APPENDIX F

Soils, Geology, and Geologic Hazards

CORNERSTONE EARTH GROUP

Type of Services	**Current Conditions** **Soils, Geology, and Geologic Hazards** **Envision San José 2040 General Plan Update**
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ENVISION SAN JOSÉ 2040 GENERAL PLAN UPDATE

SECTION 1: INTRODUCTION

1.1 PURPOSE

This Current Conditions Report presents a discussion of issues related to soils, geology and geologic hazard conditions within the City of San José's sphere of influence, shown in Figure 1, Site Map. This report was prepared for the Envision San José 2040 General Plan Update.

San José's current General Plan was adopted in 1994 and guides the City's day-to-day decision-making for land use and city services. While the strategies in the Plan serve as a consistent and stable framework, San José's dynamic landscape continues to grow and evolve. In June 2007, the City Council approved the proposed Guiding Principles, Work Program and Community Participation Program for the Envision San José 2040 General Plan Update. The Envision San José 2040 General Plan Update will serve as the blueprint for the future of San José.

SECTION 2: SOILS AND GEOLOGIC CONDITIONS

2.1 GEOLOGIC OVERVIEW OF SAN JOSÉ

The City of San José's proposed sphere of influence (see Figure 1) covers about 288 square miles in the northeastern portion of the Santa Clara Valley. The topography of the Santa Clara Valley rises from sea level at the south end of San Francisco Bay to elevations of more than 2,000 feet to the east. The average grade of the Valley floor ranges from nearly horizontal to about two percent generally down to the northwest. Grades are steeper on the surrounding hillsides.

The Diablo Range of mountains extends along the eastern boundary of the Santa Clara Valley. This range consists of northwest-trending subparallel ridges with slopes varying between 20-60 percent, and small intervening valleys. The Santa Cruz Mountains extend along the southwest portion of the Valley. This mountain range consists of similar northwest-trending ridges with intervening valleys, and slopes ranging from 40-60 percent or greater. Other topographic features within the City of San José include the Silver Creek Hills, an extension of the Diablo Range in the southeastern portion of the City, and the Santa Teresa Hills, an extension of the Santa Cruz Mountains located in the south central portion of the City.

The Santa Clara Valley is located within the Coast Ranges geomorphic province of California. This province is characterized by northwest-trending ridges and valleys, underlain by strongly deformed sedimentary and metamorphic rocks of the Franciscan Complex. Parts of the San Francisco Bay Area have undergone substantial sedimentation during recent times. The Santa

Clara Valley consists of a large structural basin containing alluvial deposits derived from the Diablo Range to the east and the Santa Cruz Mountains to the west interbedded with bay and lacustrine deposits in the north-central region. The San José Alluvial Plain is located on the flat-lying floor of the Santa Clara Valley. The valley sediments were deposited as a series of coalescing alluvial fans by streams that drain the adjacent mountains. These alluvial sediments make up the ground water aquifers of the area. Soils in the Valley include clay in the low-lying central areas, loam and gravelly loam in the upper portions of the Valley, and eroded rocky clay loam in the foothills.

The following discussion of general geologic and soil conditions in the San José area is based on geotechnical data and maps from the Technical Report, Geological Investigation, City of San José's Sphere of Influence (Cooper-Clark Associates, 1974); maps and reports by the California Geological Survey regarding liquefaction potential and earthquake induced landslide zones; seismic evaluation of the Liquefaction Potential in San José, California (Power, et al. 1992); and a review of the City's Fault Hazard Maps (1983) and other geologic hazard maps maintained by the Department of Public Works.

2.2 LANDSLIDES

The stability of a slope is affected by the following primary factors: inclination, material type, moisture content, orientation of layering, and vegetative cover. In general, steeper slopes are less stable than more gently inclined ones. Slopes underlain by deeply weathered bedrock, unconsolidated deposits, or soils with a high content of expansive clay also have a greater tendency to fail. Increased moisture content decreases a slope's stability so landslides are more common in the winter months. Landslides triggered by seismic shaking are termed "Earthquake-Induced landslides"; these are discussed in Section 3.5. Activities that can increase landslide potential include poorly designed cuts or fills, inappropriate blockage or diversion of streams, and removal of protective vegetation. Most landslide activity has occurred in the Diablo Range on the east side of the City with lesser amounts in the Santa Teresa Hills and Santa Cruz Mountains to the southwest.

The California Geological Survey (CGS) has an ongoing program to map Seismic Hazard Zones at 7.5 minute quadrangle scale (1:24,000) in the Bay area. These maps show areas having a potential for earthquake-induced landslides. As of February 2009, official Seismic Hazard Zone Maps have been released of all quadrangles covering the City's Sphere of Influence except the Lick Observatory quadrangle, which has mapping in progress. The names and locations of these quadrangles are shown in Figure 3. In addition, there are many other geologic maps of the area published by the United States Geological Survey (USGS), CGS, or others private consulting firms that often show mapped major landslides.

Active landslides are usually obvious and easily identified; however, recent or old landslides, or large-scale landslides that encompass entire hillslopes may require the perspective of aerial photographs or subsurface exploration to be identified. Also, geologists are not always in agreement as to the existence or extent of a particular landslide, so multiple sources should be conferred in assessing a particular area. Several regional maps depict landslides within San José. Tor Nilsen of the USGS did aerial photo interpretation of landslides in the northern Diablo Range. This work was compiled at a scale of 1:24,000 in the early 1970s and later released at 1:62,500. Cooper-Clark & Associates (1974) produced two sets of maps at a scale of 1:48,000 depicting slope stability conditions: one set (Plates 1-A and 1-B) shows ancient, old, and young landslides identified by field mapping or aerial photo interpretation; the other set (Plates 1-C and 1-D) show six landslide susceptibility zones ranging from "Lowest" to "Very High". Norfleet Consultants (1995) mapped active, recent, and old landslides at a scale of 1:2,400 along San José's eastern foothills from Penitencia Creek to the Milpitas boundary, an area of abundant deep-seated landslides identified as a Special Geologic Hazard Study Area (SGHSA), regulated by Municipal Code Chapter 17.10 titled, "Geologic Hazard Regulations." The City of San José Special Geologic Hazard Study Area is reproduced as Figure 4.

There are several types of landslides in the San José area. Varnes (1978) proposed a classification system for slope movement which is composed of six categories based on type of movement: 1) falls, 2) topples, 3) slides, rotational and translational, 4) lateral spreads, 5) debris flows and 6) complex. In San José, the most common types of landslides are rock fall, rock slide (translational), debris slide (rotational and translational), debris flows triggered by excessive rainfall, earthslide (rotational and translational), debris flow, earth flow, and complex slides. For example, complex landsliding is present in the SGHSA, which includes smaller, shallow rotational earthslides occurring within areas of deep seated, slow moving translational landslides, as documented by Norfleet (1995) and others.

The City of San José General Plan policies typically limit urban levels of development to those areas of the hillsides ringing the valley floor that are located below the 15% slope line[1] and that are proven to be stable and appropriate for development. The City Geologist will require a landslide hazard evaluation for all sites within State landslide hazard zones or within locally identified landslide hazard zones. If landsliding is determined to be a site hazard, mitigation recommendations will be required.

2.3 WEAK/EXPANSIVE SOILS

The San José area contains areas of weak and expansive soils. Cooper-Clark and Associates (1974) has produced maps showing soil creep zones (Plates 1A and 1B), weak soil zones (Plates 5A and 5B) and expansive soil zones (Plates 6A and 6B). The referenced maps are on file at the City of San José. Expansive soils have a high shrink-swell potential and occur where a sufficient percentage of certain clay materials are present in the soil. These soil conditions can impact the structural integrity of buildings and other structures. Much of the soil in San José is moderately to highly expansive. In general, moderately to highly expansive soils are found on the valley floor and on hillside areas. Expansive soils on sloping hillsides are subject to soil creep, which can induce lateral forces on foundations and retaining walls.

Weak soils can compress, collapse, or spread laterally under the weight of buildings and fill, causing settlement relative to the thickness of the weak soil. Usually this thickness will vary and differential settlement will occur. Weak soils also tend to amplify shaking during an earthquake, and can be susceptible to liquefaction, as discussed further in sections below. The most hazardous weak soils in San José are younger Bay Mud and certain granular soils or fills with a high water content. Bay Mud is present in the margins near San Francisco Bay; potentially collapsible soils are located in isolated areas around the City; and potentially liquefiable soils occur throughout much of the lands of San José.

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[1] A line at the edge of the floor of the Santa Clara Valley which connects lowest elevation points of fifteen percent or steeper slope.

2.4 NATURALLY-OCCURRING ABESTOS (NOA)

Chrysotile and amphibole asbestos occur naturally in certain geologic settings in the City of San José (City of San José, 2003), most commonly in ultramafic rocks. The most common type of asbestos is chrysotile, which is commonly found in the Santa Clara Valley area in serpentinite rock formations. The City of San José Environmental Services Department has prepared a map showing "Areas of Definite and Likely Natural Asbestos Occurrence with 1000 Ft Buffers" and it is reproduced as Figure 2. When disturbed by construction, grading, quarrying, or mining operations, asbestos-containing dust can be generated. Exposure to asbestos dust can result in lung cancer, mesothelioma, and asbestosis. In July 2001, the California Air Resources Board approved an Asbestos Airborne Toxic Control Measure for Construction, Grading, Quarrying, and Surface Mining activities in areas where naturally-occurring asbestos (NOA) will likely be found and they provide requirements for dust mitigation measures and practices. In the San José area, NOA may be found in mountainous areas or areas of shallow bedrock that could be encountered during construction. The undisturbed rock formations containing asbestos have not been identified as health threats.

2.5 EROSION

Erosion typically occurs when bare soils are exposed to water or wind. In San José, erosion occurs primarily from concentrated water generated on hillsides. In addition to erosion of hillsides, erosion occurs in stream and creek beds and banks during high flow periods. In areas where construction activities have exposed soils and bedrock, erosion can occur as a result of rainfall. Erosion can result in various impacts, including the loss of topsoil, sedimentation of creeks and drainages, undercutting of stream banks, degradation of natural habitats, and possible decrease of slope stability. Accelerated erosion can be caused by removal of vegetative cover, increases in runoff, poor grading practices, and excessive irrigation. Cooper-Clark & Associates (1974, Plate 5A and 5B) map five erosion potential zones ranging from "none" to "very high" throughout San José. These maps are on file at the City of San José.

2.6 ARTIFICIAL FILL

Artificial fill, often referred to as undocumented or man-made fill, has been placed throughout San José. The fills include materials that were placed to fill in naturally low areas, materials to create building pads and roadways, and landfills. In some cases, older, non-engineered fills have been placed without standards for fill materials or compaction. Building on non-engineered fills could result in excessive settlement of structures, pavements, and utilities. Artificial fills placed using current engineering practices, however, are likely to avoid impacts from excessive or differential settlement.

2.7 GROUND SUBSIDENCE DUE TO GROUND WATER REMOVAL

Ground water removal from the aquifers beneath Santa Clara Valley has caused subsidence of the ground surface over broad areas by compaction of the dewatered sediments. Subsidence causes several problems including: changes in slope of streams, canals, or drains; damage to structures, roads, railroads, levees, and pipelines; fissuring at the ground surface; and failure of well casings. The rate of subsidence was greatest in San José in the first half of the 20th century when pumping for agriculture was at its peak. Poland (1971) shows more than 8 feet of subsidence in a trough extending from Edenvale to Agnew in the period from 1934 to 1967. Cooper-Clark and Associates (1974) show as much as 10 feet of future land subsidence below the 1967 levels centered near San José State University. Leake (2004) indicates 12 feet is the maximum amount of subsidence in Santa Clara Valley as of 1997. Subsidence has stopped or greatly slowed now because of improved ground water management. Regional subsidence is not expected to be a problem in San José unless ground water pumping increases above the rate of recharge. Localized subsidence caused by improper construction of dewatering wells may cause settlement of nearby structures, utilities, or streets.

2.8 MINERAL RESOURCES

Pursuant to the mandate of the Surface Mining and Reclamation Act of 1975 (SMARA), the State Mining and Geology Board has designated the Communications Hill Area (Sector EE), bounded generally by the Union Pacific Railroad, Curtner Avenue, State Route 87, and Hillsdale Avenue, as containing mineral deposits which are of regional significance as a source of construction aggregate materials. Other than the Communications Hill area, San José does not have designated mineral deposits subject to SMARA. Urban development on Communications Hill and the vicinity has resulted in the loss of access to mineral resources in this area.

2.9 SOILS AND GEOLOGIC CONDITIONS

As discussed above, different areas within the City of San José's sphere of influence are subject to one or more of the following soils and geologic conditions, which can impact proposed development throughout San José:

- Landslides
- Weak/expansive soils
- Naturally-occurring asbestos
- Erosion
- Artificial fill
- Ground subsidence due to ground water removal

Current General Plan policies addressing these hazards are presented in the "Regulatory Setting" section below. Under General Plan policies and San Jose municipal code requirements, geologic and geotechnical investigations are required to evaluate the potential for these hazards, and present mitigation recommendations where appropriate.

SECTION 3: SEISMICITY AND RELATED GEOLOGIC HAZARDS

3.1 GENERAL SEISMICITY

The San Francisco Bay area is recognized by geologists and seismologists as one of the most seismically active regions in the United States. Significant earthquakes occurring in the Bay area are generally associated with crustal movement along well-defined, active fault zones of the San Andreas Fault system, which spans the Coast Ranges from the Pacific Ocean to the San Joaquin Valley. The San Andreas Fault generated the great San Francisco earthquake of 1906 and the Loma Prieta earthquake of 1989 and passes through the Santa Cruz Mountains southwest of San José. Two other major active faults near San José are the Hayward Fault, located to the north, and the Calaveras Fault, located in the hills to the east. These two faults merge in a series of splays and step-overs in the hills between Mission Peak and Mount Hamilton.

In addition to the active faults discussed above, there are several smaller potentially active faults mapped by the City of San José and shown on the City of San José Fault Hazard Maps (1983). The active and potentially active faults are considered as potential sources of fault rupture and strong seismic ground shaking. Strong seismic ground shaking is a concern throughout the Sphere of Influence for the City of San José including the valley floor and hillside areas.

The Working Group on California Earthquake Probabilities (2003) developed estimates of earthquake probabilities in the San Francisco Bay area for the period from 2002 to 2031. Their findings suggest the probability of a magnitude 6.7 or greater earthquake occurring during this time period in the San Francisco Bay region is 62 percent. The probabilities of a magnitude 6.7 or greater earthquake occurring on the San Francisco Peninsula segment of the San Andreas Fault, the southern Hayward Fault, and the central segment of the Calaveras Fault are believed to be 13, 12, and 3 percent, respectively, in that time period. The probability of a magnitude 6.7 earthquake being generated on an unknown fault or any of the potentially active faults in the San Francisco Bay region including, the Berryessa, Crosley, Clayton, Quimby, Shannon, Evergreen, and Silver Creek faults in San José is 14 percent. The U.S. Geological Survey's Working Group on California Earthquake Probabilities (2007) forecast a 99.7 percent chance of a magnitude 6.7 or greater earthquake somewhere in California before 2038. During such an earthquake the danger of fault ground rupture is limited to sites immediately adjacent to these fault zones, but strong ground shaking would occur Citywide.

Seismologists and Geologists recognize the City of San José and the entire South Bay to be within one of the most seismically active areas in the United States. The 2007 California Building Code (Section 1613) provides a classification system termed "Site Class", where each site is classified based on the soil types and their engineering properties as defined in Section 1613.5.2 and Table 1613.5.2. There are six site classifications, Site Class A through Site Class F. In general, much of the City of San José would be classified as Site Class D (stiff soil) unless the geotechnical investigation provides data that justifies classifying the site otherwise. In addition, the Alquist-Priolo (AP) Earthquake Fault Zoning Act establishes seismic hazard zones designated by the State of California, which require specialized geologic investigations. The City of San José has also established Geologic Hazard Zones that identify potential geologic hazard areas within the City's Sphere of Influence. Areas within the Earthquake Fault Zones or Geologic Hazards Zones may require special study prior to development. The California Geological Survey (CGS) has an ongoing program to map Seismic Hazard Zones at 7.5 minute quadrangle scale (1:24,000) in the Bay Area. These maps show areas having a potential for earthquake-induced landslides and liquefaction. Figure 3 illustrates the CGS mapped zones for Alquist-Priolo zones (faults), liquefaction, and landsliding.

3.2 GROUND SHAKING

Ground shaking is the most widespread hazardous phenomenon associated with seismic activity in San José. Ground shaking will impact developments constructed on the valley floor and hillsides. Earthquake damage resulting from ground shaking is determined by several factors: the magnitude of an earthquake, depth of focus, distance from the fault, intensity and duration of shaking, local ground water and soil conditions, presence of hillsides, structural design and the quality of workmanship and materials used in construction.

3.3 FAULT RUPTURE

Fault rupture occurs when fault displacement extends upward to the ground surface creating a visible offset. Fault rupture may occur abruptly during an earthquake or slowly due to fault creep. Displacements from surface rupture along fault traces have the potential to damage structures or anything else crossing their path and result in loss of life.

Alquist-Priolo Earthquake Fault Zone maps (originally called “Special Studies Zones”) were begun in the early 1970s by the California Division of Mines and Geology and continue to be updated and released by the California Geological Survey. These maps show Holocene-active faults (movement within the last 11,000 years) with bordering zones within which construction for human occupancy is not permitted until studies have been conducted showing there are no signs of recent fault activity crossing a project site. The investigations usually involve trenching. Alquist-Priolo Earthquake Fault Zone maps are compiled on 7.5-minute quadrangles (scale 1:24,000). The City of San José is included on parts of Calaveras Reservoir, Cupertino, Lick Observatory, Los Gatos, Milpitas, Morgan Hill, Mt. Sizer, San José West, and San José East quadrangles, as shown on Figure 3.

Cooper-Clark & Associates (1974, Plates 2-A and 2-B) mapped two types of fault traces within the San José Sphere of Influence: (1) active or potentially active; and (2) faults inactive within Quaternary time (no movement within the last 1.6 million years or indeterminate). These maps also show zones on either side of the faults where fault delineation studies are required by the State and where studies are recommended but not mandated by the state (width of the zone depends on if the fault is considered active or not).

The City of San José Fault Hazard Maps (1983) show fault zones subject to ground rupture during seismic activity at a scale of 1:24,000. These maps depict three types of fault hazard zones listed by decreasing probable hazard: State of California Alquist-Priolo Special Studies Zones; City of San José Special Study Zones; and City of San José Potential Hazard Zones. The maps also show reported faults generally not believed to represent a hazard. The potential for fault movement and rupture is constantly being studied and updated by geologists and seismologists. Therefore, the City of San José may update the potential fault rupture zone in the future based on new information.

One such instance of updated studies concerns the Silver Creek Fault, which is zoned as a fault rupture hazard by the City of San José in the foothills, but where it becomes buried by significantly thick alluvial sediments out in the valley floor, the zone for fault rupture hazard is discontinued. Recent studies by Geomatrix Consultants (2004) and Hatch Mott McDonald/Bechtel (2005) for the BART extension to San José project, included review of previous and on-going fault studies. Their conclusions regarding the northern segment of the Silver Creek Fault were that while the available data may indicate active faulting and that faulting may extend through the Quaternary sediments to as shallow as about 100 feet, there is a lack of evidence for surface rupture, supporting City’s fault rupture hazard zone only for the southern segment.

Evaluation of potential fault hazards is required by the City Geologist for all associated bedrock/hillside sites and soil sites that may be within certain potential fault rupture areas. The geologic evaluations will need to indicate whether fault rupture is possible and present recommended setbacks.

3.4 OTHER GROUND FAILURES

Seismic activity can also result in hazards resulting from other forms of ground failure. Ground failure refers to seismically-induced ground movements which are significant enough to cause severe distress or infrastructure failure. Ground failure includes surface rupture along fault traces, vertical and lateral failures due to soil liquefaction, seismically-induced landslides, earth lurches, lateral spreading, differential settlement, and levee or dam failure. Discussions of each of these ground failure mechanisms are presented below; surface rupture along fault traces is discussed under the “Fault Rupture” section above.

3.4.1 Liquefaction and Lateral Spreading

The majority of the City of San José is located within the Santa Clara Valley, which is a broad alluvial plain with alluvial soils extending several hundred feet below ground surface. During strong seismic shaking, loose, saturated sand and silt layers can soften, potentially resulting in significant ground deformation and/or flow failures in sloping ground or where open faces are present (lateral spreading). Factors that influence liquefaction potential include geologic age of a soil deposit, soil type, soil cohesion, and ground water level. Along active stream channels, liquefaction susceptibility is typically high. Bedrock areas are not typically susceptible to liquefaction.

Lateral spreading typically occurs as a form of horizontal displacement of relatively flat-lying material toward an open face such as an excavation (either temporary or permanent), channel, or body of water. This movement is generally due to failure along a weak plane in soils and may often be associated with liquefaction. Areas of San José most prone to lateral spreading include lands adjacent to the Guadalupe River and Coyote Creek, where liquefaction probability is greatest (U.S. Geological Survey, 2008), and in the marshland deposits of northernmost San José.

The California Geological Survey (CGS) has prepared maps of areas likely to have potentially liquefiable soil conditions titled, “State of California Seismic Hazard Zones,” overlain on 7.5-minute quadrangle sheets. In general, the City Engineering Geologist will require a liquefaction hazard evaluation for all sites within State liquefaction hazard zones (except minor residential addition projects, exempted by the Building Department). In addition, for sites adjacent to creeks, rivers, or other bodies of water, a lateral spreading hazard analysis will need to be performed. If liquefaction and/or lateral spreading are determined to be site hazards, mitigation recommendations, such as densification of loose soils or use of deep foundations, are required.

3.4.2 Liquefaction-Induced Ground Surface Manifestations

Liquefaction-Induced ground surface manifestations include sand boils, ground fissuring or ground cracking (also referred to as lurching), and are a result of fracturing, distortion, and displacement of near surface soils from seismic shaking that cannot be related to fault ground rupture, landslides, or ground settlement due to static loads. The occurrence of this type of ground failure is often related to moisture content of the soils and it is most commonly seen in previous or current marshy areas or valley bottom lands. These areas are often underlain by shallow liquefiable sediments that sometimes erupt onto the ground surface as sand boils. For these ground surface manifestations to occur, the pore water pressure within the liquefiable soil layer will need to be great enough to break through the overlying non-liquefiable layer. Liquefaction evaluations will need to determine whether the depth and thickness of the potentially liquefiable layer could result in these ground surface manifestations, and present mitigation recommendations if it is determined to be a site hazard.

3.4.3 Differential Seismic Settlement or Unsaturated Sand Compaction

Loose unsaturated sandy soils can settle during strong seismic shaking. In San José, sandy soils are present along creeks, areas adjacent to creeks, and other low-lying areas where sandy sediments were deposited during past flooding events. Differential settlement during seismic shaking can be a hazard to buildings, roadways, trails, and hardscape improvements. Geotechnical investigations in areas with loose to medium dense sandy soils need to evaluate the potential for seismic compaction, and present mitigation recommendations if it is determined to be a site hazard.

3.4.4 Seismically-Induced Waves

Seismically induced waves are induced onto bodies of water by earthquakes. In the ocean they are caused by displacement of the sea floor by a submarine earthquake and are called tsunamis. Seiches are waves produced in a confined body of water such as a lake or reservoir by earthquake ground shaking or landsliding. Only the northernmost extent of San José's Sphere of Influence adjacent to San Francisco Bay and Guadalupe and Alviso sloughs (i.e., not within the City's Urban Service Area) are presently believed to be within a tsunami runup area (Ritter and Dupre, 1972). If sea level rises, this potential inundation area would extend further to the southeast. Seiches are possible at the reservoir or pond sites within San José; however, the potential for loss of life from this hazard is low.

3.5 EARTHQUAKE INDUCED LANDSLIDES

In hillside areas and along creeks, earthquakes can trigger landslides. CGS has prepared maps of areas considered likely to be susceptible to earthquake-induced landslides titled, "State of California Seismic Hazards Zones", overlain on 7.5 minute quadrangle sheets. In general, the City's Engineering Geologist will require a landslide hazard evaluation within State considered Earthquake-Induced Landslide areas.

3.6 SUMMARY OF SEISMICITY AND GEOLOGIC HAZARDS

As discussed above, different areas within the City of San José Sphere of Influence are subject to one or more of the following hazards, which can impact future development or redevelopment:

- Seismicity
- Strong ground shaking
- Fault rupture
- Liquefaction and lateral spreading

- Ground rupture
- Differential seismic compaction
- Seismically-induced waves
- Earthquake-Induced Landslides

Current General Plan policies addressing these hazards are presented in the "Regulatory Setting" following this section. Geologic and geotechnical investigations are required to evaluate the potential for these hazards, and present mitigation recommendations where appropriate.

SECTION 4: REGULATORY SETTING

4.1 REGULATORY SETTING OVERVIEW

Development within the City of San José is controlled by various Federal, State, and local agencies to reduce the potential impacts of geologic hazards to people, property and the environment, as well as how planned site activity will affect adjacent properties. The Building Standards Commission is authorized by California Building Standards Law (1953) (Health and Safety Cody sections 18901 through 18949.6) to administer the process related to the adoption, approval, publication, and implementation of California's building codes. These building codes serve as the basis for the design and construction of buildings in California including within the City of San José.

The geologic and seismic safety of schools is reviewed and approved at the State of California level by the Division of the State Architect under The Field Act (1933). The geologic and seismic safety of acute care hospitals is reviewed and approved at the State of California level by the Office of Statewide Health Planning and Development (OSHPD) under Alfred E. Alquist Hospital Facilities Seismic Safety Act of 1983, also known as the Seismic Safety Act. Landfills within the City of San José are regulated by the State of California Integrated Waste Management Board (CIWMB) and San Francisco Bay Regional Water Quality Control Board. The City of San José acts as the Local Enforcement Agency (LEA) for landfills in San José under CIWMB regulations.

Projects other than public schools, acute care hospitals, and landfills are reviewed and approved by the City of San José. The City of San José adopted the 2007 California Building, Plumbing, Mechanical, Electrical, Existing Building, and Historical Building Codes under ordinance No. 28166 (2007). The City of San José has the right to make certain exceptions, modifications, and has the right to make certain exceptions, modifications, and additions to the State Building and Fire Codes. It is noted that the Unreinforced Masonry Building Law (URM Law) was enacted in 1986 and is recognized by local governments including the City of San José to: 1) create inventory of URM Buildings, 2) establish an earthquake loss reduction program for these buildings, and 3) report all information about these efforts to their seismic safety commission. For geotechnical and geologic investigations, applicable state regulations include the Alquist-Priolo Earthquake Fault Zoning Act of 1972 and the Seismic Hazards Mapping Act of 1997. The California Geological Survey (formerly California Division of Mines and Geology) has issued Geologic hazard maps that identify active fault zones, earthquake induced landslide and liquefaction hazard zones.

Policies and regulations that govern the management of geologic hazards in San José are described in the following sections.

4.2 SAN JOSÉ 2020 GENERAL PLAN

San José 2020 General Plan is an adopted statement of policy for the physical development of the City of San José. As such, it represents the official policy regarding the future character and quality of development. The 2020 General Plan represents the City's assessment of the amount, type, and phasing of development needed to achieve the City's social, economic and environmental goals. It was developed with the participation of all City departments and the community at large.

Chapter 4 of the San José 2020 General Plan presents goals and policies for numerous and varied topics. We have summarized the goals and policies for Hazards, Soils and Geologic Conditions, and Earthquakes.

Existing San José General Plan Goals and Policies

The City of San José's goal regarding potential natural hazards is to "Strive to protect the community from injury and damage resulting from natural catastrophes and other hazard conditions." Existing general hazard policies intended to meet the City's goal include the following:

1. Development should only be permitted in those areas where potential danger to the health, safety, and welfare of the residents of the community can be mitigated to an acceptable level.
2. Levels of "acceptable exposure to risk" established for land uses and structures based on descriptions of land use groups and risk exposure levels (see 2020 General Plan Figure 15), "Acceptable Exposure to Risk Related to Various Land Uses", and should be considered in the development review process.
3. Provision should be made to continue essential emergency public services during natural catastrophes.
4. The City should continue updating, as necessary, the San José Building Code and Fire Prevention Code to address geologic, fire and other hazards.
5. The City should promote awareness and caution among San José residents regarding possible natural hazards, including soil conditions, earthquakes, flooding, and fire hazards.
6. Disaster preparedness planning should be undertaken in cooperation with other public agencies and appropriate public-interest organizations.

Goals regarding soil and geologic conditions state: "Protect the community from the hazards of soil erosion, soil contamination, weak and expansive soils and geologic instability." Existing soil and geologic hazard policies include the following:

1. The City should require soils and geologic review of development proposals to assess such hazards as potential seismic hazards, surface ruptures, liquefaction, landholdings, mudsliding, erosion and sedimentation in order to determine if these hazards can be adequately mitigated.

2. The City should not locate public improvements and utilities in areas with identified soils and/or geologic hazards to avoid any extraordinary maintenance and operating expenses. When the location of public improvements and utilities in such areas cannot be avoided, effective mitigation measures should be implemented.
3. In areas susceptible to erosion, appropriate control measures should be required in conjunction with proposed development.
4. In order to prevent undue erosion of creek banks, the City should seek to retain creek channels in their natural state, where appropriate.
5. The Development Review process should consider the potential for any extraordinary expenditure of public resources to provide emergency services in the event of a man-made or natural disaster.
6. Development in areas subject to soils and geologic hazards should incorporate adequate mitigation measures.
7. The City should cooperate with the Santa Clara Valley Water District's efforts to prevent the recurrence of land subsidence.
8. Development proposed within areas of potential geological hazards should not be endangered by, nor contribute to, the hazardous conditions on the site or on adjoining properties.
9. Residential development proposed on property formerly used for agricultural or heavy industrial uses should incorporate adequate mitigation/remediation for soils contamination as recommended through the Development Review process.

The City's goal regarding earthquakes is to "minimize the risk from exposure to seismic activity." Existing earthquake policies include the following:

1. The City should require that all new buildings be designed and constructed to resist stresses produced by earthquakes.
2. The City should foster the rehabilitation or elimination of structures susceptible to collapse or failure in an earthquake.
3. The City should only approve new development in areas of identified seismic hazard if such hazard can be appropriately mitigated.
4. The location of public utilities and facilities, in areas where seismic activity could produce liquefaction should only be allowed if adequate mitigation measures can be incorporated into the project.
5. The City should continue to require geotechnical studies for development proposals; such studies should determine the actual extent of seismic hazards, optimum location for structures, the advisability of special structural requirements, and the feasibility and desirability of a proposed facility in a specified location.
6. Vital public utilities as well as communication and transportation facilities should be located and constructed in a way which maximizes their potential to remain functional during and after an earthquake.
7. Land uses in close proximity to water retention levees or dams should be restricted unless such facilities have been determined to incorporate adequate seismic stability.
8. Responsible local, regional, State, and Federal agencies should be strongly encouraged to monitor and improve the seismic resistance of dams in the San José area.

4.3 CITY OF SAN JOSÉ GEOLOGIC HAZARD ORDINANCE

In addition to the above General Plan policies regarding soils and geologic hazards, the City of San José amended the Municipal Code to include Chapter 17.10 titled, "Geologic Hazard Regulations." This ordinance restricts the ability to issue grading and building permits within defined geologic hazard zones until the Director of Public Works has issued a Certificate of Geologic Hazard Clearance. The areas affected by this ordinance include:

- Very high landslide susceptibility, high or moderate/high landslide susceptibility zones identified in the Technical Report, Geological Investigation, City of San José's Sphere of Influence," prepared by Cooper, Clark and Associates (1974); or
- Within designated State Seismic Hazard Zones for Liquefaction and Earthquake-Induced Landslides.
- Within the boundary of the City of San José geologic hazard zone map dated November, 1985 on file in the Department of Public Works; or
- Within the boundary of the City of San José fault hazard zone maps dated 1983 on file in the Department of Public Works.

The approximate boundary of the Special Geologic Hazard Study Area adopted in 1985 has been overlain on the CGS Seismic Hazard Zone 7.5 Minute Quadrangle Map (Calaveras Reservoir Quadrangle, 2001), and is presented as Figure 4.

The following summary of general development rules and unique geotechnical problems associated with the development types are anticipated within the City of San José:

- Hillside areas, ie. East Berryessa foothills (SGHSA), Silver Creek, Almaden Valley: Landslides (buttressing), earthquake induced landslides, debris flows, fault rupture (setback zones), erosion, soil creep, grading, asbestos, cut/fill slope stability, water tanks, debris basin construction, retaining walls, drilled pier and grade beam foundations.

- North San Jose/Alviso: Liquefaction, bay mud (settlement, mud waves), expansive soils, artificial (undocumenteded) fill/construction debris, landfills, methane, soil contamination, seismic ground shaking amplification, high ground water, wetlands, regional subsidence, tsunami/seiche potential.

- Former Quarry sites: Examples: Communications Hill, Hillsdale Quarry, Valley Christian, Cerro Plata, Dandini Circle, Graystone, Riverview Drive, Rosemar Avenue, Guadalupe Mines Road: Deep unengineered quarry fills, high oversteepened cut and fill quarried slopes, rock fall hazards, buried mine shafts, collapse/settlement, environmental concerns/soil contamination.

- Development Along Creeks i.e. Coyote and Thompson Creeks, Guadalupe River: Slope protection for erosion (rip rap, gabions, sacked concrete, etc.), flooding, creek bank migration, static and seismic induced landslides, landslide dams, creek bank instability due to rapid drawdown, liquefaction/lateral spreading, debris basins/sedimentation, outfall structures and culverts.

- In-Fill Development: i.e. Winfield/Coleman Avenue, Blossom Hill Road, Almaden Winery, Willow Glen: Old artificial (undocumented) fills, deleterious materials, hazardous requirements, specialized foundation systems, weak or expansive soils, saturated, organic soils or old bay mud.

- Downtown area: i.e. Multi-story buildings with basement levels, examples: CIM, Forrest City Development, Adobe Systems, etc. Stability of excavation slopes/shoring systems, stability of adjacent streets and improvements, liquefaction mitigation, lateral spreading, debris basins/sedimentation, outfall structures and culverts.

- In-Fill Development: i.e. Winfield/Coleman Avenue, Blossom Hill Road, Almaden Winery, Willow Glen: Old artificial (undocumented) fills, deleterious materials, hazardous waste/soil contaminants, subexcavation, undermining adjacent structures/shoring requirements, specialized foundation systems, weak or expansive soils, saturated, organic soils or bay mud.

- Downtown area: i.e. Multi-story buildings with basement levels, ex. CIM, Forrest City Development, Adobe Systems, etc. Stability of excavation slopes/shoring systems, stability of adjacent streets and improvements, liquefaction mitigation, lateral spreading, local subsidence/groundwater pumping/fines removal, piping, dewatering, pile or mat foundations.

- Landfill Sites: Examples: i.e. Remillard Court, Hellyer, Alviso: Differential settlement, soil contamination, methane gas, static and seismic slope stability, specialized foundations and building/improvement techniques, amplified seismic ground shaking, stability of public improvements, leachate collection systems, landfill cover materials/reclamation.

4.4 STATE CONSIDERED GEOLOGIC HAZARDS

As discussed above, applicable state regulations include the Alquist-Priolo Earthquake Fault Zoning Act of 1972 and the Seismic Hazards Mapping Act of 1997. The California Geological Survey (formerly California Division of Mines and Geology) has issued Geologic hazard maps which identify active fault zones, earthquake induced landslide and liquefaction hazard zones. These areas are illustrated on Figure 3. These hazards are required to be evaluated for proposed projects subject to the 2007 Building Code, City of San José Geologic Hazard Ordinances, and State law. Discussions of the three main State of California considered hazards are presented below.

4.4.1 Strong Seismic Shaking and Faulting

The City of San José is located within a region of high seismic activity with various fault zones nearby. The two major regional faults are the San Andreas Fault, located within the Santa Cruz Mountains to the southwest, and the Hayward-Calaveras Fault zones, located within the Diablo Range to the east. Development within the zones surrounding these major faults is controlled by the Alquist-Priolo Act, known formerly as a Special Studies Zone.

Numerous other faults including, the Shannon, Berryessa, Silver Creek, Crosley, Clayton, Quimby, and Evergreen Faults, are considered potentially active. The locations of these faults are shown in the City of San José Fault Hazard Maps, contained in the "Technical Report, Geological Investigation, City of San José's Sphere of Influence," which summarizes many researchers' efforts on local USGS quadrangle maps. Evaluation of potential fault hazards is required by the City Geologist for all associated bedrock/hillside sites. CGS Special Publications 42 (2007) and 49 (2002) provide guidelines for evaluation of fault hazards. The evaluations are required to indicate whether fault rupture is possible and present recommended setbacks.

4.4.2 Liquefaction and Lateral Spreading

The City of San José is located within the Santa Clara Valley, which is a broad alluvial plain with alluvial soils extending several hundred feet below ground surface. During strong seismic shaking, loose, saturated sand and silt layers can soften, potentially resulting in significant ground deformation and/or flow failures in sloping ground or where open faces are present (lateral spreading). The California Geological Survey (CGS) has prepared maps of areas likely to have potentially liquefiable soil conditions titled, "State of California Seismic Hazard Zones," overlain on 7.5-minute quadrangle sheets. CGS Special Publication 117 (2008), and SCEC provide guidelines for evaluation liquefaction and mitigation alternatives. The City Geologist will require a liquefaction hazard evaluation for all sites within State zones unless the structure is a minor addition project meeting the exemption conditions set forth by the Building Department. In addition, for sites adjacent to creeks, rivers, or other bodies of water, a lateral spreading hazard analysis will need to be performed. If liquefaction and/or lateral spreading are determined to be site hazards, mitigation recommendations will be required.

4.4.3 Landsliding and Debris Flows

The eastern foothills and the Santa Teresa Hills areas are known areas of slope instability concerns. The California Geological Survey (CGS) has prepared maps of areas likely to have potentially unstable slope conditions titled, "State of California Seismic Hazard Zones," overlain on 7.5-minute quadrangle sheets. The City Geologist will require a landslide hazard evaluation for all sites within State zones. All landslide investigations, especially in the East Foothills (SGHSA), should comply with the recommendations in Norfleet (1995), in addition to existing CGS and SCEC (2002) guidelines adopted by the City of San José. If landsliding is determined to be a site hazard, mitigation recommendations will be required.

SECTION 5: POTENTIAL SOIL, GEOLOGIC AND SEISMIC CONSTRAINTS IN PLANNED GROWTH AREAS

Implementation of the City of San Jose's Envision 2040 General Plan Update, as currently proposed, will result in development of new residential, commercial and industrial uses throughout the City. Intensification of development is anticipated to occur within Village, Corridor and Specific Plan areas. Known soil, geologic and seismic hazards that could adversely impact future development and redevelopment within specific Planning Areas of the City are identified in Appendix A on Tables A1 to A13.

A brief description of the methodology used for identifying geologic and seismic hazards within the Planning Areas, as well as a more detailed discussion of the potential hazards and general mitigation options available for each hazards are presented in the following sections.

5.1 METHODOLOGY USE TO IDENTIFY POTENTIAL SOIL, GEOLOGIC AND SEISMIC HAZARDS

As discussed, the methodology used to determine the general soil, geologic and seismic conditions in the San José area is based on geotechnical data and maps from the “Technical Report, Geological Investigation, City of San José's Sphere of Influence” (Cooper-Clark Associates, 1974); maps and reports by the California Geological Survey regarding liquefaction potential and earthquake induced landslide zones; seismic evaluation of the Liquefaction Potential in San José, California (Power, et al. 1992); a review of the City's Fault Hazard Maps (1983) and other geologic hazard maps maintained by the Department of Public Works. The specific Planning Areas were superimposed onto these maps to determine which Village, Corridor or Specific Plan areas may be impacted by a known hazard. Relative distances to known or potential hazards were taken into consideration, such as distances to existing creeks, earthquake faults, or mapped landslides, so that Planning Areas adjacent to or within a reasonable distance to potential hazards could be considered.

For example, if a proposed Commercial Village was located adjacent to an existing creek that was locally mapped as a liquefaction hazard zone as determined by the State of California but the Village did not lie within the mapped zone, the potential impact to the Village due to liquefaction and lateral spreading was considered moderate and was therefore identified in the corresponding table. In another example, the potential impact due to the presence of artificial (man-made) fill was identified for most Planning Areas due to the potential for unknown historic or known prior development. Artificial fills are common in previously developed areas, and therefore, require site specific investigations be performed to further evaluate the presence of these materials.

5.2 MITIGATION OF POTENTIAL SOIL AND GEOLOGIC HAZARDS

5.2.1 Landslides

As discussed in “Section 2: Soil and Geologic Conditions”, the stability of a slope is affected by the following primary factors: inclination, material type, moisture content, orientation of layering, and vegetative cover. In general, steeper slopes are less stable than more gently inclined ones. Slopes underlain by deeply weathered bedrock, unconsolidated deposits, or soils with a high content of expansive clay also have a greater tendency to fail. Increased moisture content decreases a slope’s stability so landslides are more common in the winter months. Activities that can increase landslide potential include poorly designed cuts or fills, inappropriate blockage or diversion of streams, and removal of protective vegetation. Most landslide activity has occurred in the Diablo Range on the east side of the City with lesser amounts in the Santa Teresa Hills and Santa Cruz Mountains to the southwest.

There are several types of landslides in the San José area. Varnes (1978) proposed a classification system for slope movement which is composed of six categories based on type of movement: 1) falls, 2) topples, 3) slides, rotational and translational, 4) lateral spreads, 5) debris flows and 6) complex. In San José, the most common types of landslides are rock fall, rock slide (translational), debris slide (rotational and translational), debris flows triggered by excessive rainfall, earthslide (rotational and translational), debris flow, earth flow, and complex slides.

The City of San José General Plan policies typically limit urban levels of development to those areas of the hillsides ringing the valley floor that are located below the 15% slope line[2] and that are proven to be stable and appropriate for development. The City Geologist requires a landslide hazard evaluation for all sites within State landslide hazard zones or within locally identified landslide hazard zones.

5.2.2 Mitigation of Landslides

Existing slopes that are to remain adjacent to or within developments should be evaluated for the geologic conditions mentioned above. In general, slopes steeper than about 15 degrees are most susceptible; however, failures can occur on flatter slopes if unsupported weak rock units are exposed in the slope face. For suspect slopes, appropriate geotechnical investigation and slope stability analyses should be performed for both static and dynamic (earthquake) conditions. For deeper slides, mitigation typically includes such measures as buttressing slopes or re-grading the slope to a different configuration. Protection from rock falls or surficial slides can often be achieved by protective devices such as barriers, retaining structures, catchment areas, or a combination of the above. The runout area of the slide at the base of the slope, and the potential bouncing of rocks must also be considered. If it is not feasible to mitigate the unstable slope conditions, building setbacks should be imposed.

The City of San Jose requires that all development projects within a Geologic Hazard Zone prone to landsliding must be evaluated and reviewed by State licensed engineering geologists and civil/geotechnical engineers (for landslide investigation and analysis, this typically requires both). A discussion of impacts and potential mitigation for seismically-induced landslides is presented in Section 5.3.

5.2.3 Weak Compressible Soils

As discussed in “Section 2: Soil and Geologic Conditions”, weak compressible soils are typically geologically young (Holocene age) unconsolidated sediments of low density that may compress under the weight of proposed fill embankments and structures. The settlement potential and the rate of settlement in these sediments can vary greatly, depending on the soil characteristics (texture and grain size, natural moisture and density, thickness of the compressible layer(s), the weight of the proposed load, the rate at which the load is applied, and drainage. The young sediments that underlie the City of San Jose are generally moist to saturated and soft to stiff/loose to medium dense in the upper 20 feet, and are therefore susceptible to settlement. In areas that have been intensely farmed, such as orchards or pastures, the upper few feet of soil commonly have a high organic content. Areas of San Jose that have been graded under modern grading codes are generally not susceptible to future settlement, unless a major change in usage is proposed – for example, light weight buildings such as small homes are replaced with large fill embankments or multistory structures. Undeveloped land and land built upon

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[2] A line at the edge of the floor of the Santa Clara Valley which connects lowest elevation points of fifteen percent or steeper slope.

before modern grading codes are areas most likely to require mitigation for compressible soils when new construction is planned.

5.2.4 Mitigation of Weak Compressible Soils

When development is planned within areas that contain potentially compressible soils, a geotechnical soil analysis is required to identify the presence of this hazard. The analysis should consider the characteristics of the soil column in that specific area, and also the load of any proposed fills and structures that are planned, the type of structure (i.e. a road, pipeline, or building), and the local groundwater conditions. The analysis should also determine if settlement will impact existing improvements adjacent to the project site. At a minimum, the mitigation of compressible soils requires the removal and re-compaction of the near-surface soils. Deeper removals may be needed for heavier structures or embankments (i.e. heavy loads), or for structures that are sensitive to minor settlement. If the organic content of the upper soils is very high, it may be necessary to completely remove the upper layer of soil from the building site. In cases where it is not feasible to remove and re-compact the compressible soils, buildings can be supported on specially engineered foundations that may include deep concrete caissons or piles, or improved ground such as impact/rammed aggregate piers.

5.2.5 Expansive Soils

As discussed in “Section 2: Soil and Geologic Conditions”, fine-grained soils, such as silts and clays, may contain variable amounts of expansive clay minerals. These minerals can undergo significant volumetric changes as a result of changes in moisture content. The upward pressures induced by the swelling of expansive soils can have significant harmful effects upon structures and other surface improvements. The near-surface sediments blanketing much of the City of San Jose are composed primarily of fine-grained silt and clay soils with varying expansive clay minerals, as well and varying sand and gravel content. Such units are typically moderately to very highly expansive. In general, alluvial fan sediments become increasingly finer grained with greater distance from the mountains. Consequently, expansive soils are more likely to be encountered in the relatively flat portions of Santa Clara Valley, where clayey silts and silty clays are present. Locally, expansive bedrock such as claystone, may be present locally in hillside areas of San Jose.

5.2.6 Mitigation of Expansive Soils

Building areas with moderate to highly expansive soils are typically “pre-saturated” to a moisture content and depth specified by the geotechnical engineer, thereby “pre-swelling” the soil prior to constructing the structural foundation or hardscape. This method is often used in conjunction with a layer of imported non-expansive fill material placed directly below foundations and slabs to control seasonal moisture fluctuations. In addition, stronger foundations are often utilized, such as rigid mat or grid footing foundations, which can resist small ground movements without cracking. Good surface drainage control is essential for all types of improvements, both new and old. Property owners should be educated about the importance of maintaining relatively constant moisture levels in their landscaping. Excessive watering or alternating wetting and drying can result in distress to improvements and structures.

5.2.7 Naturally Occurring Asbestos (NOA)

As discussed in “Section 2: Soil and Geologic Conditions”, chrysotile and amphibole asbestos occur naturally in certain geologic settings in the City of San José (City of San José, 2003), most commonly in ultramafic rocks. The most common type of asbestos is chrysotile, which is commonly found in the Santa Clara Valley area in serpentinite rock formations. When disturbed by construction, grading, quarrying, or mining operations, asbestos-containing dust can be generated. Exposure to asbestos dust can result in lung cancer, mesothelioma, and asbestosis. The undisturbed rock formations containing asbestos have not been identified as health threats.

5.2.8 Mitigation of Naturally Occurring Asbestos (NOA)

In July 2001, the California Air Resources Board approved an Asbestos Airborne Toxic Control Measure for Construction, Grading, Quarrying, and Surface Mining activities in areas where naturally-occurring asbestos (NOA) will likely be found; it provides required dust mitigation measures and practices. If NOA is encountered during grading for new development, typical mitigation involves capping asbestos containing bedrock or fill materials with clean, non-asbestos containing materials, performing air and dust monitoring during grading activities, and using best-management practices to limit spreading asbestos-containing materials to surrounding areas.

5.2.9 Erosion

As discussed in “Section 2: Soil and Geologic Conditions”, erosion, runoff, and sedimentation are influenced by several factors including climate, topography, soil and rock types, as well as vegetation. The extreme topographic relief between the valley and the adjacent mountains makes erosion and sedimentation important issues for communities built on alluvial fans or hillside terrain. The fractured and crushed condition of the bedrock forming the mountains, combined with rapid geologic uplift and infrequent but powerful winter storms leads to very high erosion rates. Further, erosion can increase significantly when mountain slopes are denuded by wildfires, such as those that occurred in the local mountains in the past 5 years. Winter storms that follow a season of mountain wildfires can transport great volumes of sediment onto the alluvial valley below.

Locally, the young alluvial soils that underlie the city are generally fine-grained to granular, poorly consolidated, and moderately to very susceptible to erosion. Natural erosion processes are often accelerated through man’s activities – whether they are associated with agriculture or land development. Land development increases the potential for erosion and sedimentation by removing protective vegetation, altering natural drainage patterns, and constructing cut- and fill-slopes that may be more susceptible to erosion than the natural condition. Compacted fill constructed with granular sediments are also susceptible to erosion until they are protected by vegetation or other means. Developments also reduce the surface area available for infiltration, leading to increased flooding and erosion downstream of the project.

5.2.10 Mitigation of Erosion

Mitigation of erosion and sedimentation typically includes structures and best management practices to slow down stream velocity, such as check dams and drop structures within canyons, devices to collect and channel the flow, and catchment basins. Debris basins must be cleaned out to function properly. Failure of the basins during a winter of severe storms could result in flooding of and sedimentation on downstream communities. Percolation basins (used to collect storm water for infiltration into the Santa Clara Valley aquifer), also collect some of the sediment. These structures, along with other components of the regional flood control system (such as levees, and channels), have greatly reduced the extent of natural sedimentation processes on the valley floor in San Jose.

There are many options for protecting graded slopes from erosion. Available options include terracing slopes to minimize the velocity attained by runoff, the addition of berms and v-ditches, and installing adequate storm drain systems, establishing protective vegetation, and placing mulches, rock facings (either cemented or noncemented), gabions (rock-filled galvanized wire cages), or building blocks with open spaces for plantings on the slope face. Building pads are typically engineered to direct drainage away from the tops of slopes. Diversion dikes, interceptor ditches, swales, and slope down-drains are commonly lined with asphalt or concrete. These ditches, however, can also be lined with gravel, rock, decorative stone, or grass to make them more attractive.

Temporary erosion control measures must be provided during the construction phase of a development, as required by local building codes and ordinances, as well as State and Federal stormwater pollution regulations. In addition, permanent erosion control and clean water runoff measures are required for new developments. These measures might include desilting basins, percolation areas to cleanse runoff from the development, proper care of drainage control devices, appropriate irrigation practices, and rodent control. Erosion control devices are typically field-checked following periods of heavy rainfall to assure they are performing as designed and have not become blocked by debris.

5.2.11 Artificial (Man-Made) Fill

As discussed in “Section 2: Soil and Geologic Conditions”, artificial fill, often referred to as undocumented or man-made fill, generally consists of soil or other materials used to construct earth embankments, building pads, roadways, levees or other various uses. Artificial fill can be placed across level or sloping ground, or be used to fill topographically low areas such as wetlands, valleys, drainages, creeks or other localized excavations or ground surface depressions. The degree of compaction for artificial fill is often unknown on previously developed sites or in areas where

Sidehill fills are artificial fill wedges typically constructed on natural slopes to create roadways or level building pads. Deformation of sidehill fills was noted in earlier earthquakes, but this phenomenon was particularly widespread during the 1989 Loma Prieta and 1994 Northridge earthquakes. Older, poorly engineered road fills were most commonly affected, but in localized areas, building pads of all ages experienced deformation. The deformation was usually manifested as ground cracks at the cut/fill contacts, differential settlement in the fill wedge, and bulging of the slope face. The amount of displacement on the pads during these earthquakes was generally about 3 inches or less, but this resulted in minor to severe property damage (Stewart et. al., 1995).

5.2.12 Mitigation of Artificial (Man-Made) Fill

Flatland and hillside grading designs are typically conducted during site-specific geotechnical investigations to determine if there is a potential for this hazard. Mitigation for existing artificial fill material typically consists of over-excavation and re-compaction, in-situ ground improvement to densify loose fills, or special foundations designed to extend through artificial fills into competent soils. There are currently no proven engineering standards for mitigating sidehill fill deformation, consequently current published research on this topic should be reviewed by project consultants at the time of their investigation. It is thought that the effects of this hazard on structures may be reduced by the use of post-tensioned foundations, deeper over-excavation below finish grades, deeper over-excavation on cut/fill transitions, and/or higher fill compaction criteria.

5.2.13 Ground Subsidence

As discussed in “Section 2: Soil and Geologic Conditions”, ground subsidence is the gradual settling or sinking of the ground surface with little or no horizontal movement. Most ground subsidence is man-induced. In the areas of northern California where significant ground subsidence has been reported (such as the Santa Clara and Sacramento-San Joaquin Valleys) this phenomenon is usually associated with the extraction of ground water from below the surface in sediment-filled valleys and floodplains.

Ground-surface effects related to subsidence can include earth fissures, sinkholes or depressions, and disruption of surface drainage (Holzer, 1984). Damage is generally restricted to structures sensitive to slight changes in elevations, such as canals, levees, underground pipelines, and drainage courses; however, significant subsidence can result in damage to wells, buildings, roads, railroads, and other improvements. Subsidence due to groundwater extraction has largely been brought under control in affected areas by good management of local water supplies, including reducing pumping of local wells, importing water, and use of artificial recharge (Johnson, 1998; Stewart et al., 1998). Subsidence as a result of oil and gas extraction is not an issue for San Jose. Currently, San Jose gets roughly 50 percent of its water supply from wells owned and operated in Santa Clara County that penetrate three subbasins within Santa Clara Valley (SCVWD website). The thick alluvial deposits comprising the aquifer would be susceptible to compaction (with resulting subsidence at the surface) should rapid ground water withdrawal occur beneath the area in response to the water needs of a growing population.

5.2.14 Mitigation of Ground Subsidence

Prevention of subsidence requires a regional approach to groundwater management, as the significant progress made in recent years for the Santa Clara Valley can attest. County voters approved the creation of the Santa Clara Valley Water District in the early 1930s partially to protect groundwater resources and minimize land subsidence. Subsidence is costly, as it can lead to flooding that damages properties and infrastructure, and saltwater intrusion that degrades groundwater quality.

The district reduces the demand on groundwater and minimizes subsidence through the conjunctive use of surface water and groundwater. A major component of the district's conjunctive use program is recharging the groundwater basin to replenish the groundwater that is withdrawn.

The district also actively monitors for land subsidence through benchmark surveying, groundwater elevation monitoring, and data from compaction wells. The district surveys hundreds of benchmarks each year to determine if there has been any change in the land surface elevation. The district also monitors groundwater levels to ensure that the amount of groundwater being pumped will not cause further subsidence. Finally, the district collects data from two compaction wells, which are 1,000 foot deep wells designed to measure any changes in the land surface resulting from groundwater extraction.

To that end, the program includes the following elements, all of which will result either directly or indirectly in the reduction of ground subsidence:

- Increase the understanding of the basin's geology, hydrology, and hydraulic control;
- Increase the basin's safe yield with greater recovery and recharge of storm water and imported water;
- Monitor groundwater levels and publish reports on basin condition;
- Protect water quality;
- Monitor ground levels for subsidence;
- Store water that is set aside for dry years; and
- Create a database of historical and current information.

The primary goal of this program, which includes recommendations for technical studies, monitoring programs, and facility upgrades, is to insure a low-cost, sustainable supply of quality water for the future.

5.3 MITIGATION OF POTENTIAL SEISMIC HAZARDS

5.3.1 Fault Rupture

As discussed in "Section 3: Seismicity and Related Geologic Hazards," fault rupture refers to fissuring and offset of the ground surface along a rupturing fault during an earthquake. Primary ground rupture typically results in a relatively small percentage of the total damage in an earthquake, but being too close to a rupturing fault can cause severe damage to structures. As discussed previously, development constraints within active fault zones were implemented in 1972 with passage of the California Alquist-Priolo Earthquake Fault Zoning Act. The Alquist-Priolo Act prohibits the construction of new habitable structures astride an active fault and requires special geologic studies to locate and evaluate whether a fault has ruptured the ground surface in the past about 11,000 years. If an active fault is encountered, structural setbacks from the fault are defined.

5.3.2 Mitigation of Fault Rupture

In most cases, it is impractical to reduce the damage potential of surface fault rupture by engineering design; therefore, the most often used and most appropriate mitigation measure is to simply avoid placing structures on or near active fault traces. The intent of the Alquist-Priolo Earthquake Fault zones is to require that geologic investigations, which may include fault trenching, be performed if conventional structures designed for human occupancy are proposed within the zone. These studies must evaluate whether or not an active segment of the fault extends across the area of proposed development, following the guidelines for evaluating the hazard of fault rupture presented in Note 49, published by the CGS, which is available on the internet at http://www.consrv.ca.gov/CGS/rghm/ap/index.htm.

Based on the results of these geologic studies, appropriate structural setbacks may be recommended to prevent the siting of the proposed structures directly on top or within a certain distance from the fault. A common misperception regarding setbacks is that they are always 50 feet from the active fault trace. In actuality, geologic investigations are required to characterize the ground deformation associated with an active fault. Based on these studies, specific setbacks are recommended. If a fault trace is narrow, with little or no associated ground deformation, a setback distance less than 50 feet may be recommended. Conversely, if the fault zone is wide, with multiple splays, or is poorly defined, a setback distance greater than 50 feet may be warranted. State law allows local jurisdictions to establish minimum setback distances from a hazardous fault, and some communities have taken a prescriptive approach to this issue, establishing specific setbacks from a fault, rather than allowing for different widths depending on the circumstances.

5.3.3 Liquefaction and Related Ground Failure

As discussed in “Section 3: Seismicity and Related Geologic Hazards,” liquefaction is a geologic process that causes various types of ground failure. It typically occurs in loose, saturated sediments primarily of sandy composition, in the presence of ground accelerations over 0.2g (SCEC, 2002). Recent studies have shown that low plasticity silts and clays may also be susceptible to liquefaction and/or cyclic mobility (CGS, 2008). When liquefaction occurs, the sediments involved have a total or substantial loss of shear strength, and behave like a liquid or semi-viscous substance. Liquefaction can cause structural distress or failure due to ground settlement, a loss of bearing capacity in the foundation soils, and the buoyant rise of buried structures. The excess hydrostatic pressure generated by ground shaking can result in the formation of sand boils or mud spouts, and/or seepage of water through ground cracks.

The types of ground failure typically associated with liquefaction are explained below

Lateral Spreading - Lateral displacement of surficial blocks of soil as the result of liquefaction in a subsurface layer is called lateral spreading. Even a very thin liquefied layer can act as a hazardous slip plane if it is continuous over a large enough area. Once liquefaction transforms the subsurface layer into a fluid-like mass, gravity plus inertial forces caused by the earthquake may move the mass downslope towards a cut slope or free face (such as a river channel or a canal). Lateral spreading most commonly occurs on gentle slopes that range between 0.3 degrees and 3 degrees, and can displace the ground surface by several meters to tens of meters. Such movement damages pipelines, utilities, bridges, roads, and other structures. During the 1906 San Francisco earthquake, lateral spreads with displacements of only a few feet damaged every major pipeline. Lateral spreading was also reported in and around the San Francisco Bay Area during the 1989 Loma Prieta earthquake (CDMG, 1998-2003).

Flow Failure – The most catastrophic mode of ground failure caused by liquefaction is flow failure. Flow failure usually occurs on slopes greater than 3 degrees. Flows are principally liquefied soil or blocks of intact material riding on a liquefied subsurface. Displacements are often in the tens of meters, but under favorable circumstances, soils can be displaced for tens of miles, at velocities of tens of miles per hour. Due to the distance from the edge of the San Francisco Bay shoreline, the potential for large scale flow failure in the City of San Jose is remote.

Ground Oscillation – When liquefaction occurs at depth but the slope is too gentle to permit lateral displacement, the soil blocks that are not liquefied may separate from one another and oscillate on the liquefied zone. The resulting ground oscillation may be accompanied by the opening and closing of fissures (cracks) and sand boils, potentially damaging structures and underground utilities (Tinsley et. al., 1985).

Loss of Bearing Strength – When a soil liquefies, loss of bearing strength may occur beneath a structure, possibly causing the building to settle and tip. If the structure is buoyant, it may float upward. During the 1964 Niigata, Japan earthquake, buried septic tanks rose as much as 3 feet, and structures in the Kwangishicho apartment complex tilted as much as 60 degrees (Tinsley et. al., 1985; Bray et. al, 2006).

Ground Lurching – Soft, saturated soils have been observed to move in a wave-like manner in response to intense seismic ground shaking, forming ridges or cracks on the ground surface. At present, the potential for ground lurching to occur at a given site can only generally be predicted. Areas underlain by thick accumulation of colluvium and alluvium, such as encountered throughout much of Santa Clara Valley, appear to be the most susceptible to ground lurching. Under strong ground motion conditions, lurching can be expected in loose, cohesionless soils, or in clay-rich soils with high moisture content. In some cases, the deformation remains after the shaking stops (Barrows et. al., 1994).

5.3.4 Mitigation of Liquefaction

Liquefaction Hazard maps have been prepared for the all 7.5-Minute Quadrangle Map encompassing the City of San Jose, except for the Lick Observatory 7.5-Minute Quadrangle. In accordance with the SHMA, all projects within a State-delineated Seismic Hazard Zone for liquefaction must be evaluated by a Certified Engineering Geologist and/or Registered Civil Engineer (this is typically a civil engineer with training and experience in soil engineering). Most often however, it is appropriate for both the engineer and geologist to be involved in the evaluation, and in the implementation of the mitigation measures. Likewise, project review by the local agency must be performed by geologists and engineers with the same credentials and experience. In order to assist project consultants and reviewers in the implementation of the SHMA, the State has published specific guidelines for evaluating and mitigating liquefaction (CGS, 2008). In general, a liquefaction study is designed to identify the depth, thickness, and lateral extent of any liquefiable layers that would affect the project site. An analysis is then performed to estimate the type and amount of ground deformation that might occur, given the seismic potential of the area.

Mitigation measures generally fall in one of two categories: ground improvement or foundation design. Ground improvement includes such measures as removal and re-compaction of low-density soils, removal of excess ground water, in-situ ground densification, and other types of ground improvement (such as grouting or surcharging). Special foundations that are typically considered to mitigate impacts from liquefaction range from deep piles to reinforcement of shallow foundations (such as post-tensioned mats or grid footings). Mitigation for lateral spreading may also include modification of the site geometry or inclusion of retaining structures.

The type (or combinations of types) of mitigation depends on the site conditions and on the nature of the proposed project (CGS, 2008).

5.3.5 Earthquake Induced Landslides

As discussed in "Section 3: Seismicity and Related Geologic Hazards," strong ground motions can worsen existing unstable slope conditions, particularly if coupled with saturated ground conditions. Seismically induced landslides can overrun structures, people or property, sever utility lines, and block roads, thereby hindering rescue operations after an earthquake. Although numerous types of earthquake-induced landslides have been identified, the most widespread type generally consists of shallow failures involving surficial soils and the uppermost weathered bedrock in moderate to steep hillside terrain (these are also called disrupted soil slides). Rock falls and rock slides on very steep slopes are also common. The 1989 Loma Prieta earthquake showed that reactivation of existing deep-seated landslides can also occur (Spittler et.al., 1990).

A combination of geologic conditions leads to landslide vulnerability. These include high seismic potential; rapid uplift and erosion resulting in steep slopes and deeply incised canyons; highly fractured and folded rock; and rock with inherently weak components, such as silt or clay layers. The orientation of the slope with respect to the direction of the seismic waves (which can affect the shaking intensity) can also control the occurrence of landslides. Ground water conditions at the time of the earthquake also play an important role in the development of seismically induced slope failures. For instance, the 1906 San Francisco earthquake occurred in April, after a winter of exceptionally heavy rainfall, and produced many large landslides and mudflows, some of which were responsible for several deaths. The 1989 Loma Prieta earthquake however, occurred in October during the third year of a drought, and slope failures were limited primarily to rock falls and reactivation of older landslides that was manifested as ground cracking in the scarp areas but with very little movement (Griggs et.al., 1991).

5.3.6 Mitigation of Earthquake Induced Landslides

Existing slopes that are to remain adjacent to or within developments should be evaluated for the geologic conditions mentioned above. In general, slopes steeper than about 15 degrees are most susceptible; however, failures can occur on flatter slopes if unsupported weak rock units are exposed in the slope face. For suspect slopes, appropriate geotechnical investigation and slope stability analyses should be performed for both static and dynamic (earthquake) conditions. For deeper slides, mitigation typically includes such measures as buttressing slopes or re-grading the slope to a different configuration. Protection from rock falls or surficial slides can often be achieved by protective devices such as barriers, retaining structures, catchment areas, or a combination of the above. The runout area of the slide at the base of the slope, and the potential bouncing of rocks must also be considered. If it is not feasible to mitigate the unstable slope conditions, building setbacks should be imposed.

In accordance with the Seismic Hazard Mapping Act, all development projects within a State-delineated Seismic Hazard Zone for seismically induced landsliding must be evaluated and reviewed by State licensed engineering geologists and/or civil engineers (for landslide investigation and analysis, this typically requires both). In order to assist in the implementation of the SHMA, the State has published specific guidelines for evaluating and mitigating seismically induced landslides (CGS, 2008).

5.3.7 Seismically Induced Settlement

As discussed in "Section 3: Seismicity and Related Geologic Hazards," under certain conditions, strong ground shaking can cause the densification of soils, resulting in local or regional settlement of the ground surface. During strong shaking, soil grains become more tightly packed due to the collapse of voids and pore spaces, resulting in a reduction of the thickness of the soil column. This type of ground failure typically occurs in loose granular, cohesionless soils, and can occur in either wet or dry conditions. Unconsolidated young alluvial deposits are especially susceptible to this hazard. Artificial fills may also experience seismically induced settlement. Damage to structures typically occurs as a result of local differential settlements. Regional settlement can damage pipelines by changing the flow gradient on water and sewer lines, for example.

The majority of the City of San Jose area is underlain by young, unconsolidated alluvial deposits and artificial fill that may be susceptible to seismically induced settlement.

5.3.8 Mitigation of Seismically Induced Settlement

Mitigation measures for seismically induced settlement are similar to those used for liquefaction. Recommendations are provided by the project's geologist and geotechnical engineer, following a detailed geotechnical investigation of the site. Over-excavation and re-compaction is a commonly used method to densify soft soils susceptible to settlement. Deeper over-excavation below final grades, especially at cut/fill, fill/natural or alluvium/bedrock contacts may be recommended to provide a more uniform subgrade. Over-excavation should also be performed so that large differences in fill thickness are not present across individual lots. In-situ ground improvement methods have also been used throughout San Francisco Bay Area to densify loose soils susceptible to seismic settlement. These methods typically include stone columns, compaction grouting, vibro-replacement, deep dynamic compaction, or soil-cement mixing. In some cases, specially designed deep foundations, strengthened foundations, and/or fill compaction to a minimum standard that is higher than that required by the California Building Code may be recommended.

5.3.9 Seismically Induced Waves (Seiches)

A seiche is defined as a standing wave oscillation in an enclosed or semi-enclosed, shallow to moderately shallow water body or basin. Seiches continue (in a pendulum fashion) after the cessation of the originating force, which can be tidal action, wind action, or a seismic event. Reservoirs, lakes, ponds, swimming pools and other enclosed bodies of water are subject to these potentially damaging oscillations (sloshing). Whether or not seismically induced seiches develop in a water body is dependent upon specific earthquake parameters (e.g. frequency of the seismic waves, distance and direction from the epicenter), as well as site-specific design of the enclosed bodies of water, and is thus difficult to predict. Seiches are often described by the period of the waves (how quickly the waves repeat themselves), since the period will often determine whether or not adjoining structures will be damaged. The period of a seiche varies depending on the dimensions of the basin. Whether an earthquake will create seiches depends upon a number of earthquake-specific parameters, including the earthquake location (a distant earthquake is more likely to generate a seiche than a local earthquake), the style of fault rupture (e.g., dip-slip or strike-slip), and on the configuration (length, width and depth) of the basin.

Amplitudes of seiche waves associated with earthquake ground motion are typically less than 0.5 m (1.6 feet high), although some have exceeded 2 m (6.6 ft).

Seiches due to seismic shaking could occur in any of the shallow lakes or reservoirs in San Jose, and in any of the recharge basins that occur throughout the city, if they happen to have water at the time of an earthquake. In concrete-lined lakes, seiching could result in sloshing of water out of the lake and onto the surrounding area. In unlined basins, sloshing of water against the basin sides could cause the surrounding berms to experience erosion, and locally, some surficial slope failures. Similarly, water in swimming pools is known to slosh during earthquakes, but in most cases, the sloshing does not lead to significant damage.

5.3.10 Mitigation of Seiches

The degree of damage to small bodies of water, such as to shallow lakes, basins, and swimming pools, would likely be minor. However, property owners down-gradient from these bodies of water that could seiche during an earthquake should be aware of the potential hazard to their property should a lake or pool lose substantial amounts of water during an earthquake. Site-specific design elements, such as baffles to reduce the potential for seiches, are warranted in tanks and in open reservoirs or ponds where overflow or failure of the structure may cause damage to nearby properties. Damage to water tanks in recent earthquakes, such as the 1989 Loma Prieta earthquake, resulted from seiching. As a result, the American Water Works Association (AWWA) Standards for Design of Steel Water Tanks (D-100-05) provide new criteria for seismic design (AWWA, 2005).

5.3.11 Tsunamis

A tsunami is a sea wave caused by any large-scale disturbance of the ocean floor that occurs in a short period of time and causes a sudden displacement of water. The most frequent causes of tsunamis are shallow underwater earthquakes and submarine landslides, but tsunamis can also be caused by underwater volcanic explosions, oceanic meteor impacts, and even underwater nuclear explosions. Tsunamis can travel across an entire ocean basin, or they can be local. Tsunamis are characterized by their length, speed, low period, and low observable amplitude: the waves can be up to 200 km (125 mi) long from one crest to the next, they travel in the deep ocean at speeds of up to 950 km/hr (600 mi/hr), and have periods of between 5 minutes and up to a few hours (with most tsunami periods ranging between 10 and 60 minutes). Earthquake-generated tsunamis have been studied more extensively than any other type. Researchers have found that there is a correlation between the depth and size of the earthquake and the size of the associated tsunami: the larger the earthquake and the shallower its epicenter, the larger the resulting tsunami.

Although the northern tip of the Alviso Planning Area lies adjacent to the San Francisco Bay, the potential tsunami hazard within the City of San Jose is very low, except for the northern edge of tidal flats within the National Wildlife Refuge (Ritter & Dupre, 1972).

SECTION 6: LIMITATIONS

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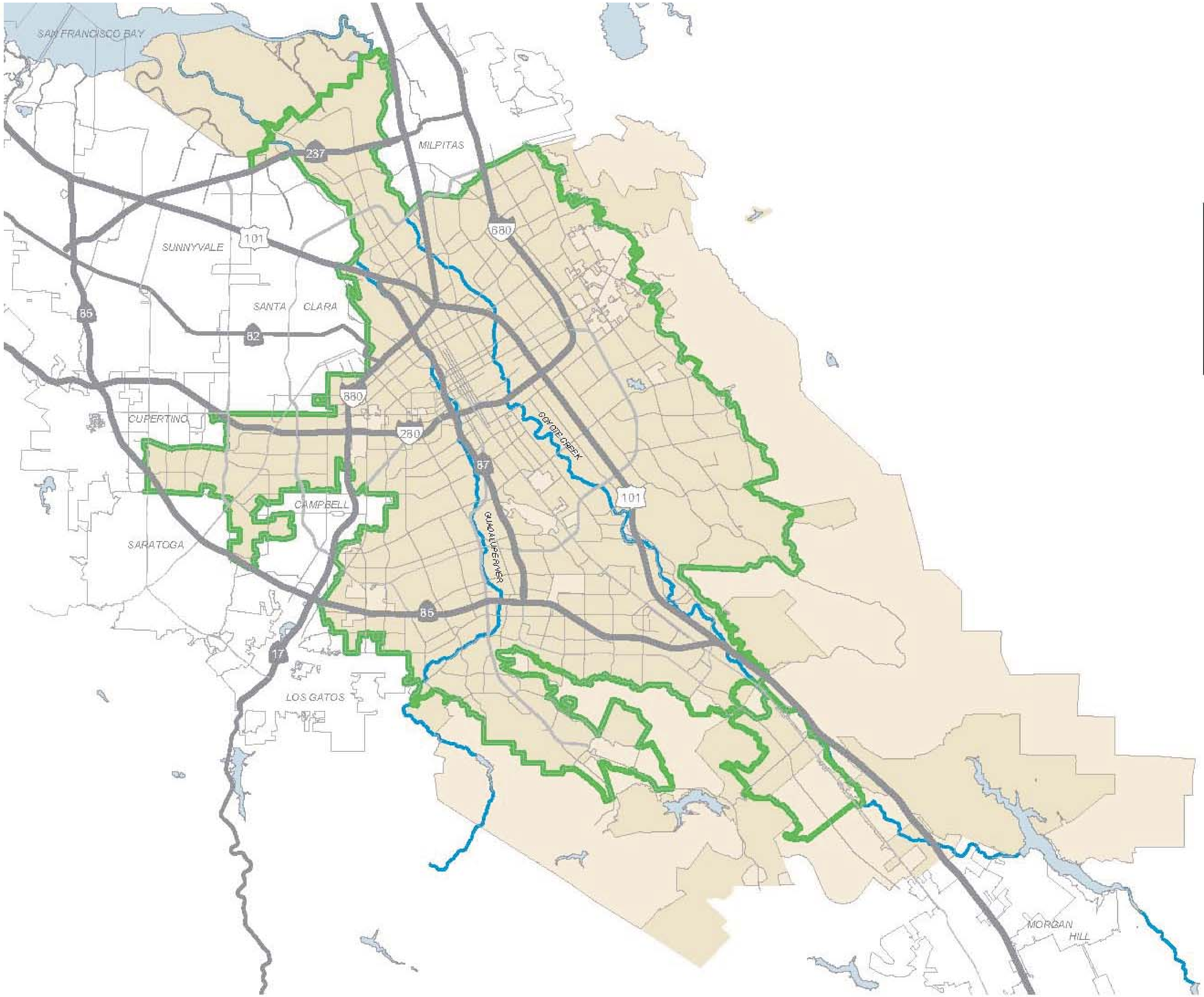
ENVISION SAN JOSE 2040



Legend

- Urban Growth Boundary
- City of San Jose
- Sphere of Influence

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Miles

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Project Number	Figure Number	Drawn By
118-13-2	Figure 1	FLL
		Date: February 2009

Site Map

Current Conditions Report
Soils, Geology and Geologic Hazards
Envision 2040 San Jose General Plan
San Jose, CA

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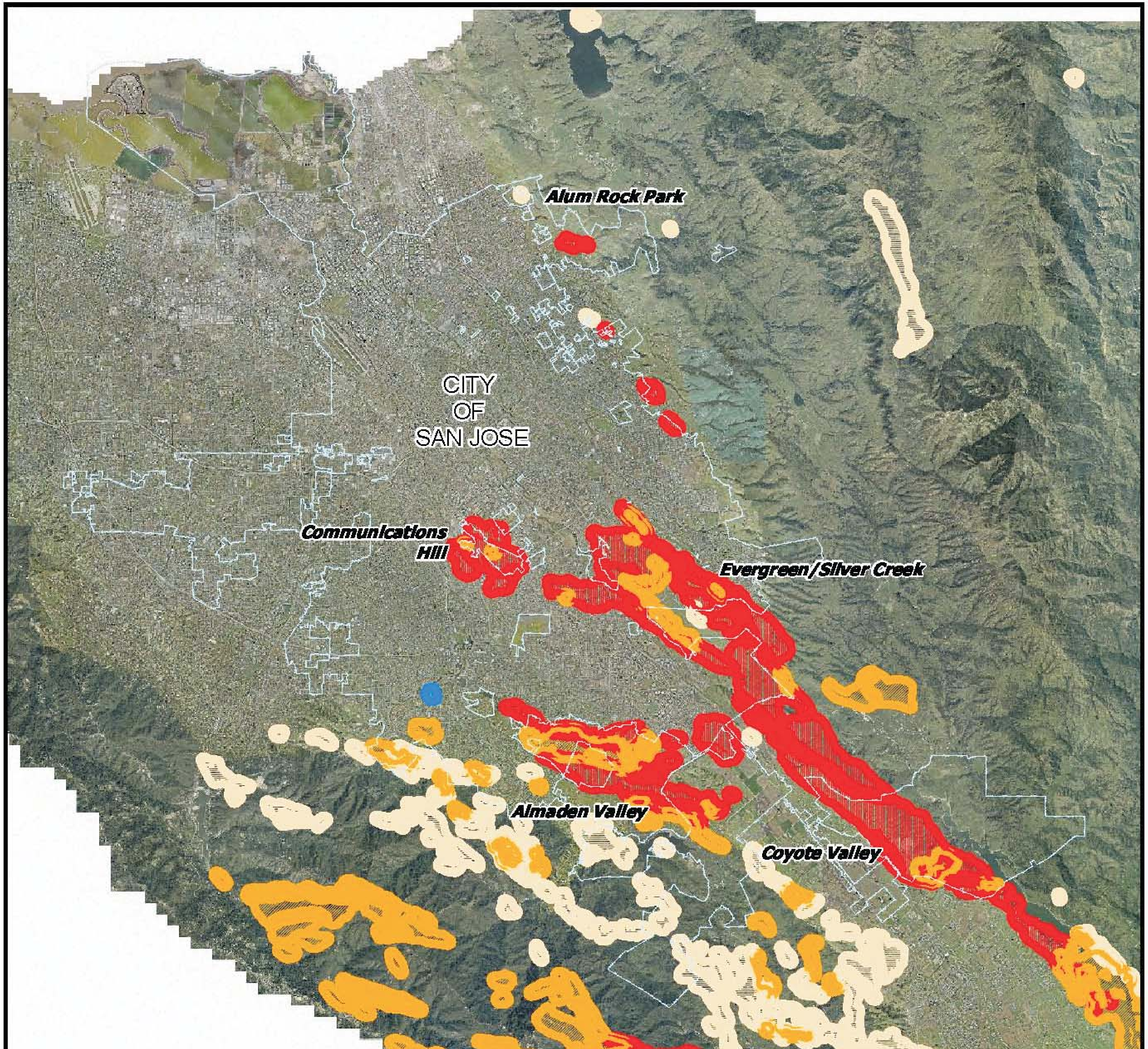
AREAS OF DEFINITE AND LIKELY NATURAL ASBESTOS OCCURRANCE with 1000 Ft Buffers

(proximate to the City of San José)



GURU OCCURRANCES

- Ultramafic-Definite
- Ultramafic-Likely
- Serpentinite-Definite
- Serpentinite-Likely

GURU 1000 FOOT BUFFER AREAS

- 1000 Ft Buffer of Ultramafic-Definite
- 1000 Ft Buffer of Ultramafic-Likely
- 1000 Ft Buffer of Serpentinite-Definite
- 1000 Ft Buffer of Serpentinite-Likely

***GURU: Geographic Ultramafic Rock Unit

Map Created By:
Policy & Planning Section
Business Services Division
Environmental Services Department
City of San José

Map Source:
1999 Geological Survey- Santa Clara Co.
US Geological Survey
(based on USGS 1:100K Geology Maps)

2002 Color Aerial Photo Mosaic-
Santa Clara Co.

Map Date:
02/28/03

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Miles

Areas of Natural Asbestos Occurrance

Current Conditions Report
Soils, Geology and Geologic Hazards
Envision 2040 San Jose General Plan
San Jose, CA

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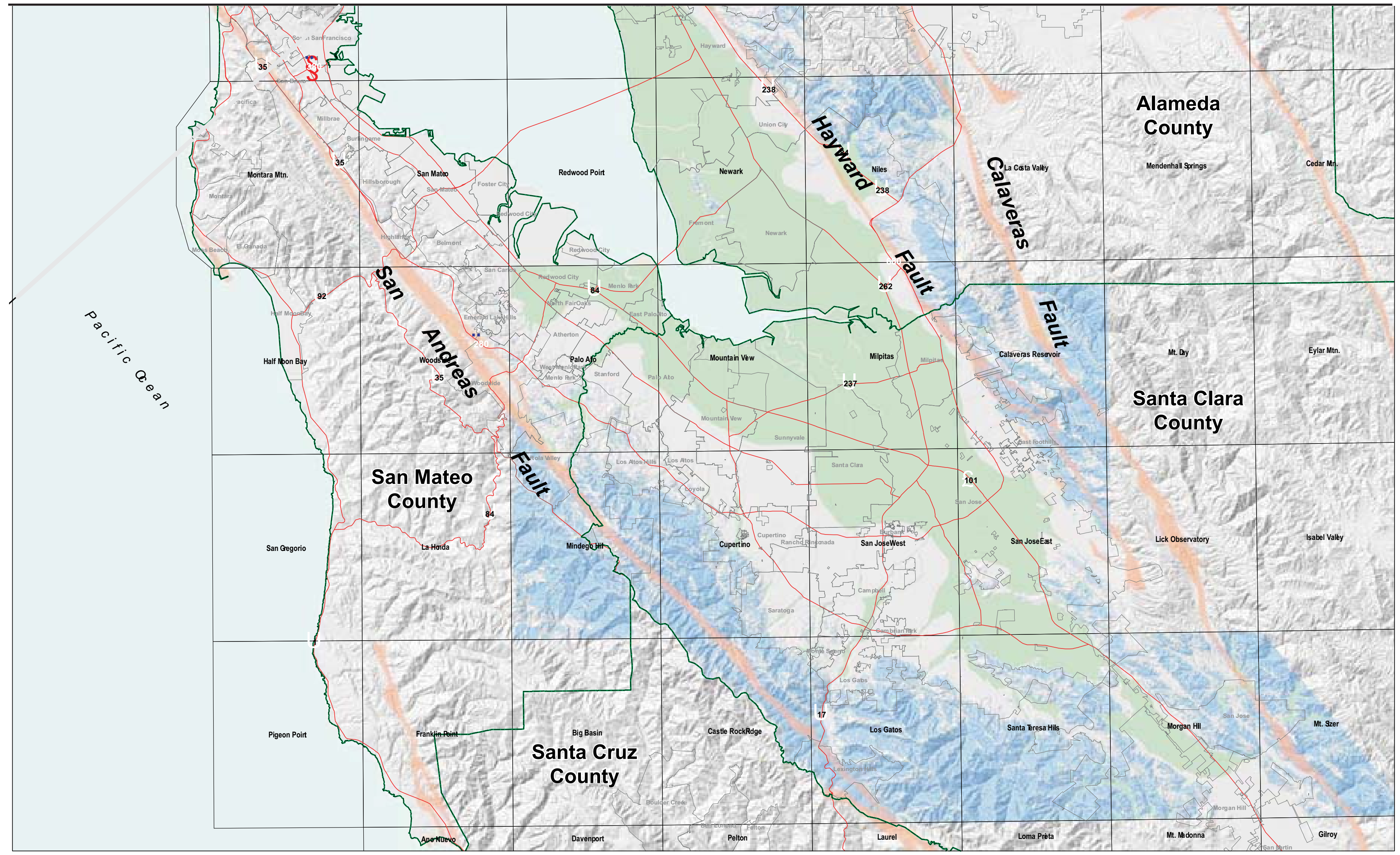
Project Number	Figure Number	Date	Drawn By
118-13-2	Figure 2	February 2009	FLL

California Geological Survey
Seismic Hazard Zonation of Northern California
0ctober 2006



Scale

5 2.5 0 5 10 15 20
Miles

5 2.5 0 5 10 15 20
Kilometers

MAP EXPLANATION
Zones of Required Investigation

Liquefaction
Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Earthquake-Induced Landslides
Areas where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Alquist-Priolo Zones
Regulatory zones encompassing active faults so as to define those areas within which fault-rupture hazard investigations are required prior to building structures for human occupancy.

DEPARTMENT OF CONSERVATION
CALIFORNIA GEOLOGICAL SURVEY
SEISMIC HAZARDS Zonation
801 K STREET, MS 12-31
SACRAMENTO, CA 95814
916 324-7299
http://conservation.ca.gov/cgs/shmp

From California Geological Survey (2006)

Seismic Hazard Zones of the San Francisco Bay Area

Current Conditions Report
Soils, Geology and Geologic Hazards
Envision 2040 San Jose General Plan
San Jose, CA

Project Number: 118-13-2
Figure Number: Figure 3
Date: February 2009
Drawn By: FLL

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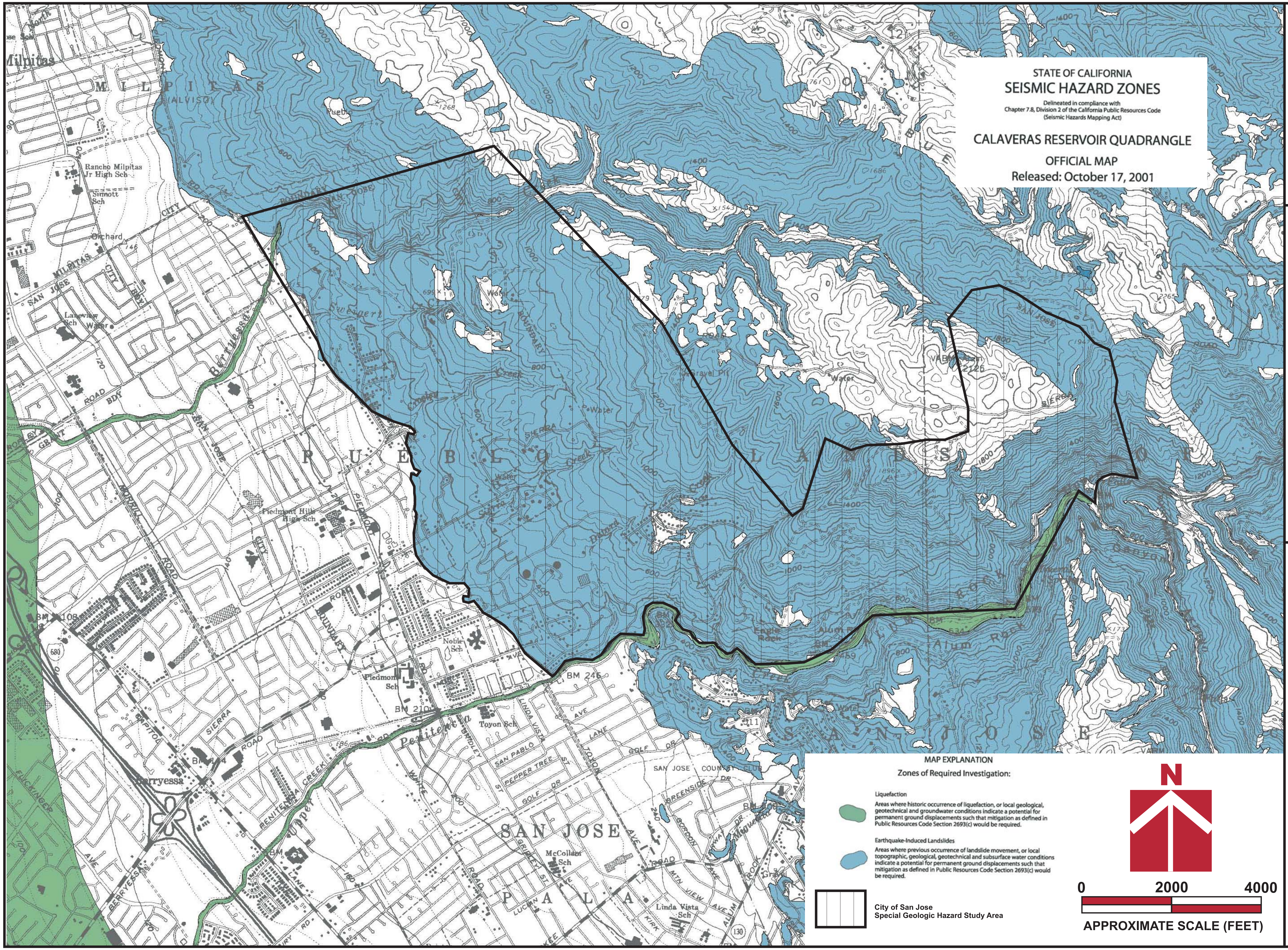

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City of San Jose Special Geologic Hazard Study Area

Current Conditions Report
Soils, Geology and Geologic Hazards
Envision 2040 San Jose General Plan
San Jose, CA

Project Number	118-13-2
Figure Number	Figure 4
Date	February 2009
Drawn By	FLL

APPENDIX A: SOIL, GEOLOGIC AND SEISMIC CONDITIONS THAT COULD ADVERSELY IMPACT FUTURE DEVELOPMENT AND REDEVELOPMENT ACTIVITIES WITHIN SPECIFIC PLANNING AREAS OF THE CITY

Almaden Planning Area – Potential Soil, Geologic and Seismic Hazards

The Almaden Planning Area lies in the largely undeveloped southern quarter of the City, adjacent to the Santa Cruz Mountains. The Almaden Planning Area is 10.2 square miles in size. This planning area contains three Neighborhood Villages and the South Almaden Valley Urban Reserve. The potential soil, geologic and seismic hazards identified in the growth areas within the Almaden Planning Area based upon existing information are identified below.

Table A1. Almaden Planning Area – Potential Soil, Geologic and Seismic Hazards

Growth Area	Soil and Geologic Hazards					Seismic Hazards						Within City's Geologic Hazard Area (2010)
	Landslides	Weak Soils	Expansive Soils	Naturally Occurring Asbestos (NOA)	Other[1] Conditions	Ground Shaking	Fault Rupture	Liquefaction	Earthquake Induced Landslides	Lateral Spreading	Other Conditions[2]	
	Villages and Corridors											
V71		●	●		B	●						
V72		●	●		B	●						
V73		●	●		B	●		●		●	D	●
	Other Areas											
South Almaden Valley Urban Reserve	●	●	●	●	A, B	●		●	●	●	D	●
Notes	1) Other potential soil and geologic hazards present may include: A) Erosion; B) Artificial Fill; and C) Ground Subsidence due to ground water removal 2) Other potential seismic hazards present may include: D) Liquefaction Induced Ground Manifestations; E) Differential Seismic Settlement or Unsaturated Sand Compaction; and F) Seismically Induced Waves.											

CORNERSTONE EARTH GROUP

Alum Rock Planning Area – Potential Soil, Geologic and Seismic Hazards

The Alum Rock Planning Area is located east of Downtown and adjacent to the Diablo Mountain Range. The Alum Rock Planning Area is 15.5 square miles in size. This planning area contains one Employment Land Area, six Transit Oriented Villages and Corridors, two Commercial Center Villages and Corridors, and four Neighborhood Villages. The potential soil, geologic and seismic hazards identified in the growth areas within the Alum Rock Planning Area based upon existing information are identified below.

Table A2. Alum Rock Planning Area – Potential Soil, Geologic and Seismic Hazards

Growth Area	Soil and Geologic Hazards					Seismic Hazards						Within City's Geologic Hazard Area (2010)
	Landslides	Weak Soils	Expansive Soils	Naturally Occurring Asbestos (NOA)	Other[1] Conditions	Ground Shaking	Fault Rupture	Liquefaction	Earthquake Induced Landslides	Lateral Spreading	Other Conditions[2]	
	Villages and Corridors											
V49		•	•		B	•						
V50		•	•		B	•						
V51		•	•		B, C	•						
V52		•	•		B	•		•			D	
V56		•	•		B	•		•			D	
VR11		•	•		B, C	•		•		•	D	
VR14		•	•		B, C	•						
VR15		•	•		B, C	•						
VR16		•	•		B	•						
VT2		•	•		B ,C	•		•		•	D	
CR29		•	•		B, C	•		•		•	D	
C34		•	•		B, C	•		•		•	D	
C42		•	•		B, C	•		•		•	D	
	Other Areas											
Mabury Employ-ment Land Area		•	•		C	•		•		•	D	
Notes	1) Other potential soil and geologic hazards present may include: A) Erosion; B) Artificial Fill; and C) Ground Subsidence due to ground water removal 2) Other potential seismic hazards present may include: D) Liquefaction Induced Ground Manifestations; E) Differential Seismic Settlement or Unsaturated Sand Compaction; and F) Seismically Induced Waves.											

Alviso Planning Area – Potential Soil, Geologic and Seismic Hazards

The Alviso Planning Area is located adjacent to the southern tip of San Francisco Bay and is the northernmost planning area in San José. The Alviso Planning Area is 16.8 square miles in size. The potential soil, geologic and seismic hazards identified in the Alviso Specific Plan area within the Alviso Planning Area based upon existing information are identified below.

Table A3. Alviso Planning Area – Potential Soil, Geologic and Seismic Hazards

Growth Area	Soil and Geologic Hazards					Seismic Hazards						Within City's Geologic Hazard Area (2010)
	Landslides	Weak Soils	Expansive Soils	Naturally Occurring Asbestos (NOA)	Other[1] Conditions	Ground Shaking	Fault Rupture	Liquefaction	Earthquake Induced Landslides	Lateral Spreading	Other Conditions[2]	
	Villages and Corridors											
None Identified												
	Other Areas											
Alviso Specific Plan Area		•	•		B, C	•		•		•	D, E	
Notes	1) Other potential soil and geologic hazards present may include: A) Erosion; B) Artificial Fill; and C) Ground Subsidence due to ground water removal 2) Other potential seismic hazards present may include: D) Liquefaction Induced Ground Manifestations; E) Differential Seismic Settlement or Unsaturated Sand Compaction; and F) Seismically Induced Waves.											

Berryessa Planning Area – Potential Soil, Geologic and Seismic Hazards

The Berryessa Planning Area lies northeast of Downtown and adjacent to the Diablo Mountain Range. The Berryessa Planning Area is 9.8 square miles in size. The planning area contains one Planned Community, three Employment Land Areas, four Transit-Oriented Villages and Corridors, and two Neighborhood Villages. The potential soil, geologic and seismic hazards identified in the growth areas in the Berryessa Planning Area based upon existing information are identified below.

Table A4. Berryessa Planning Area – Potential Soil, Geologic and Seismic Hazards

Growth Area	Soil and Geologic Hazards					Seismic Hazards						Within City's Geologic Hazard Area (2010)
	Landslides	Weak Soils	Expansive Soils	Naturally Occurring Asbestos (NOA)	Other[1] Conditions	Ground Shaking	Fault Rupture	Liquefaction	Earthquake Induced Landslides	Lateral Spreading	Other Conditions[2]	
Villages and Corridors												
V47		•	•		B, C	•		•			D	
V48	•	•	•		A, B	•						•
VR12		•	•		B, C	•		•			D	
VR13		•	•		B, C	•						
VT1		•	•		B, C	•		•			D	
VT2		•	•		B, C	•		•			D	
Other Areas												
Berryessa Business Park Employment Land Area		•	•		B, C	•		•		•	D	
East Gish Employment Land Area		•	•		B, C	•		•		•	D	
Berryessa Specific Plan Area		•	•		B, C	•		•		•	D	
North San Jose Employment Land Area		•	•		B, C	•		•		•	D	

Notes

1) Other potential soil and geologic hazards present may include: A) Erosion; B) Artificial Fill; and C) Ground Subsidence due to ground water removal

2) Other potential seismic hazards present may include: D) Liquefaction Induced Ground Manifestations; E) Differential Seismic Settlement or Unsaturated Sand Compaction; and F) Seismically Induced Waves.

Cambrian/Pioneer Planning Area – Potential Soil, Geologic and Seismic Hazards

The Cambrian/Pioneer Planning Area is located in southwestern San José adjacent to the Santa Cruz Mountains. The Cambrian/Pioneer Planning Area is 8.6 square miles in size. The planning area contains one Transit-Oriented Village, two Commercial Center Villages and Corridors, and five Neighborhood Villages. The potential soil, geologic and seismic hazards identified in the growth areas in the Cambrian/Pioneer Planning Area based upon existing information are identified below.

Table A5. Cambrian/Pioneer Planning Area – Potential Soil, Geologic and Seismic Hazards

Growth Area	Soil and Geologic Hazards					Seismic Hazards						Within City's Geologic Hazard Area (2010)
	Landslides	Weak Soils	Expansive Soils	Naturally Occurring Asbestos (NOA)	Other[1] Conditions	Ground Shaking	Fault Rupture	Liquefaction	Earthquake Induced Landslides	Lateral Spreading	Other Conditions[2]	
	Villages and Corridors											
V64		•	•		B	•		•		•	D, E	
V67		•	•		B	•						
V68		•	•		B	•		•		•	D	
V69		•	•		B	•						
V70		•	•		B	•						
VR17		•	•		B	•		•		•	D	
C40		•	•		B	•		•		•	D, E	
C44		•	•		B	•						
	Other Areas											
None Identified												

Notes

1) **Other potential soil and geologic hazards present may include: A) Erosion; B) Artificial Fill; and C) Ground Subsidence due to ground water removal**

2) **Other potential seismic hazards present may include: D) Liquefaction Induced Ground Manifestations; E) Differential Seismic Settlement or Unsaturated Sand Compaction; and F) Seismically Induced Waves.**

Central/Downtown Planning Area – Potential Soil, Geologic and Seismic Hazards

The Central/Downtown Planning Area encompasses Downtown and the surrounding area. The Central/Downtown Planning Area is 11.8 square miles in size. The planning area contains Downtown San José, four Planned Community/ Specific Plan areas, two Employment Land Areas, six Transit Oriented Villages and Corridors, two Commercial Center Villages and Corridors, and one Neighborhood Village. The potential soil, geologic and seismic hazards identified in the growth areas in the Central/Downtown Planning Area based upon existing information are identified below.

Table A6. Central/Downtown Planning Area – Potential Soil, Geologic and Seismic Hazards

Growth Area	Soil and Geologic Hazards					Seismic Hazards						Within City's Geologic Hazard Area (2010)
	Landslides	Weak Soils	Expansive Soils	Naturally Occurring Asbestos (NOA)	Other[1] Conditions	Ground Shaking	Fault Rupture	Liquefaction	Earthquake Induced Landslides	Lateral Spreading	Other Conditions[2]	
	Villages and Corridors											
V57		•	•		B, C	•		•			D	
VT3		•	•		B, C	•		•			D	
VT4		•	•		B, C	•		•			D	
VR9		•	•		B, C	•		•		•	D	
CR20		•	•		B, C	•		•		•	D	
CR28		•	•		B, C	•		•		•	D	
CR31		•	•		B, C	•		•			D	
C33		•	•		B, C	•		•			D	
C46		•	•		B, C	•		•			D	
	Other Areas											
Midtown Specific Plan Area		•	•		C	•		•		•	D	
Jackson-Taylor Specific Plan Area		•	•		C	•		•			D	
Marth Gardens Specific Plan Area		•	•		C	•		•			D	
Tamien Specific Plan Area		•	•		C	•		•		•	D	
Downtown Area		•	•		C	•		•		•	D	

Continued on next page

Table A6. Central/Downtown Planning Area – Potential Soil, Geologic and Seismic Hazards												
	Other Areas, continued											
Monterey Employ-ment Land Area		•	•		C	•		•		•	D	
Mabury Employ-ment Land Area		•	•		B, C	•		•			D	
Notes	**1) Other potential soil and geologic hazards present may include: A) Erosion; B) Artificial Fill; and C) Ground Subsidence due to ground water removal** **2) Other potential seismic hazards present may include: D) Liquefaction Induced Ground Manifestations; E) Differential Seismic Settlement or Unsaturated Sand Compaction; and F) Seismically Induced Waves.**											

Coyote Planning Area – Potential Soil, Geologic and Seismic Hazards

The Coyote Planning Area is located at the southern edge of San José's Sphere of Influence. The Coyote Planning Area is 24.84 square miles in size. The planning area contains the North Coyote Valley Employment Land Area and the Coyote Valley Urban Reserve. The potential soil, geologic and seismic hazards identified in the Coyote Planning Area based upon existing information are identified below.

Table A7. Coyote Planning Area – Potential Soil, Geologic and Seismic Hazards

Growth Area	Soil and Geologic Hazards					Seismic Hazards						Within City's Geologic Hazard Area (2010)
	Landslides	Weak Soils	Expansive Soils	Naturally Occurring Asbestos (NOA)	Other[1] Conditions	Ground Shaking	Fault Rupture	Liquefaction	Earthquake Induced Landslides	Lateral Spreading	Other Conditions[2]	
	Villages and Corridors											
None Identified												
	Other Areas											
North Coyote Valley Employ-ment Land Area	•	•	•	•	A, B	•	•	•	•	•	D	•
Coyote Valley Urban Reserve	•	•	•	•	A, B	•	•	•	•	•	D	•

Notes

1) **Other potential soil and geologic hazards present may include: A) Erosion; B) Artificial Fill; and C) Ground Subsidence due to ground water removal**

2) **Other potential seismic hazards present may include: D) Liquefaction Induced Ground Manifestations; E) Differential Seismic Settlement or Unsaturated Sand Compaction; and F) Seismically Induced Waves.**

Edenvale Planning Area – Potential Soil, Geologic and Seismic Hazards

The Edenvale Planning Area is located in the southern portion of the City. The Edenvale Planning Area is 20.6 square miles in size. The planning area contains one Employment Land Area (Old and New Edenvale), eight Transit-Oriented Villages and Corridors, one Commercial Center Village and Corridor, and four Neighborhood Villages. The potential soil, geologic and seismic hazards identified in the growth areas within the Edenvale Planning Area based upon existing information are identified below.

Table A8. Edenvale Planning Area – Potential Soil, Geologic and Seismic Hazards

Growth Area	Soil and Geologic Hazards					Seismic Hazards						Within City's Geologic Hazard Area (2010)
	Landslides	Weak Soils	Expansive Soils	Naturally Occurring Asbestos (NOA)	Other[1] Conditions	Ground Shaking	Fault Rupture	Liquefaction	Earthquake Induced Landslides	Lateral Spreading	Other Conditions[2]	
	Villages and Corridors											
V58		•	•		B	•		•			D	
V59		•	•		B	•		•			D	
V60		•	•		B	•		•			D	
V66		•	•		B	•		•			D	
VR10		•	•		B	•		•		•	D	
VR17		•	•		B	•		•			D	
VR18		•	•		B	•		•		•	D	
VR19		•	•		B	•		•			D	
VR24		•	•	•	B	•		•			D	•
VR27	•	•	•	•	A, B	•		•			D	•
VT6		•	•		B	•		•			D	
VT7		•	•		B	•		•			D	
C37		•	•		B	•		•			D	
	Other Areas											
Old Edenvale Employment Land Area		•	•		B	•		•	•		D	
New Edenvale Employment Land Area	•	•	•	•	A, B	•		•	•	•	D	•
Silver Creek Specific Plan Area	•	•	•	•	A, B	•		•	•	•	D	•
Notes	1) Other potential soil and geologic hazards present may include: A) Erosion; B) Artificial Fill; and C) Ground Subsidence due to ground water removal 2) Other potential seismic hazards present may include: D) Liquefaction Induced Ground Manifestations; E) Differential Seismic Settlement or Unsaturated Sand Compaction; and F) Seismically Induced Waves.											

Evergreen Planning Area – Potential Soil, Geologic and Seismic Hazards

The Evergreen Planning Area is located in southeast San José. The Evergreen Planning Area is 15.1 square miles in size. The planning area contains one Planned Community/Specific Plan Area, one Employment Land Area, two Transit-Oriented Villages and Corridors, one Commercial Center Village and Corridor, and three Neighborhood Villages. The potential soil, geologic and seismic hazards identified in the growth areas in the Evergreen Planning Area based upon existing information are identified below.

Table A9. Evergreen Planning Area – Potential Soil, Geologic and Seismic Hazards

Growth Area	Soil and Geologic Hazards					Seismic Hazards						Within City's Geologic Hazard Area (2010)
	Landslides	Weak Soils	Expansive Soils	Naturally Occurring Asbestos (NOA)	Other[1] Conditions	Ground Shaking	Fault Rupture	Liquefaction	Earthquake Induced Landslides	Lateral Spreading	Other Conditions[2]	
	Villages and Corridors											
V53		●	●		B	●						
V54		●	●		B	●		●		●	D	
V55		●	●		B	●						
VR22		●	●		B	●		●		●	D	
VR23		●	●		B	●		●			D	
C34		●	●		B, C	●		●			D	
	Other Areas											
Evergreen Specific Plan Area	●	●	●		A, B	●	●		●			●
Silver Creek Specific Plan Area	●	●	●	●	A, B	●		●	●	●	D	●
Evergreen Campus Industrial Employ-ment Land Area	●	●	●		A, B	●			●			●
Notes	1) Other potential soil and geologic hazards present may include: A) Erosion; B) Artificial Fill; and C) Ground Subsidence due to ground water removal 2) Other potential seismic hazards present may include: D) Liquefaction Induced Ground Manifestations; E) Differential Seismic Settlement or Unsaturated Sand Compaction; and F) Seismically Induced Waves.											

North San Jose Planning Area – Potential Soil, Geologic and Seismic Hazards

The North San José Planning Area is located between Downtown and State Route 237. The North San José Planning Area is 8.8 square miles in size. The planning area contains one Planned Community/Specific Plan Area, one Employment Land Area, and one Transit-Oriented Village and Corridor. The potential soil, geologic and seismic hazards identified in the growth areas within the North San Jose Planning Area based upon existing information are identified below.

Table A10. North San Jose Planning Area – Potential Soil, Geologic and Seismic Hazards

Growth Area	Soil and Geologic Hazards					Seismic Hazards						Within City's Geologic Hazard Area (2010)
	Landslides	Weak Soils	Expansive Soils	Naturally Occurring Asbestos (NOA)	Other[1] Conditions	Ground Shaking	Fault Rupture	Liquefaction	Earthquake Induced Landslides	Lateral Spreading	Other Conditions[2]	
	Villages and Corridors											
VT5		●	●		B	●		●			D	
	Other Areas											
North San Jose Employment Land Area		●	●		B	●		●		●	D, E	
Rincon South Specific Plan Area		●	●		B	●		●		●	D	
Notes	1) Other potential soil and geologic hazards present may include: A) Erosion; B) Artificial Fill; and C) Ground Subsidence due to ground water removal 2) Other potential seismic hazards present may include: D) Liquefaction Induced Ground Manifestations; E) Differential Seismic Settlement or Unsaturated Sand Compaction; and F) Seismically Induced Waves.											

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South San Jose Planning Area – Potential Soil, Geologic and Seismic Hazards

The South San José Planning Area is located directly south of Downtown between State Route 87 and US 101. The South San José Planning area is 11.4 square miles in size. The planning area contains one Planned Community/ Specific Plan Area, two Employment Land Areas, six Transit-Oriented Villages and Corridors, and two Commercial Center Villages and Corridors. The potential soil, geologic and seismic hazards identified in the growth areas within the South San Jose Planning Area based upon existing information are identified below.

Table A11. South San Jose Planning Area – Potential Soil, Geologic and Seismic Hazards

Growth Area	Soil and Geologic Hazards					Seismic Hazards						Within City's Geologic Hazard Area (2010)
	Landslides	Weak Soils	Expansive Soils	Naturally Occurring Asbestos (NOA)	Other[1] Conditions	Ground Shaking	Fault Rupture	Liquefaction	Earthquake Induced Landslides	Lateral Spreading	Other Conditions[2]	
	Villages and Corridors											
VR8		●	●	●	B	●		●			D	●
VR10		●	●		B	●		●		●	D	
VR24		●	●	●	B	●		●			D	●
VR25		●	●		B	●		●			D	
VR26		●	●		B	●		●			D	
VR27	●	●	●	●	A, B	●		●			D	●
C33		●	●		B, C	●		●			D	
C45		●	●	●	C, B	●		●			D	
	Other Areas											
Monterey Business Corridor Employ-ment Land Area		●	●		B, C	●		●			D	
Senter Road Employ-ment Land Area		●	●		B, C	●		●		●	D	
Communi-cations Hill Specific Plan Area	●	●	●	●	A, B	●		●	●		D	●
Notes	1) Other potential soil and geologic hazards present may include: A) Erosion; B) Artificial Fill; and C) Ground Subsidence due to ground water removal 2) Other potential seismic hazards present may include: D) Liquefaction Induced Ground Manifestations; E) Differential Seismic Settlement or Unsaturated Sand Compaction; and F) Seismically Induced Waves.											

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West Valley Planning Area – Potential Soil, Geologic and Seismic Hazards

The West Valley Planning Area is the westernmost area of San José. The West Valley Planning Area is 10.9 square miles in size. The planning area contains two Transit-Oriented Villages and Corridors, five Commercial Center Villages and Corridors, and two Neighborhood Villages. The potential soil, geologic and seismic hazards identified in the growth areas in the West Valley Planning Area based upon existing information are identified below.

Table A12. West Valley Planning Area – Potential Soil, Geologic and Seismic Hazards

Growth Area	Soil and Geologic Hazards					Seismic Hazards						Within City's Geologic Hazard Area (2010)
	Landslides	Weak Soils	Expansive Soils	Naturally Occurring Asbestos (NOA)	Other[1] Conditions	Ground Shaking	Fault Rupture	Liquefaction	Earthquake Induced Landslides	Lateral Spreading	Other Conditions[2]	
	Villages and Corridors											
V61		•	•		B	•						
V62		•	•		B	•		•		•	D	
C35		•	•		B	•		•			D	
C36		•	•		B	•						
C38		•	•		B	•						
C41		•	•		B	•						
C43		•	•		B	•		•			D	
CR30		•	•		B, C	•		•			D	
CR32		•	•		B, C	•		•		•	D	
	Other Areas											
None Identified												
Notes	1) Other potential soil and geologic hazards present may include: A) Erosion; B) Artificial Fill; and C) Ground Subsidence due to ground water removal 2) Other potential seismic hazards present may include: D) Liquefaction Induced Ground Manifestations; E) Differential Seismic Settlement or Unsaturated Sand Compaction; and F) Seismically Induced Waves.											

Willow Glen Planning Area – Potential Soil, Geologic and Seismic Hazards

The Willow Glen Planning Area is located southwest of Downtown. The Willow Glen Planning Area is 10.4 square miles in size. The planning area contains one Transit-Oriented Village and Corridor, three Commercial Center Villages and Corridors, and three Neighborhood Villages. The potential soil, geologic and seismic hazards identified in the growth areas in the Willow Glen Planning Area based upon existing information are identified below.

Table A13. Willow Glen Planning Area – Potential Soil, Geologic and Seismic Hazards

Growth Area	Soil and Geologic Hazards					Seismic Hazards						Within City's Geologic Hazard Area (2010)
	Landslides	Weak Soils	Expansive Soils	Naturally Occurring Asbestos (NOA)	Other[1] Conditions	Ground Shaking	Fault Rupture	Liquefaction	Earthquake Induced Landslides	Lateral Spreading	Other Conditions[2]	
	Villages and Corridors											
V63		•	•		B, C	•		•		•	D, E	
V64		•	•		B	•		•		•	D, E	
V65		•	•		B	•						
C39		•	•		B, C	•						
C40		•	•		B	•		•		•	D, E	
C44		•	•		B	•						
CR21		•	•		B, C	•		•		•	D, E	
	Other Areas											
None Identified												
Notes	1) Other potential soil and geologic hazards present may include: A) Erosion; B) Artificial Fill; and C) Ground Subsidence due to ground water removal 2) Other potential seismic hazards present may include: D) Liquefaction Induced Ground Manifestations; E) Differential Seismic Settlement or Unsaturated Sand Compaction; and F) Seismically Induced Waves.											