## 5.6 GEOLOGY AND SOILS

This section of the Draft Environmental Impact Report (DEIR) evaluates the potential for implementation of the City of Menifee General Plan to impact geological and soils in the City of Menifee. The analysis in this section is based in part on the following technical study:

- *Technical Background Report to the Safety Element of the General Plan for the City of Menifee, Riverside County, California,* Earth Consultants International, Inc., July 2010

A complete copy of this study is included in Appendix G to this Draft EIR.

### 5.6.1 Environmental Setting

#### Geologic Setting

Menifee lies in the northern part of the Peninsular Ranges Geomorphic Province, which is characterized by northwest-trending mountains and valleys extending from the Los Angeles Basin on the north southeast into Baja California. The province is bounded by the San Andreas fault zone on the east and extends offshore to the west. The northern, onshore part of the province is divided into three major fault-bounded blocks that are, from west to east, the Santa Ana Mountains block, the Perris block, and the San Jacinto Mountains block. The Perris block, where Menifee is located, is bounded by the Elsinore fault zone on the southwest and the San Jacinto fault zone on the northeast. In spite of being surrounded by active fault systems and growing mountain ranges, the Perris block is an area of lower relief that has remained relatively stable and undeformed for thousands of years.

Movements along the San Andreas, San Jacinto, and Elsinore Faults have elevated the San Jacinto and Santa Ana Mountains blocks and down-dropped the Perris block. In response, the uplifted mountains and hills are rapidly eroding (in geologic time), shedding sand, silt, and gravel and forming fans that are filling the valleys. The alluvial fans of the Menifee area have a range of ages coincident with the rise of the nearby mountains (early Pleistocene to Holocene, approximately 1 million years to less than 11,000 years old).[1] Deposition is still ongoing, with the youngest sediments filling the active drainage channels and floodplains. At depth, this sequence of alluvial sediments is underlain by crystalline rock similar to that exposed in the surrounding hills and mountains.

The City encompasses numerous brush-covered hills and low mountains surrounded by a series of interconnected, broad, nearly flat-bottomed valleys. The steepest slope and largest cluster of hillsides can be found north of Menifee Lakes, traveling northward across McCall Boulevard. Quail Valley also has a significant number of steep hillsides that influence development patterns in the area. Elevations in the City range from about 1,400 feet above mean sea level (amsl) for the valley floor to approximately 2,600 feet amsl for the local hills; Bell Mountain is 1,850 amsl. Menifee includes parts of three valleys: the Perris Valley in the north end of the City, the Menifee Valley in the central part of the City, and the Paloma Valley in the southeast area.

[1] The geologic time scale used in the description of geologic units:
Holocene: Present–11,500 years before present (ybp)
Pleistocene: 11,500–1.8 million ybp
Pliocene: 1.8–5.3 million ybp
Miocene: 5.3–23 million ybp
Oligocene: 23–33.9 million ybp
Eocene: 33.9 – 58 million ybp

Most of the developed land uses in Menifee are in the central valleys. Rural and semi-rural residential development has spread out into valley and hillside areas in the northern, western, and southern areas of the city.

***Geologic Units in Menifee***

Geologic units, that is, rock and soil types, in the City are shown on Figure 5.6-1, *Geologic Map*.

*Sediments*

Sedimentary units in the Menifee area consist mainly of alluvial (water-transported) sand, silt, clay, and gravel derived from erosion of the adjacent hills and mountains. The youngest deposits also include sediments eroded from older alluvium that is exposed at the surface. The younger sediments range in age from late Holocene to late Pleistocene (present day to approximately 15,000 years old). Older deposits, which for the most part have been buried by the younger deposits, range in age from late to early Pleistocene (approximately 15,000 to one million years old).

**Young Surficial Deposits:** Sediments within washes, valleys, fans, and channels (Geologic Map Symbols: Qw, Qv, Qyf, and Qya).

Very young wash deposits (Qw) consist of unconsolidated sediments lining the active drainage courses. These deposits have been mapped only in the western part of the Salt Creek channel; however modern silt, sand, and gravel also occur in numerous small, unnamed channels, washes, and gullies that cut through the hills and fans in the area. The upper reaches of the drainage channels, especially near the mountains, may contain large rocks deposited during flash floods.

Very young alluvial valley deposits (Qv) include fine-grained silt and clay deposited on the floodplain of the San Jacinto River. This unit is present in the northwestern corner of the City. The unit is so young that a soil has not formed on it, and its surface is subject to reworking and burial by new sediments when the river floods.

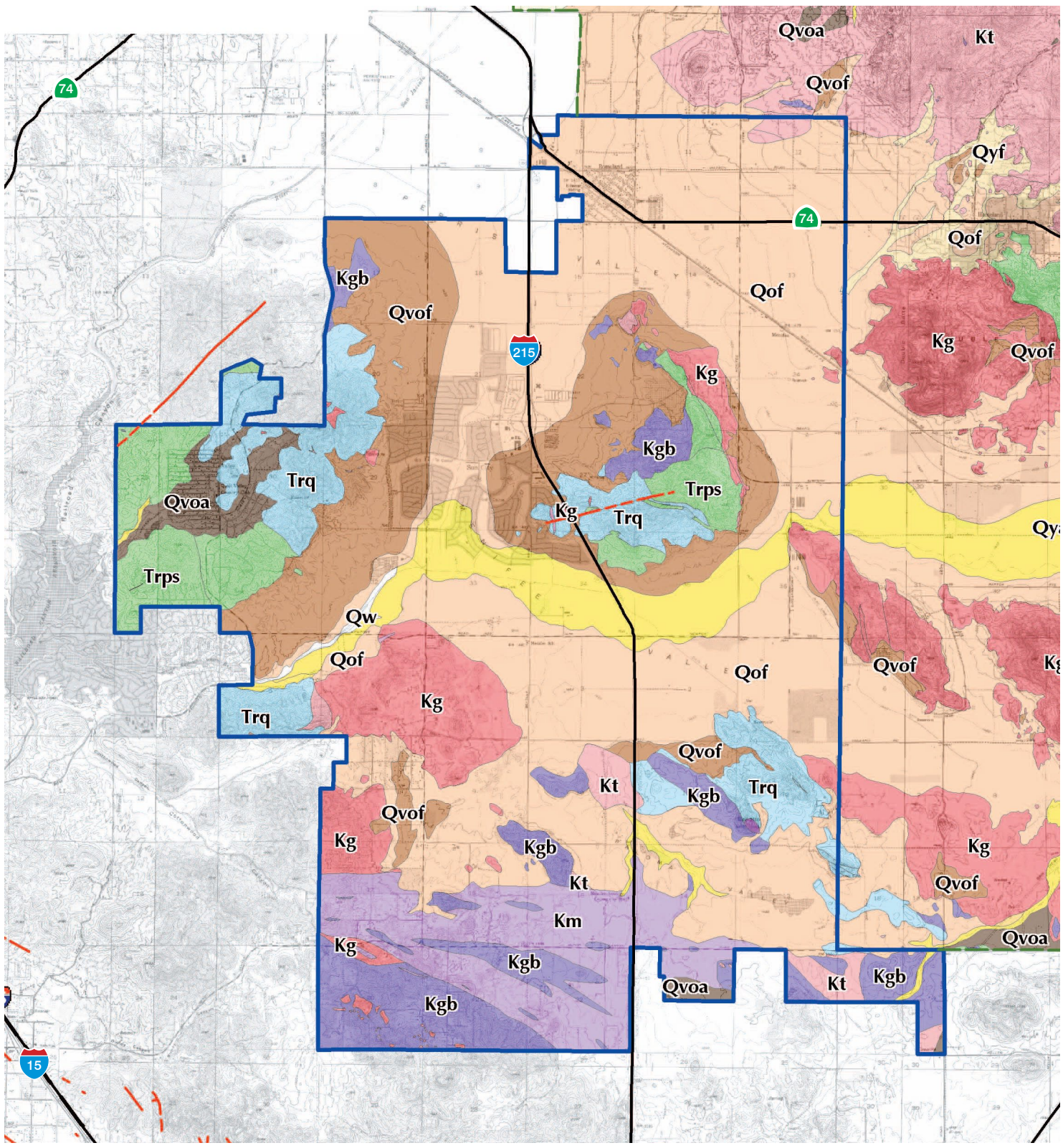
Young alluvial fan deposits (Qyf) are mapped locally on the south side of the Lakeview Mountains, in drainages near the head of older fans. These sediments are unconsolidated and generally consist of poorly bedded silt, sand, and gravel.

Young alluvial valley and channel deposits (Qya) include unconsolidated sand and silt deposited in Salt Creek, the Paloma Valley drainages, and Warm Springs Creek.

**Old Surficial Deposits.** Alluvial Fan, Valley, and Channel Sediments (Geologic Map Symbols: Qof, Qvof, and Qvoa).

Older alluvial deposits (Qof) are late to middle Pleistocene in age (about 11,000 to 500,000 years old) and are mostly fan sediments, but also include some valley and channel sediments. This unit is widespread in the City, forming the numerous interconnected valleys, where it has been slightly dissected by modern streams. Near-surface soils of this unit are typically low density and reddish-brown. Below the surface, this unit is moderately dense and consists of brown, yellowish brown, and olive brown silty sands, clayey sands, silty to sandy clays, and sandy to clayey silts with minor gravel.

# Geologic Map




## SEDIMENTARY UNITS

### Young Surficial Deposits

**Qw** Very Young Wash Deposits - Unconsolidated sand and gravel deposited in active washes, ephemeral river channels, and channels on active alluvial fans. Late Holocene.

**Qv** Very Young Alluvial Valley Deposits - Unconsolidated clay and silt in the San Jacinto River floodplain. Late Holocene.

**Qyf** Young Alluvial Fan Deposits - Unconsolidated silt, sand, and gravel on alluvial fans and headward drainages of fans at the base of the Lakeview Mountains. Holocene to late Pleistocene.

**Qya** Young Alluvial Valley and Channel Deposits - Unconsolidated fluvial (stream deposited) sand and silt in Salt Creek, Paloma Valley, and Warm Springs Creek. Holocene to late Pleistocene.

### Old Surficial Deposits

**Qof** Old Alluvial Fan Deposits - Moderately to well-consolidated silt and sand forming valley floors throughout the General Plan area. Late to middle Pliestocene.

**Qvof** Very Old Alluvial Fan Deposits - Moderately to well-consolidated silt, sand, and gravel. Erosional remnants of this unit are present throughout the General Plan area; largest deposits are present at the base of the hills to the east and est of Sun City. Middle to early Pleistocene.

**Qvoa** Very Old Channel Deposits - Predominantly well-consolidated to well-indurated fluvial sand deposited on canyon floors. Deposits in Quail Valley contain sand and rounded cobbles; isolated deposit in the hills south of Paloma Valley contains sand and clay. Middle to early Pleistocene.

City Boundary

Menifee General Plan Boundary

Fault; solid where location known, dashed where approximate, dotted where concealed.

## CRYSTALLINE ROCK UNITS

### Plutonic Rocks

**Kt** Tonalite - Gray biotite-hornblende tonalite with minor intermixed monzogranite, granodiorite, and gabbro; medium to coarse-grained; massive to foliated. Foliations commonly dip steeply to the north. Most abundant rock type in the Lakeview Mountains. Cretaceous.

**Kg** Granodiorite - Light gray horneblende biotite granodiorite grading to tonalite; relatively uniform; medium-grained; massive. Forms isolated hills in the central, eastern and western parts of the General Plan area including Bell Mountain and the western part of Double Butte. Locally contains fine-grained light to dark gray dikes consisting of massive to well foliated and lineated biotite, horneblende biotite, horneblenede dacite, and quartz latite. The dikes are more resistant to weathering than the surrounding granodiorite and form conspicuous ribs and walls. Cretaceous.

**Km** Monzogranite - Pale gray biotite monzogranite with less abundant horneblende-biotite granodiorite; medium-grained; massive. Contains common to abundant, small to large blocks of gabbro. Cretaceous.

**Kgb** Gabbro - Mainly brown horneblende gabbro; medium to very coarse-grained. Very large horneblende crystals are common. Exopsed primarily in the hills southwest of Paloma Valley; small isolated exposures are present in the hills north and south of Menifee Valley, and north of Quail Valley. Locally contains thin, discontinuous, arcuate dikes of light colored granitic pegmatite-aplite. Cretaceous.

### Metasedimentary Rocks

**Trq** Quartz-rich Rocks - Quartzite and quartz-rich metasandstone, locally intermixed with metagraywacke; locally conglomeratic. Exposed intermittently in hills within the central, western, and southern part of the General Plan area. Triassic.

**Trps** Phyllite and Schist - Black fissile phyllite and dark gray biotite schist, locally intermixed or interlayered with metagraywacke or quartzite; fine-grained. Other metasedimentary rocks may be presend in small amounts. Triassic.

Geologic Contact

0 1
Scale (Mile)

*Source: Earth Consultants International 2010*

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Very old alluvial deposits (Qvof and Qvoa) are middle to early Pleistocene in age (about 500,000 to 1 million years old) and consist primarily of silt, gravel, and medium- to coarse-grained sand. These sediments are moderately consolidated to hard and have a deeply dissected surface. The upper part of these deposits is reddish soil. These deposits occur in two large areas along the base of the hills east and west of Sun City, and as small isolated patches throughout the City.

*Crystalline Rocks*

The oldest geologic units in the Menifee area are very hard, crystalline rock that forms the hills and mountains, and is buried beneath the alluvium. The rocks in this area can be classified into two main groups: 1) rocks that have crystallized from the molten state deep within the Earth's crust (granitic rocks), and 2) rocks of sedimentary origin that have recrystallized under extreme conditions of heat and pressure deep below the Earth's surface (metasedimentary rocks).

**Plutonic Rocks (Geologic Map Symbols: Kt, Kg, Km, and Kgb).** Commonly referred to as "granitic," these rocks generally have large grains that can easily be seen without magnification. They often have a spotted appearance and have highly variable mineral composition. Most of these rocks crystallized from magmas between about 65 million and 225 million years ago, during the Cretaceous Period (symbolized on maps by the letter K). Hills formed of plutonic rocks are commonly covered by rounded, bouldery outcrops. Where very weathered, these rocks decompose, producing sediments composed primarily of sand-sized grains.

In the Lakeview Mountains, the predominant mineral assemblage is a light gray, medium- to coarse-grained rock classified as tonalite (Kt). This rock unit contains abundant light- to dark-colored streaks or bands of minerals.

Isolated hills in the central, eastern, and southern part of the City are underlain predominantly by granodiorite (Kg), a relatively uniform, gray, medium-grained rock.

Hills in the southern part of Menifee are underlain in part by pale gray medium-grained monzogranite (Km) with a lesser amount of granodiorite. This unit contains small to large blocks of gabbro, the dark, preexisting rock into which it intruded.

Gabbro (Kgb), is a dark colored, very coarse-grained rock along the southern edge of the City, with small isolated patches in the hills east of Green Acres, east of Sun City, and north of Quail Valley. This unit is highly variable in both texture and mineral composition.

**Metasedimentary Rocks (Geologic Map Symbols: Trq and Trps).** Rocks of Triassic age (symbolized on the map by the letters Tr) underlie portions of the hills throughout the City, where they tend to weather to rounded hilltops and generally lack the bold outcrops seen in the granitic hills and mountains. These rocks have been combined into two general categories: quartz-rich rocks (Trq) consisting mainly of quartzite and quartz-rich metasandstone, and a highly diverse group of fine-grained rocks consisting predominantly of black phyllite and gray schist (Trps). Very fine-grained phyllite occurs in thick sections in the hills west of Quail Valley and in a portion of the hills east of Sun City, where it can be recognized by the sheen produced by layers of very fine-grained mica. The schist has slightly larger grains, but locally grades to a phyllite. It can also be found interlayed with quartzite and phyllite. Metasedimentary rocks generally have a texture of multiple thin layers.

## Seismic Hazards

### *Surface Fault Rupture and Ground Shaking*

Surface fault rupture is fissuring and displacement of the ground surface and can occur along the fault that breaks in an earthquake or another fault. Faults are classified as active, potentially active, or inactive:

- Active: faults show evidence of ground displacement within the last 11,000 years, and are thus thought capable of producing earthquakes.
- Potentially Active: show evidence of movement within the past 1.6 million years, but no evidence confirms movement within the last 11,000 years.
- Not Active: evidence shows the fault has not moved in the last 11,000 years.

However, some faults previously thought not active have ruptured in recent earthquakes—including the Landers earthquake—and evidence needed to determine whether a fault has moved in the last 11,000 years can be difficult to obtain.

*Measuring Earthquakes*

**Energy Released.** The energy released by an earthquake is measured as moment magnitude (Mw). The moment magnitude scale is logarithmic; therefore, each one-point increase in magnitude represents a tenfold increase in amplitude of the waves as measured at a specific location and a 32-fold increase in energy. That is, a magnitude 7 earthquake produces 100 times (10 x 10) the ground motion amplitude of a magnitude 5 earthquake.

**Ground motion.** Motion at the ground surface during an earthquake is measured as horizontal ground acceleration in g, where g is the acceleration of gravity.

**Effects on buildings, and peoples' sensations.** The Modified Mercalli Intensity (MMI) Scale is a qualitative scale of how earthquakes are felt by people and now they affect buildings. The MMI is a 12-point scale ranging from Intensity I, which is rarely felt by people, to Intensity XII, in which damage to structures is total and objects are thrown into the air (USGS 2009). In California, the estimated relationship between peak ground acceleration and MMI intensity is shown in Table 5.6-1.

**Table 5.6-1**
**Estimated Relationship between Peak Ground Acceleration and Intensity**

| Peak Ground Acceleration, g | MMI | Effects |
|---|---|---|
| 0.039–0.092 | V | Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop. |
| 0.092–0.18 | VI | Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight. |
| 0.18–0.34 | VII | Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken. |
| 0.34–0.65 | VIII | Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. |
| 0.65–1.24 | IX | Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations. |
| >1.24 | X+ | MMI X: Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.<br>MMI XII: Damage total. Lines of sight and level are distorted. Objects thrown into the air. |

Source: Ward 1999.

*Faults*

Faults that could generate strong ground shaking in Menifee are shown on Figure 5.6-2, *Fault Map*, and are described below:

**San Andreas Fault.** The San Andreas fault is the principal boundary between the Pacific and North American plates. The fault extends over 750 miles from near Cape Mendocino in northern California to the Salton Sea region in southern California. This fault is considered the master fault in southern California because it has frequent, large earthquakes and controls the seismic hazards of the area. However, as discussed further below, at least two other faults closer to Menifee have the potential to cause stronger ground shaking, and therefore more damage, than the San Andreas fault.

Large faults, such as the San Andreas fault, are often divided into segments based on physical characteristics along the fault, in order to evaluate their future earthquake potential. The southern and central San Andreas fault is now divided into 10 segments named, from north to south, Parkfield, Cholame, Carrizo, Big Bend, Mojave North, Mojave South, San Bernardino North, San Bernardino South, San Gorgonio-Garnet Hill, and Coachella.

The Coachella segment extends 71 miles from approximately the Salton Sea to San Gorgonio Pass. This segment has not produced any large surface-rupturing earthquakes in historic times. The last surface-rupturing earthquake on the Coachella segment for which there is geologic evidence occurred around A.D 1680. Rupture of the Coachella fault segments in a magnitude 7.2 earthquake is estimated capable of generating peak ground accelerations in Menifee of about 0.06g.

The San Bernardino segments combined are about 49 miles long and extend from the San Gorgonio Pass northward to approximately Cajon Pass. This is a structurally complex zone that is poorly understood, and for which there are scant data on fault behavior. This section of the San Andreas fault is thought capable of producing a magnitude 7.5 earthquake, which could result in peak ground accelerations in Menifee of between 0.09g and 0.06g.

The Mojave segments of the San Andreas fault combined extend from just northwest of Cajon Pass, northwestward to the San Andreas fault juncture with the Garlock fault near Tejon Pass.

A group of scientists has calculated that the southern San Andreas fault has a 59 percent probability of causing an earthquake of at least magnitude 6.7 in the next 30 years.

**Elsinore Fault Zone.** The Elsinore fault extends from northern Baja California to the Los Angeles Basin, a distance of about 190 miles, and is part of the San Andreas fault system. The fault is divided, from south to north, into the Laguna Salada, Coyote Mountain, Julian, Temecula, Glen Ivy, Chino, and Whittier segments. The section closest to Menifee is the Temecula segment, which at its closest approach is about 6 miles to the west. This segment includes two roughly parallel faults, the Wildomar and Willard strands. The next closest segment is the Glen Ivy, 6.8 miles to the northwest of Menifee. The Glen Ivy and Temecula segments bound the Elsinore Trough, a relatively shallow depression.

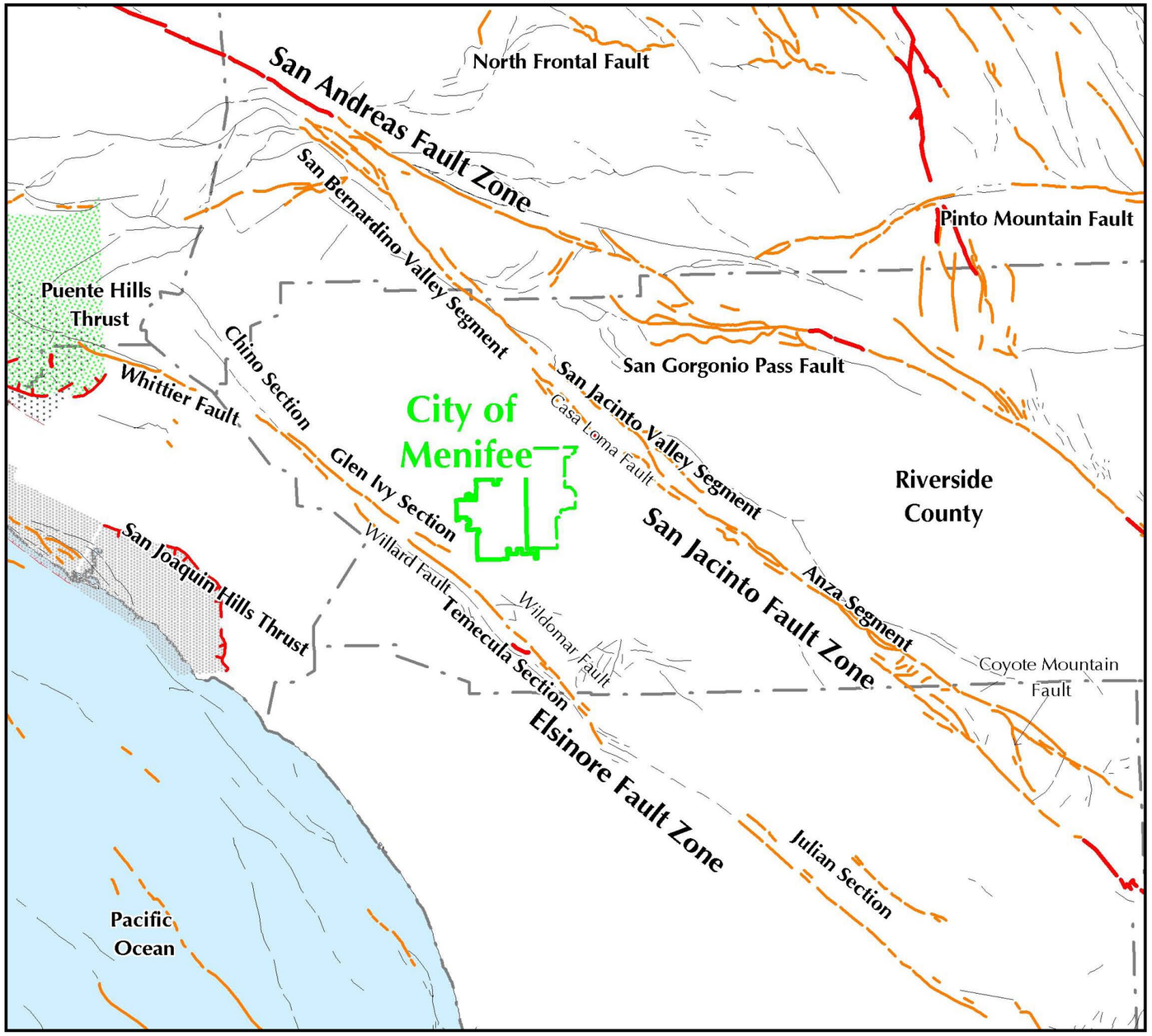
Although historical earthquakes have been reported on only two segments (the Glen Ivy and Laguna Salada segments), studies indicate that all segments of the Elsinore fault have moved in the last about 11,000 years, and are therefore considered active. The Julian segment, at about 35 miles long, is the longest section of the Elsinore fault zone. The Laguna Salada segment ruptured in the April 4, 2010, earthquake near Mexicali, Mexico.

A M 6.8 earthquake on either the Temecula or Glen Ivy segments of the fault would generate strong shaking in Menifee, with horizontal peak ground accelerations between 0.3g and 0.1g, and Modified Mercalli intensities in the VII to IX range. If the Julian segment of the Elsinore fault ruptured in a M 7.1 earthquake, peak ground motions of between about 0.12g and 0.08g are anticipated in the Menifee area. Rupture of the Chino segment in a M 6.7 earthquake would generate peak ground motions between about 0.11g and 0.07g, whereas the Whittier segment, farther north, would generate shaking of at least 0.07g.

**San Jacinto Fault Zone.** The San Jacinto fault zone consists of a series of closely spaced faults that form the western margin of the San Jacinto Mountains. The zone is about 175 miles long and extends from its junction with the San Andreas fault in San Bernardino southeast toward the Brawley area, where it continues south of the international border as the Imperial fault. The San Jacinto fault zone has been divided into seven segments. From north to south these include the San Bernardino Valley, San Jacinto Valley, Anza, Coyote Creek, Borrego Mountain, Superstition Hills, and Superstition Mountain segments. Each segment, in turn, consists of a series of roughly parallel faults. The San Jacinto Fault is estimated to have a 31 percent probability of rupturing between 1994 and 2024. At least 16 past earthquakes on the Anza segment have been recognized in faulted rock layers.

The San Bernardino Valley segment extends from San Bernardino to the northern end of the San Jacinto Valley. The segment of the San Jacinto fault closest to Menifee is the San Jacinto Valley segment—this segment includes several strands, including the San Jacinto, Claremont, Hot Springs, Casa Loma, and Park Hill faults, and extends about 24 miles to where the Claremont and Casa Loma faults come together forming the Clark fault. The nearest part of the San Jacinto Fault Zone to Menifee is a branch of the Casa Loma Fault about 10.5 miles northeast of the City.

## Fault Map




### 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)

0 12
Scale (Miles)

Source: Earth Consultants International 2010

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A maximum credible earthquake of magnitude 6.7 on the San Bernardino Valley segment of the San Jacinto fault has the potential to generate ground motions with peak horizontal ground accelerations of between about 0.1g and 0.06g in the Menifee area. A 6.9 Mw earthquake on the San Jacinto Valley segment would generate peak horizontal ground accelerations in Menifee of between about 0.3g and 0.16g, and a 7.2 earthquake on the Anza segment would generate peak horizontal ground accelerations in the city of between about 0.24g and 0.12g. The San Jacinto Valley section of the San Jacinto fault and the Temecula segment of the Elsinore fault could each generate the worst-case earthquake scenario for Menifee.

**Faults in Menifee.** There are two faults with approximate locations mapped within the City: one in Sun City in the central part of the City, and the second in Quail Valley near the western City boundary (see Figure 5.6-2). These faults are confined to bedrock; they do not affect sediments of Holocene or late Pleistocene age (about the last 15,000 years) and thus are not considered active faults.

*Ground Shaking*

The Elsinore fault is estimated to have an 11 percent probability of rupturing in an earthquake of at least magnitude 6.7 earthquake in the next 30 years.

The San Jacinto fault has historically produced more large earthquakes than any other fault in southern California, although none of these earthquakes has been as large as the 1857 and 1906 earthquakes on the San Andreas fault. The two most-recent surface-rupturing earthquakes on the San Jacinto fault were the April 9, 1968, Mw 6.5 on the Coyote Creek segment, and the 1987 event on the Superstition Hills segment.

***Liquefaction***

Liquefaction is a loss of strength and stiffness in soil due to ground shaking; it typically occurs within 50 feet of the surface, in saturated, loose, fine- to medium-grained sandy to silty soils. Liquefaction can substantially damage structures and can cause structures to sink or tilt. Three conditions are needed for liquefaction to occur: ground shaking with acceleration of about 0.2g or greater; loose, unconsolidated sediments; and saturated soil within about 50 feet of the surface. Ground shaking is potentially present in Menifee due to earthquakes on faults in the region. Depths to groundwater of 10 feet or less have been reported in the Menifee and Paloma Valleys. Young, loose, unconsolidated sediments also occur in the General Plan Area, usually along active drainages including Salt Creek and Warm Springs Creek, and in the Paloma Valley. Parts of the City considered to have a potential for liquefaction are shown on Figure 5.6-3, *Seismic Hazard Areas*.

Liquefaction in subsurface soils can result in ground failure, including lateral spreading, downslope movement of surface soil, usually on gentle slopes between 0.3 and 3 percent grade above a cut slope or free face (such as a riverbank). Lateral spreading damages structures in soil such as pipelines and other utilities, as well as structures on the soil.

***Earthquake-Induced Landslides***

Strong ground shaking can worsen existing slope instability. Earthquake-induced landslides can overrun structures, harm people, sever utility lines, and block roads, thereby hindering rescue operations after an earthquake. Conditions contributing to such landslides include high earthquake 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 General Plan area contains many rugged, moderately steep hills and low mountains consisting of granitic and metamorphic bedrock; these bedrock areas are susceptible to landslides of surface material that could impact structures directly downslope. Granite weathers into large boulders, posing rockfall hazard to structures below. Parts of the General Plan area where there is a potential for earthquake-induced landslides are shown on Figure 5.6-3.

***Seismically Induced Settlement***

Strong ground shaking can cause compaction and densification of soils. Such settlement 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. Seismically induced settlement can damage structures when the settlement is of different amounts under various parts of a structure or foundation.

***Vulnerability of Structures to Earthquake Damage***

Although it is not possible to prevent earthquakes, their destructive effects can be minimized, especially since most of the loss of life and injuries due to an earthquake are related to the collapse of hazardous buildings and structures.

Therefore, the vulnerability of a community to earthquake damage can be reduced with a comprehensive hazard mitigation program that includes the identification and mapping of hazards, prudent planning and enforcement of building codes, and expedient retrofitting and rehabilitation of weak structures.

Building damage is commonly classified as either structural or nonstructural. Structural damage impairs the building's support, such as frames, walls, and columns. Nonstructural damage does not affect the building's support elements, but includes such things as broken windows, collapsed or rotated chimneys, unbraced parapets that fall into the street, and fallen ceilings.

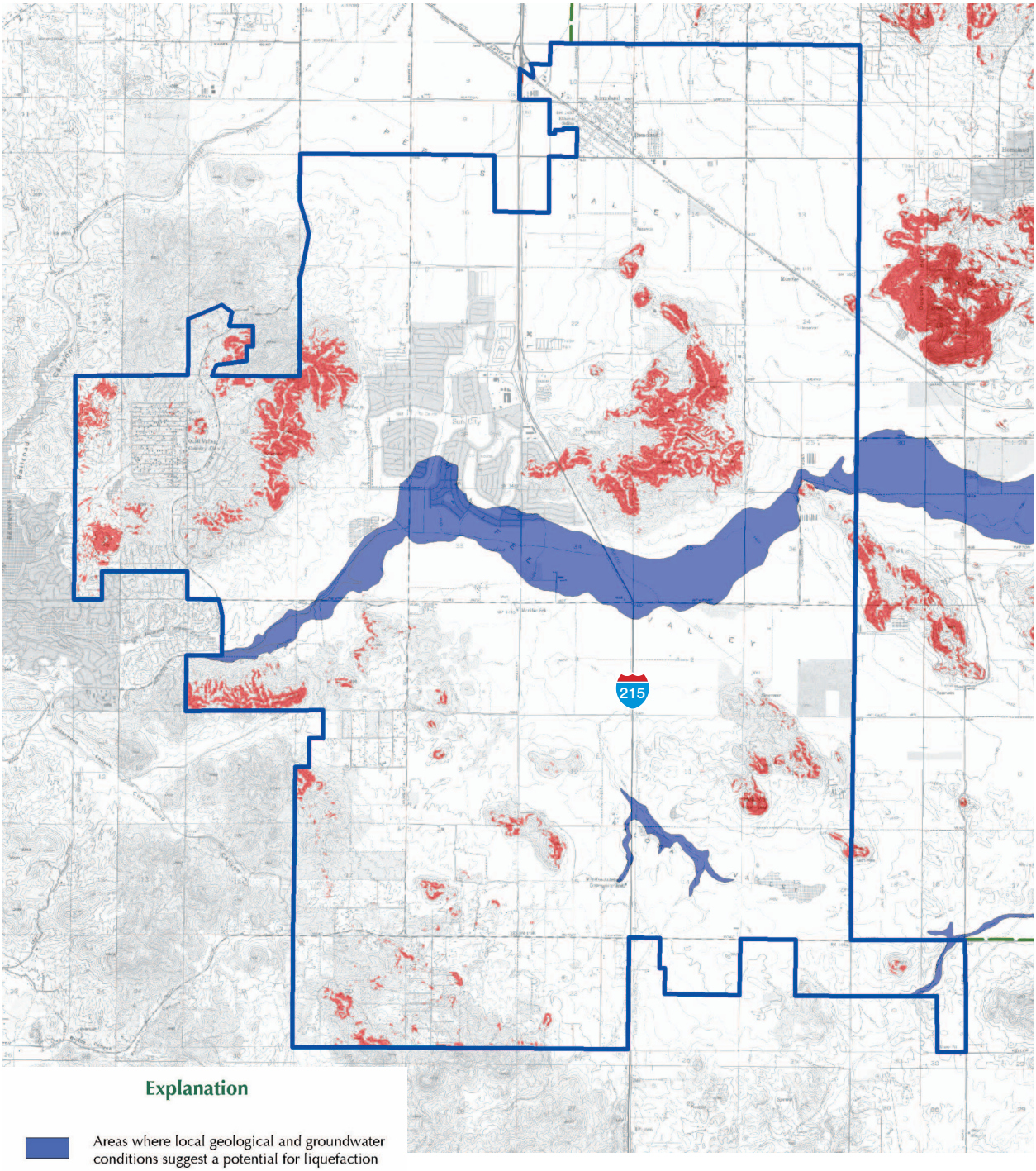
During an earthquake, buildings get thrown from side to side and up and down. Given the same acceleration, heavier buildings are subjected to higher forces than lightweight buildings. Damage occurs when structural members are overloaded or when differential movements between different parts of the structure strain the structural components. Larger earthquakes and longer shaking tend to damage structures more. The level of damage can be predicted only in general terms, since no two buildings undergo the exact same motions, even in the same earthquake. Past earthquakes have shown, however, that some types of buildings are far more likely to fail than others. This section assesses the general earthquake vulnerability of structures and facilities common in the southern California area, including in Menifee. This analysis is based on past earthquake performance of similar types of buildings in the U.S.

*Unreinforced Masonry Buildings*

Unreinforced masonry buildings (URMs) are prone to failure due to inadequate anchorage of the masonry walls to the roof and floor diaphragms, lack of steel reinforcing, the limited strength and ductility of the building materials, and sometimes, poor construction workmanship. Furthermore, as these buildings age, the bricks and mortar tend to deteriorate, making the buildings even weaker. As a result, the state legislature passed Senate Bill 547, addressing the identification and seismic upgrade of URMs.

In response to the URM Law, all cities and counties in what was referred to as Seismic Zone 4 were to conduct an inventory of their URMs, establish an URM loss-reduction program, and report their progress to the state by 1990. The Seismic Safety Commission has conducted updates to this inventory, more recently in 2003 and 2006.

# Seismic Hazard Areas




**Explanation**

- Areas where local geological and groundwater conditions suggest a potential for liquefaction
- Areas where local topographic and geological conditions suggest the potential for earthquake-induced landslides
- City of Menifee Corporate Boundary
- Menifee General Plan Area Boundary

0 2
Scale (Miles)

Source: Earth Consultants International 2010

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URMs in Menifee have not been inventoried due to the City's recent incorporation (2008). The Seismic Safety Commission's database does not include any data for Menifee or for any of the communities that together became part of the City of Menifee. There are 71 URMS listed in the HazUS database reports for the 11 census tracts that cover most of the Menifee General Plan area.

*Soft-Story Buildings*

Of particular concern are soft-story buildings (buildings with a story, generally the first floor, lacking adequate strength or toughness due to too few shear walls). Residential units above glass-fronted stores and buildings perched atop parking garages are common examples of soft-story buildings. Collapse of a soft story and "pancaking" of the remaining stories killed 16 people at the Northridge Meadows apartments during the 1994 Northridge earthquake (EERI 1995). There are many other cases of soft-story collapses in past earthquakes. In response, the state encourages the identification and mitigation of seismic hazards associated with these types of potentially hazardous buildings.

*Wood-Frame Structures*

Structural damage to wood-frame structures often results from an inadequate connection between the building and the foundation. These buildings may slide off their foundations, with consequent damage to plumbing and electrical connections. Unreinforced masonry chimneys may also collapse. These types of damage are generally not life threatening, although they may be costly to repair. Wood-frame buildings with stud walls generally perform well during an earthquake unless they have no foundation or have a weak foundation constructed of unreinforced masonry or poorly reinforced concrete. In these cases, damage is generally limited to cracking of the stucco, which dissipates much of the earthquake's induced energy.

*Precast Concrete Structures*

Partial or total collapse of buildings where the floors, walls, and roofs fail as large intact units, such as large precast concrete panels, cause the greatest loss of life and difficulty in victim rescue and extrication. These types of buildings are common not only in southern California, but abroad. In southern California, many of the parking structures that failed during the Northridge earthquake, such as the Cal-State Northridge and City of Glendale Civic Center parking structures, consisted of precast concrete components.

*Tilt-up Buildings*

Tilt-up buildings have concrete wall panels, often cast on the ground or fabricated offsite and trucked in, which are then tilted upward into their final position. Connections and anchors have pulled out of walls during earthquakes, causing the floors or roofs to collapse. A high rate of failure was observed for this type of construction in the 1971 San Fernando and 1987 Whittier Narrows earthquakes. Tilt-up buildings can also generate heavy debris.

*Reinforced Concrete Frame Buildings*

Reinforced concrete frame buildings, with or without reinforced infill walls, display low ductility. Earthquakes may cause shear failure (if there are large tie spacings in columns or insufficient shear strength), column failure (due to inadequate rebar splices, inadequate reinforcing of beam-column joints, or insufficient tie anchorage), hinge deformation (due to lack of continuous beam reinforcement), and nonstructural damage (due to the relatively low stiffness of the frame). A common type of failure observed following the Northridge earthquake was confined column collapse, due to infilling between columns which confined the length of the columns that could move laterally in the earthquake.

*Multistory Steel Frame Buildings*

Multistory steel frame buildings generally have concrete floor slabs. However, these buildings are less likely to collapse than concrete structures. Common damage to these types of buildings is generally nonstructural, including collapsed exterior curtain wall (cladding) and damage to interior partitions and equipment. Overall, modern steel frame buildings have been expected to perform well in earthquakes, but the 1994 Northridge earthquake broke many welds in these buildings, a previously unanticipated problem.

Older, pre-1945 steel frame structures may have unreinforced masonry such as bricks, clay tiles, and terra cotta tiles as cladding or infilling. Cladding in newer buildings may be glass, infill panels, or precast panels that may fail and generate a band of debris around the building exterior (with considerable threat to pedestrians in the streets below).

*Mobile Homes*

Mobile homes are prefabricated housing units that are placed on isolated piers, jackstands, or masonry block foundations (usually without any positive anchorage). Floors and roofs of mobile homes are usually plywood, and outside surfaces are covered with sheet metal. Mobile homes typically do not perform well in earthquakes. Severe damage occurs when they fall off their supports, severing utility lines and piercing the floor with jackstands. Such hazards can be mitigated substantially if manufactured homes are inspected and seismically retrofitted as needed.

*Combination Types*

Buildings are often a combination of steel, concrete, reinforced masonry, and wood, with different structural systems on different floors or different sections of the building. Combination types that are potentially hazardous include: concrete frame buildings without special reinforcing, precast concrete and precast-composite buildings, steel frame or concrete frame buildings with unreinforced masonry walls, reinforced concrete wall buildings with no special detailing or reinforcement, large capacity buildings with long-span roof structures (such as theaters and auditoriums), large unengineered wood-frame buildings, buildings with inadequately anchored exterior cladding and glazing, and buildings with poorly anchored parapets and appendages.

In addition to building types, there are other factors associated with the design and construction of the buildings that also have an impact on the structures' vulnerability to strong ground shaking. Some of these conditions are discussed below:

**Building Shape.** A building's vertical and/or horizontal shape can be important in determining its seismic vulnerability. Simple, symmetric buildings generally perform better than nonsymmetric buildings. During an earthquake, nonsymmetric buildings tend to twist as well as shake. Wings on a building tend to act independently during an earthquake, resulting in differential movements and cracking. The geometry of the lateral load-resisting systems also matters. For example, buildings with one or two walls made mostly of glass, with the remaining walls of concrete or brick, are at risk. Asymmetry in the placement of bracing systems that provide a building with earthquake resistance can result in twisting or differential motions.

**Pounding.** Site-related seismic hazards may include the potential for neighboring buildings to "pound," or for one building to collapse onto a neighbor. Pounding occurs when buildings very close to each other strike each other as they move in response to an earthquake. The effects of pounding can be especially damaging if the floors of the buildings are at different elevations, so that, for example, the floor of one building hits a supporting column of the other. Damage to a supporting column can result in partial or total building collapse.

## Geologic Hazards

### *Landslides and Slope Instability*

Developments that encroach upon the edge of natural slopes may be impacted by slope failures. Even if a slope failure does not reach the adjacent property, the visual impact will generally cause alarm to homeowners. A significant portion of the General Plan area is hillside terrain. At present, the hills and mountains have rural to semirural type development, and scattered development is present along the base of steep slopes.

*Types of Slope Failures*

Slope failures occur in a variety of forms. Gross failures include deep-seated or relatively thick slide masses, such as landslides, whereas surficial failures can range from minor soil slips to destructive mud or debris flows. Failures can occur on natural or man-made slopes. Most failures of man-made slopes occur on older slopes built at slope gradients steeper than those allowed by today's grading codes. Although infrequent, failures can also occur on newer, graded slopes, generally due to poor engineering or poor construction. Furthermore, slope failures often occur as elements of interrelated natural hazards in which one event triggers a secondary event, such as earthquake-induced landsliding, fire-flood sequences, and storm-induced mudflows.

*Gross Failures*

Landslides are movements of relatively large landmasses, either as nearly intact bedrock blocks or as jumbled mixes of bedrock blocks, fragments, debris, and soils. Landslide materials are commonly porous and very weathered in the upper portions and along the margins of the slide. The rock types in the Menifee General Plan area are generally resistant to large landslide failures, and no landslides have been mapped within the City. However, depending on their fracture pattern, foliation, and weathering, these rocks may become susceptible to slope failure if they are cut to very steep gradients, such as are commonly found in highway roadcuts.

*Surficial Failures*

Surficial may be present locally in hillside areas, typically occurring in drainage swales and in the accumulated sediments and deeply weathered bedrock near the base of steep slopes. Surficial failures generally occur throughout the mountainous areas during winters of particularly heavy and/or prolonged rainfall. The most common types of surficial instability are described below.

**Slope creep** is imperceptibly slow and relatively continuous movement of rock and/or soil on moderate to steep slopes. Creep occurs most often in soils that develop on fine-grained rock units. Rock creep is a similar process, and involves permanent deformation of the outer few feet of the rock face resulting in folding and fracturing. Rock creep is most common in highly fractured, fine-grained rock units, such as siltstone, claystone and shale, but can also occur in igneous and metamorphic rocks, such as those that form the local mountains.

Creep also occurs in graded fill slopes. This is related to the alternate wetting and drying of slopes constructed with fine-grained, expansive soils. The repeated expansion and contraction of the soils at the slope face leads to loosening and fracturing of the soils, thereby leaving the soils susceptible to creep. Soil creep is not catastrophic, but it can cause damage to structures and improvements located at the tops of slopes. Soil creep and creep of graded fill slopes are not a widespread hazard in the General Plan area, since most soils in this area are granular and not highly expansive. Rock creep is not a common hazard in the rock types found in this area.

Soil slip failures are generated by strong winter storms and are widespread in mountainous areas, particularly after winters with prolonged and/or heavy rainfall. Failures occur on canyon slopes and in soils that have accumulated in swales, gullies and ravines. Slope steepness has a strong influence on the development of soil slips, with most slips occurring on slopes having gradients between about 27 and 56 degrees. Slopes within this range of gradients are present in the higher hills and mountains.

**Debris flow** is the most dangerous and destructive of all types of slope failure. A debris flow (also called mudflow, mudslide, and debris avalanche) is a rapidly moving slurry of water, mud, rock, vegetation and debris. Larger debris flows are capable of moving trees, large boulders, and even cars. This type of failure is especially dangerous as it can move at speeds as fast as 40 feet per second (27 miles per hour), is capable of crushing buildings, and can strike with very little warning. As with soil slips, the development of debris flows generally occur during or shortly after very heavy storms.

A debris flow most commonly originates as a soil slip in the rounded, soil-filled "hollow" at the head of a drainage swale or ravine. The rigid soil mass is deformed into a viscous fluid that moves down the drainage, gathering additional soil and vegetation into the flow.

Watersheds that have been recently burned typically yield greater amounts of soil and debris than those that have not burned. Erosion rates during the first year after a fire are estimated to be 15 to 35 times greater than normal, and peak discharge rates range from 2 to 35 times higher. These rates drop abruptly in the second year and return to normal after about 5 years.

Within the General Plan area, locations most susceptible to debris flows are at the base of moderate to steep slopes or at the mouths of small to large drainage channels. Although surficial slope failures were not generally visible after the recent heavy winter rains, small surficial landslides, debris flows, and rock falls have been reported in the area in the past.

**Rockfalls** are free-falling to tumbling masses of bedrock that have broken off steep canyon walls or cliffs. The debris from repeated rockfalls typically collects at the base of extremely steep slopes in cone-shaped accumulations of rock fragments called talus. Rockfalls can happen wherever fractured rock slopes are oversteepened by stream erosion or human activities.

The granitic bedrock common to the area's hillsides weathers into large boulders that perch precariously on slopes, posing a rockfall hazard to areas adjacent to and below these slopes. A rockfall may happen suddenly and without warning, but is more likely to occur in response to earthquake-induced ground shaking, during periods of intense rainfall, or as a result of human activities, such as grading and blasting.

Rockfall hazard in the General Plan area is largely restricted to properties at or near the base of boulder-covered slopes.

***Compressible Soils***

Compressible soils are typically 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.

In the Menifee General Plan area, compressible soils are most likely to occur in the modern and prehistoric floodplains of the major drainages, such as the San Jacinto River, Salt Creek, Warm Springs Creek, and

Paloma Valley. Engineering properties of surface soils and rock outcrops in Menifee are summarized on Figure 5.6-4, *Engineering Materials Map*. Compressible soils are also commonly found in hillside areas, typically in canyon bottoms, swales, and at the base of natural slopes. Although older alluvium in the Menifee area is relatively dense, the upper few feet, which are commonly weathered and/or disturbed, are typically compressible. Deep fill embankments, generally those more than about 60 feet deep, will also compress under their own weight.

***Collapsible Soils***

Hydroconsolidation or soil collapse typically occurs in recently deposited, Holocene-age soils that accumulated in an arid or semiarid environment. Soils prone to collapse are commonly associated with alluvial fan and debris flow sediments deposited during flash floods. These soils are typically dry and contain minute pores and voids. When collapsible soils become saturated, their grains are rearranged and lose cementation, resulting in substantial and rapid settlement under relatively light loads. An increase in surface water infiltration, such as from irrigation, or a rise in the groundwater table, combined with the weight of a building or structure, can initiate rapid settlement and cause foundations and walls to crack. Typically, differential settlement of structures occurs when landscaping is heavily irrigated near the structure's foundation.

The young and very young alluvial sediments in the General Plan area may be locally susceptible to this hazard due to their low density, rapid deposition in alluvial fans, and the generally dry condition of the upper soils.

***Expansive Soils***

Fine-grained soils, such as silts and clays, may contain variable amounts of expansive clay minerals. These minerals can shrink or swell substantially as a result of changes in moisture content. The upward pressures induced by the swelling of expansive soils can significantly damage structures and other surface improvements.

The valley and canyon areas of the General Plan area are underlain by alluvial sediments that are composed of interlayered granular materials (silty sand and sand) and fine-grained materials (silts and clays). Consequently, after site grading, the expansion characteristics of the soils at finish grade can be highly variable. The San Jacinto River floodplain contains very fine-grained silts and clays that are likely to be expansive. Soils on weathered old alluvial fan deposits are commonly clay-rich and are probably moderately expansive.

Igneous and metamorphic rocks underlying the hills and mountains generally have low expansion characteristics (crystalline bedrock by nature is not expansive), but sheared zones within these rock units may contain clays with expansive minerals.

Engineered fills may be expansive and cause damage to improvements if such soils are placed in the fill near the finished surface.

***Corrosive Soils***

Corrosive soils can, over time, cause extensive damage to buried metallic objects such as pipelines and steel foundation elements. Whether and how much corrosion occurs depends on both soil conditions and on the size and composition of buried structures. For soils, the most common factor used in identifying corrosion potential is electrical resistivity. Soils with low resistivity are especially liable to corrosion reactions.

Other soil characteristics that increase the risk of corrosion to metals are low pH (acidic soils), wet soils, high chloride levels, low oxygen levels, and the presence of certain bacteria.

High concentrations of soluble sulfates in soil can be converted to sulfides by bacteria; sulfides increase the risk for corrosion. If the concentration of soluble sulfates is high enough, the soil will be corrosive to concrete.

In general, the near-surface soils throughout the valley areas have low electrical resistivity, making them moderately to highly corrosive to metals. Soluble sulfates and chlorides are low, and pH is generally above the acidic range.

***Ground Subsidence***

Ground subsidence is the gradual settling or sinking of the ground surface with little or no horizontal movement. Most ground subsidence is induced by humans. In the areas of California where ground subsidence has been reported (such as the San Joaquin Valley, Coachella Valley, and Wilmington), this phenomenon is most commonly associated with the extraction of fluids (water and/or petroleum) from subsurface sediments. Subsidence can also occur when dry collapsible soils become saturated. Less commonly, ground subsidence can occur as a response to natural forces such as earthquake movements.

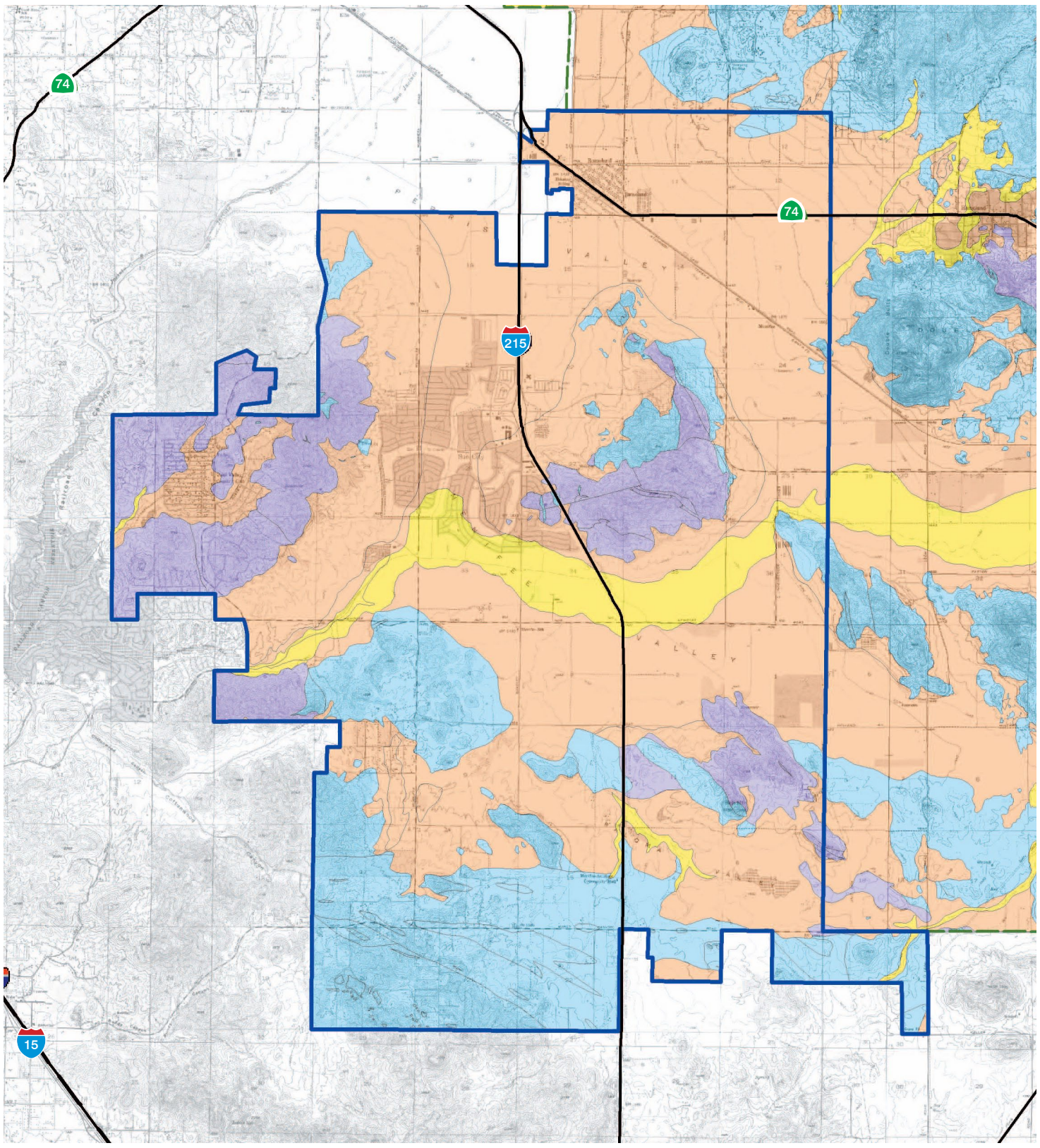
Ground-surface effects related to regional subsidence can include earth fissures, sinkholes or depressions, and disruption of surface drainage. Damage is generally restricted to structures sensitive to slight changes in elevations, such as canals, levees, underground pipelines, and drainage courses; however, significant subsidence can result in damage to wells, buildings, roads, railroads, and other improvements. Subsidence due to the overdraft of groundwater supplies can also result in the permanent loss of aquifer storage capacity. Subsidence has largely been brought under control in affected areas by careful management of local water supplies, including reducing pumping of local wells, importing water, and using artificial recharge.

Although subsidence has not been reported in Menifee, this hazard has been documented nearby in the San Jacinto Valley, from Hemet to Moreno Valley, and in Temecula and Murrieta. In the San Jacinto Valley and Temecula, the subsidence and related ground fissuring have been attributed to groundwater withdrawal. In Murrieta, rapid growth of the area led to large-scale application of landscape water to arid alluvial soils. This caused a rise in the water table and subsequent collapse of the soils, resulting in localized surface land subsidence and ground fissures, which cost millions of dollars in property damage to homes, schools, and infrastructure.

The Menifee General Plan area is above the southwestern part of the San Jacinto Groundwater Basin. Natural replenishment to the basin is via percolation from the San Jacinto River and its tributaries; less recharge comes from rainfall on the valley floor. Natural recharge has been artificially increased since the early 1900s by spreading floodwaters over the adjacent sandy washes in the upper reaches of the river. Today, artificial recharge also occurs by percolation of imported and reclaimed water through infiltration ponds in the upper reaches of the river, Lake Perris, and storage ponds distributed throughout the valleys. Artificial recharge often exceeds natural recharge, especially in dry years.

In 1915, groundwater levels in the greater part of the Menifee, Paloma, and Winchester valleys were within 10 to 20 feet of the surface. In the Sun City and Perris Valley area, groundwater was deeper, ranging from about 40 to 100 feet deep. Over the following decades, groundwater levels in various parts of the basin declined and/or rose, largely as a result of pumping, artificial recharge, and recycling of water, as well as changes that occurred in usage as the Menifee area transitioned from agriculture to urbanization. More recently, well water levels in the General Plan area ranged from about 6 feet to 176 feet deep.

# Engineering Materials Map




## GENERAL ENGINEERING CHARACTERISTICS OF GEOLOGIC UNITS IN THE MENIFEE GENERAL PLAN AREA

### Surficial Materials

**Very Young to Young Alluvial Deposits (Qw, Qv, Qyf, and Qya)**
COMPOSITION: Variable, but commonly contains silt, sand, and gravel; may also contain vegetation and debris. DENSITY: Generally low and compressible. EXPANSION POTENTIAL: Generally low; locally moderate, depending on fine-graining fraction. Sitls and clays withing the San Jacinto floodplain are in the moderate range. SLOPE STABILITY: Generally poor. EROSION/SEDIMENTATION POTENTIAL: Highly susceptible to erosion, especially where water flow is concentrated; locally subject to sedimentation carried by floodwaters and debris flows. PERMEABILITY: High. EASE OF EXCAVATION: Easy. SUITABILITY AS FILL: Generally good after organics, debris, and oversize rocks are removed. Clay-rich deposits should not be placed near finish grades.

**Old Alluvial Deposits (Qof, Qvof, Qvoa)**
COMPOSITION: Variable mix of silt, sand, and gravel; weathered surface may be enriched with clay due to soil development. DENSITY: Generally dense below the upper few feet. EXPANSION POTENTIAL: Low to high, depending on original composition and degree of soil development. SLOPE STABILITY: Generally good. EROSION/SEDIMENTATION POTENTIAL: Moderate. PERMEABILITY: Highly variable. EASE OF EXCAVATION: Easy. SUITABILITY AS FILL: Generally good.

### Bedrock Materials

**Plutonic Rocks (Kt, Kg, Km, and Kgb)**
COMPOSITION: Mix of medium-to coarse-grained granitic rocks. DENSITY: Very dense. EXPANSION POTENTIAL: Low. SLOPE STABILITY: Generally good in cut slopes that are not oversteepened. Natural slopes are typically covered with large boulders that pose a rockfall hazard. EROSION POTENTIAL: Very low. PERMEABILITY: Low. EASE OF EXCAVATION: Difficult to very difficult where unweathered. May require blasting. SUITABILITY AS FILL: Good for weathered, decomposed granitics. Relatively poor for unweathered rock, as excavation may product significant oversize rock. Blasting may produce smaller rock sizes that can be used for rock fills, however these fills require greater amounts of applied water, and compaction is difficult to verify.

**Metasedimentary Rocks (Trq and Trps)**
COMPOSITION: Mix of metamorphosed sedimentary rocks. DENSITY: Very dense. EXPANSION POTENTIAL: Very low. SLOPE STABILITY: Good in natural slopes. Generally good in cut slopes. EROSION POTENTIAL: Very low. PERMEABILITY: Low. EASE OF EXCAVATION: Difficult to very difficult where unweathered. May require blasting. SUITABILITY AS FILL: Moderate to poor, as excavation may produce significant oversize rock. Blasting may produce smaller rock sizes that can be used for rock fills, however these fills require greater amounts of applied water, and compaction is difficult to verify.

City Boundary

Menifee General Plan Boundary

0 1
Scale (Mile)

*Source: Earth Consultants International 2010*

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### *Soil Erosion*

Erosion, runoff, and sedimentation are influenced by several factors, including climate, topography, soil and rock types, and vegetation. The topographic relief between the valleys and the adjacent mountains makes erosion and sedimentation an important issue for communities built on alluvial fans and within hillside areas. The fractured condition of the bedrock forming the mountains, combined with rapid geologic uplift and infrequent but powerful winter storms, leads to high erosion rates. Further, erosion can increase significantly when mountain slopes are denuded by wildfires. Winter storms that follow a season of mountain wildfires can transport great volumes of sediment onto the low-lying areas below.

In the General Plan area, the unconsolidated sediments are generally the most susceptible to erosion. Natural erosion processes, even in more consolidated deposits, are often accelerated through human activities—whether they are agricultural or land development. Development often 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 original, natural slope conditions. Developments also reduce the surface area available for infiltration, leading to increased flooding, erosion, and sedimentation downstream of the project.

## Regulatory Setting

### *State*

*California Alquist-Priolo Earthquake Fault Zoning Act*

The Alquist-Priolo Earthquake Fault Zoning Act was signed into state law in 1972. Its primary purpose is to mitigate the hazard of fault rupture by prohibiting the location of structures for human occupancy across the trace of an active fault. The act requires the State Geologist to delineate “Earthquake Fault Zones” along faults that are “sufficiently active” and “well defined.” The act also requires that cities and counties withhold development permits for sites within an earthquake fault zone until geologic investigations demonstrate that the sites are not threatened by surface displacement from future faulting. Pursuant to this act, structures for human occupancy are not allowed within 50 feet of the trace of an active fault.

*Seismic Hazard Mapping Act*

The Seismic Hazard Mapping Act (SHMA) was adopted by the state in 1990 to protect the public from the effects of nonsurface fault rupture earthquake hazards, including strong ground shaking, liquefaction, seismically induced landslides, or other ground failure caused by earthquakes. The goal of the act is to minimize loss of life and property by identifying and mitigating seismic hazards. The California Geological Survey prepares and provides local governments with seismic hazard zone maps that identify areas susceptible to amplified shaking, liquefaction, earthquake-induced landslides, and other ground failures. Geotechnical investigations for projects within seismic hazard zones are required by the Seismic Hazards Mapping Act to evaluate seismic hazards.

*California Building Code*

Current law states that every local agency enforcing building regulations, such as cities and counties, must adopt the provisions of the California Building Code (CBC) within 180 days of its publication. The publication date of the CBC is established by the California Building Standards Commission and the code is also known as Title 24, Part 2 of the California Code of Regulations. The most recent building standard adopted by the legislature and used throughout the state is the 2010 version of the CBC, often with local, more restrictive amendments that are based on local geographic, topographic, or climatic conditions. These codes provide minimum standards to protect property and public safety by regulating the design and construction of

excavations, foundations, building frames, retaining walls, and other building elements to mitigate the effects of seismic shaking and adverse soil conditions. The CBC contains provisions for earthquake safety based on factors including occupancy type, the types of soil and rock onsite, and the strength of ground shaking with specified probability of occurring at a site.

*Natural Hazards Disclosure Act*

The Natural Hazards Disclosure Act requires that sellers of real property and their agents provide prospective buyers with a "Natural Hazard Disclosure Statement" when the property being sold lies within one or more state-mapped hazard areas, including a Seismic Hazard Zone. California law also requires that when houses built before 1960 are sold, the seller must give the buyer a completed earthquake hazards disclosure report and a booklet titled "The Homeowners Guide to Earthquake Safety." This publication was written and adopted by the California Seismic Safety Commission.

*Soils Investigation Requirements*

Requirements for soils investigations for subdivisions requiring tentative and final maps, and for other specified types of structures, are in California Health and Safety Code Sections 17953–17955, and in Section 1802 of the 2010 California Building Code. Testing of samples from subsurface investigations is required, such as from borings or test pits. Studies must be done as needed to evaluate slope stability, soil strength, position and adequacy of load-bearing soils, the effect of moisture variation on load-bearing capacity, compressibility, liquefaction, differential settlement, and expansiveness.

### 5.6.2 Thresholds of Significance

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

G-1 Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

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

ii) Strong seismic ground shaking.

iii) Seismic-related ground failure, including liquefaction.

iv) Landslides.

G-2 Result in substantial soil erosion or the loss of topsoil.

G-3 Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse.

G-4 Be located on expansive soil, as defined in Table 18-1B of the Uniform Building Code (1994), creating substantial risks to life or property.

G-5 Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water.

The Initial Study, included as Appendix A, substantiates that impacts associated with Threshold G-1.i (Alquist-Priolo Earthquake Fault Zoning) would be less than significant. This impact will not be addressed in the following analysis.

### *5.6.3 Environmental Impacts*

The following impact analysis addresses thresholds of significance for which the Initial Study identified potentially significant impacts. The applicable thresholds are identified in brackets after the impact statement.

***IMPACT 5.6-1: BUILDOUT OF THE PROPOSED GENERAL PLAN WOULD SUBJECT PEOPLE AND STRUCTURES TO SUBSTANTIAL GROUND SHAKING. [THRESHOLDS G-1.ii]***

***Impact Analysis:*** Strong ground shaking may occur in Menifee due to earthquakes on a number of active faults in the region, including the San Andreas, San Jacinto, and Elsinore faults. The San Jacinto Valley section of the San Jacinto fault, and the Temecula segment of the Elsinore fault, each could generate the worst-case earthquake scenario for Menifee. A 6.9 Mw earthquake on the San Jacinto Valley segment of the San Jacinto Fault would generate peak horizontal ground accelerations (PHGA) in Menifee of between about 0.3g and 0.16g; a Mw 6.8 earthquake on either the Temecula or Glen Ivy segments of the Elsinore fault would generate PHGA between 0.3g and 0.1g. Modified Mercalli Scale intensities would be in the in the VII to IX range in either case. Ground shaking of Intensity VIII would considerably damage and partly collapse ordinary substantial buildings. Chimneys, factory stacks, columns, monuments, and walls would collapse, and heavy furniture would be overturned. Two mapped faults in the City of Menifee, one in Sun City and one in Quail Valley, do not affect sediments of about 15,000 years or younger ages and thus are not considered active faults.

Buildout of the proposed General Plan would increase the number of residents and workers and total development intensity. Thus, General Plan buildout would increase the numbers of people and structures that would be exposed to strong ground shaking.

Each development project considered for approval by the City under the proposed General Plan would be required to comply with seismic safety provisions of the CBC (Title 24, Part 2 of the California Code of Regulations) and have a geotechnical investigation conducted for the affected project site. The geotechnical investigation would calculate seismic design parameters pursuant to CBC requirements and would include foundation and structural design recommendations, as needed, to reduce hazards to people and structures arising from ground shaking. Impacts would be less than significant.

Impacts would be the same under the Expanded EDC Scenario.

***IMPACT 5.6-2 GENERAL PLAN BUILDOUT WOULD NOT SUBJECT PERSONS AND STRUCTURES TO SUBSTANTIAL HAZARDS ARISING FROM SEISMIC-RELATED LIQUEFACTION [THRESHOLD G-1.iii]***

***Impact Analysis:*** There is a potential for liquefaction in parts of the City and General Plan area, as shown on Figure 5.6-3. Certain areas of Menifee are underlain by young, unconsolidated alluvial deposits and by artificial fill; these sediments are susceptible to seismically induced settlement.

Overexcavation and recompaction is the most commonly used method to densify soft soils susceptible to settlement. Deeper overexcavation below final grades, especially at cut/fill, fill/natural, or alluvium/bedrock contacts may be recommended to provide a more uniform subgrade. Overexcavation should also be performed so that large differences in fill thickness are not present across individual lots. In some cases, specially designed deep foundations, strengthened foundations, and/or fill compaction to a minimum standard that is higher than required by the CBC may be recommended.

Projects developed pursuant to the proposed General Plan would be required to have geotechnical investigations of the project sites conducted per state laws and regulations and General Plan policies. Compliance with recommendations in the geotechnical investigations reports would be required as conditions of issuance of building and grading permits. Impacts would be less than significant.

The additional area that would be designated EDC in the Expanded EDC Scenario is not mapped as susceptible to liquefaction. Impacts would be the same under the Expanded EDC Scenario.

***IMPACT 5.6-3 BUILDOUT OF THE GENERAL PLAN WOULD NOT PUT PEOPLE OR STRUCTURES AT RISK FROM EARTHQUAKE-INDUCED LANDSLIDES. [THRESHOLD G-1.iv]***

A significant portion of the City is hillside terrain. The hills have rural to semirural development, and scattered development is present along the base of steep slopes. Though the rock types in Menifee are generally resistant to slope failure, slope instability remains a potential hazard that would be evaluated in geotechnical investigations for each project in hillside areas.

**Reducing Slope Instability Hazards in Future Development**

Careful land management in hillside areas can reduce the risks of injuries and property damage from slope failures. This generally includes land use zoning to restrict development in unstable areas, grading codes for earthwork construction, geologic and soil engineering investigation and review, construction of drainage structures, and if warranted, placement of warning systems.

Soils and geology reports for hillside areas should include a geotechnical evaluation of any slope that may impact the future use of the property, as well as any impact to adjacent properties. This includes existing slopes that are to remain natural and any proposed graded slopes. This type of investigation typically includes borings and/or test pits to collect geologic data and soil samples, laboratory testing of the soil samples to determine soil strength parameters, and engineering calculations. Numerous soil-engineering methods are available for stabilizing slopes that pose a threat to development. These methods include designed buttresses (replacing the weak portion of the slope with engineered fill); reducing the height of the slope; designing the slope at a flatter gradient; and adding reinforcements to fill slopes such as soil cement or layers of geogrid (a tough polymeric net-like material that is placed between the horizontal layers of fill). Most slope stabilization methods include a subdrain system to prevent excessive groundwater (typically landscape water) from building up within the slope area. If it is not feasible to manage the slope stability hazard, building setbacks are typically imposed.

For debris flows, assessment of this hazard for individual sites should focus on structures located or planned in vulnerable positions. This generally includes canyon areas; at the toes of steep, natural slopes; and at the mouths of drainage channels. Hazards of debris flows are usually reduced through containment (debris basins), or diversion (impact walls, deflection walls, diversion channels, and debris fences). A system of baffles may be added upstream to slow the velocity of a potential debris flow. Other methods may include avoidance by restricting habitable structures to areas outside of the potential debris flow path.

There are numerous methods for minimizing hazards from rockfalls. Choosing the best method depends on the geological conditions (i.e., slope height, steepness, fracture spacing, orientation of layering), safety, type and cost of construction repair, and aesthetics. A commonly used method is to regrade the slope. This ranges from locally trimming hazardous overhangs to completely reconfiguring the slope to a more stable condition, possibly with the addition of benches to catch small rocks. Another group of methods focuses on holding the fractured rock in place by draping the slope with wire mesh, or by installing tensioned rock bolts, tie-back walls, or even retaining walls. A third type of slope management includes catchment devices at the toe of the slope, such as ditches, walls, or combinations of both. Designing the width of the catchment structure requires analysis of how the rock will fall. For instance, the slope gradient and roughness of the slope determines if rocks will fall, bounce, or roll to the bottom.

Temporary slope stability is also a concern, especially where earthwork construction is taking place next to existing improvements. Temporary slopes are those made for slope stabilization backcuts, fill keys, alluvial removals, retaining walls, and underground utility lines. The risk of slope failure is higher in temporary slopes because they are generally cut at a much steeper gradient. In general, temporary slopes should not be cut steeper than 1:1 (horizontal:vertical), and depending on actual field conditions, flatter gradients or shoring may be necessary. The potential for slope failure can also be reduced by cutting and filling large excavations in segments and not leaving temporary excavations open for long periods of time.

Development of projects pursuant to the General Plan would require subsurface geotechnical exploration and testing and required compliance with recommendations in project geotechnical investigation reports. Site-specific recommendations must be provided by a geotechnical engineer. After required geotechnical investigations and required implementation of recommendations in geotechnical investigation reports, developments pursuant to the General Plan would not create substantial hazards arising from earthquake-related slope failures.

Impacts would be the same under the Expanded EDC Scenario.

***IMPACT 5.6-4 GENERAL PLAN BUILDOUT COULD CAUSE SOIL EROSION. [THRESHOD G-2]***

***Impact Analysis:*** Buildout of the proposed General Plan would involve development or redevelopment of large parts of Menifee. Grading and construction of development and redevelopment projects could expose large amounts of soil and could result in soil erosion if effective erosion control measures were not used. Best management practices (BMPs) for erosion control are required under National Pollution Discharge Elimination System (NPDES) regulations pursuant to the federal Clean Water Act. NPDES requirements for construction projects one acre or more in area are set forth in the General Construction Permit issued by the State Water Resources Control Board (SRWCB; Order No. 2009-0009-DWQ). Categories of BMPs required for construction projects are described in Table 5.6-2.

**Table 5.6-2**
**Construction BMPs**

| Category | Purpose | Examples |
|---|---|---|
| Erosion Controls | Cover and/or bind soil surface, to prevent soil particles from being detached and transported by water or wind | Mulch, geotextiles, mats, hydroseeding, earth dikes, swales |
| Sediment Controls | Filter out soil particles that have been detached and transported in water. | Barriers such as straw bales, sandbags, fiber rolls, and gravel bag berms; desilting basin; cleaning measures such as street sweeping |
| Wind Erosion Controls | The aims and methods of wind erosion control are similar to those of erosion control described above. | See *Erosion Controls* above. |
| Tracking Controls | Minimize the tracking of soil offsite by vehicles | Stabilized construction roadways and construction entrances/exits; entrance/outlet tire wash. |
| Nonstorm Water Management Controls | Prohibit discharge of materials other than stormwater, such as discharges from the cleaning, maintenance, and fueling of vehicles and equipment. Conduct various construction operations, including paving, grinding, and concrete curing and finishing, in ways that minimize non-stormwater discharges and contamination of any such discharges. | BMPs specifying methods for: paving and grinding operations; cleaning, fueling, and maintenance of vehicles and equipment; concrete curing; concrete finishing. |
| Waste Management and Controls (i.e., good housekeeping practices) | Management of materials and wastes to avoid contamination of stormwater. | Spill prevention and control, stockpile management, and management of solid wastes and hazardous wastes. |

Source: CASQA 2003.

Furthermore, demolition, land clearing, grading, and construction activities of projects approved pursuant to the proposed General Plan would be required to comply with South Coast Air Quality Management District Rules 403 and 403.2 regulating fugitive dust emissions, thus minimizing wind erosion from such ground-disturbing activities. Construction activities would not generate substantial erosion. Soil erosion impacts would be less than significant.

Impacts would be the same under the Expanded EDC Scenario.

***IMPACT 5.6-5: SOIL CONDITIONS COULD RESULT IN RISKS TO LIFE OR PROPERTY. [THRESHOLDS G-3 AND G-4]***

***Impact Analysis:*** The following describes potential hazards from soil conditions in Menifee.

**Compressible Soils**

Compressible soils are most likely to occur in the modern and prehistoric floodplains of the major drainages, such as the San Jacinto River and Warm Springs Creek outside the City, and Salt Creek and Paloma Valley within the City boundary. Compressible soils are also commonly found in hillside areas, typically in canyon bottoms, swales, and at the base of natural slopes. The upper few feet of older alluvium, which are commonly weathered and/or disturbed, are also typically compressible.

When development is planned within areas that contain potentially compressible soils, a geotechnical soil analysis is required to identify this hazard. The analysis should consider soil types onsite; the load of any proposed fills and structures that are planned; the type of structure (i.e., a road, pipeline, or building); and local groundwater conditions. Removal and recompaction of near-surface soils are generally the minimum required. Deeper removals may be needed for heavier loads or for structures that are sensitive to minor settlement. Based on the soil analysis, partial removal and recompaction of the compressible soils is sometimes performed, followed by settlement monitoring for a number of months after additional fill has been placed but before structures are built. In cases where it is not feasible to remove the compressible soils, buildings can be supported on specially engineered foundations that may include caissons or piles.

**Collapsible Soils**

Young alluvial sediments in the Menifee area may be locally susceptible to soil collapse due to their low density, granular nature, rapid deposition in the alluvial fan environment, and the generally dry condition of the near-surface soils.

The potential for soils to collapse should be evaluated on a site-specific basis as part of the geotechnical studies for development. If the soils are determined to be collapsible, the hazard can be reduced by several different measures or combination of measures, including excavation and recompaction, or presaturation and preloading of the susceptible soils in place to induce collapse prior to construction. After construction, infiltration of water into the subsurface soils should be minimized by proper surface drainage design to direct excess runoff to catch basins and storm drains.

**Expansive Soils**

Soils in parts of the City may be expansive: valley and canyon areas and weathered old alluvial fan deposits. Development of projects on sites underlain by expansive soils could subject people and structures to hazards from expansive soils. Development of projects pursuant to the General Plan would require subsurface geotechnical exploration and testing and compliance with recommendations in project geotechnical investigation reports.

**Corrosive Soils**

Near-surface soils throughout the valley areas have low electrical resistivity, making them moderately to highly corrosive to metals. Development of projects on sites in valley areas could expose people and structures to hazards from corrosive soils. Development of projects pursuant to the General Plan would require subsurface geotechnical exploration and testing and compliance with recommendations in project geotechnical investigation reports. Site-specific recommendations must be provided by an engineer who is a corrosion specialist.

**Ground Subsidence**

Although subsidence has not been reported in Menifee, this hazard has been documented nearby in the San Jacinto Valley, from Hemet to Moreno Valley, and in Temecula and Murrieta. In the San Jacinto Valley and Temecula, the subsidence and related ground fissuring have been attributed to groundwater withdrawal. In Murrieta, the subsidence and fissuring were caused by large-scale application of landscape water to arid alluvial soils.

General Plan buildout would increase water demands in the City. The water provider for Menifee, Eastern Municipal Water District, relies on local groundwater for part of its water supplies. The City overlies parts of

the Perris South and Menifee Management Zones of the San Jacinto Groundwater Basin. Groundwater levels in the West San Jacinto Groundwater Basin Management Area, a 250-square-mile area extending from Menifee in the south to Moreno Valley in the north, have been increasing in recent years; high total dissolved solids in the groundwater in the area limit production of groundwater for municipal use. Thus, while General Plan buildout would increase water demands in the City, it is unlikely that buildout would result in lowered groundwater levels under Menifee that could cause ground subsidence.

Water efficiency requirements for landscape irrigation in Menifee are in Chapter 15.04 of the City Municipal Code. Projects developed pursuant to the proposed General Plan would comply with Municipal Code Chapter 15.04, thus reducing the potential for landscape irrigation in the City to cause ground subsidence. Considering water supplies available in Menifee and current and planned water management efforts, substantial hazards from land subsidence are unlikely. Impacts would be less than significant.

Impacts would be the same for the Expanded EDC Scenario.

***IMPACT 5.6-6 USE OF SEPTIC TANKS OR OTHER ALTERNATIVE WASTE WATER DISPOSAL SYSTEMS WOULD BE SUPPORTED. [THRESHOLD G-5].***

***Impact Analysis:*** The City of Menifee is in the wastewater treatment service area of the Eastern Municipal Water District. Most development and redevelopment that would be approved pursuant to the proposed General Plan would involve sewer connections. However, septic tanks may be used in General Plan designations permitting residential densities below two units per acre. Five proposed General Plan designations would permit residential development at densities of two units per acre or less: four Rural Residential designations, RR5 through RR1/2, and the Rural Mountainous (RM) designation. New developments in General Plan designations where use of septic tanks would be permitted would be required to conduct percolation tests before installation of septic systems—as required by the Riverside County Department of Environmental Health—to verify that water will percolate into soil under the site at an adequate rate for the septic system to function. Additionally, septic systems are required to comply with the California Plumbing Code, California Code of Regulations, Title 24, Part 5. Impacts would be less than significant.

The Expanded EDC Scenario would permit development of 101 fewer residential units in Rural Residential designations (RR1 and RR2) than would the proposed General Plan, and would thus reduce slightly the number of permitted residential units that would be allowed to use septic tanks. Impacts would be less than significant.

### *5.6.4 Existing Regulations and Standard Conditions*

**State**

- Alquist-Priolo Earthquake Fault Zoning Act (California Public Resources Code Sections 2621 et seq.)
- Seismic Hazards Mapping Act (California Public Resources Code Section 2695)
- California Building Code (CBC; Title 24, California Code of Regulations [CCR], Part 2)
- Unreinforced Masonry Law (California Government Code Sections 8875 et seq.)
- Natural Hazards Disclosure Act (California Civil Code Sections 1103 et seq.; California Public Resources Code Section 2694)
- General Permit for Discharges of Storm Water Associated with Construction Activity (Order 2009-0009-DWQ, State Water Resources Control Board)
- California Health and Safety Code Sections 17953 to 17955 and CBC Section 1802: Requirements for Geotechnical Investigation
- California Code of Regulations Title 24 Part 5: California Plumbing Code

**Regional**

South Coast Air Quality Management District Rules 403 and 403.2: Fugitive Dust Control

**Relevant General Plan Policies**

Relevant Menifee General Plan policies are in the Safety Element and are listed in Appendix C of this EIR.

### *5.6.5 Level of Significance Before Mitigation*

Upon implementation of regulatory requirements and standard conditions of approval, the following impacts would be less than significant: 5.6-1, 5.6-2, 5.6-3, 5.6-4, 5.6-5, and 5.6-6. These significance conclusions would be the same for the Expanded EDC Scenario.

### *5.6.6 Mitigation Measures*

No mitigation measures are required.

### *5.6.7 Level of Significance After Mitigation*

Impacts would be less than significant for the proposed General Plan as well as for the Expanded EDC Scenario.

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