5.5 - Geology and Soils

5.5.1 - Introduction

Purpose

The purpose of this section is to identify the existing geology and soils setting and potential impacts from the project implementation on these resources. This section also identifies mitigation measures to reduce any potentially significant geology and soils impacts and describes the residual impact, if any, after imposition of the mitigation.

Sources

Information in this section is based on the following sources:

- City of Orange, Manual of Grading, March 1990.
- Preliminary Geologic and Geotechnical Engineering Investigation and Tentative Grading Plan Review, Ridgeline Equestrian Estates, Neblett & Associates, Inc., December 5, 2007, and Response to the City of Orange Corrections/Comments, prepared by Neblett & Associates, June 20, 2008. The complete report is contained in Appendix F.
- Comments received during the NOP public comment period. These comments are included in Appendix A.

5.5.2 - Existing On-Site Setting

The project site is located in the northern portion of the Peninsular Ranges physiographic province and near the southwestern terminus of the Santa Ana Mountains, which are approximately 1,700 feet west of Santiago Creek. Bedrock exposed on and underlying the project has been assigned to the Eocene to Miocene age marine deposited Vaqueros and non-marine Sespe Formation that have not been differentiated. The undifferentiated Vaqueros-Sespe Formation is comprised of sandstones, conglomerates and random red claystones that are typical of the Sespe Formation. The tennis courts, swimming pool, and clubhouse are still in use as of the date the Notice of Preparation was published and work on the Draft EIR began , but the golf course and driving range ceased operations in November 2006.

Tectonics

Historically, the structural geology of southern California has been strongly influenced by the San Andreas Fault and other sympathetic faults, including the San Jacinto, Whittier/Elsinore and Newport-Inglewood faults.

The significant faults near the project site include both the Peralta Hills thrust fault and the El Modeno fault. According to the Preliminary Geologic and Geotechnical Investigation prepared for Ridgeline project, and as amended by correspondence with the City, the El Modeno fault has been inferred to lie approximately 500 feet west of the project site. The Peralta Hills thrust fault lies

approximately 9,000 feet to the north of the site. Faults have not been mapped through the project site. The project site is not within a designated Alquist-Priolo Earthquake Fault Zone.

Geology

The bedrock unit underlying the project site is the Eocene-Miocene undifferentiated Vaqueros Sespe Formation (Tvs). The surficial materials are comprised of non-marine terrace deposits (Qt), and artificial fill (afu). Brief description of these units follow.

Vaqueros Sespe Formations Undifferentiated (Tvs) - The Vaqueros Sespe Formations undifferentiated have been mapped in the central ridge within the project site and along its eastern boundary. These formations are comprised predominantly of inter-bedded moderately to well-cemented sandstone and conglomerate that is very hard and dense. Occasional reddish brown claystone beds are also present. Prevailing bedding structure inclines westerly to southerly.

Terrace Deposits (Qt) - Alluvial derived terrace deposits generally consist of gravelly and clayey sands, sandy clays and clays. These units are mapped within the topographically depressed areas of the project site and reach explored depths ranging to 51 feet below existing grade along the Handy Creek channel bordering the west project site limits.

Undocumented Artificial Fill (afu) - Undocumented artificial fill associated with the former golf course and tennis court development mantles the flat-lying areas of the project site. This undocumented fill was placed to infill a canyon at the northeast corner of the project site. Some fill is also present adjacent to the eastern property line and may have been placed to locally stabilize the ascending easterly slope. These fills are apparently derived from local materials and may include imported soil from off-site sources. This undocumented artificial fill generally consists of silty sands and sandy silts, with some gravelly sands and boulders/gravels, clayey sands and sandy clays, and silty clays.

Groundwater

During Neblett's field exploration in preparation of the Preliminary Geologic and Geotechnical Engineering Investigation, ground water was encountered in borings located across the western portion of the site (NHS-1 through NHS-9 and NHS-11 through NHS-13), and in some of the borings located in the northeastern portion of the site (NBA-1 and NBA-5). The ground water encountered across the western portion occurred at depths ranging from approximately 8-1/2 to 33 feet below ground surface (BGS) within the terrace deposits and appears to be associated with the bordering Handy Creek drainage channel. The ground water encountered in the northeastern portion of the site was at depths of 35 and 25 feet BGS in NBA-1 and NBA-5, respectively, and appears to be related to tributary ground water flow and/or irrigation water accumulation. Generally, ground water conditions can be affected by seasonal fluctuations of rainfall and environmental changes such as irrigation and pumping. Free groundwater encountered in the Neblett borings drilled in late 2006 during the driest season on record contrast with the subsurface investigative findings by John A. Sayers and

Associates, Inc. (JASA) during the wet season of 1998, where free water was encountered at elevations approximately 5 feet higher than in our borings. Neblett concluded in written correspondence (June 20, 2008) to the City, and appended to the Geotechnical study (refer to Appendix F) that because the golf course closed and associated irrigation have ceased for almost a year, the groundwater levels can be expected to be lower than at the time of the Neblett subsurface investigation..

Ripability

During the field exploration, dense and massive Vaqueros Sespe Formation (Tvs) sandstone was encountered. Factors affecting the ripability of the underlying bedrock units include joint spacing, fracturing, the degree of weathering, and the presence or absence of siltstone or mudstone interbeds. Based on field mapping and subsurface exploration, the Vaqueros Sespe Formation is generally massive, but displays minor fracturing and jointing.

5.5.3 - Regulatory Setting

Federal

No federal regulations are associated with this topical environmental issue area.

State

The California Building Code, which is certified in the CCR, Title 24, Part 2, and is a portion of the California Building Standards Code (Title 24 is assigned to the California Building Standards Commission, which by law is responsible for coordinating all building standards).

The Alquist-Priolo Earthquake Fault Zone Act of 1972, which requires that special geologic studies be conducted to locate and assess any active fault traces in and around known active fault areas before development of structures for human occupancy.

The Seismic Hazards Mapping Act of 1990, which addresses non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides.

Local

The City of Orange (City) Manual of Grading sets forth rules and regulations intended to control excavation, grading and earthwork, and cuts and fills for development projects.

5.5.4 - Significance Thresholds

According to Appendix G of the State CEQA Guidelines, a project would normally have a significant effect on the environment if it would result in the following:

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 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 Uniform Building Code (1994), creating substantial risks to life or property, and/or;

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.

5.5.5 - Project Impacts

Impacts Not Found To Be Significant

The Initial Study determined that impacts related to the Alquist-Priolo Earthquake Fault Zone mapping and strong seismic groundshaking were less than significant. No impacts were related to liquefaction, loss of topsoil, and use of septic systems. Refer to the Initial Study in Appendix A for a complete discussion.

Potentially Significant Impacts

Potentially significant impacts are associated with the long-term operational phase of the project including exposing site structures to landslides, unstable geologic conditions, and expansive soils. No impacts are related to the short-term construction phase of the project.

Landslides

Impact 5.5-1	**The project has the potential to expose people or structures to potential substantial adverse effects, including the risk of loss, injury or death involving:** **(a)(iv) Landslides?** **[CEQA Geology and Soils Threshold 6(a)(iv)]**

Landslides and Slumps

The Neblett geotechnical investigation included an evaluation of a 1998 geotechnical investigation by John A. Sayers and Associates, Inc. (JASA) that tentatively mapped a landslide off-site of the eastern site boundary. In addition, this study suggested that two more landslides may be present in the northeastern portion of the project site.

The geotechnical study Neblett & Associates prepared for the proposed project found no evidence of any of these three landslides. This evaluation included a literature review, aerial photo analysis, and

subsurface exploration that included a visual downhole examination of boring excavations. Neblett determined that no recognizable evidence for these suggested features was observed. Canyon areas where these features were mapped were subsequently modified by grading improvements. Pre-1968 aerial photos identify suspect lobate features on the eastern portion of the property. These features do not appear to be associated with deep-seated landsliding and are most likely attributed to displacement of surface soils, specifically rain triggered debris flow events. Boring NBA-2 was drilled within the toe of one of the JASA mapped slides and did not intercept slide-affected soils that suggests the slide. Boring in this location would provide the most-likely evidence of movement.

Therefore, the proposed 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 in an on- or off-site landslide, lateral spreading, subsidence, or collapse and less than significant impacts would result.

Unstable Geologic Location

Impact 5.5-2	**The project has the potential to 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.** **[CEQA Geology and Soils Threshold 6(c)]**

Geologic Setting

Development of the proposed project would result in the addition of residents and structures to the project site that could be affected by the underlying geologic unit during a seismic event. As discussed above, there are no known active or potentially active faults crossing the project site. However, there are a number of faults in the Southern California area which are considered active and would have the potential to produce moderate to strong seismic ground shaking on the project site during a seismic event. These include the San Andreas Fault, the Whittier-Elsinore Fault, the San Jacinto Fault, the Elysian Fault, and the Newport-Inglewood Fault. The possibility of ground acceleration or ground shaking on the project site would be similar to that experienced elsewhere in the Southern California region.

The strongest seismic ground shaking on-site would likely originate from the El Modeno fault, inferred approximately 500 feet west of the western site boundary. An Alquist-Priolo designated fault zone does not overlie the site boundary.

Although seismic ground shaking at the project site could be considerable, the effects on the proposed project would be minimized to the maximum extent practicable through compliance with existing seismic-resistant design criteria in the City's building and grading codes. However, potentially significant impacts could remain. The City's Manual of Grading requires seismicity reports be prepared for certain types of projects and project sites located adjacent to or near active or potentially active faults. Implementation of Mitigation Measure GEO-1, which would implement the recommendations of the Neblett & Associates geotechnical investigation and reduce artificial fill materials would reduce this potentially significant impacts below the level of significance.

Seismically-Induced Settlement

Due to the presence of unsuitable (low density, dry, porous) terrace deposits, as well as undocumented artificial fill materials on portions of the project site, the development of the proposed project could expose people or structures to potential substantially adverse effects such as seismically-induced settlement. Unsuitable terrace deposits, as well as undocumented artificial fill materials within the proposed development area would be removed in entirety, and replaced with engineered compacted fill from on-site.

Implementation of Mitigation Measure GEO-1, which would implement the recommendations of the Neblett & Associates geotechnical investigation would result in the removal of these compressible materials and replacement by engineered compacted fill. This would reduce the potential seismically-induced impacts on the project site to a less than significant level.

Soil Conditions

Development of the proposed project would result in the addition of residents and structures to the project site that could be affected by the potential unstable soil conditions on the project site including liquefaction, seismically-induced settlement, landslides and slumps. The significance of the unstable soils conditions are evaluated below.

The subsurface conditions on the project site were analyzed based on Hollow-Stem and Bucket Auger borings, and Test Pits. Exhibit 5.5-1 provides the locations of these borings and test pits. The number and location of the borings were determined by Neblett & Associates and incorporated data from the JASA study. Neblett choose the various boring locations to characterize the varying sub-surface conditions across the project site that include alluvium, bedrock, artificial fill, and unconsolidated fill materials. Undisturbed and bulk samples of the subsurface materials were obtained during the field drilling operations with the use of a split spoon sampler and SPT (Standard Penetration Test). Laboratory testing of selected soil samples to evaluate their engineering characteristics was performed. The surficial materials are comprised of non-marine terrace deposits (Qt), and artificial fill (afu) specifically Vacqueros Sespe Formation undifferentiated, terrace deposits, and undocumented artificial fill.

Liquefaction

Liquefaction occurs when loose, cohesionless, water-saturated soil (generally sands that are fine-grained) are subjected to strong seismic ground motion of significant duration. These soils generally behave like liquids losing all bearing strength. Liquefaction can cause distress to structures resulting from loss of bearing strength, settlement (especially differential settlements), lateral spreading of surface soils, or the propagation of sand boils to the ground surface. This phenomenon occurs only below the water table. However, after liquefaction has developed, it can move upward into the overlying non-saturated soil, as excess pore water dissipates.

One of the primary factors controlling the potential for liquefaction is depth to groundwater. Typically, liquefaction has a low potential where ground water is greater than 40 feet deep and is unknown below 60 feet.

The development of the proposed project could expose people or structures to potential substantially adverse effects such as liquefaction due to the presence of the inferred fault near the project site. During investigation, groundwater was encountered within the terrace deposits across the western portion of the project site. These terrace deposits predominantly consist of gravelly sand, and sandy and silty clays, and generally exhibit dense to very dense condition and very stiff to hard consistencies. Based on review of the Standard Penetration Test (SPT) blow counts recorded during the field exploration phase, and available laboratory test data and grading recommendations presented herein, the potential for site liquefaction under a major seismic event is low. Therefore, the development of the proposed project would not result in a significant impact due to the exposure of residents and structures to substantial adverse effects from liquefaction during a seismic event.

Expansion and Compressible Soils

The development of the proposed project may be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project in an on-site or off-site landslide, lateral spreading, subsidence, or collapse. Detailed slope stability analyses, include back-cut configurations, and would be accomplished with a detailed grading plan review phase.

It is anticipated that excavated on-site soils and bedrock would be generally comprised of granular materials with little or no cohesion. Engineered fill slopes constructed using these soils may be prone to surficial erosion and/or surficial instability. Mitigation Measure GEO-1 includes the recommendations provided in the Preliminary Geotechnical Investigation.

The potential for slope instability would be reduced to a less than significant level with the implementation of Mitigation Measure GEO-2.

Geotechnical Recommendations

The geotechnical investigation prepared by Neblett and Associates for the Ridgeline project determined the development of the site is feasible from a geologic and geotechnical standpoint provided the recommendations contained in the geotechnical report are implemented. Following is a summary of the geotechnical recommendations.

Table 5.5-1: Geotechnical Recommendations

Geotechnical Topic	Geotechnical Recommendation
Removal of Unsuitable Fill Materials	Unsuitable materials that are encountered on-site include soil, alluvium, undocumented fill, loose terrace deposits, and weathered bedrock will be removed in order to expose competent bedrock prior to the placement of compacted (engineered) fill. Some of the excavated materials will be re-used on-site as engineered fill materials.

Table 5.5-1 (cont): Geotechnical Recommendations

Geotechnical Topic	Geotechnical Recommendation
Removal of Unsuitable Fill Materials (cont)	Grading near (approximately 80 feet at the closest and 180 feet at the farthest) Handy Creek will be over-excavated to a depth of at least 10 feet below ground surface, or to within about 5 feet above existing groundwater levels, whichever depth is greater, and replaced with engineered fill due to groundwater/seepage conditions near Handy Creek. No grading will occur within the floodway or floodplain.
Stabilization Fill Slopes	Stabilization fills will be required along the west-facing cut slope along the eastern perimeter and will require a sub-drain. Excavations for the stabilization fill along the eastern perimeter will be performed using slot-cut grading procedures. A stabilization fill is also recommended in the central portion of the site. Stabilization fills are recommended for slopes where skin fills, skin cuts or fill over cut occur.
Fill Keys	Upon completion of the removal of unsuitable materials, fill keys and a heel drain will be required and these excavations and subdrains can be integrated with the buttress keys.
Lot and Street Overexcavation	Some areas on the site will transition from bedrock cut to engineered compacted fill. To stabilize bedrock cut/fill transitions and facilitate future footing and utility line installation, the near surface bedrock will be over-excavated a minimum 5 feet below finished sub-grade elevations and laterally at least 5 feet beyond the structure perimeter and replaced with engineered fill. If extremely hard bedrock is exposed at street grade in cut areas, overexcavating of these areas to the depths of the deepest utilities will facilitate future trench excavations.
Steep Bedrock / Fill Transition Overexcavation	In order to "soften" the steep transition from bedrock to fill and to eliminate differential settlement, some areas will require bedrock overexcavation.
Subdrainage	All stabilization fills will require sub-drains and will contain 6- to 8-inch diameter scheduled 40 PVC perforated pipe sub-drains at the heels of stabilization fills for a length of 500 feet before outletting. Sub-drains will outlet onto paved drainage devices where possible.
Preparation of Excavation Bottoms	The exposed excavation bottoms will be evaluated by the Project Geotechnical Engineer/Project Geologist for acceptability to support new fills and structures. In areas not exposing hard bedrock, approved excavation bottoms will be scarified to a minimum depth of 1 foot, and moisture conditioned to approximately 1 to 3 percentage points above optimum moisture content and compacted to minimum 90% of the maximum dry density determined in accordance with American Society for Testing and Materials' (ASTM) D 1557 test method.
Fill Placement	1. Approved fill materials will be placed in thin lifts (8-inches in loose thickness), moisture conditioned to approximately 1 to 2 percentage points above optimum moisture and compacted in-place to a minimum of 90 percent of the laboratory maximum density as determined in accordance with ASTM: D 1557. 2. Subsequent lifts will be placed and compacted as described above until final design grades are achieved. 3. Fill placement, moisture conditioning and compaction will be performed under the observation of and testing by of the Project Geotechnical Engineer

Table 5.5-1 (cont): Geotechnical Recommendations

Geotechnical Topic	Geotechnical Recommendation
	or his designated representative.
Fill Material	On-site materials determined to be suitable for re-use as engineered fill will be free of organics, over-sized rocks, and deleterious and other miscellaneous materials. Rock materials greater than 8 to 10 inches in maximum dimension are considered oversized and will require special handling during grading operations. Over-sized rocks will not be placed in the upper 10 feet of compacted fill or within 15 horizontal feet of any slope face.
Source: Preliminary Geologic and Geotechnical Engineering Investigation and Tentative Grading Plan Review, Ridgeline Equestrian Estates, Neblett & Associates, Inc., December 5, 2007.	

Recommended Mitigation Measure GEO-1 would obligate the project applicant to implement the geotechnical recommendations thereby ensuring potentially significant related to geology and soils would be reduced below the level of significance.

The potential for slope instability would be reduced to a less than significant level with the implementation of Mitigation Measure GEO-1.

Expansive Soil

Impact 5.5-3 **The project has the potential to 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.**

[CEQA Geology and Soils Threshold 6(d)]

The development of the proposed project would have the potential to result in a significant impact due to the exposure of residents and structures to expansive and compressible soils. Based upon preliminary laboratory testing, the existing on-site native and fill soils were reported to exhibit "very low" to "medium" expansive soil potential. Additional laboratory testing would be performed during the rough grading operations to substantiate the expansive soil potential on a lot-by-lot basis.

The development of the proposed project would have the potential to result in a significant impact due to the exposure of residents and structures to substantial adverse effects from the compression of the upper 5 to 10 feet of soil and undocumented fill and alluvial materials on the project site.

Geotechnical Recommendation

The existing on-site native and fill soils exhibit "very low" to "medium" expansive soil potential. Additional laboratory testing should be performed during the rough grading operations to substantiate the expansive soil potential on a lot-by-lot basis.

Implementation of Mitigation Measure GEO-1, which would implement the recommendations of the Neblett & Associates geotechnical investigation would reduce this potentially significant impact below the level of significance.

5.5.6 - Mitigation Measures

Landslides

No mitigation measures are required.

Unstable Geologic Location and Expansive Soils

GEO-1 Prior to the approval of the first grading plans or issuance of the first grading or building permit, the project applicant shall incorporate into the grading and project design the recommendations provided in the Preliminary Geologic and Geotechnical Engineering Investigation and Tentative Grading Plan Review study listed in Exhibit 5.5-1 and the Response to the City of Orange Corrections/Comments, prepared by Neblett & Associates, June 20, 2008 for review and accepted as adequate by the Community Development and Public Works Departments.

5.5.7 - Project Design Features

There are no Project Design Features associates with this topical environmental issue area.

5.5.8 - Level of Significance After Mitigation

Implementation of the recommended mitigation measures would reduce all potentially significant impacts related to geology and soils below the level of significance associated with the short-term construction-related phase. There are no impacts associated with the long-term operational phase of the project.

Unstable Geologic Location and Expansive Soils

With the implementation of the recommended Mitigation Measure GEO-1, less than significant impacts would result from unstable geologic conditions and seismic ground shaking during the long-term operational phase of the project. There are no impacts associated with the short-term construction phase of the project.

Expansive Soil

With the implementation of the recommended Mitigation Measure GEO-1 less than significant impacts would result from unstable geologic conditions related to expansive soils during the long-term operational phase of the project. There are no impacts associated with the short-term construction phase of the project.