12. SOILS AND GEOLOGY

This chapter describes existing conditions and the potential impacts of the project related to soil and geologic conditions, and identifies mitigations for potentially significant effects. This analysis is based upon information presented in the City of Sunnyvale General Plan *Community Development Element, Seismic Safety and Safety Sub-Element* (adopted 1993), the Olson Cherry Orchard Mixed-Use Project Final Environmental Impact Report (May 1999), the Sunnyvale Town Center Mall Modifications Project Draft Environmental Impact Report (January 1999), and the Sunnyvale Downtown Development Program Final Program Environmental Impact Report (August 31, 1990).

12.1 SETTING

12.1.1 Geology and Topography

Sunnyvale is located in the Santa Clara Valley, a large alluvial plain bounded by hills of the Diablo Range to the east, the Santa Cruz Mountains to the southwest, and San Francisco Bay to the north. The project area is primarily flat, sloping gently to the northeast.

Bedrock underlying the project area is composed of the Franciscan Complex--igneous, sedimentary, and metamorphic rocks ranging from 70 to 140 million years old. These rocks are part of a northwesterly trending belt of geologic material that lies along the east side of the San Andreas Fault system. Overlying the bedrock at substantial depths (approximately 1,000 feet) are younger sedimentary rocks that, in turn, underlie unconsolidated sediments. These sediments are quaternary alluvium (sediments deposited by streams and rivers in about the last million years) consisting of silts, sands, gravels, and clays with depths of 300 feet or more.[1]

[1]City of Sunnyvale, Sunnyvale Downtown Development Program Final Program Environmental Impact Report. Prepared by HGHB, August 31, 1990, p. 4-61.

12.1.2 Soils

The project area is underlain by moderately well to somewhat excessively drained medium- to fine-textured soils. Fine-textured surface soils beneath the project area may be subject to substantial shrinking and swelling, as well as minor to moderate differential settlement.[1]

12.1.3 Seismicity and Seismic Hazards

(a) Faulting. The project area is located within the seismically active San Francisco Bay Region, between the active San Andreas fault zone (to the south and west) and the Hayward and Calaveras fault zones (to the east). These major active faults are capable of generating strong earthquakes (Richter magnitudes 6.0 and above) during the project lifetime. The Hayward and Calaveras faults are located approximately 10.5 and 13.5 miles northeast of the site, respectively; the San Andreas fault is located approximately 7.5 miles to the southwest (see Figure 12.1). In addition to potential hazards associated with these major regional fault zones, the area is susceptible to hazards from very strong shaking associated with any one of about 30 lesser faults in the region.[2]

Several "inferred faults" (i.e., faults inferred from topographic or geologic data), which the City of Sunnyvale considers "suspected faults," also exist in the project vicinity. These include the Santa Clara fault, less than one mile south of the project area (near Saratoga-Sunnyvale Road and Fremont Avenue), and the San Jose fault, which runs northeast of the Washington Avenue/Evelyn Avenue intersection, near the railroad tracks. There is no evidence of historical activity on this trace; it is considered inactive and is not mapped in an Alquist-Priolo Special Studies Zone or on the Division of Mines and Geology Special Publication 42. The basic importance of such "inferred faults" lies in the knowledge that they may exist and, as additional information on their potential is developed, that information may then be applied to local safety and land use planning.[3]

(b) Earthquake Probabilities. The U.S. Geological Survey has estimated that there is a 67 percent probability of a major (Richter magnitude 7.0) earthquake in the Bay Area by the year 2020. Recent data gathered by the U.S. Geological Survey suggests a 36 to 50 percent probability of a 7.5 (Richter scale) magnitude earthquake on the Hayward fault by the year

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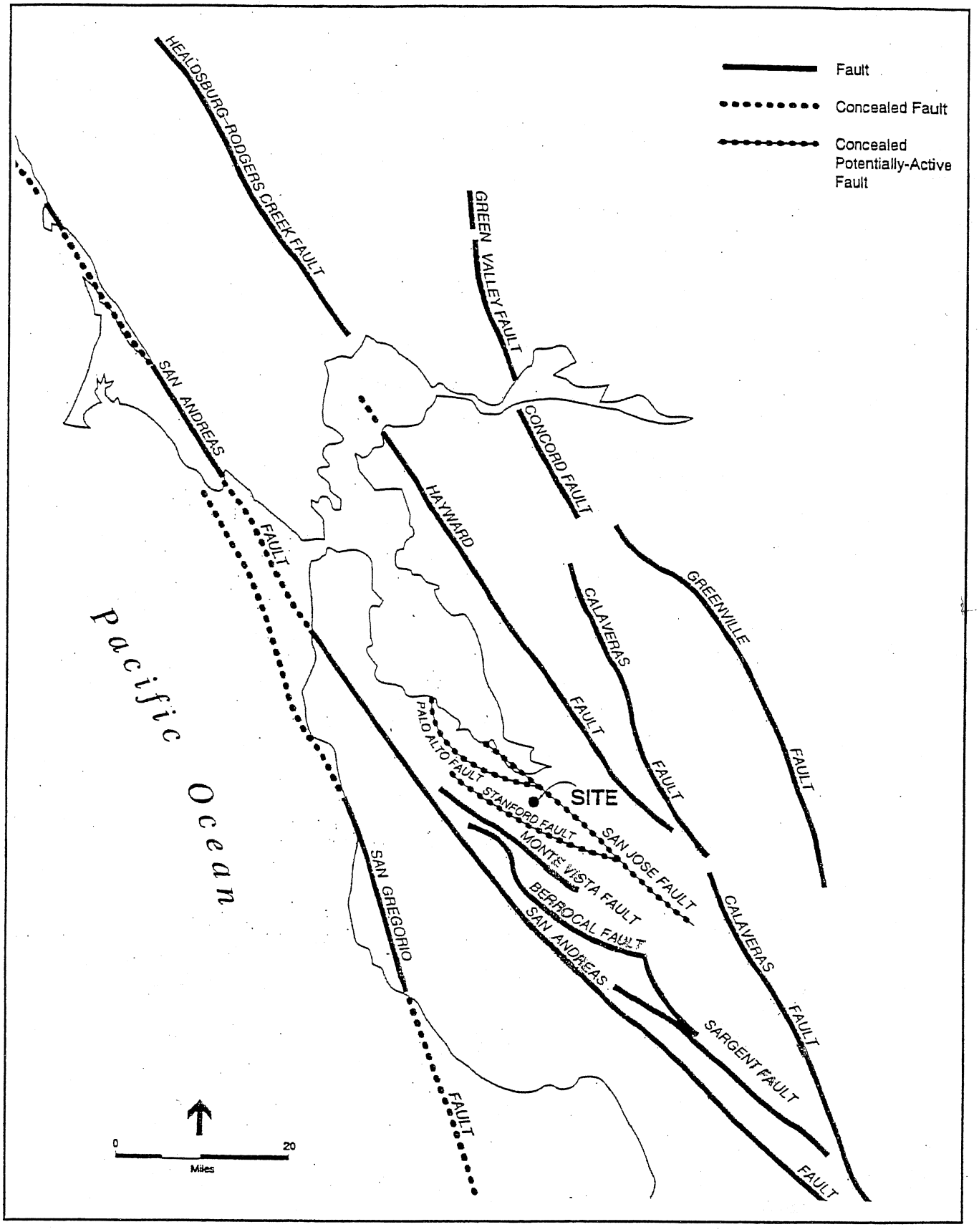
[1]City of Sunnyvale, Olson Cherry Orchard Mixed-Use Project Final Environmental Impact Report. Prepared by ESA, May 1999, p. III.3-2 (adapted from U.S. Department of Agriculture, Soils of Santa Clara County, 1998, pp. 12-28 and 217-222).

[2]Ibid.

[3]Sunnyvale Downtown Development Program Final Program EIR, p. 4-62.



SOURCE: City of Sunnyvale, Olson Cherry Orchard Mixed-Use Project Final EIR, May 1999

Figure 12.1

REGIONAL FAULT MAP

2010. A major earthquake with a magnitude of 8.0 or higher on the Bay Area segments of the San Andreas fault is expected approximately every 100 years.[1]

(c) Potential Earthquake Hazards. Four major types of hazards may be associated with earthquakes in the project area: (1) fault rupture, (2) ground shaking, (3) ground failure, and (4) earthquake-induced inundation from dam failure, tsunamis, or seiches.

(1) Fault Rupture. Consistent with the CEQA Guidelines, Appendix G, item VI(a)(i), because no portion of the project area is mapped in an Alquist-Priolo Special Studies Zone or identified in Division of Mines and Geology Special Publication 42, fault rupture is not considered a significant hazard.

(2) Ground Shaking. The project area's susceptibility to ground shaking is described as "Moderately High," the fourth highest of eight rating levels developed by the Association of Bay Area Governments (ABAG).[2] The maximum expected ground shaking intensity is classified as "D--Strong" (on a scale ranging from "A--Very Violent" to "E--Weak"). The entire Bay Area is designated by the Uniform Building Code as being within Seismic Zone 4, a high-severity zone where probable damage from nearby earthquakes would be major.[3]

The extent of hazards from seismic shaking depends on the specifics of the earthquake and the resistance of individual structures. Older (pre-1974) masonry structures are typically less resistant to seismic shaking damage than are newer wood or steel-framed structures built in accordance with more recent building codes. Similarly, structures not adequately bolted to their foundations have a greater risk of damage than adequately secured structures. No seismic analysis of structures has been undertaken as part of this review.

(3) Ground Failure. Seismic shaking can also result in ground failure through liquefaction, lateral spreading, ground lurching, and differential settlement. Conditions for liquefaction exist in downtown Sunnyvale. However, the potential for liquefaction can depend on specific, highly localized underlying soil conditions. Historically, lateral spreading has been very damaging and disruptive to structures and utilities in Sunnyvale.[4] Determination of liquefaction, differential settlement, and lateral spreading potential in the project area would require site-

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[1] City of Sunnyvale General Plan, *Community Development Element, Seismic Safety and Safety Sub-Element*, 1993, p. 20.

[2] Association of Bay Area Governments, On Shaky Ground, Publication # P95002EQK-SC-13, April 1995.

[3] Uniform Building Code, 1997, Volume 2.

[4] *Seismic Safety and Safety Sub-Element*, p. 25.

specific geotechnical studies. The potential for lurching (seismically induced lateral movement of earth) in the project area is low due to the lack of unsupported faces to lurch towards.

(4) Earthquake-Induced Inundation. Portions of Sunnyvale south of Remington Avenue and west of Saratoga-Sunnyvale Road are subject to inundation in the event of dam failure (at Stevens Creek Reservoir) that could result from an earthquake.[1] The project area is not within or adjacent to this inundation area.

12.2 PERTINENT PLANS AND POLICIES

12.2.1 City of Sunnyvale General Plan

The City of Sunnyvale General Plan *Environmental Management Element, Seismic Safety and Safety Sub-Element* (adopted 1993) contains the following policies and action statements related to soils, geology, and seismicity:

- *Evaluate and consider existing seismic potential hazards in developing land use policies. Make land use decisions based on an awareness of the hazards and potential hazards for the specific parcel of land.* (Policy A1, p. 76)
- *Maintain lifelines [essential services] in good operating condition to lessen damage and increase survivability after a major disaster.* (Policy A5, p. 79)
- *Provide for the emergency management of the City in order to protect life and property in the event of a disaster.* (Policy B2, p. 80)
- *Provide information to business and industry to plan and prepare for emergencies and disasters.* (Policy B5, p. 82)
- *Provide available emergency preparedness information to businesses and industries that request assistance.* (Action Statement B.5.1, p. 82)
- *Encourage business and industry to plan for recovery from catastrophic events.* (Action Statement B.5.2, p. 82)

12.2.2 Uniform Building Code

The construction of all buildings within Sunnyvale is regulated by the Uniform Building Code (UBC, 1997). The UBC has been formulated to ensure that buildings constructed in conformance with its earthquake design provisions can safely withstand the effects of

[1] Ibid., pp. 26-27.

earthquake-induced ground shaking. As a result, it is not expected that newly constructed buildings in Sunnyvale will collapse or otherwise fail structurally during a major earthquake, although they may sustain substantial damage.

12.3 IMPACTS AND MITIGATION MEASURES

12.3.1 Significance Criteria

Based on the CEQA Guidelines (2002 edition, Appendix G, item VI), the proposed project might have a significant adverse impact on soil or geologic conditions if it would:

(a) expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

(i) rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault (refer to Division of Mines and Geology Special Publication 42);

(ii) strong seismic ground shaking;

(iii) seismic-related ground failure, including liquefaction; or

(iv) landslides;[1]

(b) result in substantial soil erosion or the loss of topsoil;[2]

(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;[3] or

(d) be located on expansive soil as defined in Table 18-1-B of the Uniform Building Code, creating substantial risks to life or property.[4]

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[1]CEQA Guidelines, Appendix G, item VI(a).

[2]CEQA Guidelines, Appendix G, item VI(b).

[3]CEQA Guidelines, Appendix G, item VI(c).

[4]CEQA Guidelines, Appendix G, item VI(d).

12.3.2 Future Study and Subsequent Mitigation

Before final mitigation recommendations can be developed for the geotechnical aspects of the project, additional, more detailed studies must be performed to address specific concerns.

Geotechnical/geologic mitigation requirements identified in subsequent sections of this chapter include completion of additional, more detailed studies to address specific concerns as individual, site-specific project applications are submitted. Regarding any mitigation recommendations that have been described in this EIR chapter which require future additional determinations, the CEQA Guidelines and recent court decisions indicate that mitigation measures must operate in some way to alter the significant impacts of the project. The EIR mitigation measures must be capable of ensuring that the project would be implemented in a manner that alters any potential soil and geologic impacts of the project. There is substantial, reasonable, historic information to support the conclusion that the specific subsequent geotechnical/geologic investigations, inspections, and specific formulations identified in this EIR would adequately mitigate related impacts to less-than-significant levels. The City of Sunnyvale routinely requires such geotechnical/geologic investigations and specifications at phases of development review that follow EIR certification.

A significant record exists demonstrating the effectiveness of such post-EIR-certification design and engineering requirements in mitigating the related soil and geologic impacts of concern identified in this EIR. Under the City's redevelopment plan, grading permit, and building permit provisions, requirements, and regulations, a project cannot be given final approval without reasonable indication of project compliance with these geotechnical/geologic requirements. These requirements and related City inspection and verification procedures prior to project occupancy provide reasonable assurances that the project would incorporate the design and engineering refinements necessary to reduce the impact to a less-than-significant level by either avoiding identified soil and geologic impact areas altogether (i.e., basic project design changes), or by rectifying the impact through conventional engineering and construction procedures (e.g., backfilling) identified throughout the post-EIR investigation and monitoring process.

12.3.3 Impacts and Mitigation Measures

Slope Stability and Erosion Hazards. Because the project area is situated on generally level land, it would not be subject to landsliding or other slope instability hazards. In addition, erosion hazards during construction are expected to be low due to the gentle slopes and relatively high percentage of existing impervious surfaces. Potential project-related slope stability and erosion hazards would therefore represent ***less-than-significant impacts*** (see criteria 2 and 3 in subsection 12.3.1, "Significance Criteria," above).

Mitigation. No significant impact has been identified; no mitigation is required.

Impact 12-1: Expansive Soils and Soil Settlement. Additional downtown development and infrastructure improvements facilitated by the project may be subject to foundation and infrastructure (i.e., utility pipe) damage from expansive soils or settlement of soils. Although it is likely that any such soils in the project area were treated or removed prior to the construction of existing structures, it is possible that some hazards remain or that remediation standards have increased. Hazards to project-facilitated development or infrastructure improvements from expansive soils and soil settlement would therefore represent a ***potentially significant impact*** (see criterion 4 in subsection 12.3.1, "Significance Criteria," above).

Mitigation 12-1: Following normal City procedures, require and review geologic reports prior to decisions on any future discretionary development or improvements in the project area which may subject persons or property to significant ground settlement and/or earthquake-induced ground failure risk. The geologic report shall describe potential hazards and identify engineering specifications necessary to reduce all ground failure risks to an acceptable level. Where appropriate, require a geotechnical engineer or engineering geologist's certification that ground failure risks have been reduced to an acceptable level. Implementation of this measure would reduce the impact to a ***less-than-significant level.***

Seismic Shaking Hazards. Although no known active fault passes through or immediately adjacent to the project area, project-facilitated new development and infrastructure improvements, like all urban development in the region, would be subject to strong to very strong seismic shaking in the event of a major earthquake on the Hayward, San Andreas, or Calaveras fault systems. This shaking could, in turn, result in ground failure from liquefaction or differential settlement. Shaking or resulting ground failure could damage or destroy re-used older, historic structures (e.g., unreinforced masonry) or improperly designed or constructed new structures and infrastructure.

Some structures in the project area may be at higher risk of structural failure because of age or type of construction. These structures may include: (1) those constructed prior to the adoption and enforcement of local codes requiring earthquake-resistant building design, (2) those constructed of unreinforced masonry (URM), and (3) those which exhibit any of the following characteristics: exterior parapets or ornamentation that may fall off; exterior walls that are not anchored to the floors, roof, or foundation; sheeting on roofs or floors incapable of withstanding lateral loads; and non-ductile frame construction.[1]

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[1] *Seismic Safety and Safety Sub-Element*, p. 49.

URM buildings are extremely vulnerable to seismic shaking and have performed very poorly in past earthquakes. In the project area, there are URM buildings in the 100 block of S. Murphy Avenue which are historical buildings and exempt from the 1986 California law requiring earthquake hazard mitigation. Some of these buildings were voluntarily upgraded to current earthquake standards when they were remodeled for new occupancy. According to the City's *Seismic Safety and Safety Sub-Element*,[1] with the exception of a few historical buildings on S. Murphy Avenue, no URM buildings exist in Sunnyvale.

To allow a greater flexibility in retrofitting existing buildings, the Uniform Code of Building Conservation (UCBC) was created by the International Conference of Building Officials. The UCBC establishes life-safety and structural requirements for URM buildings, as well as historical buildings that undergo major alteration or a change in occupancy. This code, adopted by the Sunnyvale City Council in 1992, provides standards to mitigate hazardous buildings in a practical and economical manner.[2]

A project-facilitated new development and infrastructure construction within the project area would by law be designed and constructed in accordance with the Uniform Building Code guidelines for Seismic Zone 4 to avoid or minimize potential damage from seismic shaking. The structural design of new project-facilitated building construction proposed within the project area between now and the year 2020 would be expected to incorporate all required conventional engineering measures considered necessary to reduce related seismic shaking impact potentials, including the risk of severe damage, injury, or loss of life in an earthquake to acceptable levels. These measures would be expected to reduce project-related seismic safety impacts to ***less-than-significant levels***.

Mitigation. No significant impact has been identified; no mitigation is identified.

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[1]Ibid., p. 50.

[2]Ibid.