IV. ENVIRONMENTAL IMPACT ANALYSIS  
D. GEOLOGY & SOILS  

INTRODUCTION  

The information and analysis in this section is based primarily on the following reports, which are included in Appendix IV.C of this EIR:

- Peer Review of the Geotechnical Feasibility Study Reports for the 700 University Avenue Mixed-Use Project in Berkeley, CA, Kleinfelder, October 14, 2005.

ENVIRONMENTAL SETTING  

Subsurface Geology and Soils at the Project Site  

Treadwell & Rollo investigated the subsurface conditions at the project site by advancing three cone penetration tests (CPTs) (CPT-1, CPT-2, and CPT-3). The results of the CPTs indicate the soil conditions vary widely between the locations of the three CPTs. The site is apparently blanketed by approximately four to eight feet of fill. The fill appears to be predominantly granular in nature, consisting of medium dense sand and/or clayey sand, with some sandy clay.

At the location of CPT-1, the fill is generally underlain by stiff clay to a depth of approximately 33 feet below ground surface. Thin medium stiff to stiff (weaker) zones were encountered at various depths between 4 and 33 feet, including a thin layer at a depth of approximately 6 feet below ground surface. The shallower weaker zones may limit the allowable bearing capacity of the foundations. The clay is underlain by medium dense to dense sand to a depth of approximately 44 feet. The sand layer appears to be highly variable in both density and fines content, indicating it may be part of a former stream deposit. The sand is underlain by interbedded layers of very stiff silt and clay and dense sand to the maximum depth explored.

At the location of CPT-2, the fill is underlain by stiff to very stiff clay to a depth of about 20 feet below ground surface. The results of the CPTs indicate the shear strength of the material encountered in the
upper 20 feet the location of CPT-2 is significantly higher than that encountered at the location of CPT-1. The clay is underlain by a layer of silty material that extends to a depth of approximately 28 feet below ground surface. This material appears to have little cohesion. The results of the CPTs indicate this layer is stiff. However, the lack of cohesion may cause this layer to behave more like loose to medium dense granular layer, especially under seismic loading. The silty layer is underlain by interbedded layers of very stiff silt and clay and dense to very dense sand to the maximum depth explored.

CPT-3 indicates the fill is underlain by alternating layers of medium stiff to very stiff clay and sandy clay and medium dense to dense clayey sand. An approximately two-foot-thick layer of medium stiff, slightly over consolidated clay was encountered at a depth of approximately seven feet below ground surface. Treadwell & Rollo estimates this layer may be moderately to highly compressible under a moderate increase in overburden stress (greater than 1,000 pounds per square foot). Additional thin layers of medium stiff to stiff clay were encountered at depths of approximately 12 and 14 ½ feet below ground surface. However, these layers are less than one foot thick and deep enough such that they should have relatively low compressibility. Interbedded layers of moderately compressible clay within more competent materials are typical of former meandering stream deposits because of the random depositing of different soil types depending on the water flow through the area. The alternating clay, sandy clay, and clayey sand layers are generally underlain by stiff to very stiff clay to the maximum depth explored (50.5 feet), with the exception of thin layers (1 to 2 feet thick) of dense to very dense clayey sand at depths of approximately 41 and 49 feet below ground surface.

**Groundwater**

Groundwater at the project site was measured at depths ranging from approximately 9.5 to 10 feet below ground surface. It is estimated that groundwater depths at the site could vary by up to two feet seasonally depending on the amount of recent rainfall. Accordingly, Treadwell & Rollo concluded a high groundwater depth of eight feet below ground surface could occur.

**Seismicity and Seismic Hazards**

Seismic hazards include ground motion, ground surface fault rupture, liquefaction and cyclic densification, lateral spreading, and seismically-induced slope instabilities. The project site is located in a seismically active region of California. It can be expected that the project site will experience future periodic, minor earthquakes and possibly a major earthquake on one of the nearby faults. The active faults closest to the project site include the Hayward, Calaveras, and San Andreas faults, which are approximately 3.7, 26, and 26 kilometers from the site, respectively.

**Ground Motion**

Ground motion is generated during an earthquake as two blocks of the Earth’s crust slip past each other. In general, ground motion is greatest near the epicenter, increases with increasing magnitude, and decreases with increasing distance. However, the ground motion measured at a given site is influenced by
a number of criteria, including depth of the epicenter, proximity to the projected or actual fault rupture, fault mechanism, duration of shaking, local geologic structure, source direction of the earthquake, underlying earth material, and topography. Considering the potential for seismic activity in the project region, the project site would be subject to ground motion during an earthquake along a regional fault.

**Fault Rupture**

The project site is not within an Earthquake Fault Zone, as defined by the Alquist-Priolo Earthquake Fault Zoning Act, and no known active or potentially active faults exist on the site. In a seismically active area, the remote possibility exists for future faulting in areas where no faults previously existed. However, Treadwell & Rollo concluded that the risk of surface faulting and consequent secondary ground failure at the site is very low.

**Liquefaction and Cyclic Densification**

Soil liquefaction results from loss of strength during cyclic loading, such as imposed by earthquakes. When seismic ground-shaking occurs, the soil is subject to seismic shear stresses that may cause the soil to undergo deformations. If the soil undergoes virtually unlimited deformation without developing significant resistance, it is said to have liquefied. When soils consolidate during and following liquefaction, ground settlement occurs. Soils most susceptible to liquefaction are clean, loose, saturated, uniformly graded, fine-grained sands. Shallow groundwater is considered a factor as it creates the saturated condition of the soil. The project site is within a designated liquefaction hazard zone as shown on the map prepared by the California State Geological Survey titled, *State of California, Seismic Hazard Zones, Oakland West Quadrangle*, dated February 14, 2003.

Cyclic densification (also referred to as differential compaction) is a phenomenon in which non-saturated, cohesionless soil is densified by earthquake vibrations, causing ground surface settlement. Existing fill at the project site could be susceptible to cyclic densification during a major earthquake.

**Lateral Spreading**

Lateral spreading typically occurs as a form of horizontal displacement of relatively flat-lying alluvial material toward an open or “free” face such as an open body of water, channel, or excavation. Generally in soils, this movement is due to failure along a weak plane, and may often be associated with liquefaction. As cracks develop within the weakened material, blocks of soil displace laterally toward the open face. Cracking and lateral movement may gradually propagate away from the face as blocks continue to break free. Lateral spreading can occur within areas having potential for liquefaction. According to Treadwell & Rollo, the relative density of the potentially liquefiable layers encountered is sufficiently high, and the layers are sufficiently discontinuous that lateral spreading will not occur. Thus, the potential for lateral spreading to occur at the site is low.
Landslides and Slope Instabilities

The project site and surrounding areas are relatively flat. As such, the potential for geologic hazards associated with landsliding to occur at the site is low.

ENVIRONMENTAL IMPACTS

Thresholds of Significance

In accordance with Appendix G of the CEQA Guidelines, the proposed project could have a significant environmental impact if it would:

(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.

   (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 the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.

(d) Be located on expansive soil, as defined in Table 18-1-B of the California Building Code (2001), creating substantial risks to life or property.

(e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water.

Geology & Soils Issues Not Analyzed Further

As discussed previously, the project site is not within an Earthquake Fault Zone, as defined by the Alquist-Priolo Earthquake Fault Zoning Act, and no known active or potentially active faults exist on the site. Thus, the 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

As discussed in the Initial Study (refer to Appendix I), the proposed project would change the drainage patterns on the project site. However, all runoff associated with the proposed project would be either directed to landscaped areas and/or pre-manufactured stormwater quality best management practices (BMPs) for infiltration and water quality purposes or directed to an impervious drainage system. As such, the alteration of the existing drainage pattern would not result in substantial erosion or siltation on- or off-site. Thus, the project would not result in substantial soil erosion or the loss of topsoil. Therefore, no further analysis of this issue is required.

As discussed in the Initial Study, the project site and surrounding area are relatively flat and are not located within an area that is prone to landslides. Therefore, the project would not expose people or structures to potential substantial adverse effects involving landslides. Thus, no further analysis of this issue is required.

As discussed previously, the potential for lateral spreading at the project site is low. Thus, the project would not 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 lateral spreading. Therefore, no further analysis of this issue is required.

As discussed in the Initial Study, the project site is located in a developed area of the City of Berkeley that is served by a municipal wastewater collection, conveyance, and treatment system. No septic tanks are proposed. Therefore, no further analysis of this issue is required.

Project Impacts

Seismic Ground Shaking

The project site is located in a seismically active region, and development of the proposed project would expose future users of the site to seismic groundshaking. Seismic groundshaking could damage the proposed buildings, parking areas, and utility infrastructure. However, the project applicant would be required to design and construct the project in conformance to the most recently adopted Unified Building Code (UBC) design parameters. The parameters shown in Table IV.D-1 for the seismic design of the project were derived or taken from the most recent UBC.

The UBC specifies that all proposed structures on the project site should be able to: (1) resist minor earthquakes without damage; (2) resist moderate earthquakes without structural damage but with some nonstructural damage; and (3) resist major earthquakes without collapse but with some structural as well as nonstructural damage. According to Treadwell & Rollo, conformance with the current UBC requirements would reduce the potential for structures on the project site to sustain damage during an earthquake event, and project impacts related to groundshaking would be less than significant.
Table IV.D-1

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<th>Parameter</th>
<th>Value</th>
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<tr>
<td>Near Source Factor $N_v$</td>
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</table>

*Source: Treadwell & Rollo, November 10, 2005.*

Mitigation Measures (Seismic Ground Shaking)

Because no significant impacts related to seismic ground shaking would occur, no mitigation measures are required.

Ground Failure (Liquefaction, Cyclic Densification, and Settlement)

Treadwell & Rollo performed liquefaction analysis using the CPT data in accordance with the methodology presented in the publication titled *Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils*, prepared by the National Center for Earthquake Engineering Research, dated December 31, 1997. Treadwell & Rollo conservatively assumed an earthquake Moment Magnitude of 7.5 and a peak ground acceleration of 0.56 times gravity, in accordance with the seismic design requirements of the 1997 UBC for a soil profile type $S_{D}$ site, which is appropriate for the soil conditions encountered. At the location of CPT-1, the analysis indicates liquefaction is expected to occur in the sand between depths of 33 and 44 feet below ground surface. At the location of CPT-2, seismically induced softening and/or liquefaction could occur in the silty layer between depths of 20 and 28 feet below ground surface. Treadwell & Rollo preliminarily estimate 0.25 to 1.5 inches of liquefaction-induced ground surface settlement could occur at the site during a design-level earthquake on one of the nearby faults. It is difficult to predict the differential settlement that could occur based on the available data since each potentially liquefiable layer was only encountered at one location, indicating there is a potential for abrupt changes in soil conditions over relatively short distances. However, for the purpose of the geotechnical feasibility study prepared by Treadwell & Rollo, it is assumed that up to half of the maximum estimated liquefaction-induced settlement, or 0.75 inch, could occur differentially between adjacent columns associated with the proposed development. Additionally, as stated previously, the existing fill at the project site may be susceptible to cyclic densification during a major earthquake. Treadwell & Rollo estimates that the site could experience up to $\frac{1}{4}$ inch of settlement due to cyclic densification of unsaturated fill.

However, prior to issuance of a grading permit, the project applicant would be required to submit a final geotechnical report to the City Building and Safety Division for review that would include test borings.
and additional CPTs performed at the project site. During development of the proposed project, geotechnical engineers would be on site to ensure implementation of all recommendations regarding foundations and settlement and excavation and below-grade walls outlined in the Revised Geotechnical Feasibility Study and Letter of Transmittal and Response to Peer Review prepared by Treadwell & Rollo and any additional recommendations that will be included in the final geotechnical report. Compliance with these recommendations would ensure that project impacts related to potential ground failure would be less than significant.

Mitigation Measures (Ground Failure)

Because no significant impacts related to ground failure would occur, no mitigation measures are required.

Expansive Soils

According to Treadwell & Rollo, soils at the project site could be expansive. As stated previously, prior to issuance of a grading permit, the project applicant would be required to submit a final geotechnical report to the City Building and Safety Division for review that would include test borings and additional CPTs performed at the project site. During this final investigation, laboratory tests would be performed on soil sample obtained during drilling. Atterberg limits tests would be performed on near-surface soil to determine if expansive soil is present. If the on-site soil is found to be moderately to highly expansive, during development of the proposed project, geotechnical engineers would be on site to ensure implementation of the following recommendations regarding foundations and settlement and excavation and below-grade and any additional recommendations that will be included in the final geotechnical report:

- Moisture-conditioning, replacing, or lime-treating the existing soil, as appropriate, to reduce the potential for shrink/swell below pavements.
- Supporting buildings on deepened footings or piers, as appropriate, to gain support below the depth of moisture change.
- Overexcavating and replacing the expansive soil with non-expansive, select fill or lime treating the expansive soil below slabs on grade.

Compliance with these recommendations would ensure that project impacts related to expansive soils would be less than significant.

Mitigation Measures (Expansive Soils)

Because no significant impacts related to expansive soils would occur, no mitigation measures are required.
Cumulative Impacts

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

Mitigation Measures

Because no significant cumulative impacts related to geology and soils have been identified, no additional mitigation measures are required.

LEVEL OF SIGNIFICANCE AFTER MITIGATION

With implementation of the mitigation measures listed above, impacts related to geology and soils would be less than significant.