4.5 GEOLOGY, SOILS AND SEISMICITY

This section describes the existing geologic setting and conditions on and around the proposed project site, and presents an evaluation of the impacts of the proposed project on site geology. The information presented in this section is based on a geotechnical engineering report completed by Gary E. Underdahl, Registered Professional Engineer. The report is attached in its entirety as Appendix E of this EIR.

A. Existing Setting

The site is a steeply sloping, mostly cut, slope on the east side Keller Avenue, between Greenridge Drive and Rilea Way. The lot is mostly a 2:1 slope cut for the construction of Keller Avenue. The upper part of the slope is cut by two swales which were filled, possibly as part of the upslope subdivision(s) or as part of the construction of Keller Avenue. A search by the project applicant of the City of Oakland files found no geotechnical information about the Keller Road construction, and no geotechnical reports for the upslope subdivision(s) are known to be available. There is no report of significant recent movement or erosion of any site soils. There is no known contamination on the site.

The site is a irregularly shaped parcel, with approximately 950 feet of frontage on Keller Avenue and a depth of up to 250 feet. Most of the lot is cut, with an approximate 2:1 slope. Above the cut slope, along the upslope or eastern side of the site, the slope is gentler. The gentler slopes are filled or natural, with gradients ranging from 2:1 to 3:1. Elevations on the site range from 350 to 460 feet. Existing drainage occurs in sheet flow down the slope to Keller Avenue.

1. Regulatory Setting

a. Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act requires the delineation of zones along active faults in California. The purpose of the Alquist-Priolo Act

is to regulate development on or near fault traces to reduce the hazard of fault rupture and to prohibit the location of most structures for human occupancy across these traces. Cities and counties must regulate certain development projects within the zones. The proposed project site is not located within an Earthquake Fault Zone.

b. Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act was developed to protect the public from the effects of strong ground shaking, liquefaction, landslides, or other ground failure, and from other hazards caused by earthquakes. This act requires the State Geologist to delineate various seismic hazard zones and requires cities, counties, and other local permitting agencies to regulate development within these zones. Geotechnical investigations must be conducted for sites within a Seismic Hazard Zone prior to any development, and appropriate mitigation measures must be incorporated into the project design. The project site and most of the surrounding hillsides east and west of I-580 are located within a Seismic Hazard Zone for landslides.

c. California Building Code

The California Building Code is included in Title 24 of the California Code of Regulations (CCR), and is a portion of the California Building Standards Code. Under state law, all building standards must be centralized in Title 24 or they are not enforceable. The California Building Code incorporates the Uniform Building Code (UBC), a widely adopted model building code in the United States. The California Building Code also includes necessary California amendments, including criteria for seismic design. The 1997 UBC, the code currently adopted by the City of Oakland, requires extensive geotechnical analysis and engineering for grading, foundations, retaining walls, and structures within seismic zones. The project site is located within Zone 4, as is much of western California. Of the four seismic zones designated in the United States, Zone 4 is expected to experience the greatest effects from earthquake ground shaking and therefore has the most stringent requirements for seismic design.

d. City Of Oakland

The City of Oakland Building Services Division reviews engineering analyses and detailed engineering drawings for all proposed projects in order to ensure that all buildings are designed and built in conformance with the seismic requirements of the City of Oakland Building Code. The engineering analysis and drawings for any proposed project must be submitted and approved by the Building Services Division prior to excavation, grading, or construction activities on a project site.

2. Site Geology

The City of Oakland lies within the geologic region of California referred to as the Coast Ranges geomorphic province. Discontinuous northwest-trending mountain ranges, ridges and intervening valleys composed of ancient seafloor rocks characterize this province.

The cited geologic maps indicate that the site is on geologically young volcanics, labeled the Leona Rhyolite by Radbruch.[1] The bedrock of this formation varies considerably in strength and hardness. The Nilsen Landslide Map shows the site to be on rock and colluvial filled swales. The mapping identifies colluvium and numerous landslides on the adjacent hillsides and swales.

3. Site Seismicity

The San Francisco Bay Area includes this site and is a very seismically active region. Alquist-Priolo Earthquake Fault Zones are created by the State Geologist for faults which are considered to be potentially active.[2] Active faults are those which show evidence of movement within the last 11,000 years. The project site is not within an Earthquake Fault Zone, however, it is in a large area of soils with a potential for permanent ground displacement in an

[1] Crane, Ron, 1988, *Oakland East Quadrangle*, geology modified from others, and Radbruch, D. H., 1969, *Aerial and Engineering Geology of the Oakland East 7½' Quadrangle*, USGS GQ-769.

[2] Davis, James F., 1982 and 2000, *Oakland East Quadrangle, State of California Special Studies Zones and Seismic Hazard Zones*, California Division of Mines and Geology.

TABLE 5 **ACTIVE AND POTENTIALLY ACTIVE FAULTS IN THE PROJECT SITE VICINITY**

Fault	Closest Distance	Maximum Moment Magnitude	Slip Rate (mm/year)	Recurrence Interval
Hayward	0.06 mi	7.1	9.0	167 years
Concord	13 mi	6.9	6.0	176 years
Calaveras	9 mi	6.8	6.0	146 years
San Andreas	19 mi	7.1	17.0	400 years

earthquake. There are several mapped faults in the vicinity. The northwest-trending Hayward fault is approximately 330 feet to the southwest and is considered active. No other nearby faults are mapped as potentially active, and no surface ruptures are shown to cross the lot. Active and potentially active faults in the project site vicinity are listed in Table 5.

4. Site Soils

According to the National Cooperative Soil Survey, the natural soil on the project site is Xerorthents-Millsholm complex, found on 50 to 75 percent slopes. Xerorthents is on the cut and fill urban development area and therefore has quite variable characteristics. It is generally a loamy soil making up approximately 60 percent of the area. The Millsholm is a loam, making up 20 percent of the area. Small areas of Maymen loam, Los Gatos loam, and Los Osos silty clay loam are included in the soils mapping of the site and making up 20 percent of the complex.

The Xerorthents fill is typically a loam, silt loam or light silty clay loam with up to 50 percent angular fragments of shale and sandstone. Xerorthents cut is typically interbedded shale and fine-grained sandstone. The Millsholm is typically shallow and formed in the residuum of weathered shale or fine-grained sandstone. It is typically composed of two layers, a 7-inch-thick silt

loam topsoil and a 20-inch-thick silt loam subsoil, underlain by shale. Both soils typically have a low shrink-swell potential, with a Plasticity Index from non-plastic to a plascticity of 10, and silt and clay fines content of 50 to 75 percent.

To supplement the data from the National Cooperative Soil Survey, three test pits were dug on the project site at depths ranging from 1.5 to 6 feet. The test pit locations are shown in Figure 17. In general, the three test pits on the site found fill over natural clay topsoil and bedrock. The conditions found in the test pits can be grouped as follows:

- **Fill.** The upper soil layer in the central swale is a well-compacted fill. The fill is composed of a gravelly silt or clay or silty gravel, with the gravel consisting of sandstone and shale rock fragments.
- **Topsoil.** The natural layer, under the fill, is a firm and dry sandy clay topsoil, ranging from 6 inches to 18 inches in thickness. The topsoil is moderately to highly plastic and probably highly expansive. Sand and gravel content is relatively high, 46 percent in the sample from Test Pit 3.
- **Bedrock.** The bedrock is a hard and strong volcanic.
- **Groundwater.** No ground water was found in any of the test pits. Depth to ground water is unknown. No ground water is likely to be found in the fill or natural soils on the site.

In contrast with the general data provided by the National Cooperative Soil Survey, the test results of soil sample 3-1, taken from Test Pit # 3 on the proposed project site, showed a higher plasticity index of 21 and a fines content of 53.6 percent. Soil sample 3-1 was taken from the buried topsoil of the site.

5. Soil Expansion

The natural layer of topsoil on the site, which lies beneath a layer of fill, ranges from six to 18 inches in thickness. The topsoil is a firm and dry sandy clay, moderately to highly plastic and probably highly expansive. Beneath the topsoil, the majority of the site is located on a hard and strong volcanic bedrock which is not expansive.

FIGURE 17

TEST PIT LOCATIONS

B. Standards of Significance

In this section, an impact has found to be significant if it would:

- Expose people or structures to potential substantial adverse effects, including risk of loss, injury, or death involving
  - Rupture of a known fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map or Seismic Hazards 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 Publications 42 and 117 and PRC §2690 et. seq.);
  - Strong seismic ground shaking, or seismic related ground failure, including liquefaction, lateral spreading, subsidence, collapse; or
  - Landslides.
- Result in substantial soil erosion or loss of topsoil, creating substantial risks to life, property, or creeks/waterways.
- Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994, as it may be revised), creating substantial risks to life or property;
- Be located above a well, pit, swamp, mound, tank vault, or unmarked sewer line, creating substantial risks to life or property;
- Be located above landfills for which there is no approved closure and post-closure plan, or unknown fill soils, creating substantial risks to life or property ; or
- 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.

C. Impacts and Mitigation Measures

The proposed project is not located above a well, pit, swamp, mound, tank vault, unmarked sewer line or landfill, and so would not create any risks to life or property. In addition, the proposed project would not include the use of septic tanks, so no impacts relating to septic tanks would occur.

1. Fault Rupture

The project site is located roughly 330 feet from the Hayward Fault, which is active. Additionally, the site is located 13 miles, 9 miles and 19 miles from the Concord, Calaveras and San Andreas Faults, none of which are considered active. The risk of surface fault rupture on the proposed project site is very low because no active faults are known to cross the lot. Based on the State Geologist's determination that the Earthquake Fault Zone of the Hayward fault is very narrow in the area of the project site, there is no reason to believe that there are any undiscovered trace faults on the site. Therefore, no impacts from fault rupture are expected to occur.

2. Ground Shaking

Impact GEO-1: The proposed project site is within a seismically-active region, and the proposed project site will likely be subject to strong seismic ground shaking during its design life. (Potentially Significant)

Although the proposed project site is not located within an Earthquake Fault Zone as mapped on the Alquist-Priolo Earthquake Fault Zones created by the California State Geologist, it is considered to be in Seismic Zone 4 based on the standards of the 1997 Uniform Building Code. Areas within Zone 4 are expected to experience maximum magnitudes and damage in the event of an earthquake.

A large magnitude earthquake on any of several Bay Area faults is capable of producing damaging levels of ground shaking on the site. Obviously, the highest ground shaking intensities on the site would be associated with a high

magnitude earthquake on the Hayward fault. In addition, the Concord, Calaveras, San Andreas faults are all relatively close to the site and can be expected to cause moderate to strong ground shaking at the site in the event of a large earthquake. A strong earthquake originating on these or other known or unmapped faults in the greater San Francisco Bay region can be expected to damage structures over a broad area. The seismic response of the site is expected to be similar to that of other nearby developed lots and would not be affected by the construction of the proposed project. However, there is a high risk of potentially damaging intensities of ground shaking at the site during the useful life of the planned structures, which could have impacts on the proposed project. This is a potentially significant impact. Therefore, the project shall incorporate the following mitigation measure:

Mitigation Measure GEO-1: Structures shall be designed in compliance with current building codes related to seismic safety.

Significance After Mitigation: Less than Significant.

3. Landslides and Liquefaction

The risks of earthquake induced landsliding and lurch cracking are essentially non-existent on the site, because of the hard rock underlying the site at shallow depths. The risks of earthquake induced liquefaction or lateral spreading are also non-existent because of the lack of saturated clean silts or sands on the site.

4. Slope Stability

Impact GEO-2: As the soils on the site become saturated in an earthquake event, the slopes become less stable. (Potentially Significant)

Currently the cut and fill slopes on the site are stable, composed of rock, strong fill and firm, natural soils. However, as the soils on the site become saturated in an earthquake event, the slopes become less stable. As mentioned in the project description, a preliminary grading plan has been prepared in

which slope grades are limited to 2-to-1 horizontal to vertical ratio with retaining walls to support this slope. However, soil instability in an earthquake event is a potentially significant impact.

Mitigation Measure GEO-2a: The final grading plan for the proposed project shall limit slope grades to a maximum 2-to-1 horizontal to vertical ratio with retaining walls to support this slope.

Mitigation Measure GEO-2b: New retaining walls and foundations shall be designed following the detailed criteria set forth in the Geotechnical Investigation completed for the proposed project.

Mitigation Measure GEO-2c: Detailed grading plans and construction drawings shall be submitted to the City of Oakland Building Services Department for approval prior to excavation to ensure that the buildings and retaining walls conform with Uniform Building Code requirements.

Mitigation Measure GEO-2d: Foundations of the buildings shall bear on rock.

Mitigation Measure GEO-2e: In addition to the requirements contained in Mitigation Measure HYDRO-3, drainage on the site shall be designed and maintained to minimize ponding of surface water and/or saturation of the soils, following the detailed criteria in the geotechnical investigation completed for the project.

Significance After Mitigation: Less than Significant

5. Erosion

Impact GEO-3: Soils on the site above the fill layer are at risk of erosion. (Potentially Significant)

The project site is composed of well-compacted fill, the natural layer of dry, sandy topsoil and strong volcanic bedrock. There is minimal vegetation on

this heavily graded site. Thus, the soils above the fill layer are at risk of erosion.

Mitigation Measure GEO-3a: An erosion control plan to minimize wind and water erosion during the construction period shall be prepared, as is standard during the grading and building permit approval process. This erosion control plan shall incorporate appropriate measures in accordance with the mitigation measures outlined in Mitigation Measure HYDRO-1, HYDRO-2a and HYDRO-2b.

Mitigation Measure GEO-3b: Long-term erosion shall be addressed through installation of landscaping and storm drainage facilities.

Significance After Mitigation: Less than Significant

6. Soil Expansion

Impact GEO-4: The proposed project would be placed on slightly to moderately expansive soil and non-expansive bedrock and on steep slopes. (Potentially Significant)

As discussed above, the project would be located on a 6- to 18-inch-thick layer of topsoil that is moderately to highly plastic and probably highly expansive. However, below the topsoil is a hard and strong volcanic bedrock that could adequately and safely support the foundations of the proposed units.

Mitigation Measure GEO-4: Foundations shall be drilled piers and grade beams.

Significance After Mitigation: Less than Significant