5.5 GEOLOGY AND SOILS

This section of the Draft Environmental Impact Report (DEIR) evaluates the potential for implementation of the Spring Trails project to impact geological and soil resources in the Devore area of unincorporated San Bernardino County, the sphere of influence of the City of San Bernardino, and the City of San Bernardino.

The analysis in this section is based in part on the following technical report(s):

- *Geotechnical Feasibility and Geologic Fault Study, 350 Acres, Martin Ranch Tentative Tract 15576, Devore Area, San Bernardino County, California*, Kleinfelder, May 28, 1997
- *Preliminary Geotechnical Investigation, Proposed Residential Development, 353 Acres, Martin Ranch Tentative Tract 15576, Devore Area, San Bernardino, California*, Kleinfelder, July 28, 2000
- *2007 California Building Code Seismic Design Parameters Proposed Martin Ranch Development, Devore Area of Unincorporated San Bernardino County (City of San Bernardino Sphere of Influence), California*, Leighton and Associates, June 17, 2009

Complete copies of these studies are included in the Technical Appendices to this Draft EIR (Volume II, Appendices F1 through F3).

5.5.1 Environmental Setting

Geologic Setting

Regional Setting

The project site is on the southwestern slopes of the San Bernardino Mountains. The San Bernardino Mountains are in the eastern portion of the Transverse Ranges Geomorphic Province, an east–west trending series of steep mountain ranges and valleys that extend from Santa Barbara County in the west to central Riverside County in the east. This province is structurally complex and is traversed by several major fault zones, including the San Andreas, San Jacinto, Cucamonga, San Gorgonio Pass, Crafton Hills, Tokay, and Peters fault zones. The San Bernardino Mountains are the youngest of the eastern Transverse Ranges and are being actively elevated. The San Bernardino Mountains are surrounded by the San Andreas Fault and the Cajon Pass to the west, the San Andreas Fault and San Gorgonio Pass to the south and southwest, the Little San Bernardino Mountains to the east, and the Mojave Desert to the north.

Regional geology is dominated by right lateral faulting of the San Andreas Fault. The modern trace of the San Andreas Fault near the project site is the Cajon Pass-Mill Creek segment of the San Bernardino Strand. The San Bernardino strand passes through the southern part of the project site and extends roughly 37 miles from Cajon Pass to near Banning Canyon. The Cajon Pass-Mill Creek segment is characterized by conspicuous expression in landforms, simplicity, and abundant evidence of youthful activity. Such evidence includes scarps, sag ponds, and pressure and shatter ridges; linear vegetation; shallow groundwater backed up behind the fault; and alluvial fans and drainage lines that have been offset by the fault during Holocene and recent time, that is, within roughly the last 10,000 years. Maximum displacement of the San Bernardino Strand of the San Andreas is estimated at no more than three kilometers. The Holocene slip rate of the San Andreas Fault has been measured as 25 millimeters per year in the Cajon Pass area.

Project Site

Most of the site consists of a southwest-sloping alluvial terrace dissected on the west and east by Cable Canyon and Meyers Canyon, respectively. In the south-central part of the site the San Andreas Fault Zone forms a northwest-trending topographic break. The southeast and northern parts of the site are relatively steep hillsides. Slopes onsite range from about 10 to 15 percent toward the southwest in the central and southwest portions of the site, to 15 to 70 percent with steeply incised drainage areas on the balance of the site. Elevations onsite range from 2,010 feet above mean sea level (amsl) in the southeast portion of the site to 3,540 feet amsl in the northeastern part of the site, as shown on Figure 5.5-1, *Site Topography*. The site is surrounded to the south and southwest by an alluvial fan that has formed where Cable Creek and Meyers Creek flow out of the San Bernardino Mountains and into the Upper Santa Ana River Valley.

Geologic Units

Geologic units onsite include outcrops of the metamorphic rocks schist and gneiss in the northern part of the site, labeled *Gn* on Figure 5.5-2, *Geologic Map*. These rocks are mostly highly weathered, fractured, foliated,[1] and moderately hard.

Older alluvial deposits of late Pleistocene to early Holocene age[2] are found at depths below four to six feet below ground surface (bgs) in the central and southwest parts of the site, and are labeled *Qalo* on Figure 5.5-2. These soils are generally well consolidated and contain boulders, cobbles, and gravels within a matrix of silty sand and sand. On ridges within the site, there are late Pleistocene remnant alluvial surfaces consisting of poorly to moderately cemented, well-consolidated sands and silts with significant amounts of cobbles and gravels. Cobbles and gravels in soils on ridges consist of easily crumbled to hard granitic rock derived from the San Bernardino Mountains to the north. South of the San Andreas Fault, these materials were typically overlain by four to six feet of reddish colluvial material.[3]

In the central and southwest parts of the site, late to mid-Holocene alluvial deposits lie generally four to five feet thick over the Pleistocene sediments. These Holocene deposits are typically dry to slightly moist noncohesive cobbles and gravels within a sandy silt and silty sand matrix, and are labeled *Qal2* on Figure 5.5-2.

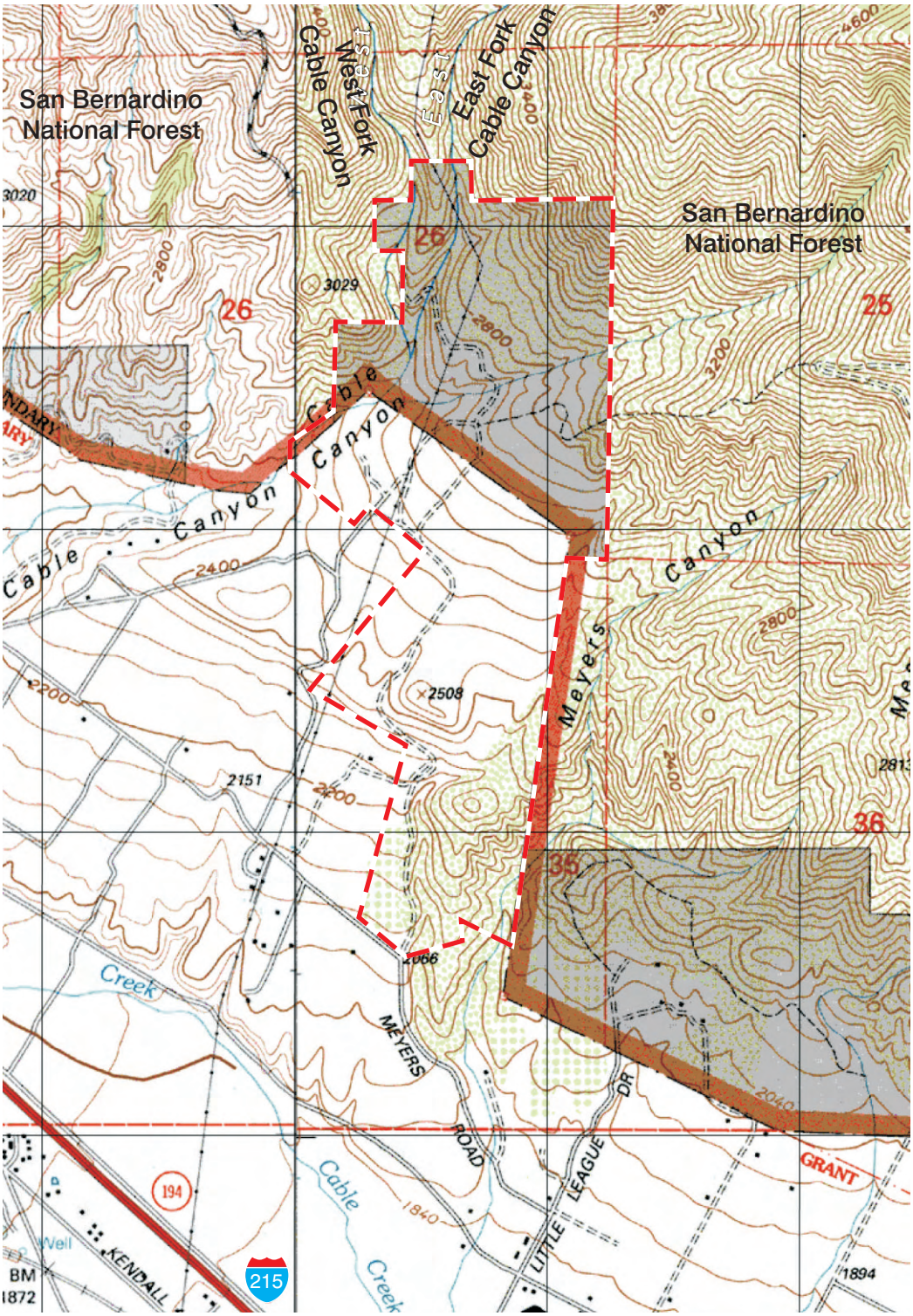
Recent alluvium, denoted *Qal1* on Figure 5.5-2, occurs in the active drainage areas of the site. This material consists of poorly to well-bedded deposits of cobbley gravelly sands and silts. This alluvium coalesces with *Qal2* alluvium and also overlies Pleistocene alluvium and metamorphic bedrock.

Groundwater

Generally, groundwater levels beneath the site are greater than 50 feet below ground surface (bgs). During the 2000 geotechnical investigation by Kleinfelder, 25 exploratory borings were excavated to depths of up to 40 feet bgs, and 18 test pits were dug to depths of up to 8 feet bgs. Evidence of groundwater was not observed in any of the test pits dug onsite to depths of up to 8 feet. However, recent alluvial deposits in Cable Canyon and Meyers Canyon, denoted *Qal1* on Figure 5.5-2, contain lush riparian vegetation and very moist soils, indicating shallow groundwater levels in the lower parts of these canyons. Groundwater was found in borings B-22 and B-23 at 20 feet bgs. These borings are in an isolated area in the eastern part of the site along the northeast side of the San Andreas Fault, which acts as a local groundwater barrier within the site.

[1] Sheet-like arrangement of minerals in a rock.
[2] The Pleistocene Epoch extends from roughly 10,000 years before present (ybp) to about 1.8 million ybp, and the Holocene Epoch extends from the present to about 10,000 ybp.
[3] Colluvium is sediment that falls to the base of a slope and then builds up there, such as talus or scree.

Site Topography



Site Boundary

Source: Maptech 1997

0 1,600
Scale (Feet)

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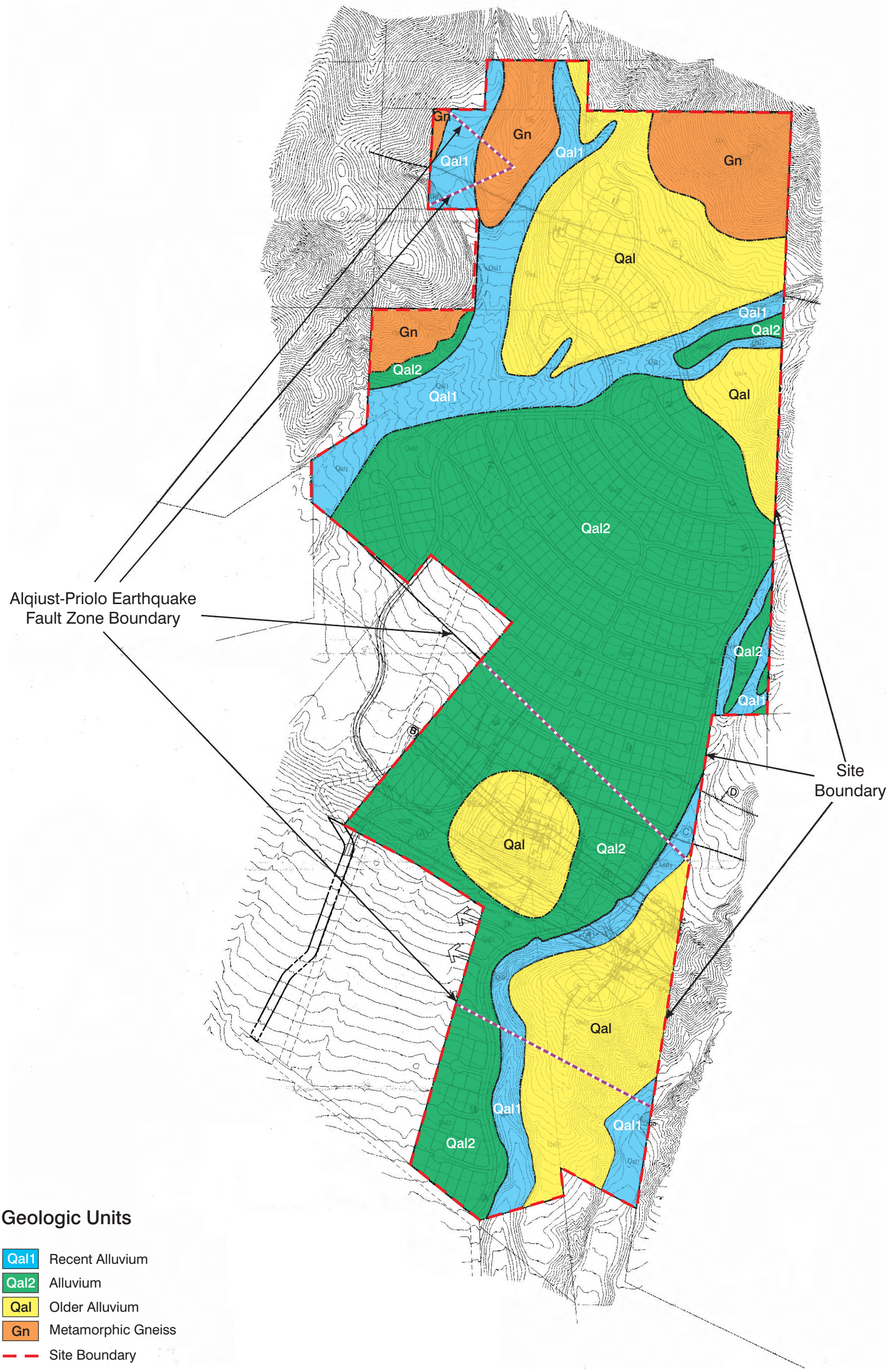
Geologic Map



Source: Kleinfelder Inc. 1997

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Geologic Hazards

Faulting and Seismic Hazards

Southern California is known to be seismically active. The amount of energy released by an earthquake determines the amplitude of the waves that the earthquake generates. The Richter scale is a logarithmic scale of the amplitude of earthquake waves as measured at a specific location. Each one-point increase in magnitude represents a 10-fold increase in wave amplitude 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, and releases approximately 1,000 times (32 x 32) more energy.

San Andreas Fault

The central Transverse Ranges segment of the San Andreas Fault consists of four strands; from northwest to southeast these are the San Bernardino, Mill Creek, Wilson Creek, and Mission Creek strands. Together these four strands have generated about 100 miles of right-lateral displacement. The youngest of these strands, the San Bernardino Strand, extends about 37 miles along the base of the San Bernardino Mountains from Cajon Pass southeast to near Banning Canyon and has a well-documented Holocene slip rate of about one inch per year.

Four splays, or lineaments, of the San Andreas Fault have been identified onsite. The main splay is a zone ranging from roughly 50 to 150 feet wide, designated "A" on Figure 5.5-3, *Fault Splays on the Project Site*. The splay is a strong topographic break between younger alluvial soils and Pleistocene-age alluvium. There is a right-lateral drainage offset[4] about 700 feet in length in the southeastern part of the site. Five exploratory fault trenches were excavated across lineament A. Evidence of active faulting in these trenches included a rupture zone extending to the ground surface, a groundwater barrier with groundwater seepage, and offset sediment layers.

Lineament B is about 500 to 650 feet north of and roughly parallel to lineament A. Lineament B is on the north side of a knoll next to the northeast side of the San Andreas Fault. Eleven fault trenches were excavated across lineament B; evidence of active faulting was seen in 10 of the 11 trenches.

Lineament C trends west-northwest across the central part of the site, and is characterized by a subtle break in slope in foothills to the east and by irregular vegetation in the central portion of the site. Seven fault trenches were excavated across lineament C. In five of the trenches, depositional surfaces were observed over pre-Holocene fault scarps; however, no evidence of Holocene age displacement was observed.

Lineament D lies outside the Alquist-Priolo Fault Zone, partially running through the eastern edge of the project site.

Lineament E crosses the northern part of the site trending west-northwest. One fault trench was excavated across the trace. A small fracture was found in older sediments near the bottom of the trench, and is thought to be related to a deeper bedrock fault that may have caused the surface expression of Lineament E.

Other Regional Faults

A database search identified 31 active and potentially active faults within 62 miles of the project site. This entire list of faults is included in Appendix F3; the five faults that are considered to have the greatest potential

[4] Right-lateral offset is horizontal, with ground on the opposite side of the fault from the viewer appearing to have shifted to the right.

to cause strong ground shaking on the project site are listed in Table 5.5-1 and are shown in Figure 5.5-4, *Regional Fault Map*.

Table 5.5-1
Significant Faults near the Project Site

Fault Name	Approximate Distance from Site, miles	Maximum Earthquake, Moment Magnitude
San Andreas – San Bernardino Branch	Onsite	7.5
San Andreas – Mojave Branch	8	7.4
San Jacinto – San Bernardino Branch	3	6.7
Cucamonga	4	6.9
North Frontal – Western Branch	8	7.2

Source: Leighton and Associates, 2009.

As shown in Table 5.5-1, other than the San Bernardino Branch of the San Andreas Fault that passes through the project site, the faults that are capable of generating the strongest earthquakes at the project site are the Mojave Branch of the San Andreas Fault and the Western Branch of the North Frontal Fault.

Surface Rupture of a Fault

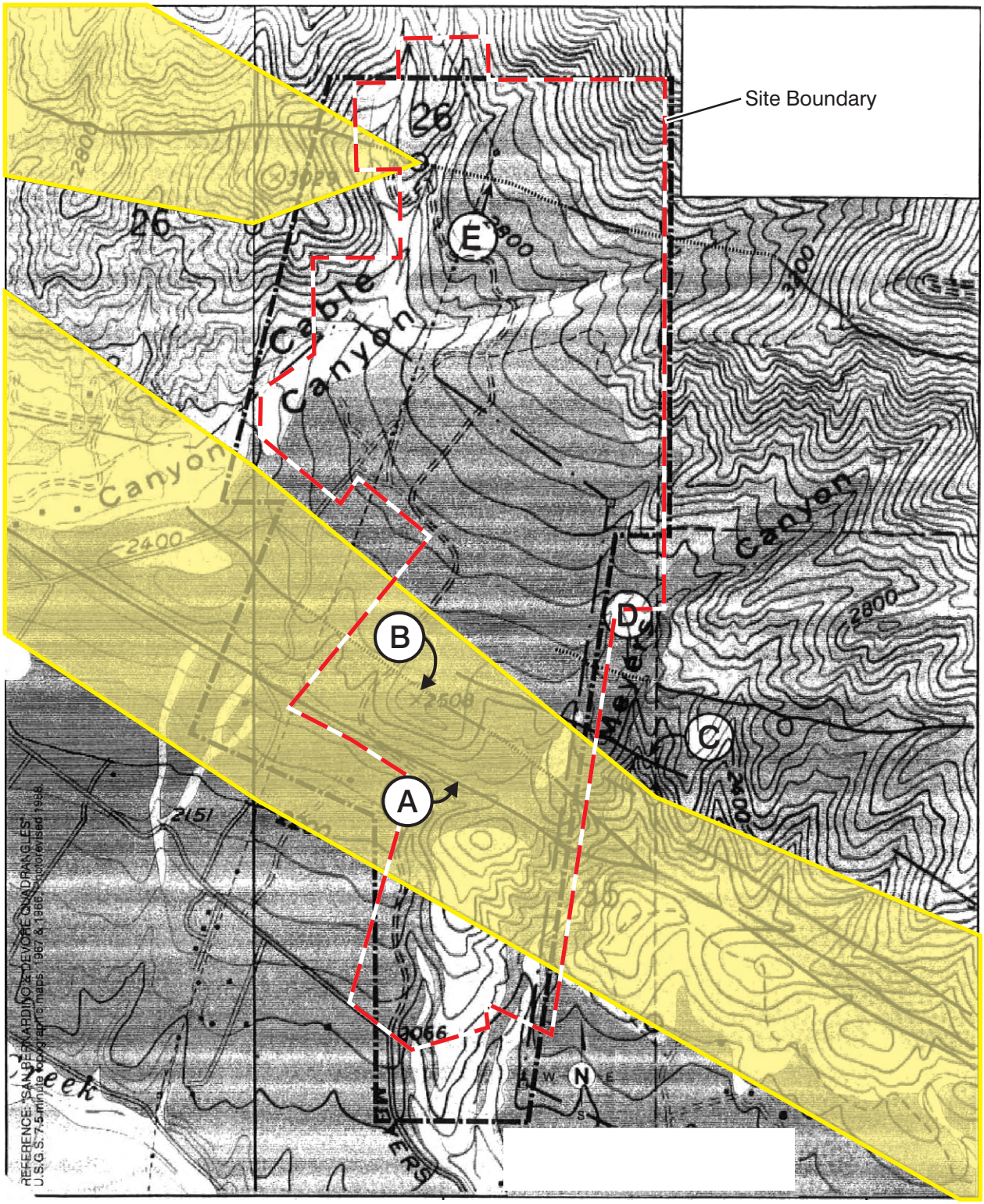
As evidence of active faulting was observed along lineaments A and B, and a small rupture in fault trench was observed along lineament E, surface rupture of a fault splay could occur onsite from an earthquake on the San Andreas Fault. The geotechnical investigation of the site recommended setback zones extending 50 feet from each side of lineaments A, B, and E.

Two portions of the site are within Alquist-Priolo Earthquake Fault Zones. The Alquist-Priolo Earthquake Fault Zone Act, described below under Regulatory Setting, requires the State Geologist to delineate “Earthquake Fault Zones” along faults that are “sufficiently active” and “well defined.” One of two zones on the site consists of much of the southern half of the site and includes lineaments A, B, and C; the second is in a portion of the northwest corner of the site and includes part of lineament E. Figure 5.5-3 shows these fault zones, which run northwest to southeast through the project site.

Strong Ground Shaking

The peak horizontal ground acceleration that could affect the site was estimated by Leighton and Associates using the computer program EZ-FRISK (see Appendix F3). The maximum considered earthquake is an earthquake with a 2 percent probability of exceedence at a site in 50 years, or an average return period of 2,475 years. The peak horizontal ground acceleration (PHGA) expected on the site in such an earthquake is 1.15 g, where g is the acceleration of gravity. An acceleration of 1.15 g corresponds roughly to an intensity of IX on the Modified Mercalli Intensity (MMI) Scale, which is a scale of how earthquakes are felt by people and how they affect structures (Wald 1999). The MMI Scale 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. In an Intensity IX earthquake damage is considerable in specially designed structures; well-designed frame structures are thrown out of plumb. Damage is great in substantial buildings, with partial collapse and buildings are shifted off foundations (USGS 2009). Seismic design parameters for the site were also determined by Leighton and Associates and are contained in Appendix F3.

Fault Splays on the Project Site



Site Boundary

Alquist-Priolo Earthquake Fault Zones

A Splay of San Andreas Fault

0 1,200
Scale (Feet)

Source: Kleinfelder 1997

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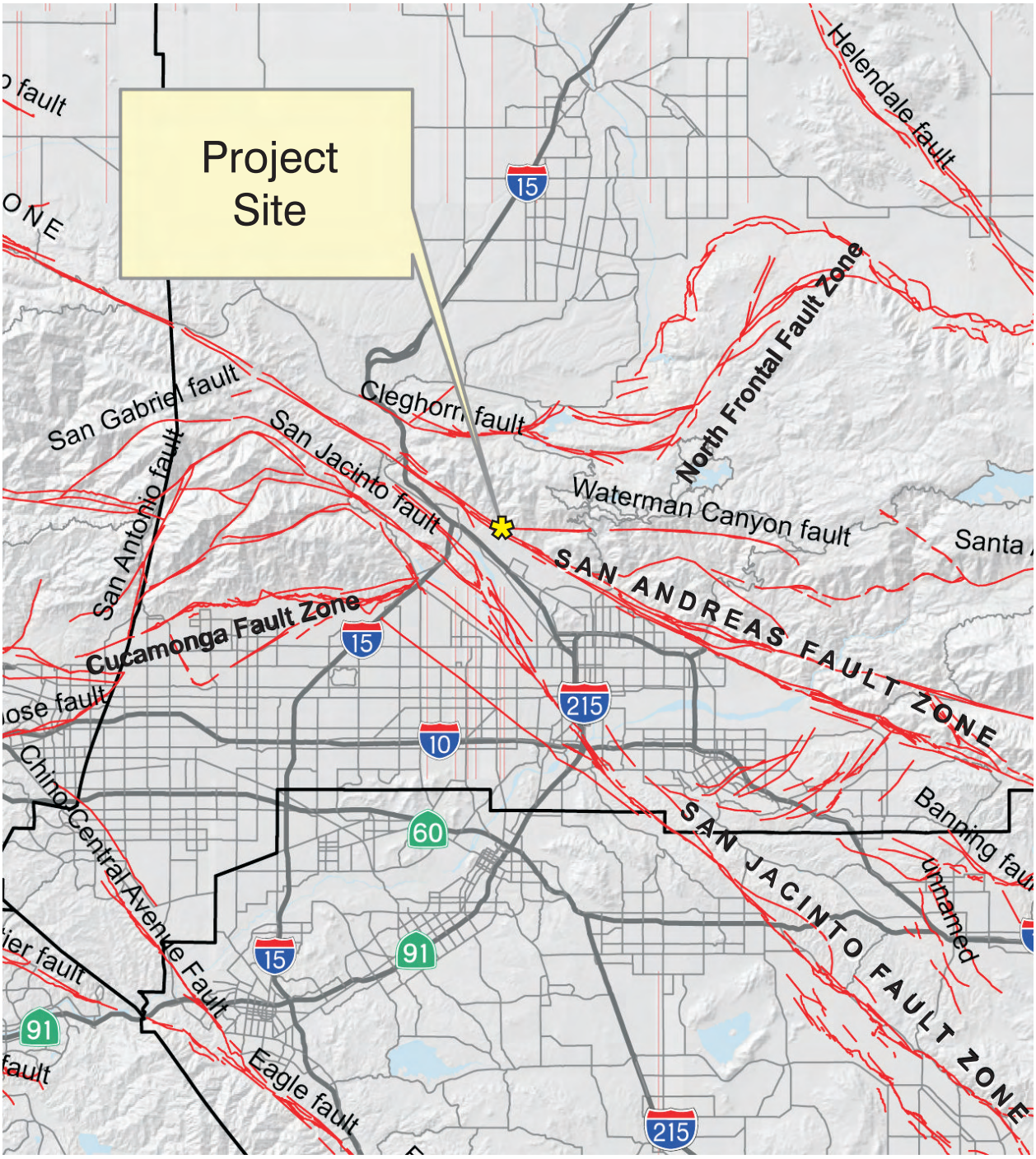
Regional Fault Map



0 7.75
Scale (Miles)

Source: Leighton Group 2009

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Liquefaction

Liquefaction is the transformation of a granular material, usually a saturated sand, from a solid state to a weakened or liquefied state as a result of ground shaking. Sand that is shaken tends to become compacted. If water cannot drain from the sand, the compaction tends to increase water pressure in pores between the sand grains to such an extent that the sand loses strength and develops a liquefied state. In general, the more recently sediment has been deposited, the more susceptible it may be to liquefaction. In addition, liquefaction potential is greater in loose, poorly graded sands and silty sands. Other factors influencing susceptibility to liquefaction include shallow groundwater, confining stresses on sediments, soil density, and intensity and duration of ground shaking.

Generally, groundwater levels beneath the site are greater than 50 feet bgs. During the 2000 geotechnical investigation by Kleinfelder, 25 exploratory borings were excavated to depths of up to 40 feet bgs, and 18 test pits were dug to depths of up to 8 feet bgs. Evidence of groundwater was not observed in any of the test pits to depths of up to 8 feet. However, recent alluvial deposits in Cable Canyon and Meyers Canyon (*Qal1* on Figure 5.5-1) contain lush riparian vegetation and very moist soils, indicating shallow groundwater levels in the lower parts of these canyons. Groundwater was found in borings B-22 and B-23 at 20 feet bgs. These borings are in an isolated area in the eastern part of the site along the northeast side of the San Andreas Fault, which acts as a local groundwater barrier within the site.

With the exception of recent alluvial deposits in the southern part of the project site, the site is underlain by older (late Pleistocene to early Holocene age) alluvial/colluvial soils, which, together with probable deep groundwater, indicate a low liquefaction potential. An isolated area in the eastern part of the site along the northeast side of the San Andreas Fault is underlain by variable depths of apparent Holocene silty sands where groundwater is within eight feet of the ground surface. This area is considered susceptible to liquefaction and is shown in Figure 5.5-5, *Areas of Liquefaction Potential*.

Lateral Spreading

Lateral spreading is the downslope movement of surface sediment caused by both gravity and ground shaking and due to liquefaction in a subsurface layer. Such movement can occur on slope gradients of as little as one degree. Lateral spreading typically damages pipelines, utilities, bridges, and structures. The potential for lateral spreading on most of the site is considered to be very low, due to the low potential for liquefaction.

Seismic Settlement

Seismic events can trigger the settlement of soils, thereby lowering the surface elevation. This phenomenon can be increased when the weight of structures adds additional pressure to the ground. The subsurface soils on most of the site are relatively dense and thus are not expected to be prone to substantial seismic settlement.

Earthquake-Induced Landslides

The maximum gradient of the natural slopes on the site approaches 1.2:1 (horizontal:vertical). No surface indications of slope instability or significant “out of slope” geologic bedding conditions were observed. No significant natural slope instability exists.

Other Geologic Hazards

Expansive Soils

Expansive soils shrink or swell as their moisture content increases or decreases; this shrinkage or swelling may cause structures or pavements on such soils to settle or heave. Based on the nature of the soils under the site, the expansion potential of soils is thought to be low to very low.

Corrosive Soils

One sample of near-surface soil from boring B-17 was tested for potential for corrosion to concrete and reinforcing steel. These test results indicate a low to moderate potential for corrosion to concrete, and moderate potential for buried metals.

Collapsible Soils

A collapsible soil shrinks considerably when wetted, when a load is placed atop the soil, or under both conditions. Such shrinkage can damage structures built on the soil, or structures such as pipelines built within the soil. The potential for soil collapse is regarded as low due to the granular nature of the soils.

Ground Subsidence

Ground subsidence is usually a result of the withdrawal of groundwater or oil from an area. Leighton and Associates is not aware of substantial groundwater or oil withdrawals in the area that could lead to subsidence, and the potential for ground subsidence is regarded as low.

Regulatory Setting

State, regional, and local laws, regulations, plans, or guidelines related to geology and soils that are potentially applicable to the proposed project are summarized below.

State

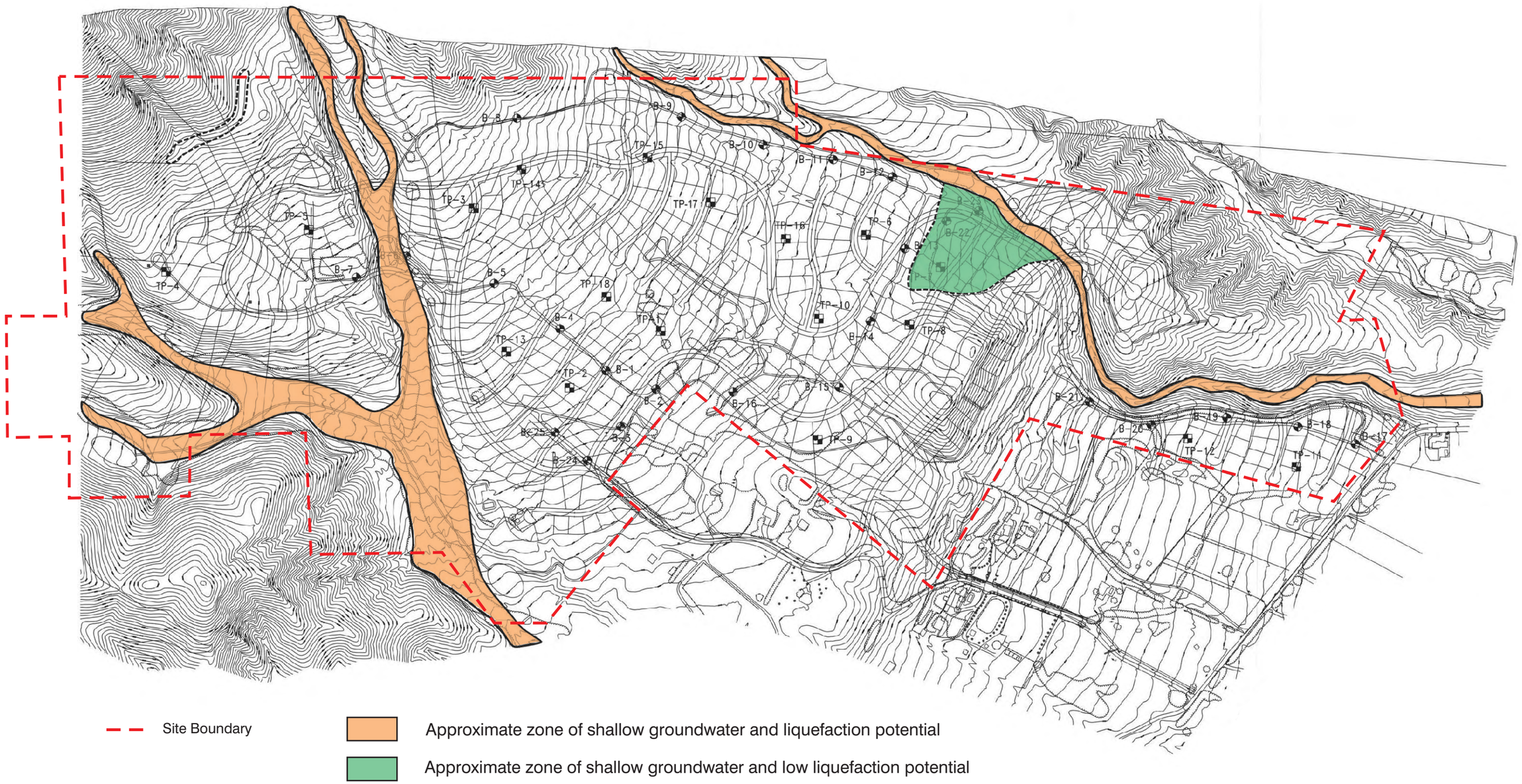
California Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was signed into state law in 1972, with its primary purpose 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 was adopted by the state in 1990 for the purpose of protecting 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 zones maps that identify areas susceptible to amplified shaking, liquefaction, earthquake-induced landslides, and other ground failures.

Areas of Liquefaction Potential



Source: Lilburn Corporation 2006

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Uniform Building Code and California Building Code

Current law states that every local agency enforcing building regulations, such as cities and counties, must adopt the provisions of the 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 of the California Code of Regulations. The most recent building standard adopted by the legislature and used throughout the state is the 2007 version of the CBC, often with local, more restrictive amendments that are based upon local geographic, topographic, or climatic conditions. These codes provide minimum standards to protect property and the public welfare 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 procedures and limitations for the design of structures are based on site characteristics, occupancy type, configuration, structural system height, and the strength of ground motion with specified probability of occurring at the 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 Hazards Disclosure Statement when the property being sold lies within one or more state-mapped hazard areas. If a property is located in a Seismic Hazard Zone, as shown on a map issued by the State Geologist, the seller or the seller's agent must disclose this fact to potential buyers. 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" by the California Seismic Safety Commission.

General Permit for Stormwater Discharges Associated with Construction Activities

Pursuant to the federal Clean Water Act, in 2009 the State Water Resources Control Board (SWRCB) issued a statewide general NPDES Permit for stormwater discharges from construction sites (NPDES No. CAS000002). Under this Statewide General Construction Activity permit construction sites with a disturbed area of one or more acres are required to control stormwater discharges by completing and filing a Notice of Intent (NOI) with the SWRCB and developing and implementing a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP must be prepared prior to start of grading activities and must be implemented during construction. The SWPPP must list BMPs implemented on the construction site to prevent soil erosion and discharge of other construction-related pollutants that could contaminate nearby water resources. The proposed project encompasses 352.8 acres and is therefore subject to the stormwater discharge requirements of the General Construction Permit. Prior to obtaining any grading permits, the project applicant must provide evidence of compliance with the General Construction Permit by providing a copy of the Waste Discharger's Identification Number to the City's Development Services Department.

City of San Bernardino

San Bernardino Municipal Code Sections 15.04.163 and Section 15.04.210: Grading

Chapter 15.04.163 states that a grading plan and a grading permit shall be required for any grading activity involving more than 50 cubic yards, and that all grading plans shall be prepared by a registered civil engineer. Chapter 15.04.210 incorporates Section 112 of Appendix J of the International Building Code into the City's Municipal Code.

San Bernardino Development Code Chapter 19.15: Foothill Fire Zones Overlay District

Chapter 19.15 of the City of San Bernardino Development Code includes standards for erosion control and for construction and development design, which are required in Foothill Fire Zones Overlay Districts.

San Bernardino Development Code Chapter 19.17: Hillside Management Overlay District

Chapter 19.17 of the City of San Bernardino Development Code includes development performance standards regarding soils and grading, geotechnical conditions, and preservation or reestablishment of vegetation on slopes, including graded slopes. Performance standards in Chapter 19.17 relevant to geotechnical and soils conditions are listed below.

Section 19.17.070 Development Performance Standards

1. Soils and Grading

A. Grading of any site shall conform to the following grading standards, based upon the percent of the natural slope. The City Engineer shall review and make recommendation to the Planning Commission on the proposed grading.

1. 0–15%. Redistribution of earth over large areas may be permitted.

2. 15+–25%. Some grading may occur, but landforms must retain their natural character. Padded building sites may be allowed, but custom foundations, split level designs, stacking and clustering is expected to mitigate the need for large padded building areas.

3. 25+–30%. Limited grading may occur, however, major topographic features shall retain their natural landforms. Special hillside architectural and design techniques are expected in order to conform to the natural land form, by using techniques such as split level foundations of greater than 18 inches, stem walls, stacking and clustering.

4. Greater than 30%. Development and limited grading can only occur in this category if it can be clearly demonstrated that safety, environmental, and aesthetic impacts will be avoided. Use of larger lots, variable setbacks and variable building structural techniques such as stepped or pole foundations are expected. Structures shall blend with the natural environment through their shape, materials and colors. Impact of traffic and roadways is to be minimized by following natural contours or using grade separations.

B. Grading shall be designed to:

1. Conserve natural topographic features and appearances by means of land sculpturing to blend graded slopes and benches with natural topography.

2. Retain major natural topographic features such as canyons and prominent landmarks.

C. All graded areas shall be protected from wind and water erosion through acceptable slope stabilization methods such as planting, walls, or netting. Interim erosion control plans shall be required, certified by the project engineer, and reviewed and approved by the Public Works Department.

D. Slopes created by grading of the site shall not exceed 50 percent or 2:1, without a soils report and stabilization study indicating a greater permissible slope; or shall not exceed 30 feet in height between terraces or benches; except that the Planning Commission may permit slopes

exceeding these dimensions where the slopes will result in a natural appearance and will not create geological or erosion hazards.

2. Geotechnical

1. Any subdivision within the Alquist-Priolo "Special Studies Zone" shall conduct a geologic study in conformance with the requirements of the Zone. This study shall be prepared by a certified engineering geologist.

2. No structure for human occupancy shall be permitted within 50 feet of an active or potentially active fault trace. Sensitive and high occupancy structures as defined in the General Plan shall maintain a minimum 100 foot setback.

3. No emergency facilities, community facilities, or places of general public assembly (not including open space areas) shall be permitted within the Alquist-Priolo Zone.

4. All structures within the trace shall require the seismic features of the structure to be reviewed and approved by a professional engineer specializing in seismic/structural design.

5. The Building Official may require special construction methods of structures where it has been determined to have potential geologic hazards.

6. A statement shall be included at the time of purchase agreement and at the close of escrow to the purchaser of each lot within the development, which informs the prospective owner of the potential for seismic activity, and the potential hazards.

3. Water/Drainage

B. Natural drainage courses should be protected from grading activity.

Laws and Regulations Governing Erosion into Stormwater

Construction of the proposed project would comply with best management practices (BMPs) that have the aim of reducing or eliminating soil erosion from construction sites. Common means of soil erosion from construction sites include water, wind, and being tracked offsite by vehicles. Compliance with these BMPs is required by the federal Clean Water Act and within the City of San Bernardino is administered by the NPDES Division of the City's Department of Development Services, pursuant to Chapter 8.80 of the San Bernardino Municipal Code.

5.5.2 Thresholds of Significance

According to the City of San Bernardino's environmental impact thresholds, a project would normally be determined to have a significant environmental impact related to geology and soils if the project would:

G-1 Involve earth movement (cut and/or fill) based on information contained in the Preliminary Project Description?

G-2 Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death including:

i) Rupture of a known earthquake fault within an Alquist-Priolo Earthquake Fault Zone?

ii) Strong seismic ground shaking?

iii) Seismic related ground failure, including liquefaction?

G-3 Be located within an area subject to liquefaction as identified in the City's General Plan?

G-4 Be located within an area subject to landslides, mudslides, subsidence or other similar hazards including areas identified in the City's General Plan?

G-5 Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?

G-6 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?

G-7 Modify any unique geological or physical feature based on a site survey/evaluation?

G-8 Result in erosion, dust, or unstable soil conditions from excavation, grading, fill, or other construction activities?

G-9 Development within Hillside Management Overlay District on slopes in excess of 15 percent?

The Initial Study, included as Appendix A, substantiates that impacts associated with Threshold G-6 would be less than significant; therefore, this impact will not be addressed in the following analysis.

5.5.3 Environmental Impacts

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

In addition to the proposed development of the project site, the proposal also includes the annexation of an adjacent 26.4-acre area consisting of six parcels owned by various property owners. A land use proposal has not been submitted for this 26.4-acre area and it is not owned or otherwise under the control of the applicant. For these reasons, no development is expected to occur on these parcels. Therefore the annexation would not contribute to impacts related to geology and soils.

Alternative (Overhead Electric Line) Development Plan

The Spring Trails project assumes that the Southern California Edison (SCE) overhead electric lines that traverse the western portion of the site will be located underground. In the event that the overhead electric lines cannot be located underground, an alternative plan accommodating the lines above ground, as shown in Chapter 3, *Project Description*, Figure 3-3A*, Alternative (Overhead Electric Lines) Development Plan,* is proposed for the project site. The alternative plan for Spring Trails is the same as the preferred plan in every respect except for the treatment of the land beneath the aboveground electric lines and the number of residential lots. Both scenarios are analyzed in this section to assess their respective impacts to geology and soils.

IMPACT 5.5-1: ***THE PROJECT WOULD INVOLVE GRADING ON ABOUT 216.7 ACRES OF LAND, WITH ROUGHLY 3.1 MILLION CUBIC YARDS OF CUT AND 2.8 MILLION CUBIC YARDS OF FILL. PROJECT EARTH MOVEMENT WOULD NOT RESULT IN SUBSTANTIAL ADVERSE EROSION OR DUST IMPACTS. [THRESHOLDS G-1 AND G-8 (PART)]***

Impact Analysis: Proposed site grading is described below in Table 5.5-2 and depicted in Figure 3-5, *Conceptual Grading Plan*, in Section 3, *Project Description*.

Table 5.5-2
Proposed Site Grading

Location	Cut Grading, Cubic Yards	Fill Grading, Cubic Yards[1]	Total Area Graded, Acres	Net Earthwork, Cubic Yards Deficit (–) or Surplus (+)
Project Site	2,700,000	2,700,000	193.0	---
Primary Access Road	171,000	55,000	4.2	+ 116,000
Secondary Access Road	244,000	109,000	19.5	+ 135,000
Total	3,115,000	2,864,000	216.7	+ 251,000

[1] Does not include shrinkage due to compaction of fill soils.

As shown above in Table 5.5-2, in addition to the specified amounts of cut and fill grading, the project would involve roughly 251,000 cubic yards of soil export. This quantity would be the same for the preferred development plan and the alternative (overhead electric lines) development plan since earthwork would be balanced on the project site under either scenario.

Project features are incorporated into the Spring Trails Specific Plan that would minimize soil erosion.

Project Features Regarding Soil Stability

Design Guidelines (Spring Trails Specific Plan)

- All graded slopes shall be stabilized and planted with the approved trees, shrubs, and groundcovers listed in the *Landscape Zones Plant Palette*, Table 3.6 in the Specific Plan Design Guidelines.

Development Standards

The Grading Plan in the Development Standards for the Spring Trails Specific Plan has been devised with overall goals, including minimizing grading quantities, minimizing slope maintenance and water consumption, and providing for stable slopes and building pads. Specific guidelines in the Grading Plan include:

- Minimize grading where possible.
- Avoid grading in areas where slopes exceed an average of 15 percent, to the greatest extent possible.
- Terrace drains and benches shall be added where slope height exceeds 30 feet, in accordance with the Uniform Building Code. In some instances, benches should be widened to provide for dual use as a recreation trail.

- Existing significant drainage courses shall be maintained as much as possible.
- Final grading design shall adhere to the final soils report recommendations.
- Grading shall be performed under the supervision of a registered soils engineer.
- Prepare and process a storm water pollution prevention program prior to grading.
- Preserve the natural terrain as much as possible by focusing development in the development footprint shown on Figure 3-3, *Development Plan*.
- Earth retention systems, where slopes can be planted to blend with the natural terrain, should be used where possible.
- All cut-and-fill slopes shall be revegetated to control erosion.

These guidelines would meet City and state development standards and soil stability would be maintained. In addition, the Safety Plan includes the following requirement pertaining to erosion control:

- Grading for building pads and roads shall conform to specifications of the geologist, based on a soils study and final geotechnical study.

Erosion Control Measures during Project Construction

In addition to the project guidelines and development standards described above, the project would prepare and implement a SWPPP specifying BMPs for minimizing pollution of stormwater during project construction. Categories of BMPs that would be included in the SWPPP include erosion control BMPs that cover and/or bind soil to prevent soil from entering runoff; and sediment control BMPs, such as barriers, that intercept and filter out soil that has been detached and transported by flowing water. Implementation of BMPs specified in the SWPPP would help stabilize project site slopes while vegetation planted by the project grows.

After implementation of project guidelines and development standards, and BMPs for erosion control and sediment control to be specified in the project's SWPPP, project development is not expected to result in substantial erosion.

IMPACT 5.5-2: THE PROJECT COULD EXPOSE PEOPLE OR STRUCTURES TO POTENTIAL SUBSTANTIAL ADVERSE EFFECTS FROM RUPTURE OF A KNOWN EARTHQUAKE FAULT. [THRESHOLD G.2i]

Impact Analysis: Five splays, or lineaments, of the San Andreas Fault have been identified onsite. Four of these splays are within Alquist-Priolo Fault Zones. Fault trenching studies onsite found evidence that three lineaments, A, B, and C, are active splays of the fault. The onsite segments of Lineaments A, B, and C are within an Alquist-Priolo Earthquake Fault Zone that covers much of the southern half of the site. The fourth lineament, lineament E, is within a second Alquist-Priolo Earthquake Fault Zone near the northwest corner of the site and part of the fifth lineament, lineament D, partially runs through the eastern edge of the project site, not in an Alquist-Priolo Fault Zone (see Figure 5.5-3, *Fault Splays on the Project Site*). Lineament E and D are not thought to be an active fault splays. Setbacks extending 50 feet from each side of the three active lineaments have been designated so that no structures would be built in the setbacks.

Additional investigation is recommended to confirm findings in Kleinfelder Associates' geotechnical studies (1997, 1998, and 1999), and trenching on the western part of Lineament A where trenching studies were not done previously in 1995.

Setbacks recommended by the project geotechnical consultant (Leighton Group) would be incorporated into the project design; compliance with such recommendations would be required conditions of approval by the City of San Bernardino. However, the proposed project presents potentially significant impacts related to the exposure of people and structures to known earthquake faults under both the preferred development plan and the alternative (overhead electric lines) development plan.

IMPACT 5.5-3: ***THE PROJECT COULD EXPOSE PEOPLE OR STRUCTURES TO POTENTIAL SUBSTANTIAL ADVERSE EFFECTS FROM STRONG GROUND SHAKING. [THRESHOLD G.2ii]***

Impact Analysis: The San Andreas Fault passes through the project site, and several other faults in the region could potentially generate strong ground shaking at the site. The peak horizontal ground acceleration that could affect the site was estimated by Leighton Group. The PHGA that would occur during an earthquake with a 2 percent probability of exceedance in 50 years, that is, an average return period of 2,475 years, is 1.15 g where g is the acceleration of gravity. An acceleration of 1.15 g corresponds roughly to an intensity of IX on the MMI Scale. In an Intensity IX earthquake damage is considerable in specially designed structures; well-designed frame structures are thrown out of plumb. Damage is great in substantial buildings, with partial collapse, and buildings are shifted off foundations. The intensity of ground shaking used for the purpose of structural design is derived from the CBC and is provided in Appendix F3. The California Building Code (Title 14, California Code of Regulations, Part 2) contains seismic safety requirements for structures. Seismic safety provisions in the CBC are developed with the intent that most structures would remain standing during and after an earthquake so that occupants would be able to evacuate. Many structures would be expected to be substantially damaged in a strong earthquake and would require repairs before they would be habitable again (Buchiarelli 2009). This analysis is applicable to both the preferred development plan and the alternative (overhead electric lines) development plan.

IMPACT 5.5-4: ***ALTHOUGH PEOPLE OR STRUCTURES COULD BE EXPOSED TO POTENTIAL ADVERSE EFFECTS FROM SEISMIC-RELATED GROUND FAILURE SUCH AS LIQUEFACTION AND SETTLEMENT, THESE HAZARDS ARE LOW BECAUSE THE PROJECT SITE IS NOT IN A MODERATE OR HIGH LIQUEFACTION HAZARD ZONE IDENTIFIED IN THE CITY OF SAN BERNARDINO GENERAL PLAN. [THRESHOLDS G-2iii AND G-3]***

Impact Analysis:

Liquefaction

The potential for liquefaction on most of the project site is considered to be low due to older alluvial/colluvial soils underlying the bulk of the site, plus the depth of groundwater, which is thought to be more than 50 feet bgs under most of the site. There are two limited areas of the site that are or may be susceptible to liquefaction: the lower parts of the Cable Canyon and Meyers Canyon drainages in the southern part of the site; and an isolated part of the eastern part of the site along the northeast side of the San Andreas Fault, where groundwater was found at 20 feet bgs in two borings.

The site plan almost entirely avoids placing homes over recent alluvium in the Cable Canyon and Meyers Canyon drainages. The geotechnical feasibility study for the project (Kleinfelder 1997) recommends removal

of loose or soft earth materials and undocumented fill to a depth of two to five feet below existing grades or two feet below the bottom of proposed footing depths, whichever is greater. Deeper removals are anticipated in isolated areas of the site, including the areas susceptible to liquefaction.

Additionally, the project site is not within a liquefaction hazard zone identified in the City of San Bernardino's General Plan.

Seismic Settlement

The subsurface soils under most of the site are relatively dense and thus are not expected to be prone to substantial seismic settlement. Near-surface soils may be settlement prone; however, near-surface soils under the sites of homes, roads, and other improvements would be removed and replaced with compacted fill. Seismic settlement may pose a hazard where loose soils have been found near the San Andreas Fault. However, development in this area would be limited to nonstructural improvements, and settlement-prone soils may be overexcavated to limit seismic settlement.

The analysis pertaining to liquefaction and seismic settlement described above is applicable to both the preferred development plan and the alternative (overhead electric lines) development plan.

IMPACT 5.5-5 THE PROJECT SITE IS NOT SUBJECT TO SUBSTANTIAL HAZARDS FROM LANDSLIDES, MUDSLIDES, OR SUBSIDENCE. [THRESHOLD G-4]

Landslides

The maximum gradient of the natural slopes on the site approach is 1.2:1 (horizontal:vertical). No surface indications of slope instability or significant "out of slope" geologic bedding conditions were observed onsite. No significant natural slope instability exists onsite.

Proposed cut-and-fill slopes would be designed at grades of 2:1, with maximum slope heights of 80 feet. Such cut-and-fill slopes have been analyzed and found to be grossly stable. Some surficial slope instability should be anticipated due to onsite materials being generally granular. Cut slopes that expose bedrock will tend to weather over time and would be planted with deep-rooted vegetation.

Mudslides

A mudslide or mudflow is a type of landslide consisting of a mixture of water-saturated rock debris and soil with a consistency of wet cement. Mudflows occur on steep slopes where vegetation is not sufficient to prevent rapid erosion, but can also occur on gentler slopes. The site plan avoids the lower portions of Cable Canyon and Meyers Canyon, which could act as channels for mudflows. The site plan also avoids the steeper slopes near the northern end of the site. All cut-and-fill slopes created by the project would be vegetated, thereby controlling erosion and reducing mudflow hazard.

Subsidence

Ground subsidence is usually a result of the withdrawal of groundwater or oil from an area. Leighton and Associates is not aware of substantial groundwater or oil withdrawals in the area that could lead to subsidence, and the potential for ground subsidence is regarded as low.

The analysis pertaining to landslides, mudslides, and subsidence described above is applicable to both the preferred development plan and the alternative (overhead electric lines) development plan.

IMPACT 5.5-6 ***THE EXPANSION POTENTIAL OF SITE SOILS IS LOW TO VERY LOW, AND PROJECT DEVELOPMENT WOULD NOT CREATE SUBSTANTIAL HAZARDS ARISING FROM EXPANSIVE SOILS. [THRESHOLD G-5].***

Expansive soils are generally characterized as having the ability to undergo significant volume change due to increases or decreases in the moisture content of the soil. The Spring Trails site is predominated by relatively recent alluvial deposits (from the Holocene and Pleistocene age). These deposits have led to the existence of sands and sands with gravel in the upper layers (5 to 10 feet deep) and the gravelly sands (sand with silt, cobbles, and occasional boulders) of the lower layers (below 10 feet). These layers are generally medium dense to very dense throughout most of the site and have dry to moist conditions. The geotechnical analysis did not determine these soils to be prone to expansion. Therefore, the expansion potential of soils is low to very low. No specific geotechnical recommendations for expansive soils are required. The potential for expansive soils is the same under both the preferred development plan and the alternative (overhead electric lines) development plan.

IMPACT 5.5-7 ***PROJECT DEVELOPMENT WOULD MODIFY PART OF THE SAN ANDREAS FAULT, A UNIQUE GEOLOGICAL FEATURE. [THRESHOLD G-7]***

The San Andreas Fault is considered to be a unique geological feature. The fault is a right-lateral strike-slip fault, meaning that motion on the fault is horizontal, with land across the fault appearing to move to the right of the viewer. The fault is a boundary between the North American and Pacific plates of the earth's crust. The Pacific Plate moves northward relative to the North American Plate (Harden 2004). The fault extends over 800 miles, trending northwest-southeast, from offshore of Cape Mendocino to the Mexican Border. Well-known major earthquakes that occurred on the fault include the 1906 San Francisco Earthquake and the 1857 Fort Tejon Earthquake; in addition, the Wrightwood Earthquake of 1812 may have occurred on the fault (SCEC 2009).

Five splays of the San Andreas Fault occur on the site, described in detail above in Section 5.5.1. The majority of the segment of Splay A on the site would remain open space, while the balance of the splay would be graded. Most of Splays B, C, and D would be graded, and most of Splay E would remain open space. The grading on Splays A, B, C, D, and E would not substantially change the physical and geological characteristics of the fault. Since the alternative (overhead electric lines) development plan would not change the grading of the project site, impacts would be the same for either scenario.

IMPACT 5.5-8 ***PROJECT GRADING AND CONSTRUCTION WOULD BE CONDUCTED SO AS NOT TO RESULT IN SUBSTANTIAL AMOUNTS OF UNSTABLE SOILS. [THRESHOLD G-8 (PART)]***

Project features are incorporated into the Spring Trails Specific Plan that would prevent grading and construction activities from creating substantial amounts of unstable soils. For the purposes of this analysis, unstable soils are considered those arising from conditions such as collapsible soils, expansive soils, or seismic settlement. Soil instability related to erosion is analyzed separately under Impact 5.5-1, while impacts from erosion in the form of landslides are discussed in Impact 5.5-5. Soil instability arising from liquefaction is analyzed separately under Impact 5.5-4. This analysis is applicable to both the preferred development plan and the alternative (overhead electric lines) development plan.

Project Features Regarding Soil Stability

Development Standards

The following development standards in the Grading Plan and Safety Plan of the Spring Trails Specific Plan would aid in preventing the creation of substantial amounts of unstable soils.

- Final grading design shall adhere to the final soils report recommendations.
- Grading shall be performed under the supervision of a registered soils engineer.
- Final grading plans shall be prepared and certified by a registered civil engineer and registered geotechnical engineer in the State of California Board of Professional Registration and approved by the City Engineer.

IMPACT 5.5-9 PART OF THE PROJECT WOULD BE DEVELOPED WITHIN A HILLSIDE MANAGEMENT OVERLAY ZONING DISTRICT. [THRESHOLD G-9]

Roughly 67 percent (133 acres) of the project site is within the Hillside Management Overlay District (HMOD), which covers all areas with slopes of 15 percent or greater. The HMOD contains development performance standards, including standards regarding soils and grading, geotechnical standards, and standards requiring that vegetation on slopes, including graded slopes, be preserved or reestablished; such standards are listed above in Section 5.5.1. Under either the preferred or alternative development plan, the project would be built and operated in compliance with the requirements of the HMOD that are described in Section 5.5.1.

5.5.4 Cumulative Impacts

Impacts to geology and soils are specific to the geologic and soils conditions on a particular project site. Mitigation of geologic, seismic, and soil impacts of development projects would also be specific to each site. Compliance with modern building standards, such as the UBC and CBC, serves to reduce seismic-related risks. Therefore, no adverse cumulative impacts related to soils and geology are anticipated. This analysis of cumulative impacts is applicable to both the preferred development plan and the alternative (overhead electric lines) development plan.

5.5.5 Existing Regulations and Standard Conditions

State

- California Building Code (Title 14, California Code of Regulations, Part B)
- Alquist-Priolo Earthquake Fault Zoning Act
- Seismic Hazards Mapping Act
- Natural Hazards Disclosure Act
- Statewide General Construction Activity Permit

City of San Bernardino

- Municipal Code Sections 15.04.163 and 15.04.210 (Grading)
- San Bernardino Development Code Chapter 19.17: HM (Hillside Management Overlay) District
- San Bernardino Development Code Chapter 19.15: FF (Foothill Fire Zones Overlay) District

5.5.6 Level of Significance Before Mitigation

Upon implementation of regulatory requirements and standard conditions of approval, the following impacts would be less than significant: 5.5-1, 5.5-5, 5.5-6, 5.5-7, 5.5-8, and 5.5-9.

Without mitigation, the following impacts would be **potentially significant**:

- Impact 5.5-2 Project development could expose people and structures to hazards from rupture of a known earthquake fault.
- Impact 5.5-3 Project development could expose people or structures to hazards from strong ground shaking.
- Impact 5.5-4 The project could expose people or structures to hazards arising from seismic ground failure, including liquefaction.

5.5.7 Mitigation Measures

Impact 5.5-2

5-1 Prior to recordation of final maps,additional fault studies shall be conducted to the satisfaction of the geotechnical consultant of record on the project and the City Engineer. These studies shall include:

1. Trenching across Splay E to locate the splay and gauge its activity in order to determine the required width of setbacks from the splay.
2. A trench across Splay A in the western part of the site to confirm the location of the splay in that part of the site and to aid in determining the width of required setbacks from the splay.
3. A trench between Splays A and B in the central part of the site.

If the geotechnical consultant recommends expanded or modified setbacks from faults based on the findings of such additional studies, then the project will be required to comply with such setbacks, and any lots that would not be developable according to the development standards of the Specific Plan will be eliminated prior to recordation of TTM 15576 or the associated phase of TTM 15576.

Impacts 5.5-3 and 5.5-4

5-2 Prior to recordation of final maps, a detailed design-level geotechnical investigation report shall be prepared and submitted with engineering grading plans to further evaluate liquefaction, seismic settlement, lateral spreading, subsidence, collapsible soils, corrosive soils, slope stability including earthquake-induced landslides, and other geotechnical constraints and provide site-specific recommendations to address such conditions, if determined necessary. The geotechnical reports shall be prepared and signed/stamped by a Registered Civil Engineer specializing in geotechnical engineering and a Certified Engineering Geologist. The project will be required to comply with any recommendations that are made in the report of such investigation.

5-3 For each phase of the project, at the completion of grading and before project construction begins, final geotechnical testing for corrosive soils and expansive soils shall be conducted. A final geotechnical report for the relevant phase shall be prepared and signed/stamped by a Registered Civil Engineer specializing in geotechnical engineering and a Certified Engineering Geologist. Such report shall contain recommendations to address corrosive soils and expansive soils, as determined necessary. The project will be required to comply with any recommendations that are made in the report of such investigation.

5.5.8 Level of Significance After Mitigation

The mitigation measures identified above would reduce potential impacts associated with geology and soils to less than significant. Therefore, no significant unavoidable adverse impacts relating to geology and soils have been identified.