and reduce the potential impacts of liquefaction on new and existing lifelines.

Analysis: The following Section GEO-1 evaluates the potential impacts of developing the project based on existing geotechnical constraints on the site, and finds them to be less than significant with mitigation, and as long as future development is constructed consistent with the various geotechnical studies that have been prepared on this site and for this project. Therefore, the project is consistent with this goal and these policies.

Goal 10.8: “Prevent the loss of life, serious injuries, and major disruption caused by the collapse of or severe damage to vulnerable buildings in an earthquake.”

- **Policy 10.8.1:** Enforce the requirements of the California Seismic Hazards Mapping and Alquist-Priolo Earthquake Fault Zoning Acts 10-28 City of San Bernardino when siting, evaluating, and constructing new projects within the City. (LU-1)
- **Policy 10.8.2:** Require that lifelines crossing a fault be designed to resist the occurrence of fault rupture.
- **Policy 10.8.3:** Adopt a program for the orderly and effective upgrading of seismically hazardous buildings in the City for the protection of health and safety. Compliance with the Unreinforced Masonry Law shall include the enactment of an effective program for seismic upgrading of unreinforced masonry buildings within the City.

Analysis: Two branches of the San Andreas Fault cross the project site, so the location of structures and improvements on the site must be carefully planned. The UHSP document shows that all residences, roads, etc. have been planned with the fault locations in mind (i.e., no habitable structures within the identified fault setback zone). Therefore, the project is consistent with this goal and these policies.

Goal 10.9: “Minimize exposure to and risks from geologic activities.”

- **Policy 10.9.1:** Minimize risk to life and property by properly identifying hazardous areas, establishing proper construction design criteria, and distribution of public information.
- **Policy 10.9.2:** Require geologic and geotechnical investigations in areas of potential geologic hazards as part of environmental and/or development review process for all new structures. (LU-1)
- **Policy 10.9.3:** Require that new construction and significant alterations to structures located within potential landslide areas (Figure S-7) be evaluated for site stability, including potential impact to other properties during project design and review. (LU-1)

Analysis: The UHSP document demonstrates that all residences, roads, etc. have been planned based on the locations of the fault branches and other potential geotechnical constraints onsite. Therefore, the project is consistent with this goal and these policies.

Local - San Bernardino City Code

The City’s Code Development Code (Municipal Code Section 19) establishes requirements related to grading and erosion control. The division sets forth rules and regulations to control excavation, grading, and earthwork construction, including fills and embankments, and establishes administrative requirements for issuance of permits and approval of plans and inspection of grading construction in accordance with the requirements for grading and excavation. All projects within the City limits involving earthwork activities must obtain a grading permit and adhere to the requirements stipulated in the City Code.

NOP Comments

During circulation of the revised NOP, Dr. Norm Meek from CSUSB attended the scoping meeting and warned that placing homes and people in close proximity to the San Andreas Fault was extremely dangerous despite compliance with existing seismic and building codes.

Methodology

GRA performed geotechnical evaluations of the project site for the original Paradise Hills project in 1990, while CHJ, Inc. and Geo Mat Testing Laboratories, Inc. performed more recent studies for the University Hills project (CHJ 2007). The following sections summarize their findings and their studies are included in Appendix E. These geotechnical reports included literature reviews of regional geology, faults, and seismic hazards, as well as the review of previous laboratory testing results of soils on the project site to analyze the subsurface profile of the site.

The following are summaries from geotechnical studies conducted on the proposed project site:

Geotechnical Review of Conceptual Grading Design, Geo Mat, December 3, 2007

A geotechnical study was conducted by Geo Mat (December 3, 2007) on 35 deep borings explored by CHJ Incorporated on February 22 and March 8, 2006. The exploratory borings were drilled to a maximum depth of 51.5 feet below existing ground surface. Following the exploratory borings, extensive laboratory tests were conducted by CHJ Incorporated. Findings from the test include evidence of significant groundwater on the south branch of San Andreas Fault Zone. Furthermore, wells located south of the project site showed groundwater depths of greater than 80 feet; however no groundwater was encountered in the exploratory borings to maximum depths of 52 feet. In addition, there is the potential for springs or seeps to develop on the site, especially when considering future landscape irrigation. The seeps may result in minor nuisances or, in extreme cases, may lead to slope failure.

An analysis of slope stability was discussed for the proposed UHSP. The slope stability analysis calculated the highest fill and fill-over-cut slopes, at approximately 46 feet high and the fill-over-cut slopes are as high as 84 feet. The analysis found that due to the high seismic activity, the seismic condition controls the slope stability of this site. Therefore, the stability of the fill and fill over cut slopes should be further evaluated during grading.

The geotechnical study determined that the undocumented fill and loose/hydroconsolidatable native soils will not provide uniform or adequate support; therefore the study recommended mitigation to reduce impacts on the proposed UHSP. After mitigation the geotechnical study concluded the conceptual grading plan is feasible from a geotechnical standpoint.

Subsurface Investigation of Faulting, CHJ Incorporated, January 31, 2006

This report determined that development of the project site was feasible from an engineering geologic standpoint, provided the recommendations contained in the report and in the recommended subsurface investigation were implemented during design, grading, and construction. However, the report indicated that severe seismic shaking of the site can be expected during the lifetime of the proposed development and should be considered in site development.

According to the report, “a larger portion of the site is included in an Alquist-Priolo Earthquake Fault Zone designated by the State of California to include traces of suspected faulting associated with the northwest-trending San Andreas fault zone (SAFZ). We encountered the South Branch SAFZ and an older strand, the Mill Creek fault, within the site. Other faults encountered included faults within the landslide deposits west of Badger Creek that appear to be primarily associated with landslide movement; however, some of these features have trends similar to that of the Mill Creek fault. Based on the data from our subsurface investigation, faults of the SAFZ, including the Mill Creek fault and North Branch fault, are considered to be active for planning purposes.” Therefore, a “recommended restricted use zone” (RRUZ) was suggested to mitigate the potential for the hazard of surface

rupture during movement on the identified faults. The location of the RRUZ can be seen on Enclosure "A-4" in the Subsurface Investigation of Faulting report (CHJ Inc. January 31, 2006).

Additional observations on the proposed project site include landslides, which should be considered a potential hazard to the proposed development unless further investigation precludes the hazard. Furthermore, groundwater depth near the mouth of Badger Creek and north of the SAFZ on the project site poses risks for liquefaction. "The liquefaction susceptibility should be evaluated for these areas, and the hydrocollapse potential should be evaluated for the site during the recommended geotechnical investigation where exploratory borings will provide additional groundwater and soils data".

Furthermore, there is evidence of recent significant erosion/flooding of portions of the site from perched groundwater. Conditions may also result in a potential future shallow water table, particularly associated with landscape irrigation, native/fill contacts, in fill over cut slopes, and in filled drainages. An evaluation of the flood potential of the site and the design of adequate drainage was recommended.

Geotechnical Investigation, CHJ Incorporated, May 18, 2006

According to this geotechnical investigation, the proposed project site contains undocumented fill and loose/hydroconsolidatable native soils, which will not, in their present condition, provide uniform or adequate support for the proposed structures. Density testing concluded the native soils ranged from loose to very dense states. Furthermore, site clearing could further aggravate the settlement-prone conditions.

The study concluded that because of site conditions, it will be necessary to remove at least the upper 36 inches of existing soil in areas to be graded. Additionally, following the minimum removal, an engineering geologist should observe the bottom of the excavation prior to scarification to confirm that all undocumented fill and loose/hydroconsolidatable native soils have been removed. Furthermore, the study recommended that in order to provide adequate support for the proposed structures further subexcavation, as necessary, and recompaction to provide a compacted fill mat beneath footings and slabs which would provide a dense, uniform, high-strength soil layer to distribute the foundation loads over the underlying soils be required.

In addition, "special fill reinforcement measures, such as utilization of Geogrid, will be necessary for fill or fill over cut slopes. Because the slope stability depends significantly on the cohesive strength of fill materials, the stability of the fill and fill over cut slopes should be further evaluated during grading by verifying the strength parameters of the fill materials with additional direct shear testing performed by the geotechnical engineer on a regular basis". See geotechnical investigation study for fill requirements.

Furthermore, “due to the depth to groundwater and the required removal of any loose soils, liquefaction is not considered to be a significant hazard to the site. The on-site soils are generally granular and are considered to be non-critically expansive”.

Geotechnical Investigation, CHJ Incorporated, January 5, 2006

According to this geotechnical investigation, the proposed offsite road and spreading basin improvements including storm drainage improvements consisting of reinforced concrete boxes (RCB), overcrossings, and/or slab bridges are feasible from a geotechnical standpoint, provided the recommendations contained in the report are implemented during grading and construction.

The study concluded that no large landslides or surficial failures occur on the project site. However, evidence of landslides or surficial failures can be obscured by erosion and vegetation cover. Therefore, steep slopes in the Pelona Schist should be considered to have a potential for surficial failure and the generation of debris flows downslope of them. In addition, the potential for deep-seated slope failure is expected to be low for the proposed cut slopes on Little Mountain Road. However, the potential for smaller, popout type failures in finished cut slopes may be significant. Additional observations included concerns that off-site road alignments in the upper 36 inches of native soils will not provide uniform or adequate support for the proposed roadway alignment. The report concluded that the extent and depth of removal should be confirmed by the engineering geologist.

Undocumented fill was encountered in several exploratory boring locations. The study recommended that all such undocumented fill be completely removed if allowed. “Complete removal should be confirmed by the engineering geologist. However, complete removal may not be possible due to issues with removal of flood control structures and berms by the flood control district”. The geotechnical investigation contained specific fill requirements for different areas of the site.

Furthermore, “the current depth to groundwater at the site is not known; however, based on historical groundwater data and the present grade of the site, a minimum depth to groundwater of greater than 50 feet bgs beneath the lower elevations of the alignment during the life of the project does not appear to be unreasonable or overly conservative”. In addition, no evidence of recent significant flooding of the site or surrounding area was observed. Therefore, liquefaction is not considered to be a potential hazard to the site due to the depth to groundwater and age and density of the alluvium and bedrock

4.5.3 - Thresholds of Significance

According to the CEQA Guidelines’ Appendix G, Environmental Checklist, to determine whether impacts to geology and soils are significant environmental effects, the following questions are analyzed and evaluated. Would the project:

- a.) 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?
- b.) Result in substantial soil erosion or the loss of topsoil?
- c.) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of subsidence, liquefaction or collapse?
- d.) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?
- e.) 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?

4.5.4 - Project Impacts and Mitigation Measures

This section identifies potential impacts related to geology, soils, and seismicity. Impacts analyzed in this section include seismic hazards, erosion hazards, expansive soils, and unstable geologic units. Data from the project engineer indicates onsite grading will require approximately 2 million cubic yards of earthwork, which is expected to be balanced onsite. The site is expected to be mass graded at one time to help balance earthwork and minimize the potential for offsite export or import (PBS&J 2007).

Seismic Hazards

Impact GEO-1: **The Proposed Project would not expose people or structures to potential substantial adverse effects, including the risk of loss, injury or death involving: rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault (Division of Mines and Geology Special Publication 42); strong seismic ground shaking; seismic-related ground failure, including liquefaction; or landslides.**

Impact Analysis

The project site is located in an area of high seismicity, as is all of Southern California. However, two branches of the major active SAFZ cross the central and northern portions of this site. Potential seismic hazards include fault rupture, strong ground shaking, ground failure, and landsliding. CHJ conducted extensive seismic trenching on the site (approximately 5,000 linear feet) to a depth of 50

feet in some locations to identify the specific location of the SAFZ on the project site. This and the other geotechnical reports that evaluated the potential for seismic hazards are summarized below:

Fault Rupture

The project site is within the Alquist-Priolo Earthquake Fault Zone identified for the SAFZ. In addition, the smaller Mill Creek Fault crosses the project site between the two branches of the SAFZ on the project site. These conditions indicate there is a high probability of fault rupture occurring on the project site. The proposed UHSP indicates that no habitable structures have been placed in areas that would be subject to ground rupture or failure. In addition, the City will require the Proposed Project to comply with all applicable California Building Standards Code seismic design standards. Compliance with these standards will help ensure that the proposed structures would not expose persons to seismic-related ground failure hazards. Therefore, the project design has reduced this potential risk to a **less than significant impact**.

Seismic Ground Shaking

A major seismic event on one of the faults listed in Table 4.5-1 will result in strong ground shaking on the project site. To reduce the potential for exposure of persons and property to harm, the Proposed Project would be required to meet the applicable seismic design standards of the California Building Standards Code. As noted above, these design standards correspond to the level of seismic risk in a given location and are intended primarily to protect public safety and secondly to minimize property damage. Compliance with the seismic design standards of the California Building Standards Code would ensure that potential impacts in this regard are **less than significant**.

Seismic-Related Ground Failure

The various geotechnical reports prepared for this site indicated that “severe seismic shaking and possible ground rupture of the south branch of the San Andreas Fault is expected during the lifetime of the proposed development” (page 17, GRA 1990). The proposed UHSP indicates that no habitable structures have been placed in areas that would be subject to ground rupture or failure. In addition, the City will require the Proposed Project to comply with all applicable California Building Standards Code seismic design standards. Compliance with these standards will help ensure that the proposed structures would not expose persons to seismic-related ground failure hazards. Therefore, the project design has reduced this potential risk to a **less than significant impact**.

Landslides

Most of the project site proposed for development is on a sloping alluvial terrace and has a relatively low potential for landslides. However, Planning Area 15, north of the south branch of the San Andreas Fault, has a moderate to high potential for landslides. Several large landslides (deep-seated slope failures) and debris flows (shallow failures) have been documented on the project site in Planning Area 15 (CHJ 1990)(CHJ 2007). The previous geotechnical reports recommended that no occupied structures be placed in this area until more detailed geotechnical studies could be performed. Until such time as these studies are completed, this represents a **significant impact** to a portion of the

project site and must be mitigated. The Specific Plan contains a similar requirement (TPC 2007, page 2-29); however, this mitigation measure will assure that the identified measure is implemented prior to any subsequent discretionary action on Planning Area 15.

Seiches

Strong seismic shaking can induce standing waves or seiches in enclosed water storage facilities such as reservoirs. The UHSP project contains two reservoirs. Strong seismic shaking along the San Andreas Fault or other regional faults may induce seiching in the onsite reservoirs that might in turn cause partial or complete failure of the reservoir tank. If one or both of the tanks were to fail, a large volume of water could be released suddenly, which would flow downhill. If such an event were to occur, it is possible that homes in the west end of Planning Area 15 might be damaged by seiche flows. This impact is considered **potentially significant** and requires mitigation. Conversely, any water released during failure of the reservoir in Planning Area 23 would flow down Badger Creek and would not damage or threaten any occupied structure. Therefore, impacts associated with tank failure at this location are less than significant.

Level of Significance Before Mitigation

Significant impact.

Mitigation Measures

MM GEO-1a Prior to the recordation of any map in the area north of the South Branch of the San Andreas Fault (Planning Area 15), detailed geologic investigations shall be prepared to determine slope stability, landslide limits, and specific structural and grading requirements to identify the most appropriate design and construction requirements for specific building foundations. This study must demonstrate that any residences to be built in this area will not be subject to landslides, or that risks associated with any landslide features or conditions can be alleviated or reduced to a level equivalent to that of other residential planning areas in the project. This measure shall be implemented to the satisfaction of the City Planner in consultation with the City Geologist or qualified geotechnical personnel retained by the City.

MM GEO-1b Prior to the recordation of any tract map in the area north of the South Branch of the San Andreas Fault (Planning Area 15), the developer must demonstrate that the reservoir in Planning Area 22 will have no impact on any homes in Planning Area 15 from a seiche event that could occur from strong seismic ground shaking. The reservoir must be designed to withstand anticipated seismic shaking, and must be dyked or otherwise protected so as to protect downstream homes from seiche flow damage.

Level of Significance After Mitigation

Less than significant impact.

Soil Erosion or Topsoil Loss

Impact GEO-2: The Proposed Project may result in substantial erosion or loss of topsoil.

Impact Analysis

The Proposed Project would require extensive grading and excavation. During these activities, there would be the potential for surface water to carry sediment from onsite erosion into the stormwater system and local waterways. Soil erosion may occur along project boundaries during construction in areas where temporary soil storage is required. As noted in Table 4.5-1, approximately 90.7 acres or 54 percent of the areas planned for development have soil types with moderate to high erosion potential. These soils are generally located on the upper portion of the West Village area and in the East Village area. Therefore, a potentially significant risk of erosion associated with construction activities exists.

Construction activities associated with the Proposed Project would involve vegetation removal, grading, and excavation activities that could expose barren soils to sources of wind or water, resulting in erosion and sedimentation on and off the project site. NPDES Phase II stormwater permitting programs regulate stormwater quality from construction sites, which includes erosion and sedimentation. Under the NPDES permitting program, the preparation and implementation of SWPPPs are required for construction activities more than one acre in size. The SWPPP must identify potential sources of erosion or sedimentation that may be reasonably expected to affect the quality of stormwater discharges as well as identify and implement BMPs that ensure the reduction of these pollutants during stormwater discharges. Typical BMPs intended to control erosion include sand bags, detention basins, silt fencing, landscaping, hydroseeding, storm drain inlet protection, street sweeping, and monitoring of water bodies.

Prior to construction grading, the applicant must file a NOI to comply with the General NPDES Permit issued to the RWQCB and prepare the SWPPP, which addresses the measures that would be included in the project to minimize and control construction and post-construction runoff to the “maximum extent practicable.” In addition, the Proposed Project would be required to comply with the City Code requirements pertaining to grading and excavation.

Implementation of the above requirements, including the preparation and implementation of a SWPPP and compliance with City Code requirements, would reduce potential construction-related erosion impacts to less than significant levels, as outlined in HYD-1 in the section on Hydrology and Water Quality. Implementation of the Water Quality Management Plan for the project will also reduce erosion impacts. Over the long-term, the Proposed Project would result in the coverage of the project site with impervious surfaces and landscaping, which would eliminate the potential for erosion to occur once the project has been completed.

Level of Significance Before Mitigation

Potentially significant impact over the short-term, long-term impacts are less than significant.

Mitigation Measures

Refer to Mitigation Measures HYD-1a and HYD-1b in Section 4.7, *Hydrology and Water Quality* to address short-term impacts during construction.

Level of Significance After Mitigation

Less than significant impact (both short- and long-term).

Unstable Geologic Units or Soils

Impact GEO-3: **The project is located on a geologic unit or soil that is unstable, or that would become unstable as a result of subsidence, liquefaction or collapse.**

Impact Analysis

The various geotechnical reports for the Proposed Project and/or the project site indicate that there were some isolated areas of undocumented fill materials onsite, but that those areas were not planned for development (e.g., former Circle K Camp in Planning Area 24, planned as permanent open space). The reports found underlying soils to be capable of supporting the proposed development (GeoMat 2007) (CHJ 2006). These reports did not find evidence of any geologic or soil limitations that would preclude or largely restrict development of the site as proposed under the UHSP. In addition, available evidence indicates the site would not be subject to liquefaction. However, the GeoMat 2007 report made grading recommendations for each planning area based on the underlying soil conditions, and these will need to be implemented during grading (see also MM GEO-3b). Until these recommendations are implemented, the Proposed Project has the potential to produce **potentially significant** impacts in regard to unstable geologic units. It should be noted that the City's development review process and the Uniform Building Code require site specific geotechnical reports for foundation, wall, and other design and construction requirements for each map where specific unit locations are shown.

According to the project geotechnical reports, shallow, perched ground water (less than 30 feet deep) is expected within the younger alluvial materials in the Badger Canyon drainage northeast of the south branch of the San Andreas fault. Therefore, a potential for liquefaction may exist beneath these younger alluvial materials. Numerous seeps or shallow springs were identified on the site, generally following the north side of the south branch of the SAFZ. Shallow groundwater and possible surface flow is expected associated with the seeps. Shallow, perched groundwater is expected within onsite drainages located northeast of the south branch of the San Andreas fault. Fills placed within on-site drainages may require subdrains and may be recommended in cut areas where shallow groundwater exists or has occurred in the past. The GeoMat report examined each Planning Area proposed for development and made specific foundation recommendations based on existing soil conditions, including the potential for liquefaction.

Level of Significance Before Mitigation

Potentially significant impact.

Mitigation Measures

- MM GEO-3a** Prior to the commencement of grading activities, the applicant shall retain a qualified geotechnical consultant to test any areas planned for development that are underlain by existing imported fill soils to determine their *in situ* compaction and suitability for excavation and reuse as engineered fill. Soil testing can be avoided if the applicant elects to remove the fill and place it either in areas where it will not support buildings, be located in paved or landscaped areas, or be disposed of offsite. This measure shall be implemented to the satisfaction of the City Geologist.
- MM GEO-3b** The developer shall implement the grading recommendations identified in the GeoMat 2007 and the CHJ 2006 reports. Prior to the commencement of building construction, the applicant shall retain a qualified engineer to design foundations adequate to support the Proposed Project's structures where necessary, based on the recommendations of the GeoMat 2007 study. Settlement analysis shall be performed once the structural design loads and foundation system geometry have been defined for each building.

Level of Significance After Mitigation

Less than significant impact.

Expansive Soils

Impact GEO-4: The project site does not contain expansive soils, as defined in Table 18-1-B of the Uniform Building Code (1994), which would create substantial risks to life or property.

Impact Analysis

When certain soil types are exposed to water, mainly those with moderate to high clay content, they can deform and either shrink or swell, depending on their particular physical characteristics. Such soils can expose overlying buildings to differential settlement and other structural damage. The various geotechnical and soils reports for the Proposed Project indicate that onsite soils do not contain expansive clay materials that might expose buildings to structural damage (GeoMat 2007; CHJ 1989; GRA 2990; and CHJ 2006). The City will require that the recommendations in the various site-specific geotechnical reports be implemented during grading and construction, as outlined in Mitigation Measure GEO-3b. Therefore, this is a **less than significant** impact.

Level of Significance Before Mitigation

Less than significant impact.

Mitigation Measures

With implementation of GEO-3b, no additional measures are needed.

Level of Significance After Mitigation

Less than significant impact.

Soils Support Septic Systems

Impact GEO-5: The project site will not use septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.

Impact Analysis

The Proposed Project will connect to the City sewer system, so potential soil constraints for using septic or alternative wastewater disposal systems does not apply. Therefore, there is no impact.

Level of Significance Before Mitigation

No impact.

Mitigation Measures

No measures are needed.

Level of Significance After Mitigation

No impact.