IV. ENVIRONMENTAL IMPACT ANALYSIS
D. GEOLOGY/SOILS

INTRODUCTION

This section of the Draft EIR presents the findings of geotechnical investigation (provided in Appendix C) prepared for the proposed project and an assessment of potential impacts related to geology and soils. In addition, Baseline Environmental reviewed the Geotechnical Investigation mentioned above and provided input in preparation for this DEIR.

ENVIRONMENTAL SETTING

Regional and Local Setting

The proposed project site occupies a broad ridge that extends downward in a northwesterly direction toward the coast from residential development within the higher reaches of Fassler Avenue, which follows the ridge crest in the project area. Southeast of the proposed project site, Fassler Avenue is bounded by steep, high cuts that were originally excavated by the quarry operation that formerly occupied the project site. The lower portion of the quarry land in the project site area was graded and terraced into its present topography as a result of excavations and fills from those operations. Fills form steep banks around the outer edges of the terrace. Various low mounds of fills and boulders exist across the center of the site, which has been used in the recent past from dumping of logs, stumps, wood, and other debris.

Fassler Avenue originally climbed from Highway 1 and terminated in the lower portion of the quarry land at the project site. After the quarry was abandoned, the road was extended through the central area of the proposed project site to access the upland areas to the east. The old asphalt road is now abandoned, but is still visible on the site, as discussed in Section II (Project Description). The present alignment of Fassler Avenue of the project site extends uphill through an old quarry cut toward the residential development to the east.

Site Conditions

Bench areas that were graded for roads, trails and cuts in the northern portion of the proposed project site have several feet of man-made fill constructed over the outer downslope sides. The fill consists of poorly sorted gravelly silts, clays and quarry debris, and appears to be un-engineered. Some of the fill may have been berms intended for runoff control. The southern portion of the site has areas of relatively deep fills underlain by residual soil and bedrock, as well as areas of near-surface bedrock in locations of roadcuts. Bedrock is not normally exposed at the surface. Soil borings were taken and test pits excavated by BAGG to obtain soil types and conditions and groundwater levels. The soil borings reveal the presence of top soil over intensely weathered, soft, closely-bedded sandstone. Groundwater was encountered only at the Boring B-1 location, approximately 20 feet below the surface. Groundwater levels may fluctuate according to season.

Geologic Setting

The site is underlain by bedrock of the Franciscan Complex. Roadcuts reveal a deeply weathered mix of sandstone, siltstone, shale, and greenstone. A northwest-trending ridge extends through the site, and the elevation ranges from approximately 440 feet above mean sea level (msl) to a low point in the northwest region, about 240 feet above msl. Some local landslide deposits appear within the colluvium-filled ravines below the site. Surrounding hillsides are dissected by erosion and reveal well-developed drainages and subtle linear swales that extend downward. Landslide and debris flows are a recognized hazard in the Pacifica area, considering nearly 500 landslides occurred after an extreme rainstorm in January of 1982.

Seismicity

The coastal region of California is located at the margin of two lithospheric plates of the earth's crust, the Pacific plate to the west and the North American plate to the east. The movement of the Pacific plate northward relative to the North American plate results in the accumulation of stress along the margin of the plates. Earthquakes result as the strain is released by the rupture of the earth. The plate motion has resulted in the development of the San Andreas Fault Systems (SAFS), a series of northwest-southeast trending active faults. The SAFS includes the San Andreas, San Gregorio, Hayward-Rodgers Creek, Calaveras, and other active faults. All of these active regional faults are capable of generating damaging earthquakes. The U.S. Geological Survey has estimated that there was a 62 percent probability that between 2003 and 2032, a 6.7 or greater magnitude earthquake will occur within the San Francisco Bay Region.[1] The probability of a 6.7 magnitude or greater earthquake occurring along individual faults was estimated to be 21 percent along the San Andreas Fault, ten percent along the San Gregorio Fault, 27 percent along the Hayward-Rodgers Creek Fault, and eleven percent along the Calaveras Fault.

The Pacifica region is dominated by the northwest-trending San Andreas Fault, a strike-slip fault that traverses San Mateo County to cross the northern edge of the City of Pacifica before extending into the ocean around Mussel Rock near Daly City. The San Andreas Fault is located approximately 2.7 miles northeast of the site. The largest recorded earthquake in the area was a magnitude of 5.3, which occurred in 1957. The Association of Bay Area Governments (ABAG) provides shaking intensity maps which show that very strong to violent shaking would likely occur at the site, with a Modified Mercalli Intensity (MMI) of VII. to IX. The shaking severity range begins at I. which is not likely to be felt, and extends up to XII., where damage is estimated to be total, with rock masses displaced and objects thrown into the air. Other seismic faults in the region include the Pilarcitos fault, which lies approximately one mile to the south, and may possibly be active; the Northern San Gregorio faults to the southwest, and the Hayward, and Calaveras Faults to the east, which are located a considerable distance from the site.

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1 United State Geologic Survey, 2003, website: http://geopubs.wr.usgs.gov/fact-sheet/fs039-03

ENVIRONMENTAL IMPACTS

Thresholds of Significance

Based on Appendix G of the *CEQA Guidelines*, a project would have a significant impact related to geology and soils if the project would:

- 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 know fault. (Refer to Division of Mines and Geology Special Publication 42.);
    - Strong seismic ground shaking;
    - Seismic-related ground failure, including liquefaction;
    - Landslides; and/or
- Result in substantial soil erosion or the loss of topsoil.
- 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.
- Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code, creating substantial risks to life or property.

Geology and Soils Issues Not Discussed Further

As discussed in the Initial Study (refer to Appendix A), the proposed project is not within an Earthquake Fault Zone. Although the site is located within a zone of regional seismic activity, no known active faults are identified as traversing the site or adjacent properties.

With regard to liquefaction, geologic conditions, site-specific investigation, and regional mapping indicate that the likelihood of the presence of saturated, granular deposits is very low. As such, the susceptibility of materials to liquefaction is very low.

With regard to loss of topsoil, during construction of the proposed project, as described in mitigation measure MM IV.E-1 (Hydrology and Water Quality) the applicant will be required to prepare a Storm Water Pollution Prevention Plan which would require compliance with detailed Best Management Practices (BMPs) designed to reduce erosion of exposed topsoil and mitigate construction-related impacts to a level of insignificance. Through compliance with this mitigation measure, the proposed project would not lead to substantial increases in erosion or loss of topsoil during construction activities. During operation of the proposed project, much of the developed portion of the proposed project site would be

covered by structures, pavement, and managed landscaped areas. These conditions would generally limit the potential for erosion in the developed portion of the proposed project site. Conditions in the portions of the site that would be dedicated to recreation and open space would remain unchanged relative to existing conditions. Therefore, under developed conditions, the project would not result in substantial increases in erosion or loss of topsoil.

Finally, the project does not propose on-site septic tanks or alternative waste water disposal systems; the project would be connected to the existing sanitary sewer system.

Project Impacts

Impact IV.D-1 The proposed project could expose people or structures to potential, substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking.

During a regional earthquake within the SAFS, the level of groundshaking at the proposed project site would be dependent on the magnitude of the earthquake and the distance from the site to the epicenter of the earthquake. The "intensity" of ground shaking during an earthquake is a subjective measure of the perceptible effects of seismic energy at a given point and varies with distance from the epicenter and local geologic conditions. The MMI is the most commonly used scale for measurement of the subjective effects of earthquake intensity. This scale uses the observations of the people who experienced an earthquake to estimate its intensity. Regional analysis by ABAG of estimated groundshaking during expected earthquakes within the SAFS indicate that during an earthquake similar to the 1906 (M 7.9) event on the San Andreas Fault, ground shaking in the vicinity of the project site would be "very strong" (MMI-VIII) to "violent" (MMI-IX). During an M 7.2 earthquake on the San Gregorio Fault, ABAG estimates that the intensity of shaking at the site would be 'strong' (MMI-VII).

Intensity can also be quantitatively measured using accelerometers (strong motion seismographs) that record ground acceleration at a specific location, a measure of force applied to a structure under seismic shaking. Acceleration is measured as a fraction or percentage of the acceleration under gravity (g). Estimates of the peak ground acceleration have been made for the project area based on probabilistic models that account for multiple seismic sources. Under these models, consideration of the probability of expected seismic events is incorporated into the determination of the level of ground shaking at a particular location. Recent seismic hazards evaluations have been conducted to determine probabilistic estimates for seismic shaking levels throughout California. The California Geological Survey estimates that the expected peak horizontal acceleration (i.e., with a 10 percent chance of being exceeded in the next 50 years) from any of the known seismic sources potentially affecting vicinity of the site to be 0.6 to 0.7g.[2]

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2 *California Division of Mines and Geology (CDMG), 1996. Probabilistic Seismic Hazard Map for California, CDMG Open-File Report 96-08.*

Current geologic and seismic evidence, as summarized above indicates that strong seismic shaking is expected at the project site. As such, impacts are considered significant. Implementation of Mitigation Measure MM IV.D-1 would ensure compliance with the design standard adopted in the Uniform Building Code to minimize seismic shaking and damage. Mitigation Measure IV.D-2 requires ongoing review and approval by the geotechnical engineer of any plans submitted by the applicant, as well as peer review of geotechnical analyses prior to issuance of a building permit. Implementation of these mitigation measures would ensure that impacts related to seismic ground shaking remain ***less than significant***.

Impact IV.D-2 The proposed project could expose people or structures to potential, substantial adverse effects, including the risk of loss, injury, or death involving landslides.

The proposed project would be sited in an area of the project site that is underlain by sandstone bedrock of the Franciscan Assemblage. Regional mapping and characterization of slope stability indicates that the slopes developed on this type of bedrock in the vicinity of the proposed project site are moderately to highly stable.[3] The expected susceptibility of these slopes to failure during seismic shaking is generally characterized as very low.[4] Portions of the area proposed for development have been excavated during previous quarrying activities, forming a relatively flat bench on the ridgetop.

However, steep slopes in the vicinity of the proposed project site are susceptible to the development of debris slides, particularly during period of intense or prolonged rainfall. Debris flows usually develop within the unconsolidated slope deposits (colluvium) and are initiated during high rainfall events when groundwater levels are elevated. Landslide and debris flows are a recognized hazard in the Pacifica area, considering nearly 500 landslides occurred after an extreme rainstorm in January of 1982.[5] Although these types of failures are relatively small as compared to deep-seated rotational landslides or earthflows, their occurrence can cause significant damage to structures at the failure location or within the path of the slide mass.

The Geotechnical Investigation prepared for the proposed project did not identify evidence of slope failure or unstable slopes with the proposed project area. However, the investigation did identify evidence of a landslide on the north-facing slope, north of the area of proposed development. The geometry of the slide suggests that it is a relatively shallow, rotational landslide. Additionally the project

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3 *Wentworth, C.M., Ellen, S., Frizzell, V.A., and Schlocker, J., 1985, Map of Hillside Materials and Description of Their Engineering Character, San Mateo County, California, United States Geological Survey, Miscellaneous Investigations Series, Map I-1257D, 1:62,500.*

4 *Wieczorek, G.F., Wilson, R.C., and Harp, E.L.,1985, Map of Showing Slope Stability During Earthquakes in San Mateo County, California, United States Geological Survey, Miscellaneous Investigations Series, Map I-1257E, 1:62,500.*

5 *Ellen, S.D. and Wieczorek, G.F., 1988, Landslides, Floods, and Marine Effects of the Storm of January 3-5, 1982, in the San Francisco Bay Region, California, U.S. Geological Survey Professional Paper 1434, 310 p. + maps.*

would require site grading that involves deep cuts for the underground parking structure and up to 13-foot high retaining walls. As such, impacts related to landslides are considered significant. Mitigation Measure IV.D-3 provides grading procedures and drainage measures. Implementation of this mitigation measure would ensure that impacts remain ***less than significant***.

Impact IV.D-3 The project could 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.

The Geotechnical Investigation prepared for the proposed project identified areas of fill presumably placed during former quarrying operations at the project site. The most obvious filled area is along the outer margin of the bench (referred to also as the 'terrace') in the central portion of the proposed project site along the outside of the existing remnants of the old asphalt road. The method of placement of and materials used in the fill are not accurately known. Other mounds of fill and woody debris are located on the 'terrace'. Because of these on-site conditions, this impact is considered significant. Implementation of Mitigation Measure IV.D-4, which would reduce the potential adverse effects of unstable soil such as landslide, subsidence, and collapse to a ***less-than-significant*** level.

Impact IV.D-4 The project is not located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994).

Expansive soils were not identified as a limiting construction problem by the Geotechnical Investigation prepared for the proposed project site. Barnabe-Candlestick complex soils mapped at the site are characterized as being well-drained with bedrock at shallow depths. Exploratory borings and test pits confirm regional soil mapping description of the shallow nature of the soils. This impact is considered ***less than significant***.

MITIGATION MEASURES

The following mitigation measures are recommended to reduce impacts related to geology and soils impacts to a less-than-significant level:

MM IV.D-1: Strong Seismic Ground Shaking

The proposed project shall be designed to follow seismic design criteria derived from Chapter 16 in the most recent Uniform Building Code to reduce the potential adverse effects of strong seismic ground shaking. The applicant must submit any design/development plans for the Project to the City for review and approval, including peer review as necessary, to verify that the plans conform to the design standards. The Seismic Design parameters are:

- Seismic Zone: 4 (Z=0.40)
- Seismic Source Type A: San Andreas Fault

- Distance to Seismic Source: 2.7 miles to the northeast
- Soil Profile: S*c* (Soft Rock)

The BAGG Geotechnical Report specified Pier and Grade Beam Foundations for the proposed residential structures, and Concrete Mat Foundation for the proposed parking structure loads. These recommendations are in accordance with the UBC and are specified in Appendix E.

MM IV.D-2: Geotechnical Consultant Involvement

All geotechnical aspects of the proposed project, and preliminary development of plans shall continue to be evaluated by the project geotechnical consultant. A letter from the project geotechnical consultant shall be prepared that approves all geotechnical aspects of the proposed site development layout, verifies project geotechnical feasibility, and verifies conformance with the geotechnical consultant's design recommendations, insuring less-than-significant seismic impacts.

In addition, preparation of a single geotechnical engineering report, containing all recommended geotechnical design criteria for the project, shall be prepared no later than acceptance of detailed plans. This report shall be submitted to the City for peer review and acceptance by the City Geotechnical Consultant.

MM IV.D-3: Grading and Drainage

The BAGG Geotechnical Report recommended mitigation measures to reduce the potential adverse effect related to grading and drainage. The applicant will be required to comply with the measures identified to ensure that any impact is reduced below the level of significance. In order to reduce the potential adverse effects that could lead to landslides, the proposed project shall be designed with the following grading procedures:

- Remove vegetation, roots and debris to a minimum depth of six inches below existing grade;
- Exisiting utilities, where known, shall be located on the grading plan. Such measures will allow the project engineer to evaluate the necessity of removing abandoned pipes during site grading;
- Holes/depressions created by the removal of vegetation, roots, existing utilities, or old foundations shall be backfilled with engineered fill. The fill shall be placed in thin lifts not exceeding eight inches in loose thickness compacted to a minimum of 90 percent relative compaction at above optimum moisture content;
- Prior to construction, the loosely placed material in the geotechnical study test pits shall be replaced with compacted fill;
- Acceptable structural fill at the site shall be essentially non-expansive (Plasticity Index of less than 15), free from debris, organic and deleterious material, have a maximum rock size of four inches in diameter, and have fines content of between 15 and 65 percent. On-site material free of

organics and debris is likely to meet the requirements of acceptable structural fill. A sample of the import fill, if planned, should be delivered to the Geotechnical Engineer for testing and approval prior to importing to the site; and

- The fills placed on sloping ground must be keyed into firm, native materials. Keyway depths and locations will be determined by the Geotechnical Engineer. A typical keyway schematic is Shown on Plate 21. The keyway should be approximately 15 feet wide (1.5 times the width of the equipment). The bottom of the keyway should be inclined towards the slope. Subsurface drainage should be installed in the keyway. The typical construction details of a subdrain are shown on Plate 21 (See Geotechnical Study in Appendix E). Subdrains should be connected at their low points to storm drain system or other approved drainage facilities. Subdrain outlets should be protected from erosion and siltation.

Additionally the following surface water controls shall be implemented:

- The ground surface adjacent to all sides of the proposed buildings shall be sloped away from the foundations;
- Unpaved and landscaped areas shall slope at least five percent for a distance of at least five feet away from the face of the building;
- Surface drainage swales at the site shall slope at least one percent toward suitable discharge point;
- Runoff shall not be allowed to flow over graded or natural slopes, and any area where surface run-off becomes concentrated shall be provided with a catch basin;
- The run-off from building roofs shall be collected in closed, non-perforated pipes and discharged to the local storm drain system, or discharged in a manner that will not allow ponding adjacent to foundations or erosion on native or graded slopes; and
- Surface and subsurface drainage facilities and catchment areas shall be checked frequently and cleaned or maintained throughout the project life, as necessary.

Placement of any fill on steep slopes must be properly engineered with retaining walls designed to withstand lateral loads. The following measures must be implemented:

- Design any cut-and-fill of slopes no steeper than 2:1 without the approval of the project Geotechnical Engineer;
- Comply with specific grading procedures and requirements relating to fill outlined above; and
- Submit design plans for surface water control system to the City for review and approval to ensure that: (a) surface run off will not flow over graded or natural slopes; and (b) surface water

drainage is diverted away from a historical landslide area on the site through measures such as the catch basin mentioned under surface water controls.

The applicant shall submit the project grading plans and design plans to the City for review and approval, including peer review as necessary. Peer review shall serve to verify that all recommendations ensure the stability of the slopes at the project site.

MM IV.D-4: Unstable Soil Resulting in Landslide, Subsidence, or Collapse

The BAGG Geotechnical Report recommended mitigation measures to reduce the potential adverse effect related to unstable soil. The applicant will be required to comply with the measures identified to ensure that any impact is reduced below the level of significance. These measures include the following:

- Comply with specific minimum criteria and recommendations concerning the quality of engineered fill outlined in mitigation measure MM IV.D-3;
- Comply with specific minimum criteria and recommendations concerning the standard for soil compaction which requires that all on-site soils and bedrock materials shall be compacted to at least 90 percent of maximum dry density, as determined by ASTM Test Method D1557-01, while at a moisture content that is slightly over optimum. In the slab and pavement areas, the top 6-inches of the subgrade, including aggregate base, shall be compacted to at least 95 percent of the maximum dry density;
- Fill holes/depressions created by grading activities with engineered fill;
- Remove and replace loose fill in test pits with engineered fill; and
- Keyway depths and locations for fill placed on sloping ground must be keyed to firm, native materials, as determined by the Geotechnical Engineer.

Additionally the applicant shall submit the project grading plans to the City for review and approval, including peer review as necessary, to ensure adequate soil stability.

CUMULATIVE IMPACTS

Geotechnical impacts related to future development in the City would involve hazards related to site-specific soil conditions, subsidence, landslides, 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

The proposed project would not result in any significant impacts on geology and soils provided the mitigation measures listed above are adopted and implemented. Impacts related to geology and soils are ***less than significant***.