4.3 GEOLOGY AND SOILS

Introduction

This section of the EIR is based on a site visit by Mr. Steven Bond, a certified engineering geologist and registered geologist, and his review of related studies. The references are included at the end of this section. A geotechnical study for all components of the proposed multi-use trails has not been completed since the project elements are still in a draft design stage. A preliminary foundation report has been prepared for the Hagemann Gulch bridge. Such a study has been recommended as a mitigation measure, with specific issues to be covered at the time of the study and identification of the necessary approvals prior to construction.

Environmental Setting

Regional Geology. The project site is located in a one of the world's most geologically-active areas due to the proximity of tectonic plate boundaries. The San Andreas fault system cuts through the western part of Santa Cruz County, trending in a northwest direction. The San Andreas Fault is a right-lateral strike slip class of fault and separates the pacific tectonic plate from the North American plate. The Arana Gulch project site is 11 miles from the San Andreas Fault. Deformation along the San Andreas Fault zone has played a major role in the building of the California Coast Ranges. The Arana Gulch project site is located atop six million year-old marine sediments of the Purisima Formation and coastal terrace deposits. Site-specific conditions are discussed later in this section.

Topography and Drainage. Approximately 60 feet of relief occur over the approximately 67-acre site. Typical of the region, Arana and Hagemann Gulch waters flow from the north to the south into Monterey Bay which is about 4,000 feet south of the project.

The slopes in the upper grassland area are generally moderate, ranging from 4 degrees to 17 degrees. The steeper slopes in Hagemann Gulch are formed by the more resistant sandstone and siltstone of the Purisima Formation.

Site Geology. In general, the stratigraphy of the Arana Gulch project area consists of, from oldest to youngest, the Tertiary Purisima Formation (Tp), overlain in the uplands by Holocene coastal terrace deposits (Qcl) and overlain in the lowlands by Holocene basin deposits (Qb). The regional terrain has been dissected by natural erosion exposing the Purisima rocks in the valleys below the terrace deposits. Most recently, deposition of sediments in the lower Arana Gulch floodplain form the basin deposits.

The Purisima Formation comprises the bedrock of the project area and consists of marine sandstone and siltstone. Hickey (1968) describes this formation as a very thick-bedded siltstone with thick interbeds of semi-friable (crumbly), fine-grained sandstone. The Purisima rocks are the most resistant geologic media in the project area and as a result, form the steepest slopes.

In the upland areas the project site, coastal terrace deposits, or specifically the Lowest Emergent Coastal Terrace Deposits, overlay the Purisima rocks (Brabb, 1997). These deposits are former near-shore sea bottom deposits that are now uplifted and exposed through tectonic mountain-building forces. These deposits are relatively thin and formed of semi-consolidated and well-sorted deposits of sands with occasional beds of gravel. The thickness of these deposits ranges from 8.5 feet to 14 feet (Weber, 1996).

In the lowland areas, specifically in the floodplain of lower Arana Gulch Creek and Hagemann Gulch, are basin deposits (Brabb, 1997). These sediments consist of organic-rich, clay and silt that settle out of seasonal standing water collected in the basins (Balance Hydrologics, 1982). Basin deposits are differentiated from alluvial deposits based on location of the deposit in topographic lows and adjacent to floodplains, have a water table within 10 feet of the surface, and are subject to flooding (WLA, 2005).

At the southern end of the site, near Arana Gulch Creek and its adjacent western slope, fill material of unknown properties was used as a foundation for the parking area of the Upper Harbor. Debris and fill of unknown character is deposited on the slope above the Upper Harbor immediately north of Brommer Street in the path of the proposed Creek View Trail.

Soils. Soils on the project site includes the Elkhorn Sandy Loam, the Los Osos Loam, the Watsonville Loam, and aquent[1] soils (NRCS, 2005) (Figure 4.3-1).

The Elkhorn Sandy Loam is found in the upland (grassland) areas and slopes of the Purisima Formation. These soils are generally non-plastic and are moderately permeable (NRCS, 2005).

The Watsonville loam is a soil composed of a mixture of sand, clay, silt, and organic matter of moderate to low permeability with increasing clay content and plasticity with increasing depth (NRCS, 2005).

Aquent soils found in the eastern, lowland areas of the site in the floodplain of Arana Gulch Creek are water-saturated owing to high groundwater. These soils have chemically-reducing conditions and lack distinct soil horizons (NRCS, 2005) (see Figure 4.3-1).

Erosion. Erosion potential is the susceptibility of the soil by water or wind action. The risk of erosion depends upon the type of soil, slope of the land, slope length, rainfall amount and intensity, and vegetative cover. Removal of vegetation and the disturbance of the ground by mechanical grading accelerate the erosion process. Impervious surfaces from urban development can also concentrate runoff, causing gullying and other problems. The result may include the loss of valuable soils, sedimentation of streambeds, and habitat degradation.

Erosion potential of the Elkhorn and Watsonville soils is rated high to very-high by the City of Santa Cruz (City of Santa Cruz, 1994). Erosion of the Elkhorn Sandy Loam soils of the semi-consolidated terrace deposits and friable Purisma sediments has been observed on the project

[1] Aquent soil areas are altered or disturbed soil areas where the original soil material has been removed, repositioned, or fill has been added. Aquent soil areas have seasonally high water tables and are often sparsely vegetated.

Figure 4.3-1: On-Site Soils

site along the steeper slopes and in particular where existing trails run upslope. This visible erosion is due to drainage of stormwater runoff creating channels in the unpaved trails of the site. In addition to erosion due to a poorly-maintained trail system, the effects of sheet erosion of barren cut-slopes above the Upper Harbor have been observed in the form of colluvial fans forming at the base of these slopes, encroaching on the western portion of the Upper Harbor Access Road (located just outside the southern end of project site).

Landslides. Landslides are the rapid downward movement of rock, earth or artificial fill on a slope. Factors causing landsliding include the rock strength and orientation of elements on the slope, erosion, weathering, high rainfall, steepness of slopes, and human activities such as the removal of vegetation and inappropriate grading.

With the exception of small areas of basin deposits adjacent to Arana Gulch Creek (Balance Hydrologics, 1982), landslides are not observed in the project site. Further, the "Map of Landslide Deposits in Santa Cruz County" (Cooper-Clark, 1974) does not reveal landslides or landslide activity in the immediate region.

Seismic Activity. The area of the project site is subject to seismic activity (earthquakes).

Faulting. Seismic activity is controlled by movement along the tectonic plate boundaries. The San Andreas Fault delineates the most active boundary in the area. However, several fault boundaries may potentially affect the seismic activity in the area of the project site.

The San Andreas Fault Zone to the east and the San Gregorio Fault Zone to the west represent the two principal active faults within the region (CDMG, 1994). The San Andreas Fault Zone forms the eastern boundary to the Salinian Block, and the San Gregorio Fault Zone runs parallel to the coast and represents the westernmost zone of active faulting in the Bay Area. These faults are known as right-lateral strike-slip faults, or those with principal movement parallel to the trend of the fault. Right-lateral strike-slip movement of the San Andreas fault, for example, means that the western portion of the fault is slowly moving north, while relative motion of the eastern side is to the south. These faults are located about 11 miles from the project site.

Unlike the active faults in the region that have exhibited movement in historic time (or within the last 11,000 years), the Zayante Fault is considered a potentially active fault and shows evidence of movement within the last 1.6 million years. The Ben Lomond Fault is a pre-quaternary fault in which evidence of movement is typically not recognizable, but the fault is not necessarily inactive (CDMG, 1994). These faults are located between 2.5 (Ben Lomond) and 7 miles (Zayante) of the project site.

Earthquake Probabilities. There is a 62 percent probability of a major, damaging earthquake striking the greater San Francisco Bay Region over the next 30 years (2002–2031). Such earthquakes are most likely to occur on seven main fault systems, but may also occur on faults that were not characterized as main systems, but as background (USGS, 2003).

Although the potential risk of structural damage to trails (paved), retaining walls and Hagemman Gulch bridge due to seismic shaking is high, landslides, lateral spreading ground cracking, or liquefaction were not known or reported to have occurred at the project site in the recent (1989) Loma Prieta earthquake.

Liquefaction. Liquefaction is the transformation of loose water-saturated granular materials (such as sand or silt) from a solid into a liquid state, particularly a risk under ground-shaking conditions associated with earthquakes. Liquefaction commonly, but not always, leads to ground failure (City of Santa Cruz, 1994).

The basin deposits (floodplain sediments) of Lower Arana Gulch are recognized by Santa Cruz County as being prone to liquefaction. Previous studies commissioned by the City of Santa Cruz show that these materials have poor bearing properties and can affect the construction of embankments, weirs, or other structures (Balance Hydrologics, 1982).

Regulatory Setting

State of California. Applicable State legislation includes the Alquist-Priolo Special Studies Zones Act. This legislation was enacted by the State of California in 1972 (and renamed the Alquist-Priolo Earthquake Fault Zone Act in 1993), to prevent the construction of buildings used for human occupancy on or immediately adjacent to the surface trace of active faults. The Act requires the State Geologist to delineate earthquake fault zones by regulation along active faults within the state and to issue appropriate maps. Setbacks from the fault and special studies are required within the specified zones. For the purpose of this Act, an active fault is one that has moved in the last 11,000 years (CGS-2, 2005). The project site is not within an Alquist-Priolo Earthquake Fault Zone.

City of Santa Cruz. The Santa Cruz General Plan (amended 1994) Environmental Quality Element and Safety Element for Soils, Geologic Hazards and Seismic Hazards includes policies relevant to the Arana Gulch project. These are addressed in Section 4.1, Land Use, of this EIR.

Impacts and Mitigation Measures

Significance Criteria. The proposed Master Plan would have a potentially significant impact if it would:

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury or death.
- 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 (1994), creating substantial risks to life and property.
- 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 wastewater.

- Result in the loss of availability of known mineral resource that would be of value to the region and the residents of the State.
- Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan.

Less-Than-Significant Impacts. Although the San Andreas Fault has displayed recent, historic ground rupture in the Santa Cruz region, the project location is approximately 11 miles from the two most active and dynamic fault systems in the region, including the San Andreas fault. The nearest known fault is not known to be an active fault. There is not a known fault on the project site. The potential for ground rupture is therefore low and the impact would be less than significant.

A high potential exists for the project site to experience strong earth shaking during the next 30 years due to a large magnitude earthquake in the region. Roadway and trail surfaces, bridges, and any utilities at the project site could be damaged by strong seismic shaking.

Based on the anticipated local and region-wide earthquake damage potential, the project site and the greater surrounding region are located in Seismic Zone 4 of the Uniform Building Code. The highest seismic zone factor of earthquake resistance in the design of structures is required.

Trail surfaces, the bridge, and any utilities in the project must be designed and constructed to Uniform Building Code standards. The City Engineer would review and approve geotechnical recommendations of the City's geotechnical consultants. No mitigation would be necessary under these conditions. Refer to Mitigation Measure GEO-1.

The soils and slopes in the Arana Gulch project area are not suitable for disposal of septic wastewater (NRCS, 2005). However, the City does not propose to build facilities which would generate wastewater. The impact would be less than significant and therefore not require mitigation.

The California Surface Mining and Reclamation Act of 1975 (SMARA) requires that all cities incorporate into their general plans mapped mineral resources designations approved by the State Mining and Geology Board. SMARA was enacted to limit new development in areas with significant mineral deposits. The State geologist classifies land in California based on availability of mineral resources. Because available aggregate construction material is limited, five designations have been established for the classification of sand, gravel and crushed rock resources. A review of the geology of the area and an inspection of the project site did not reveal evidence that any significant deposits of economic mineral resources in or near the project site. Further, no such resources have been mapped in the City's General Plan (City of Santa Cruz, 1994). Refer to Section 4.16, Mineral Resources, of this chapter.

Potentially Significant Impacts. The project would have the following potentially significant impacts.

<u>Impact GEO-1</u>: The project has the potential to expose people or structures to potential substantial adverse effects, including the risk of loss, injury or death, due to liquefaction in the floodplain area of the site. (PS)

The potential for earthquake-induced liquefaction is a potential in the floodplain of the project site where basin deposits exist, are saturated, and are prone to liquefaction. The unpaved Marsh Vista Trail is planned to run along a portion of the basin deposits, but will require minimal soil disturbance. Also, liquefaction of as-yet-undefined fill materials underlying the Arana Gulch Creek crossing is also a potential. An elevated multi-use trail is planned for construction over this area, and cuts into the hillslope for the trail would result in vertical, albeit low slopes.

The potential for earthquake-induced failure of hillslopes underlain by stable bedrock (Purisima Formation) is considered low. However, a potential exists for earthquake-induced failure of slopes which are, or may be covered with unconsolidated fill and debris, such as in the area where Brommer Street descends the hill into the Upper Harbor. Slope failure may occur where slopes are over-steepened, such as the Creek View Trail alignment through these areas. Also, semi-consolidated materials of the marine terraces could likewise fail if over-steepened during construction of the bridge over Hagemann Gulch. Implementation of the following mitigation measure would reduce impacts to less-than-significant levels.

> *<u>Mitigation Measure GEO-1</u>: A project geotechnical investigation shall be conducted and reviewed and approved by the City Engineer prior to issuance of a grading permit. This report shall address the stability of fill materials at the Arana Gulch Creek area and the nature and stability of materials apparently deposited as fill on the slope where the elevated multi-use trail is proposed across Hagemann Gulch. Measures outlined in the feasibility study shall be incorporated into the construction plans. Measures to reduce the potential impacts from slope instability may include but are not limited to:*
>
> - *Slope reconstruction.*
> - *Installation of buttresses or engineered fills.*
> - *Installation of lateral restraint structures.*
> - *Installation of pile supports.*
> - *Re-location of the proposed trails.*
>
> *With the incorporation of all geotechnical recommendations into the project design and construction, this impact would be reduced to less than significant. (LTS)*

<u>Impact GEO-2</u>: The proposed Master Plan elements have the potential to result in substantial soil erosion or the loss of topsoil. (PS)

As yet, an undetermined amount of cut and fill is proposed as part of the project. Cuts into the hillslope as high as 7 feet are planned for the Brommer Street access of the multi-use trail. Bridge construction across Hagemann Gulch would require bridge footing support preparation and construction that likely would require additional cut and fill of the Purisima Formation and marine terrace materials. The combined effects of moderate to steep slopes, prolonged heavy rainfall and denuded slopes from the grading for the bridge and elevated trail could present a temporary potential for increased soil erosion and subsequent siltation in Arana Gulch Creek.

Construction of trails on the steeper slopes could result in the collection, channeling, and concentration of stormwater resulting in accelerated erosion and sediment delivery to the creeks. Implementation of the following mitigation measures would reduce impacts to less-than-significant levels.

> *Mitigation Measure GEO-2(a): The contractor for the project must comply with the City of Santa Cruz Best Management Practices (BMPs) for Construction Work. The BMPs shall be incorporated into the project plans and shall be approved by the City Engineer prior to issuance of a grading permit. If the total area to be disturbed by the project is one or more acres, the City shall obtain coverage under the General Permit for Discharges of Storm Water Associated with Construction Activity and shall submit a Storm Water Pollution and Prevention Plan (SWPPP), as required by the Regional Water Quality Control Board.*
>
> *Mitigation Measure GEO-2(b): All grading shall be conducted during the dry season (April 15 through October 15) only, and all areas of exposed soil shall be replanted within three months of completion of grading activities or prior to the first rainfall or prior to October 31, whichever is earlier, to minimize erosion and subsequent sedimentation.*
>
> *Mitigation Measure GEO-2(c): All trails shall be constructed in accord with best management practices defined in "Best Management Practices For Erosion Control During Trail Maintenance and Construction" (NHDRED 2004), or an equivalent document such as the United States Forest Service, Trail Construction and Maintenance Notebook 2004 Edition (USFS, 2004).*
>
> *The combination of the above mitigation measures would reduce project impacts to less than significant. (LTS)*

Impact GEO-3: The project could potentially result in, on- or off-site landslides, lateral spreading, subsidence, or collapse. (PS)

There are no known active or dormant landslides on or near the project site. During a field inspection of the site and the nearby surrounding area, no evidence of springs, sag ponds, escarpments, lateral spreads, or slumping was observed. Similarly, aerial photo examination did not reveal evidence of landsliding on or near the site. However, cut and fill grading activities may occur in materials that are at risk of slope failure in the area of the Brommer Street/Creek View Trail elevated multi-use trail. Implementation of the following mitigation measure would reduce this impact to a less-than-significant level.

> *Mitigation Measure GEO-3: Refer to Mitigation Measure GEO-1. (LTS)*

Impact GEO-4: Elements of the Master Plan have 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 and property. (PS)

Expansive soils are a common source of moderate damage to houses and light structures, and clay-rich natural topsoil with a high shrink-swell potential is common in the project vicinity. These clay-rich soils contain minerals that swell under wet conditions and shrink under dry conditions. Structural damage, such as cracked foundations, could result from differential movement and from several alternating periods of shrinking and swelling. Usually, damage caused by expansive soils can be minimized or eliminated by using site-specific engineering techniques. The depth of the active zone is important in controlling the expansive potential of the soil profile. The water table fixes the active zone. Soils below this depth do not experience changes in moisture content and thus do not contribute to soil expansion.

The effective plasticity index is used as a measure of a soil's shrink-swell potential (Mathewson, 1982) and there is a correlation between soil properties and shrink-swell characteristics (Erzin, 2004). The clay content of the Elkhorn series averages approximately 20 percent near the surface and increases slightly with depth; the plasticity index of the Elkhorn series is moderate (NRCS, 2005). The clay content of the Watsonville series averages approximately 25 percent near the surface and increases greatly with depth; the plasticity index of the Watsonville is also high (NRCS, 2005). Both soil series are non-plastic in the upper 1 to 2 feet of the surface (NRCS, 2005), but the Watsonville series poses the risk of critical expansive properties indicated by clay content and plasticity. However, during a recent field inspection of the existing trails, evidence of soil cracks of expansive soils was not observed in the soil surfaces.

One or more of the Hagemann Gulch bridge footings could be subject to expansive soils stresses.

Mitigation Measure GEO-4: A geotechnical investigation shall be conducted and reviewed and approved by the City Engineer prior to issuance of a grading permit. See Mitigation Measure GEO-1. Measures outlined in the geotechnical investigation shall be incorporated into the construction plans. Measures to reduce the potential impacts from slope instability may include but are not limited to:

- *Slope reconstruction.*
- *Excavation of expansive soils to bedrock.*
- *Employment of piles to support and stabilize bridge footing.*

This mitigation measure would reduce the potential impact to less than significant. (LTS)

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