Chapter IV.

ENVIRONMENTAL HAZARDS

GEOTECHNICAL ELEMENT

PURPOSE

The Geotechnical Element is intended to provide information about the geological and seismic conditions and hazards that affect the Town of Apple Valley and its Sphere-of-Influence. This element establishes a series of goals, policies, and programs that focus on reducing potential impacts, such as loss of life and property damage, associated with seismic and geologic hazards. These goals, policies, and programs also provide for the protection of the general health and welfare of the community The Element and associated maps and other supporting document will serve as a source of foundational information concerning regional geotechnical hazards and thereby provide for the establishment of future land use policies and decisions.

BACKGROUND

The Geotechnical Element considers the physical characteristics of the planning area and the safety of the community, and is therefore closely related to a number of other elements within the General Plan. These include Land Use, Circulation, Housing, Public Buildings and Facilities, Emergency Preparedness, and Police and Fire Protection. In addition, the Geotechnical Element directly relates to many issues discussed in the Water, Sewer and Utilities Element and the Flooding and Hydrology Element.

California Government Code and Public Resources Code requires that a General Plan include an element that addresses seismic safety issues. To comply with these requirements, as set forth in Government Code Section 65302(g), the General Plan must address the need to protect the community from unreasonable risks that could result from seismically induced hazards, such as surface rupture, groundshaking, ground failure, seiching, dam failure, subsidence, and other known geologic risks. Government Code Section 65303 also allows the General Plan to address other subjects related to the physical development of the community, and the Geotechnical Element contributes towards addressing these issues. The Town and all other jurisdictions located within the most severe seismic shaking zone, designated as Zone 4 (as established in Chapter 2-23, Part 2, Title 24 of the Administrative Code), are required to identify all potentially hazardous or substandard buildings and implement a program for the mitigation of these structures. This requirement is mandated and programmed in Government Code Section 8876.

A technical background study[1] was prepared to assess existing conditions and potential future conditions at build out of the proposed General Plan. This report is referenced herein and is included in its entirety as an appendix to the General Plan EIR.

1 "Technical Background Report to the Safety Element of the Apple Valley General Plan," prepared by Earth Consultants International, October 2007.

GEOLOGIC CONDITIONS IN THE PLANNING AREA

The Town of Apple Valley is generally bounded by the Turtle Mountains on the north, the Fairview Mountains and Granite Mountains on the east and the Ord Mountains on the south. The majority of Apple Valley is situated on gently sloping alluvial fans ranging in elevation from approximately 3,400 feet near the base of the Fairview Mountains to the northeast to 2,700 feet along the Mojave River to the west. Notable geologic formations within the Town include Bell Mountain at 3,897 feet and Catholic Hill at 3,645 feet. One of the most prominent features in the area is the Mojave River, a wide floodplain that generally defines Apple Valley's western boundary.

The geological character of Apple Valley and the surrounding region has been formed by its proximity to large active fault systems, including the Helendale Fault, San Andreas Fault, and the North Frontal Fault. Fault activity in this region continues to result in ground rupture, major groundshaking, subsidence, uplift and mountain building, landform compression and extension. As a result, the mountains are composed of rocks that have been sheared and intensely fractured under the strain of tectonic movement. The valley is formed by many generations of overlapping alluvial fans, the various ages of which coincide with the rise of the local mountains.

The following section describes the general physical and engineering characteristics, from youngest to oldest, of the six types of geologic deposits that underlie the Apple Valley planning area. These consist of: artificial fill, very young or recent alluvium (current or recently active), young alluvial and landslide deposits (0 to 11,000 years old), older alluvial fan deposits (11,000 to 1 million years old), sedimentary rocks (10 to 26 million years old), and crystalline rocks (65 to 225 million years old). Exhibits IV-1 and IV-1A illustrate the soil types in the Apple Valley study area.

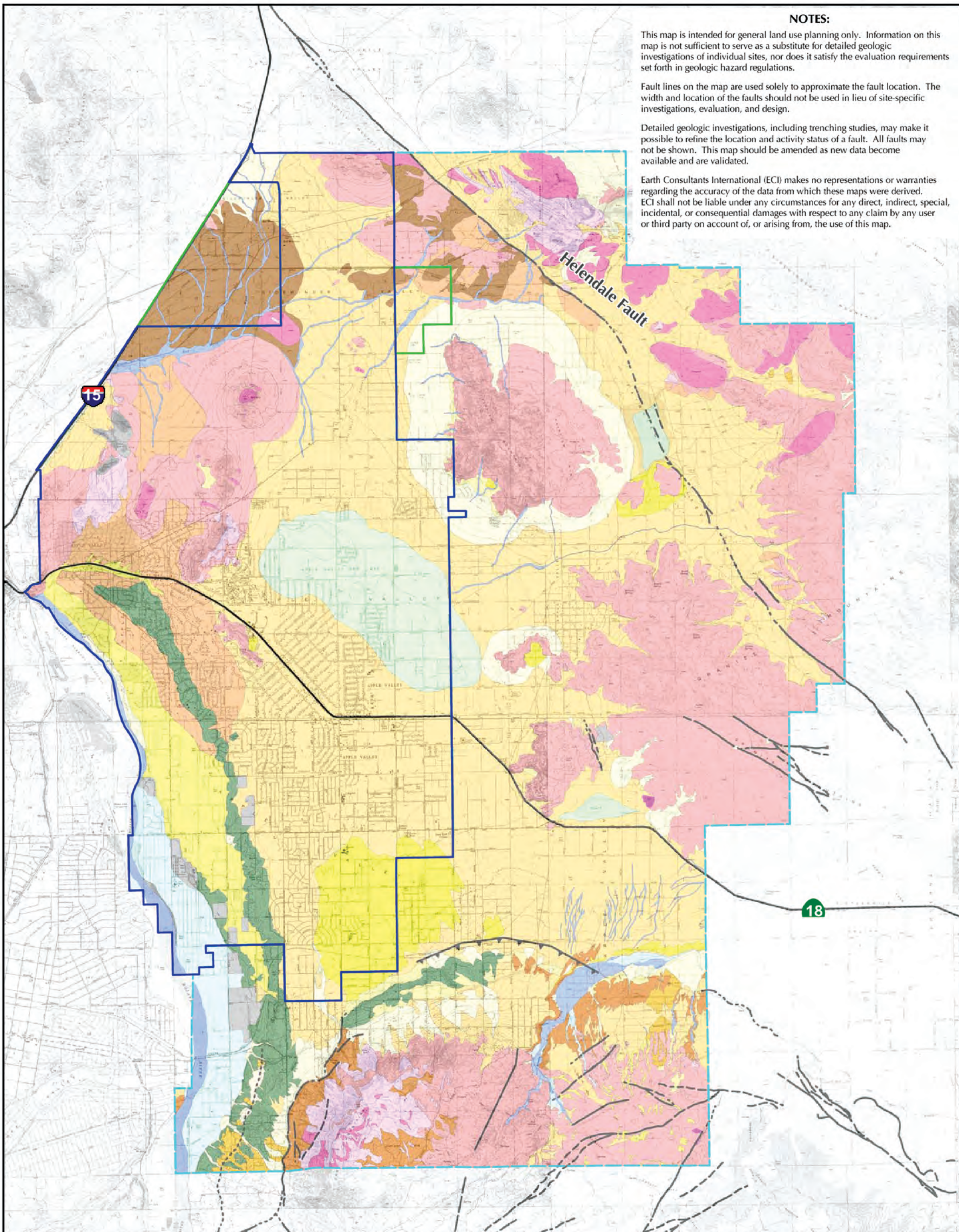
NOTES:

This map is intended for general land use planning only. Information on this map is not sufficient to serve as a substitute for detailed geologic investigations of individual sites, nor does it satisfy the evaluation requirements set forth in geologic hazard regulations.

Fault lines on the map are used solely to approximate the fault location. The width and location of the faults should not be used in lieu of site-specific investigations, evaluation, and design.

Detailed geologic investigations, including trenching studies, may make it possible to refine the location and activity status of a fault. All faults may not be shown. This map should be amended as new data become available and are validated.

Earth Consultants International (ECI) makes no representations or warranties regarding the accuracy of the data from which these maps were derived. ECI shall not be liable under any circumstances for any direct, indirect, special, incidental, or consequential damages with respect to any claim by any user or third party on account of, or arising from, the use of this map.



Scale: 1:108,000

For Geologic Unit Descriptions See Exhibit IV-1A

Base Map: USGS Topographic Map from Sure!MAPS RASTER, 1997.
Sources: Morton and Miller, 2003; Dibblee, 1960; and CGS, 2007.

Source: Earth Consultants International, December 2008

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Apple Valley General Plan
Geological Units in Apple Valley Area
Apple Valley, California

Exhibit
IV-1

Symbols

Fault; solid where location known, dashed where approximate, dotted where concealed. (For more information on faults refer to Exhibit IV-1)

Geologic Contact

Apple Valley City Boundary

Apple Valley Sphere of Influence

Apple Valley Annexed Areas

Geologic Unit Descriptions

Very Young Deposits

Qaf	Artificial Fill/ Disturbed Ground- Mainly larger fills and graded areas or mining operations. Many smaller areas, inluding both engineered and non-engineered fills, are present, but not shown.
Qw	Very Young Wash Deposits- Unconsolidated sand, gravel, cobbles, and boulders in the Mojave River and active washes. Late Holocene.
Qf	Very Young Alluvial Fan Deposits- Unconsolidated silt, sand, and gravel on active and recently active fans. Late Holocene.
Qc	Very Young Colluvium- Unconsolidated silt, sand, and gravel in drainage swales and along the toes of natural slopes. Late Holocene.
Qe	Very Young to Young Eolian Deposits- Fine-grained sand and silt. Holocene to late Pleistocene.
Qp	Very Young to Young Playa/ Dry Lake Deposits- Sand, silty to sandy clay, and clayey silt. Holocene to late Pleistocene.

Young Deposits

Qyw	Young Wash Deposits- Unconsolidated to slightly consolidated silt, sand, and gravel along the margins of the Mojave River and within Arrastre Canyon. Holocene to late Pleistocene.
Qyf	Young Alluvial Fan Deposits- Unconsolidated to moderately consolidated silt and sand; locally with gravel. Holocene to late Pleistocene.
Qya	Young Alluvial Valley Deposits- Slightly to moderately consolidated silt, sand, and gravel. Holocene to late Pleistocene.
Qyls	Landslide Deposits- Young landslides consisting of displaced bedrock blocks and/ or rubble. Holocene and late Pleistocene.

Older Deposits

Qof	Old Alluvial Fan Deposits- Moderately well consolidated silt, sand, and gravel. May contain boulders near the base of the mountains. Late to middle Pleistocene.
Qoa	Old Alluvial Valley Deposits- Weakly consolidated silt, sand, and gravel. Pleistocene.
Qvof	Very Old Alluvial Fan Deposits- Moderately to well consolidated silt, sand, and gravel. Middle to early Pleistocene.
Qvoa	Very Old Alluvial Valley Deposits- Moderately consolidated sand and gravel. Early Pleistocene to late Miocene (?).

Sedimentary Rocks

Tcr	Crowder Formation- Sandstone, pebbly sandstone, and siltstone. Pliocene to Miocene.

Crystalline Rocks

Mzp	Plutonic Rocks- Predominately monzonite, quartz monzonite, monzogranite, and syenogranite. Mesozoic.
Mzv	Volcanic Rocks- Predominately rhyolite and dacite. Mesozoic.
Mzm	Metasedimentary Rocks- Marble, schist, quartzite, and gneiss. Mesozoic.
Pzw	Wood Canyon Formation- Highly deformed schist and quartzite. Paleozoic.

Source: Earth Consultants International, December 2008

Artificial Fill/Disturbed Ground
The planning area includes numerous deposits of man-made fills. Fills are related to roadway, bridge, and railway embankments, levees, and graded developments. Some of these deposits cover a substantial area, however the size, age and composition vary widely.

Very Young or Recent Alluvium (Map Symbols Qw, Qf, Qc, Qe, and Qp)
Within Apple Valley, very young wash deposits (Qw and Qf) are found in several settings. These include unconsolidated sediments that line active drainage courses, such as sand and gravel in the Mojave River; mixed sand, gravel, and boulders found in Arrastre Canyon in the southern Sphere of Influence, Desert Knolls Wash, Bell Mountain Wash; and within the many unnamed washes and silt, sand and gravel in the numerous unnamed gullies and washes that cross alluvial fans. Surface soils on these deposits are undeveloped, and are therefore subject to being re-worked by flooding or buried by new sediment during storms. In the upper reaches of the drainages, large boulders may be deposited during flooding; this condition is most likely to be found near the mountains.

Similar in character to Qf deposits, modern colluvium (Qc) may be found in hillside areas lining drainage deposits. In hillside areas, colluvium generally accumulates in the linings of drainage depressions and along the natural toes of slopes, resulting from slope wash and weathering of underlying soil units. Colluvial deposits are characteristically very large, unconsolidated, and may contain organic material.

Fine- to medium-grained sand and silt (Qe) wind-deposited soils are found throughout Apple Valley. Typically these deposits are thin and unconsolidated. The youngest deposits tend to form patches in the sheltered side of desert vegetation. North of the Ord Mountains is a somewhat older and relatively large deposit, containing a poorly developed drainage network controlled by understated dunes.

There are several dry lake areas in the planning area and vicinity, including the Apple Valley Dry Lake in Apple Valley, as well as a small playa south of the Granite Mountains, and Reeves Lake in Fairview Valley, and Apple Valley Dry Lake. These areas contain Playa deposits (Qp) that are primarily comprised of very fine-grained sediments such as silt and clay, but also include some fine- to medium-grained sand. These areas are flat-floored basins with no ouflow, and are therefore subject to future flooding and sediment deposition.

Young Alluvial and Landslide Deposits (Map Symbols Qyf, Qyw, Qya and Qyls)
Young alluvial fan deposits (Qyf) are those ranging from a few years old up to about 15,000 years in age, blanketing most of the valley with unconsolidated to moderately consolidated silt and sand with scattered gravel. Cobbles and boulders may be present in deposits in and near the mountains, and more deeply incised drainage channels may also occur.

Young wash deposits (Qyw), which typically have an age within the last 10,000 years, occur in the planning area and vicinity as unconsolidated sand and gravel along a slightly elevated terrace adjacent to the Mojave River and within Arrastre Canyon. In the latter, undeveloped area these soils tend to be more vegetated than within the very young deposits. Along the Mojave River, where substantial development has occurred, this unit represents an older river floodplain. Along the river the lowest areas are somewhat protected by sand levees; nonetheless, localized flooding could occur during severe storm events, or in the event of catastrophic failure of one of the upstream dams.

Young alluvial valley fill (Qya) soils are within 15,000 years in age and are comprised of pale brown, slightly to moderately consolidated silt, sand, and gravel which has been incised by shallow to moderately deep drainages. In the planning area these soils form an elevated terrace above the Mojave River floodplain, as well as the relatively steep bluffs north of Yucca Loma Road.

Landslide deposits (Qyls) normally consist of blocks of intact bedrock and/or rubble. The graben area (upper part of the slide) is typically comprised of a mix of soil and bedrock fragments. There are two mapped landslide deposits, which are located in the western part of the Granite Mountains, in and near the far eastern portion of the Sphere of Influence.

<u>Older Alluvial Fan Deposits</u> (Map Symbols Qof, Qoa, Qvof and Qvoa)
There are older alluvial deposits (Qof and Qoa) in the planning area that occur as scattered remnants of erosion along the flanks of the Ord Mountains to the south, and in the Desert Knolls area. In the Black Mountain area, to the northeast, these deposits occur as isolated patches and they are generally elevated above younger fan deposits. This unit is weakly stratified and has moderate surficial soil development. These deposits range from about 11,000 to 500,000 years old, and are comprised of moderately well consolidated silt, sand and gravel, with boulders possible near the base of mountains.

Very old alluvial deposits (Qvof and Qvoa) consist primarily of silt, gravel, and medium- to coarse-grained sand. These soils are mid to early Pleistocene in age (about 500,000 to 1 million years old), and are moderately to well consolidated with a deeply dissected surface. Characteristically, such deposits may be roughly arranged in beds (layers of varying thickness and character), although these beds may give way to chaotic debris flows near the mountains. Mature soils are developed on the surface and may exhibit a reddish colored on the upper part of the deposit. In the planning area vicinity, there are very old alluvial deposits in a large area north of Bell Mountain Wash, as well as within isolated patches southwest of the Black Mountains and within the Ord Mountains (Juniper Flats and the lower mountainsides.).

In general, older alluvium may provide better structural support because it is more consolidated than young alluvium. Where clayey soils develop on the fan surface, however, they may be expansive. Stream erosion can over-steepen slopes, leading to slope instability.

<u>Sedimentary Rocks</u> (Map Symbol: Tcr)
Sedimentary rocks occur in narrow, exposed bands along the base of the Ord Mountains, and along the eastern side of the Mojave River. They include sandstone, pebbly sandstone, and conglomerate of the Miocene-age (10 to 26 million years old) Crowder Formation. This unit is pinkish-tan, pale gray, and pale brown in color. Because of their permeability, the presence of massive to planar bedding and cross-bedding, and the absence of well-developed potential slip planes, sedimentary rocks generally contribute to gross slope stability. However, they are highly

vulnerable to erosion and surface failure on natural slopes as well as on graded slopes comprised of granular materials.

Crystalline Rocks (Map Symbols: Mzp, Mzv, Mzm, Pzw)
Rocks that have crystallized from the igneous, or molten state, and rocks of sedimentary origin that have crystallized under extreme conditions deep below the earth's surface (metasedimentary), are included in this group. Where not highly weathered, these rocks are very hard, forming steep, rugged slopes and deep canyons. However, they are generally fractured, since they are brittle and have been subjected to millions of years of tectonic activity, and therefore are typically very fractured. As a result, they may be sheared near fault zones, a condition, which, along with jointing that is inherent in intrusive rocks, creates planes of weakness along which slope instability can occur. As noted above, however, there are only two small landslides mapped in the planning area vicinity, at the western edge of the Granite Mountains in the eastern Sphere of Influence.

Plutonic rocks (Mzp) are those that have solidified deep within the earth's crust. They are characterized by fine to coarse grains that are easily discernible by the human eye. These rocks tend to weather into rounded outcrops containing boulders. In the planning area and vicinity, including the Ord Mountains, Granite Mountains, Bell Mountain, and Catholic Hill, there are small patches of darker-colored rocks (horneblende diorite and gabbro).

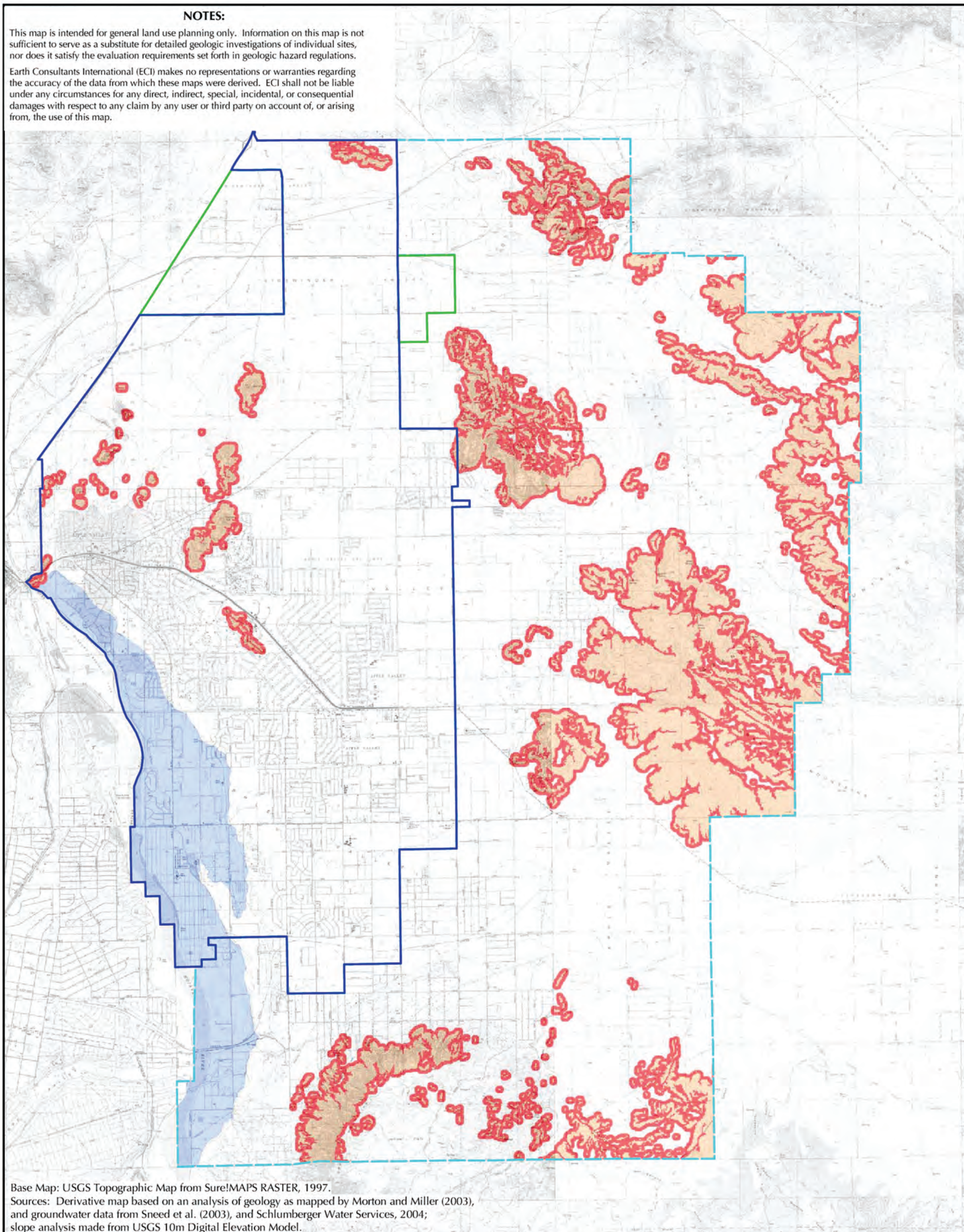
Rocks that are solidified on the ground surface, such as from a lava flow, are volcanic (Mzv). These rocks cooled quickly and thus are very fined-grained. Volcanic rocks, classified as rhyolite or dacite, occur as small isolated patches forming jagged, blocky outcrops on Bell Mountain and Catholic Hill. Volcanic rocks occur in the Sidewinder and Black Mountains, northeast of the Helendale fault.

Metasedimentary rocks (Mzm) are pale gray to tan marble, schist, quartzite and gneiss. Rocks of Mesozoic-age (251 million years ago to 65 million years ago) occur in the western part of the Ord Mountains and as small patches in the hills north of the Desert Knolls area. The north and east sides of Catholic Hill are comprised of the oldest rocks in Apple Valley, and occur on the north and east sides of Catholic Hill. These formations consist of highly deformed schist and quartzite approximately 250 to 500 million years in age, including the Wood Canyon Formation (Pzw).

Geologic Hazards

Landslide and Slope Instability
Much of the terrain within Apple Valley is hillside land, which is generally undeveloped except for local mining operations. The presence of scattered homes along the base of steep mountain slopes in the planning area represents a hazard due to slope instability. While slope failures tend to result in localized affects, in contrast to earthquakes or major floods, and are generally short-term, they can result in significant monetary losses. Such hazards may not be covered under homeowner's insurance policies, and may therefore result in additional distress to affected property owners.

The mountains and hills of Apple Valley are underlain by bedrock, which is not typically susceptible to landslides. However, canyon walls and other areas of sharp topographic relief, are potentially affected by rockfalls and rockslides, especially due to strong seismic shaking, and to mudflows and soil erosion during or after intense storm events. Exhibit IV-2, Seismic Related Hazards, shows areas of potential risk for rockfall and landslides in the planning area.



N W E S

Scale: 1:108,000

9000 0 9000
Feet

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Meters

Explanation

- Areas where local geological and groundwater conditions suggest a potential for liquefaction.
- Hillside and mountainous areas where numerous rockfalls and landslides are expected to occur during an earthquake.
- Areas where local topographic and geological conditions suggest the potential for earthquake-induced landslides.
- Town of Apple Valley Boundary
- Apple Valley Sphere of Influence
- Apple Valley Annexed Areas

Source: Earth Consultants International, December 2008

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Apple Valley General Plan
Seismic Related Hazards
Apple Valley, California

Exhibit
IV-2

Compressible Soils

Soil units that could compress under the weight of proposed fill embankments and structures are known as "compressible soils". While such soils usually involve geologically young (Holocene age) unconsolidated sediments with low density, they can also occur in conditions such as the upper weathered part of older alluvium, colluvium/slope wash that collects near the base of natural slopes, and slope failure debris. In some cases, they may be present in very weathered bedrock. Factors that determine the settlement potential and the rate of settlement in these sediments include texture and grain size, natural moisture and density, thickness of the compressible layer(s), drainage, proposed load weight, and the rate at which the load is applied.

Compressible soils are most likely to occur in the planning area where Holocene-age deposits are present, as well as active and recently active stream channels. In hills it is most likely that compressible soils will be found in canyon bottoms, swales, and at the base of natural slopes. Landslide deposits often result in compression, especially at the head or along the depression created by the slide, as well as along the margins. At depths of greater than 60 feet, deep fill embankments can also compress under their own weight. Potential hazards associated with compressible soils are preventable through the use of sound engineering practices, including a thorough geotechnical soils analysis.

Collapsible Soils

Substantial and rapid settlement can occur under relatively light loads when soil units are saturated, leading to a rearrangement of their grains and a loss of cohesion or cementation. Most susceptible soils are generally those associated with recently deposited, Holocene-age soils that have accumulated in an arid or semi-arid environment, as well sand and silts deposited by wind. Flash flooding often deposits debris flow settlements, creating alluvial fans comprised of soils that are susceptible to collapse. Surface water infiltration is increased during irrigation, or a rise in the groundwater table. When combined with the weight of a building or structure, these conditions can cause rapid settlement, causing foundations and walls to crack. Heavily irrigated landscaping in close proximity to a structure's foundation is often associated with differential settlement of structures.

Given the granular nature of the soils, the fact that upper soils are generally dry, and the rapid deposition in the alluvial fan environment, the young and very young alluvial sediments in the planning area may be locally susceptible to this hazard.

Expansive Soils

Soils with significant amount of clay minerals the ability to give up water (shrink) or absorb water (swell). These are considered expansive soils, which have potential to substantially change in volume in response to changes in moisture content. Structures and other surface improvements are subject to damage from upward pressures induced by the swelling of expansive soils.

Alluvial sediments underlying the valley and canyon areas are primarily comprised of granular materials, such as silty sand and sand. These soils typically have a low expansion potential, although pockets of fine-grained expansive soils are not uncommon within these units. There are very fine-grained silts and clays within Apple Valley Dry Lake, which are likely to be expansive.

Clay deposits accumulated in subsurface soils have developed on older fan deposits; this is due to weathering and soil development. Where such soils are rich in clay they may be expected to have moderately expansive qualities.

Ground Subsidence

The gradual settling or sinking of the ground surface with little or no horizontal movement is known as ground subsidence. This movement is due to extraction of oil, gas or groundwater in sediment-filled valleys and floodplains, and may be evidenced by earth fissures, sinkholes or depressions, and disruption of surface drainage. Damage associated with ground subsidence may include harmful effects to canals, levees, underground pipelines, wells, buildings, roads, railroads and other structures and improvements. Subsidence has been mitigated in affected areas through management of water resources, including reduction in pumping from local wells, importation of water, and artificial groundwater recharge.

Apple Valley overlies the southern part of the Mojave River Groundwater Basin; the Basin covers approximately1,400 square miles and has an estimated storage capacity of nearly five million acre-feet. It is one of the largest groundwater reservoirs in southern California. The Mojave River accounts for over 80% of the natural recharge, with the remainder coming from runoff that flows from upper reaches of tributary washes. The basin is in a state of overdraft that has developed as water extraction has exceeded natural recharge over many decades. Groundwater levels in the basin have dropped more than 100 feet between the 1950s and 1990s, and approximately 30 feet in the last 20 years alone. These issues are further discussed in the Water Resources Element.

Subsidence studies conducted by the U.S. Geological Survey (USGS) and the Mojave Water Agency (MWA) show that the closest subsidence area to Apple Valley is located approximately seven miles northwest. No subsidence has not been detected to date within Apple Valley. The MWA continues to implement groundwater conservation and recharge activities in the Apple Valley area and these activities contribute to the management of ground subsidence. Monitoring groundwater and basin conditions and increasing the use of reclaimed water, storm water or imported water are preventative measures.

Erosion

The planning area is located in an area of extreme topographic relief between the valley and the surrounding mountains and is therefore subject to erosion, runoff, and sedimentation. Key factors affecting these processes include climate, topography, soil and rock types. Natural erosion may be accelerated by human activities such as agricultural or land development, as well as grading that may involve altering natural drainage patterns. Grading and construction activities such as soil compaction, and cut and fill slopes also increase the potential for erosion, and sedimentation. The increase in impermeable surfaces associated with development may impact conditions downstream of development, increasing the potential for flooding and sedimentation.

Wind Erosion

Wind erosion is a common phenomenon occurring mostly in flat, bare areas where dry, sandy soils are present, or anywhere the topsoil is loose, dry, and finely granulated. Recognized as a serious environmental problem, wind erosion causes damage to land and natural vegetation through the air or water-borne relocation of soil from one place to another. Soil loss, dryness and deterioration of the soil structure, loss of nutrients and productivity, air pollution, as well as sediment transport and deposition are all problems created by erosion.

Apple Valley is affected by strong winds associated with the Cajon Pass, as well as climatic differences between the high desert, the mountains, and the inland valleys south of the pass. The wind, combined with sandy surface soils that are common in Apple Valley, poses an environmental hazard that may be destructive. The presence of dust particles in the air poses a health risk associated with respiratory discomfort and airborne pathogens that cause eye infections and skin disorders. Dust storms also reduce highway and air traffic visibility. Wind erosion can be managed through the use of wind barriers, watering construction sites, and vegetative ground cover.

Seismic Assessment

Much of southern California is located along the boundary between the North American and Pacific tectonic plate. This boundary, also known as the San Andreas Fault Zone, could generate strong seismic activities. The Pacific Plate is moving in a northwesterly direction, approximately 50 millimeters per year in relationship to the North American Plate. In southern California, the San Andreas Fault consists of three segments: the Mojave Desert segment, the San Bernardino Mountains segment, and the Coachella Valley segment.

The planning area is located near this boundary, and there are several active faults in the region. These include the Helendale fault, the San Andreas fault, the North Frontal fault, the Cleghorn fault, the Cucamonga fault, and the San Jacinto fault. Of these, the North Frontal fault has the potential to generate the strongest seismic shaking in Apple Valley.

Measuring Seismic Events

Classification of seismic events is based on their magnitude and intensity. The intensity of ground shaking is determined by several factors, such as the earthquake's magnitude, the distance from the epicenter, and the geologic composition of local soils and rocks. Seismic intensity is most commonly measured by the Modified Mercalli Intensity (MMI) scale, which includes twelve levels of damage. The MMI is derived from actual observations of damage to structures and human reactions to earthquakes. Based on this scale, an earthquake tremor at Level I earthquake tremor is generally not felt and is considered unlikely to result in damage, whereas a Level XII earthquake results in total destruction. Earthquake intensities may result in damage such as partial or complete collapse of masonry structures, severe damage to complete destruction of underground pipelines, rock and land slides, and massive damage or destruction of bridges, overpasses and other improvements.

Earthquake magnitude is measured by the Richter Scale on a continuum of one to nine, with each level-of-magnitude increase representing a tenfold increase in the amplitude of the waves on a seismogram. The most notable historic earthquake in the Apple Valley region was the Landers earthquake of 1992, which had a magnitude of 7.3 on the Richter Scale. The Landers earthquake, so named for its epicenter near the small desert community of Landers, also ruptured five other separate faults.

The largest earthquake likely to occur on a fault or fault segment within a specified period of time is considered the Maximum Probable Earthquake (MPE). The MPE is useful during emergency and engineering planning. It provides a means to assess the potential seismic risk within a region, is referenced to establish safe construction and design parameters, and facilitates the preparation of policies and programs that are responsive to the potential impacts of an earthquake.

Defined as the largest earthquake a fault is estimated to be capable of generating, the Maximum Credible Earthquake (MCE) also provides a useful gauge for emergency and engineering planning efforts. In the Apple Valley area, the North Frontal fault (West) is expected to generate a magnitude 7.2 earthquake with a Peak Ground Acceleration (PGA) ranging from 1.13g to 0.38g, which is equivalent to a Level XI to X on the Modified Mercalli Intensity Scale (MMI). Table IV-1 shows a list of faults that could generate significant impacts within Apple Valley and the surrounding area.

Table IV-1
Estimated Horizontal Peak Ground Accelerations and Seismic Intensities in the Apple Valley Area

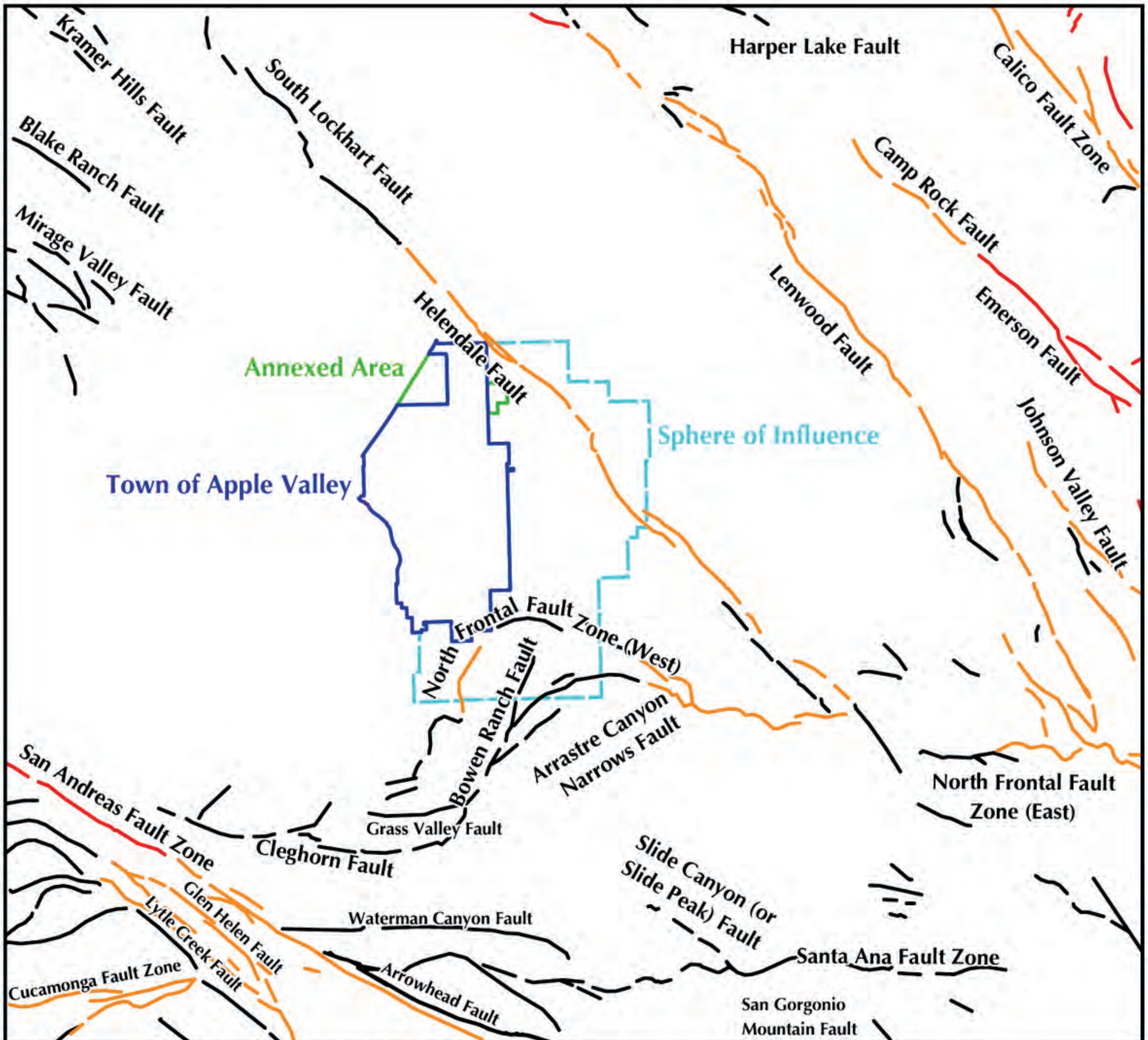
Fault Name	Distance to Apple Valley (km)	Distance to Apple Valley (mi)	Magnitude of M_{max} *	PGA (g) from M_{max}	MMI from M_{max}
North Frontal Fault (West)	<0.5 – 16.2	0.5 – 26.1	7.2	1.13 – 0.38	XI - X
Helendale – South Lockhart	<0.5 – 13.9	0.5 – 22.4	7.3	0.75 – 0.33	XI - IX
San Andreas (Whole Southern)	14.4 – 31.4	23.1 – 50.6	8.0	0.48 – 0.25	X - IX
Lenwood – Lockhart – Old Woman Springs	12.1 – 28.7	19.4 – 46.2	7.5	0.42 – 0.19	IX - VIII
San Andreas (San Bernardino – Coachella)	14.4 – 31.4	23.1 – 50.6	7.7	0.41 – 0.20	X - VIII
San Andreas (1857 Rupture or Cholame – Mojave)	16.9 – 33.2	27.2 – 53.5	7.8	0.38 – 0.20	IX - VIII
San Andreas (San Bernardino)	14.4 – 31.4	23.1 – 50.6	7.5	0.36 – 0.17	IX – VIII
Cleghorn	8.1 – 24.4	13.1 – 39.2	6.5	0.33 – 0.11	IX - VII
San Andreas (Mojave)	16.9 – 32.2	27.2 – 53.5	7.4	0.30 – 0.15	IX - VIII
Cucamonga	18 – 34.4	29 – 55.3	6.9	0.28 – 0.15	IX - VIII
Landers	17.3 – 34.5	27.9 – 55.6	7.3	0.27 – 0.14	IX - VIII
North Frontal (East)	17.3 – 32.2	27.9 – 51.9	6.7	0.26 – 0.14	IX – VIII
Sierra Madre	29.6 – 45.1	47.7 – 72.6	7.2	0.21 – 0.14	VIII
Gravel Hills – Harper Lake	20.8 – 37.5	33.5 – 60.3	7.1	0.20 – 0.11	VIII - VII
Calico – Hidalgo	29.1 – 43.6	43.1 – 70.2	7.3	0.18 – 0.11	VIII - VII
San Jacinto (San Bernardino)	18.6 – 35.7	29.9 – 57.4	6.7	0.17 – 0.09	VIII - VII
Johnson Valley (Northern)	19.9 – 32.4	32 – 52.1	6.7	0.16 – 0.10	VIII – VII
Puente Hills Blind Thrust	42.7 – 58.9	68.7 – 94.8	7.1	0.14 – 0.10	VIII - VII
Blackwater	30 – 45.2	46.8 – 72.8	7.1	0.14 – 0.09	VIII - VII
San Jacinto (San Jacinto Valley)	26.2 – 42.8	42.2 – 68.8	6.9	0.14 – 0.09	VIII - VII
Pinto Mountain	31.5 – 48.8	50.7 – 78.5	7.2	0.14- 0.09	VIII - VII
Pisgah – Bullion Mtn. – Mesquite Lake	35.5 – 51.4	57.1 – 82.7	7.3	0.13 – 0.09	VIII - VII
Emerson South – Copper Mtn.	29 – 40.6	46.7 – 65.3	7.0	0.13 – 0.09	VIII - VII

Abbreviations: mi – miles; km – kilometer; M_{max} – maximum magnitude earthquake; PGA – peak ground acceleration as a percentage of “g”, which is the acceleration of gravity; MMI – Modified Mercalli Intensity.
Source: Technical Background Report to the Safety Element for the Town of Apple Valley, prepared by Earth Consultants International, 2007.

Major Faults Affecting Apple Valley

Potential adverse effects from earthquakes may be substantial and range from property damage, to the loss of public services and facilities, to loss of life. Apple Valley and the surrounding area are most susceptible to severe impacts associated with strong ground shaking. Strong ground shaking can cause other geologic hazards, including landslides, ground lurching, structural damage or destruction, and liquefaction, which can further disrupt affected areas through fire, the interruption of essential services or damage to facilities and infrastructure, such as water, sewer, gas, electric, transportation, communications, drainage, as well as release of hazardous materials. Dam or water tank failure brought about by seismic activity can result in flood inundation.

There are no faults mapped by the State of California within the Town's corporate limits or within either of the proposed annexation areas, however two faults occur within portions of the Town's Sphere of Influence. The following discussion describes the faults in the region that are most likely to impact Apple Valley. Faults within the Apple Valley study area are illustrated in Exhibit IV-3, Faults in Apple Valley Area.



Modified from: Jennings, 1994;
www.scecd.scec.org/faults/mojfault.html
Refer to text for descriptions of these faults.

Explanation

- Fault Showing Evidence of Historic Rupture (Active).
- Fault Showing Evidence of Holocene Rupture (Active).
- Fault Showing Evidence of Quaternary and Late Quaternary Rupture (Potentially Active).

N

Source: Earth Consultants International, December 2008

TERRA NOVA®
Planning & Research, Inc.

Apple Valley General Plan
Faults in Apple Valley Area
Apple Valley, California

Exhibit

IV-3

North Frontal Fault

As previously noted, the North Frontal fault is closest to and therefore has the potential to generate the strongest seismic shaking in the planning area. The North Frontal fault is a partially blind reverse fault zone comprised of several fault splays; it trends south along the eastern flank of the San Bernardino Mountains, and has a combined total length of approximately 40 miles. Several of the fault splays interact with other faults that traverse the region. The most significant fault with which the North Frontal relates is the Helendale fault, which offsets and divides the North Frontal into two main segments, referred to as the East and West segments. The West segment is approximately 22 miles long, and is less than 0.5 miles from Apple Valley at the closest point.

The North Frontal fault is considered an active fault, based on its having moved within the last 10,000 years. However, it has not been studied in detail, and while it is has been attributed a slip rate of approximately 0.5 mm per year, the parameters of this fault are not well understood.. It is thought that movement on this fault causes an average uplift rate of the San Bernardino Mountains of about 1 mm per year. The West segment of the North Frontal fault zone is considered capable of generating a maximum magnitude 7.2 earthquake, based on its length. Such an earthquake on this fault would generate peak ground accelerations in the planning area of between about 1.1g and 0.4g, which converts to Modified Mercalli intensities as high as XI. Based on rupture of the East segment of the North Frontal fault zone in a 6.7 earthquake, ground shaking of about 0.26g to 0.14g would be felt in the planning area. This converts to Modified Mercalli intensities in the IX to VIII range.

Helendale Fault

There are several right-lateral strike-slip faults within what is known as the Eastern California Shear Zone, of which the Helendale fault is the westernmost. Approximately 9 to 23% of the total movement along the North American/Pacific plate boundary motion occurs along this zone. The Helendale fault itself is 56 miles long, but it also seems to form a continuous fault with the South Lockhart fault to the north. The southern end of the Helendale fault apparently offsets the North Frontal fault, as discussed above, forming the East and West segments. The Helendale fault extends to the northeast of the planning area, outside of Apple Valley’s northeastern corporate limits and within the Sphere of Influence.

The Helendale fault has an annual slip rate calculated at 0.8 mm/year; it has a recurrence interval for large surface-rupturing events of 3,000 to 5,000 years. Based on currently available data, the California Geological Survey estimates that a maximum earthquake of magnitude 7.3 along the combined Helendale-South Lockhart faults would generate horizontal peak ground accelerations in Apple Valley of between 0.75g and 0.3g, with Modified Mercalli Intensities of between XI and IX.

San Andreas Fault

The San Andreas Fault zone is located approximately 23 miles southwest of Apple Valley. The longest fault in the State of California, it extends approximately 750 miles from Cape Mendocino in northern California to the Salton Sea in southern California. The San Andreas, a right-lateral transform fault, is regarded as a “Master Fault” that controls the seismic hazard for central and southern California. The magnitude 8.0 Fort Tejon earthquake, which occurred in 1857, is the last major earthquake to have occurred on the southern San Andreas. As previously discussed, at least one other fault occurs closer to Apple Valley and has the potential to cause stronger ground shaking, and therefore more damage, than the San Andreas Fault. Nonetheless, the San Andreas Fault is considered to have a high probability of causing an earthquake in the near future and should therefore be considered in all seismic hazard assessment studies in southern California given its.

The Fort Tejon earthquake in 1857 ruptured the Cholame, Carrizo, and Mojave segments of the San Andreas fault, and displacements occurred along of as much as 27 feet of the rupture zone. It is estimated that peak ground accelerations in Apple Valley as a result of the 1857 earthquake may have been as high as 0.38g. Another similar earthquake that ruptured the entire southern San Andreas Fault, with its epicenter along the section of fault closest to Apple Valley, could generate even higher peak ground accelerations in Apple Valley, estimated at between 0.48g and 0.25g.

<u>Lenwood – Lockhart – Old Woman Springs Faults</u>

Another of the Eastern California Shear Zone faults is the Lenwood fault, a right-lateral strike slip fault approximately 47 miles long. It has a slip rate of about 0.8 mm/year. Based on trenching studies, this fault has ruptured at least three times and these ruptures have occurred as recently as approximately 200 to 400 years ago. Other ruptures are estimated as occurring between 5,000 and 6,000 years ago, and 8,300 years ago. Therefore a recurrence between major surface ruptures is estimated at between 4,000 to 5,000 years. Prior to the 1992 Landers earthquake the yearly slip rate on this fault had been recorded but not verified.

The Lockhart fault is approximately 44 miles long and is north of the Lenwood fault. The North Lockhart fault, a segment that evidences no activity within the last 11,000 years, is approximately 6 miles. The Lockhart fault is estimated to have an interval of between 3,000 and 5,000 years for major surface-rupture.

The Old Woman Springs segment is about 6 miles long and is the main trace in a complex fault system where the Eastern segment of the North Frontal Fault Zone and the Lenwood fault intersect. It is considered an active fault.

The Lenwood and Lockhart faults essentially form a continuous, 90-miles long system. While there is no evidence that both of these faults have ruptured together in the past, such an event may be possible, as evidenced by rupture of five separate fault segments during the Landers earthquake. The technical background study assumes a scenario wherein the Lenwood and Lockhart faults, together with the Old Woman Springs fault, rupture together in a magnitude 7.5 maximum earthquake. Such an event would generate peak ground accelerations in Apple Valley of about 0.42g to 0.19g, with Modified Mercalli Intensities in the IX to VIII range. A smaller magnitude event involving rupture along only one of these faults ruptures would cause lesser ground motions in Apple Valley than those reported above.

Cleghorn Fault

The Cleghorn fault, also known as the Silverwood Lake fault due to its extension across the lake, is approximately 19-miles long. Studies suggest that the fault zone has had about 650 feet of motion in the last 50,000 to 100,000 years, which results in a slip rate of 2 to 4 mm/year. A magnitude 6.5 earthquake on this fault is considered capable of generating horizontal peak ground accelerations in the Apple Valley area of between about 0.33g and 0.11g, with Modified Mercalli Intensities in the IX to VII range.

Cucamonga Fault

The Cucamonga fault zone is approximately 16-miles long. As one element of the Transverse Ranges family of thrust faults, it runs along the southern front of the San Gabriel Mountains from San Antonio Canyon eastward to the Lytle Creek area. It has a slip rate of between approximately 5.0 and 2.0 mm/year with an estimated average recurrence interval of 625 years. The Cucamonga fault is thought capable of generating a maximum magnitude 6.9 earthquake, based on length, and such a scenario would result in peak horizontal ground acceleration in the Apple Valley area of between about 0.28g and 0.15g, with Modified Mercalli intensities in the IX to VIII range.

Landers (or Kickapoo) Fault

The group of faults that ruptured during the 1992 Landers earthquake, including the Homestead Valley, Kickapoo, and Johnson Valley faults, and segments of the Burnt Mountain and Eureka Peak faults, are known as the Landers fault. The Landers fault now refers to the Kickapoo fault. These faults are part of the Eastern Mojave Shear Zone and were discovered after they ruptured the surface during the 1992 Landers earthquake. It is estimated that intervals between major ruptures is in the thousands of years, The 1992 earthquake resulted in substantial lateral displacement along some of these faults, for instance nearly 9.5 feet in the case of the Kickapoo fault. Individually, these faults could rupture in smaller earthquakes. Their combined lengths allowed for the magnitude 7.3 earthquake that shook southern California on June 28, 1992. Ground shaking in the Apple Valley area due to a Landers-type earthquake on these faults would cause horizontal ground accelerations of between 0.27g and 0.14g, with Modified Mercalli intensities in the IX to VIII range.

Sierra Madre Fault

The Sierra Madre fault zone or complex is approximately 47 miles long and extends along the base of the San Gabriel Mountains from the San Fernando Valley to San Antonio Canyon; from there it continues southeastward as the Cucamonga fault. The estimated slip rate of the Sierra Madre fault is estimated to be approximately 0.6 mm/year with a recurrence interval of about 8,000 years. Recent studies suggest that the last rupture event on the eastern segments of the fault occurred about 8,000 years ago, therefore, the Sierra Madre fault may be near the end of its cycle, and therefore has potential generate an earthquake in the not too distant future. The Sierra Madre fault is estimated to be capable of producing a magnitude 7.2 earthquake, resulting in peak horizontal ground accelerations in Apple Valley of between about 0.21g and 0.14g.

Gravel Hills – Harper Lake Fault

This fault zone is between 31 and 44 miles long, depending on how many fault segments are included and is considered active. The estimated annual slip rate on this fault zone is 0.9

mm/year; the recurrence interval between earthquakes is about 3,500 years. The combined fault segments are estimated to be capable of generating 7.1 magnitude earthquake, which would generate peak horizontal ground accelerations in the Apple Valley area of between 0.20g and 0.11g, with Modified Mercalli intensities in the VIII to VII range.

Seismically Induced Geotechnical Hazards

Ground Shaking

The most significant potential geotechnical hazard facing the planning area is seismically induced ground shaking. As previously noted, the effects of ground motion on structures are difficult to predict, depending as they do on a variety of factors. These include the intensity of the quake, the distance from the epicenter to the site, the composition of soils and bedrock, building design, and other physical criteria. Given the variability of these factors, ground shaking may cause no, little, or major structural damage or destruction. Generally, with increasing distance from the causative fault, peak ground accelerations and seismic intensity values decrease. The effects of seismic waves may be amplified by local conditions, such as soft soils, shallow ground water, and the presence of ridge tops, which may result in localized accelerations. Local agencies utilize the Uniform Building Code, California Building Code, and Unreinforced Masonry Law as their primary tools to ensure seismic safety in structures. Goals, policies and programs are set forth below to ensure that development in the planning area complies with the requirements established within these codes.

Liquefaction

Where loose, saturated, sandy sediments are subjected to ground vibrations greater than 0.2 g, liquefaction may occur. causing the total or substantial loss of shear strength in the affected sediments. During this process, wherein soils behave like a liquid or semi-viscous substance, structural distress or failure due to ground settlement can occur. These conditions may cause foundation soils to lose load-bearing capacity in foundation soils and the buoyant rise of buried structures.

Liquefaction is induced by three general conditions: 1) strong ground shaking over a relatively long period; 2) the presence of unconsolidated granular sediments; and 3) the occurrence of water-saturated sediments within 50 feet of the ground surface. These general conditions appear to occur in the planning area, thereby allowing the potential for liquefaction. There are a number of active faults in the region that could potentially generate earthquake characterized by strong ground shaking of long durations. Along major drainages in the planning area and vicinity, granular loose sediments occur. The alluvium underlying Apple Valley is coarsely granular and percolates well; the water table is below 50 feet of the ground surface throughout most of the area, with the exception of locally within the Mojave River floodplain, where water-saturated sediments occur within about 50 feet of the surface. These areas are likely vulnerable to liquefaction during an earthquake.

Seismically Induced Settlement

Strong ground shaking can, under certain circumstances, cause soils to densify and thereby result in local or regional settlement of the ground surface and associated ground failure, which occurs when loose granular, cohesionless soil grains become tightly packed due to the collapse of voids and pore spaces. These risks increase where there are recently deposited alluvial sediments and when artificial fills are not properly compacted, potentially resulting in damage to buildings and water, sewer, and other subsurface pipelines. Areas in the planning area that are underlain by young, unconsolidated alluvial deposits and artificial fill may be susceptible to seismically induced settlement.

Seismically Induced Rockfalls and Landslides

Landslides, rock slides and rock falls can occur as a result of strong ground motion, particularly where saturated ground conditions exist. This potential increases in the planning area where there is a high seismic potential, as well as areas where rapid uplift and erosion have resulted in steep slopes and deeply incised canyons, rock with inherently weak components such as silt or clay layers, and highly fractured and folded rock. Slope orientation relative to the direction of the seismic wave also contributes to the occurrence of landslides in the planning area.

Although most of the Town of Apple Valley is characterized by relatively level to gently sloping terrain, there are several natural slopes in the Sphere of Influence area that could be vulnerable to seismically induced slope failure. In addition, there are many areas in the San Bernardino Mountains to the south of Apple Valley that could fail during an earthquake. This has the potential to significantly impede traffic through the area immediately and for several days after an earthquake, which could indirectly impact Apple Valley's residents and visitors, in addition to restricting access to and from the area by emergency response teams.

Deformation of Sidehill Fills

The deformation of sidehill fills, which may also result from strong seismic ground shaking, can cause minor to severe property damage. Sidehill fills, which are artificial fill wedges typically constructed on natural slopes to create roadways or level building pads, may crack at the cut/fill contact area. Further, strong ground shaking may result in differential settlement in the fill wedge, and the development of bulging on the slope face. This condition is most common in relatively thin fills of 27 feet or less placed near the tops of narrow ridges. It is not expected to occur in Apple Valley, with the exception of the approaches to the two bridges in Apple Valley that extend across the Mojave River, where minor settlement of the bridge embankment could result in a step up of a few inches to the actual bridge.

Ridgetop Fissure and Shattering

Ridgetop fissuring and shattering can result from intense amplification or focusing of seismic energy due to local topographic features. During the 1989 Loma Prieta and 1994 Northridge earthquakes, linear fault-like fissures and shattering of surface soils on the crests of steep, narrow ridgelines occurred, making surfaces affected by ridgetop shattering appear as if they had been plowed. Severe structural damage may occur, especially where it occurs on relatively high (greater than 100 feet), narrow (typically less than 300 feet wide) ridges flanked by slopes steeper than about 2.5:1 (horizontal:vertical). Ridgetop shattering may occur locally in the unincorporated area of Apple Valley, in the Granite Mountains, Fairview Mountains, and Ord Mountains, and just outside the study area, at the top of the Black Mountains, Sidewinder Mountains and Turtle Mountains.

Seiches and Seismically Induced Inundation

Seismically-induced oscillation or sloshing of water contained in enclosed bodies of water including lakes, ponds, reservoirs, and swimming pools are called seiches. Factors that determine the risk of seiche in an area include the frequency of seismic waves, distance and direction from the epicenter, and site-specific design criteria of the enclosed body of water. Seiches due to seismic shaking could occur in Silverwood Lake, to the southwest of Apple Valley, and in the shallow lakes present throughout the study area if water is present at the time of the earthquake. Minor sloshing of water out of the lakes and onto the immediately adjacent surrounding areas may occur. In similar fashion, water in swimming pools is known to slosh during earthquakes; for the most part, however, such sloshing does not lead to significant damage.

Fire-suppression efforts may be affected if damage to water storage tanks and systems substantially limits water supplies after a major earthquake. Water tanks are required to include baffles and other design elements to reduce the potential for seiches in tanks, open reservoirs, and ponds where overflow or structural failure may cause damage to nearby properties. The American Water Works Association (AWWA) Standards for Design of Steel Water Tanks provides criteria for seismic design of water tanks.

Mitigation Of Earthquake Hazards

Building and structure collapses cause the majority of injuries and loss of life related to earthquakes. The occurrence of an earthquake cannot be prevented, however, it is possible to minimize such an event’s destructive effects through comprehensive hazard mitigation measures. Such measures include the identification and mapping of potential hazards, sensible planning, strict implementation of building codes, and the retrofitting and rehabilitation of weak structures.

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was signed into California law in 1972, and was intended to mitigate the hazards of fault rupture by prohibiting the location of structures for human occupancy across active fault traces. As required by the Act, the State Geologist is required to delineate active (showing evidence of Holocene surface displacement along one or more of their segments) “earthquake fault zones”, and are clearly detectable by a trained geologist as a physical feature at or just below the ground surface. An earthquake fault zone boundary is generally about 500 feet from major active faults, and 200 to 300 feet from well-defined minor faults. Counties and cities are also required to condition development permit approval for sites within earthquake fault zones to perform geologic investigation that demonstrate that the sites are safe from surface displacement associated with future faulting. Of the types of development that are regulated are defined by State law, however, local regulations may prove even more restrictive.

Currently (2008) there are no Alquist-Priolo Earthquake Fault Zones mapped within the Apple Valley corporate limits or the annexation areas. However, there are two zones extending across portions of the town’s Sphere of Influence, and a third Alquist-Priolo zone approaches the Sphere of Influence from the east-southeast. It should be noted that the State Geologist periodically revises the Alquist-Priolo Earthquake Fault Zones based upon new scientific research or fault studies' data. Local agencies, either at the county or local level, can designate additional fault hazard study zone.

Seismic Hazards Mapping Act

The Alquist-Priolo Earthquake Fault Zoning Act addresses hazards associated with surface fault rupture. In addition, the State enacted the Seismic Hazards Mapping Act in 1990. This Act addresses non-surface rupture earthquake hazards such as strong ground shaking, liquefaction, and seismically induced landslides. It is intended to identify and mitigate seismic hazards and thereby lessen loss of life and property. The Act is implemented by the California Geological Survey (CGS), which provides local governments with seismic hazard zone maps delineating areas susceptible to seismic hazards and other ground failure hazards. When development projects are proposed within these areas, termed "zones of required investigations," site-specific geological hazard investigations are required. Although CGS has not mapped seismic hazards for San Bernardino County, or the Town of Apple Valley the technical background study conducted for the proposed Apple Valley General Plan and referenced herein has analyzed and mapped this hazard.

Real Estate Disclosure Requirements

The Natural Hazards Disclosure Act, effective June 1, 1998, requires that sellers of real estate properties and their agents provide prospective buyers with a "Natural Hazard Disclosure Statement" if the property being sold occurs within one or more State-mapped hazard areas. The law further requires the seller of a house built pre-1960 to provide the buyer a completed earthquake hazards disclosure report and a booklet entitled "The Homeowner's Guide to Earthquake Safety," which was written and adopted by the California Seismic Safety Commission. The Alquist-Priolo Earthquake Fault Zoning Act and Seismic Hazards Mapping Act mandates that real estate agents, or sellers of real estate acting without an agent, must disclose to potential buyers that the property is located in an Earthquake Fault Zone and/Seismic Hazard Zone.

There are currently no official Alquist-Priolo or Seismic Hazard maps for Apple Valley. However, as noted above, Alquist-Priolo Earthquake Fault Zones are mapped across Apple Valley's Sphere of Influence. Where regions of the study area have potential to be impacted by natural hazards, as described in this document, those hazards should be disclosed to prospective buyers, following the provisions of the Natural Hazards Disclosure Act.

California Environmental Quality Act

The California Environmental Quality Act of 1970 (CEQA) was intended to ensure that local governmental agencies consider and review the environmental impacts of proposed projects within their jurisdictions. CEQA regulations require the preparation of an Environmental Impact Report (EIR) for projects with potential to result in significant impacts to the environment. As part of its analysis, an EIR must identify geologic and seismic hazards and include potential mitigation measures to reduce potential impacts.

Uniform Building Code and California Building Code

One of the important tools used by local agencies to ensure seismic safety in structures is the Uniform Building Code (UBC). It defines a variety of factors, including minimum lateral forces needed to resist seismic shaking, purpose of the building, seismic zone, type of structural system, building configuration and height, and soil profile types that result in various degrees of shaking. The last version of the UBC was issued in 1997.

California Building Code (CBC), also known as Title 24 of the California Code of Regulations, provides building regulations customized for California earthquake conditions. State law requires that every local agency, town, city, and county enforcing building regulations adopt the CBC within 180 days of its publication. A local jurisdiction may, in addition to CBC regulations, adopt more stringent amendments provided that they are based upon local geographic, topographic or climatic conditions.

Building Codes are minimum requirements, and therefore, they may, in some cases, be inadequate to protect health and safety. Therefore, it is essential for geotechnical consultants, engineers, the Town and reviewers of their work to keep up to date with current research.

Seismic Retrofitting

Seismic zones are zones near historically active faults. The entire Apple Valley area lies within Seismic Zone 4. The Unreinforced Masonry Law of 1986 requires all towns, cities, and counties in Seismic Zone 4 to identify potentially hazardous unreinforced masonry (URM) buildings in their jurisdictions, establish a URM loss reduction program, and report their progress to the State by 1990. To comply with the law, the Town of Apple Valley has conducted an inventory of its URM buildings and has notified building owners about the hazards of URM construction. In 2006, the Seismic Safety Commission reported that the Town has 14 non-historic URM buildings. These building owners have been notified of the hazards associated with this type of construction; retrofitting of the structures will be required at such time as a property owner applies to do any alterations or additions to their building. As of 2006, none of the URM buildings in Apple Valley had been retrofitted, and no warning placards had been placed in any of the buildings.

Past earthquakes have demonstrated that many types of structures, in addition to URMs, are potentially hazardous. These include pre-cast tilt-up concrete buildings (including pre-1971 structures), soft story structures, unreinforced concrete buildings, and pre-1952 single-family structures. Other structures that are considered at risk include irregular-shaped buildings and mobile homes. It is recommended that the Town consider developing and adopting a program that inventories and provides mitigation of these structures.

FUTURE DIRECTIONS

Local seismic and geotechnical conditions pose on-going challenges that the Town must continue to manage by means of those regulations and guidelines already in place. Implementation and enforcement of the requirements set forth in the Alquist-Priolo Earthquake Fault Zoning Act, CEQA Statutes and Guidelines, Uniform/International Building Code, zoning ordinance, and other applicable legislation are necessary to deal with risks addressed in this Element. The Town must also sustain or initiate close coordination with state, regional, and county agencies in order to establish or maintain an updated information database of geotechnical and seismic conditions in the region. As part of its development review process, the

Town must continue to assure that all-inclusive and thorough evaluations of geotechnical and seismic safety are provided for all development proposals. Such evaluations must include the preparation and review of all necessary special studies are conducted and reviewed, and the implementation of comprehensive mitigation measures.

GOAL, POLICIES, AND PROGRAMS

Goal

The protection and safety of human life, land, and property from the effects of seismic and geotechnical hazards shall be increased.

Policy 1.A
The Town shall begin and maintain an information database including maps and other information that describe and illustrate seismic and other geotechnical hazards that occur within and in proximity to the Town boundaries.

Program 1.A.1
The Town shall implement a program to ensure the establishment and routine improvement and updating of the database by conferring and coordinating with surrounding communities, the California Division of Mines and Geology, San Bernardino County, other applicable state and federal agencies, and professional engineering geologists.
Responsible Agency: Planning Division, California Division of Mines and Geology, San Bernardino County, Consulting Geologists.
Schedule: 2009-2010, ongoing.

Policy 1.B
In areas identified as being susceptible to slope instability, development shall be avoided unless adequately engineered to eliminate geotechnical hazards.

Program 1.B.1
The Town shall make copies of the General Plan Slope Instability Susceptibility Map available and shall either discourage development within areas so designated, or require that detailed geotechnical analysis be conducted and mitigation measures implemented to reduce potential hazards to insignificant levels.
Responsible Agency: Planning Division, Town Engineer, Consulting Engineering Geologist**.**
Schedule: 2009-2010, ongoing.

Policy 1.C
The Town shall required that future development avoid disturbing unique rock outcroppings within the Town boundary and Sphere of Influence.

Program 1.C.1
The Town shall consider unique rock outcroppings as being biologically sensitive and shall discourage disturbance of them.
Responsible Agency: Planning Division.
Schedule: 2009-2010, ongoing.

Policy 1.D
The Town shall actively support and participate in local and regional efforts at groundwater conservation and recharge, in order to minimize the potential impacts of subsidence due to extraction of groundwater.

Program 1.D.1
The Town shall consult and coordinate with local water providers, U.S. Geological Survey, and other appropriate agencies to routinely monitor groundwater levels and surface elevations in the Town.
Responsible Agency: Public Works Division, local water purveyors, U.S. Geological Survey.
Schedule: Ongoing.

Policy 1.E
In areas identified as being susceptible to rockfall, landslide, liquefaction and/or other associated hazards as depicted in the General Plan EIR, development shall be required to prepare detailed technical analysis, which shall include mitigation measures intended to reduce potential hazards below levels of significance.

Program 1.E.1
The Town shall contract with a state-certified geologist and/or geological engineer to review and determine the adequacy of geotechnical studies for proposed projects.
Responsible Agency: Planning Division, Building and Safety Division, Town Engineer/Consulting Engineering Geologist.
Schedule: Ongoing.

Policy 1.F
Development in areas susceptible to collapsible or expansive soils as shown in soils mapping in the General Plan EIR shall be required to conduct soil sampling and laboratory testing and to implement mitigation measures that reduce potential hazards below levels of significance.

Program 1.F.1
The Town Building and Safety Division shall review soils studies conducted for proposed projects, determine their adequacy, and enforce the implementation of mitigation measures.
Responsible Agency: Building and Safety Division, Town Engineer, Consulting Engineering Geologist.
Schedule: Ongoing.

Policy 1.G
The Town shall coordinate and cooperate with public and quasi-public agencies to ensure that major utility systems and roadways have continued functionality in the event of a major earthquake.

Program 1.G.1
The Town shall maintain working relationships and coordinate strategies between the Public Works Division, utilities, and other appropriate agencies to strengthen or relocate utility facilities, and take other appropriate measures to ensure the protection of major utility distribution systems.
Responsible Agency: Planning Division, Public Works Division, Town Engineer, Public and Quasi-Public Utilities.
Schedule: 2009-2010, ongoing.

Policy 1.H
To minimize the potential for localized collapse of soils, new septic tank leach fields, seepage pits, drainage facilities, and heavily irrigated areas shall be located away from structural foundations and supports.

Program 1.H.1
The Town shall require that plans indicating the location of leach fields, seepage pits, drainage facilities, and water-dependent landscaping be included in all development applications to allow Town staff to evaluate the potential for ground saturation.
Responsible Agency: Planning Division, Building and Safety Division, Town Engineer.
Schedule: 2009-2010, ongoing.