SECTION 5.9
GEOLOGY AND SEISMIC HAZARDS

5.9 GEOLOGY AND SEISMIC HAZARDS

This section evaluates the geologic and seismic conditions within the City of San Bernardino and evaluates the potential for geologic and seismic hazard impacts associated with implementation of the proposed project. Mitigation measures to reduce the significance of impacts are recommended, as necessary. Information in this section is based on the *San Bernardino General Plan* Safety Element and the *San Bernardino Final General Plan Update and Associated Specific Plans Environmental Impact Report*.

5.9.1 REGULATORY SETTING

FEDERAL SOIL PROTECTION ACT

The purpose of the Federal Soil Protection Act is to protect or restore the functions of the soil on a permanent sustainable basis. Protection and restoration activities include prevention of harmful soil changes, rehabilitation of the soil of contaminated sites and of water contaminated by such sites, and precautions against negative soil impacts. If impacts are made on the soil, disruptions of its natural functions and of its function as an archive of natural and cultural history should be avoided, as far as practicable. In addition, the requirements of the Federal Water Pollution Control Act (also referred to as the Clean Water Act [CWA]) through the National Pollution Discharge Elimination System (NPDES) permit provide guidance for protection of geologic and soil resources.

ALQUIST-PRIOLO EARTHQUAKE FAULT ZONING ACT

The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. This State law was a direct result of the 1971 San Fernando Earthquake, which was associated with extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures. The Act's main purpose is to prevent the construction of buildings used for human occupancy on the surface trace of active faults. The Act only addresses the hazard of surface fault rupture and is not directed toward other earthquake hazards.

The Act requires the State Geologist to establish regulatory zones, known as "Earthquake Fault Zones," around the surface traces of active faults and to issue appropriate maps. Earthquake Fault Zones were called "Special Studies Zones" prior to January 1, 1994. Local agencies must regulate most development projects within these zones. Before a project can be permitted, cities and counties must require a geologic investigation to demonstrate that proposed buildings would not be constructed across active faults. An evaluation and written report of a specific area must be prepared by a licensed geologist. If an active fault is found, a structure for human occupancy cannot be placed over the trace of the fault and must be set back from the fault (typically 50 feet set backs are required).

Effective June 1, 1998, 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 that is being sold lies within one or more State-mapped hazard areas, including Earthquake Fault Zones.

SEISMIC HAZARDS MAPPING ACT

The Seismic Hazards Mapping Act (S-H Act) of 1990 provides a statewide seismic hazard mapping and technical advisory program to assist cities and counties in fulfilling their responsibilities for protecting the public health and safety from the effects of strong ground shaking, liquefaction, landslides, or other ground failure, and other seismic hazards caused by earthquakes. Mapping and other information generated pursuant to the S-H Act is to be made available to local governments for planning and development purposes. The State requires: (1) local governments to incorporate site-specific geotechnical hazard investigations and associated hazard mitigation, as part of the local construction permit approval process; and (2) the agent for a property seller or the seller if acting without an agent, must disclose to any prospective buyer if the property is located within a Seismic Hazard Zone. The State Geologist is responsible for compiling seismic hazard zone maps. The S-H Act specifies that the lead agency of a project may withhold development permits until geologic or soils investigations are conducted for specific sites and mitigation measures are incorporated into plans to reduce hazards associated with seismicity and unstable soils.

UNIFORM BUILDING CODE

Development standards require projects to comply with appropriate seismic design criteria in the Uniform Building Code (UBC), adequate drainage facility design, and preconstruction soils and grading studies. Seismic design standards have been established to reduce many of the structural problems occurring because of major earthquakes. In 1998, the UBC was revised as follows.

- Upgrade the level of ground motion used in the seismic design of buildings;
- Add site amplification factors based on local soils conditions; and
- Improve the way ground motion is applied in detailed design.

CALIFORNIA BUILDING CODE

California building standards are published in the California Code of Regulations, Title 24, known as the California Building Code (2007 CBC). The 2007 CBC applies to all applications for residential building permits. The 2007 CBC consists of 11 parts that contain administrative regulations for the California Building Standards Commission and for all State agencies that implement or enforce building standards. Local agencies must ensure that development complies with the guidelines contained in the 2007 CBC. Cities and counties have the ability to adopt additional building standards beyond the 2007 CBC.

CITY OF SAN BERNARDINO

Municipal Code

The “Building Code of the City of San Bernardino” (Building Code) is codified in Title 15, Buildings and Construction, of the City’s *Municipal Code*. The Building Code adopted the 2007 Edition of the California Building Code (California Code of Regulations, Title 24, Part 2) based on the 2006 International Building Code, including Appendix Chapter 1, Administration, and Appendix 1, Patio Covers, 2007 Edition, as published by the International Code Council.

The purpose of the Building Code is to provide minimum standards to safeguard life or limb, health, property and public welfare by regulating and controlling the design, construction, quality of materials, use and occupancy, location and maintenance of all buildings and structures within the City of San Bernardino.

San Bernardino General Plan Safety Element

The *General Plan* Safety Element addresses natural and man-made hazards presents in the City of San Bernardino. Potential risks to San Bernardino residents and the local environment associated with identified hazards are considered. This Element specifically addresses the way in which the City will prepare and respond to fire hazards, geologic and seismic hazards, and flood hazards. The Safety Element provides background information related to each issue and identifies hazard locations within the City, risk-reduction strategies, and hazard abatement measures that can ultimately be used by decision-makers in their review of projects. Refer to Section 5.10, Hazards/Risk of Upset of this EIR, for a discussion of hazardous materials/waste.

Emergency Management Plan[1]

The City of San Bernardino Emergency Management Plan details the functional responsibilities and interactions of the federal, state, and local governmental agencies as well as private organizations in the event of natural and human-related disasters. Included within the natural disaster category are geologic hazards, earthquakes, floods, and fires. Potential human-related disasters include nuclear attacks, transportation-related accidents, and hazardous materials incidents. Within the Emergency Management Plan, potential hazards are described, with the possible effects delineated and recommended mitigations are discussed where applicable. Reconstruction, post-disaster aid, and financial assistance are also discussed.

Hazards Mitigation Plan[2]

The Disaster Mitigation Act of 2000 (DMA 2000), Section 322 (a-d), requires that local governments, as a condition of receiving federal disaster mitigation funds, adopt a mitigation plan that describes the process for identifying hazards, vulnerabilities, and risks, identifies and prioritizes mitigation actions, encourages the development of local mitigation, and provides technical support for those efforts. While the City cannot prevent natural disasters from occurring, the City can reduce and eliminate their effects through well organized public education and awareness effort, preparedness, and mitigation set forth in the San Bernardino Hazard Mitigation Plan.

5.9.2 ENVIRONMENTAL SETTING

The City of San Bernardino lies within the Bunker Hill-San Timoteo Basin, which is bound by the active San Andreas Fault zone on the northwest and the active San Jacinto Fault zone on the southwest. The San Andreas Fault impedes movement of groundwater, producing springs and a groundwater level change that marks the fault trace along the northern boundary of the subbasin. The San Jacinto Fault forms a solid barrier to groundwater that raises the water table

[1] City of San Bernardino General Plan, prepared by The Planning Center, dated November 1, 2005.
[2] Ibid.

nearly to the surface below the course of the Santa Ana River. The Bunker Hill-San Timoteo Basin includes the cities of Rialto, Colton, Loma Linda, Redlands, and San Bernardino.[3]

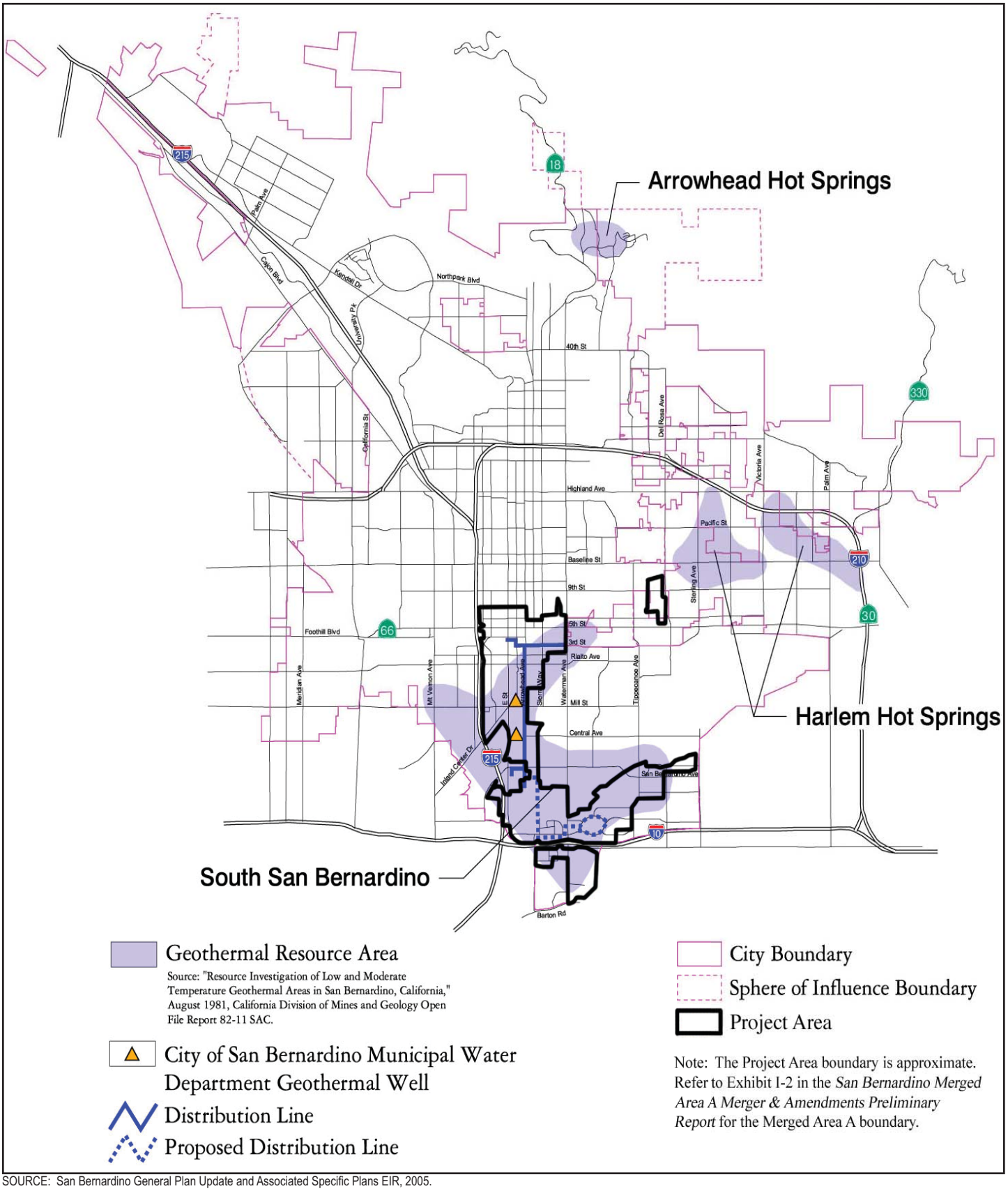
The City of San Bernardino lies on a broad, gently sloping lowland that flanks the southwest margin of the San Bernardino Mountains. The lowland is underlain by alluvial sediments eroded from bedrock in the adjacent mountains and washed by rivers and creeks into the valley region where they have accumulated in layers of gravel, sand, silt, and clay. The sediment accumulation has continued for a few million years, during which time increasing thickness of sediments have gradually buried the original hill and valley topography of the Bunker Hill-San Timoteo Basin. Shandin Hills and other small hills areas in the basin are remnants of the original topography.[4]

GEOTHERMAL ACTIVITY[5]

Geothermal activity is known to occur in the southern portion of the City of San Bernardino and the Arrowhead Springs area; refer to *Exhibit 5.9-1*, *Geothermal Resources*. Geothermal activity occurs within the South Valle, Tri-City, Southeast Industrial Park, Central City South, Meadowbrook/Central City and Central City East Project Areas. The only Project Area that doesn't appear to have geothermal activity is Central City North Project Area. The geothermal springs in the City come from a depth of 15,000 feet due to fractures of the San Andreas Fault zone. The deep subterranean faults and cracks allow rainwater and snowmelt to seep underground where the water is heated by the inner earth and circulates back up to the surface, to appear as hot springs or thermal vents. Geothermal activity is a unique geologic resource inextricably connected to the hydrology and tectonic activity within the basin. Geothermal resources beneath the City are connected to the Bunker Hill-San Timoteo Basin (aquifer). While hot water created from geothermal activity from geothermal activity from the San Andreas Fault is contained in separate perched aquifers above the fresh water aquifer, these two hydrologic resources can affect each other.

According to the San Bernardino Municipal Water Department, there are approximately 90 to 100 geothermal wells and springs currently in operation, which are concentrated in the Central City, Commerce Center, Tri-City areas, and within the vicinity of the former Norton Air Force Base. Currently, the San Bernardino Municipal Water Department maintains two wells in the southern portion of the City for geothermal energy sources. The geothermal springs in the City of San Bernardino are among the hottest in the United States, with highest historic temperatures in the City ranging from 70 degrees Celsius in the southern portions of the City to 140 degrees Celsius in the Arrowhead Springs area in the San Bernardino Mountains. One of the hottest wells in the City was located in the southwestern portion in the old Urbita Springs. The majority of the wells in the City of San Bernardino exhibit well temperatures between 120 and 140 degrees Celsius.

[3] City of San Bernardino Final General Plan Update and Associated Specific Plans EIR, prepared by The Planning Center, dated September 30, 2005.
[4] Ibid.
[5] Ibid.



SOURCE: San Bernardino General Plan Update and Associated Specific Plans EIR, 2005.

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SAN BERNARDINO MERGED AREA A – MERGER AND AMENDMENTS

Geothermal Resources

Exhibit 5.9-1

South San Bernardino[6]

The Urbita Springs were originally developed as a mineral bath and amusement park in the 1860, and water was piped at 1,000 feet. In 1966, the first contracts for the Inland Shopping Center were let in and the Urbita Hot Springs were destroyed. The site currently lies under parking lots and department stores of the Inland Shopping Center, west of the Central City South Project Area. Prior to the construction, the site was excavated and removed to a depth of 12 feet and backfilled. Today, there is a large subterranean drain that passes under a portion of the shopping center and surfaces just east of the Interstate 215 (I-215) freeway. A trickle of water in this drain is the last vestige of the Urbita Hot Springs.

The De Sienna Hot Springs were located 0.6 miles southwest of the Urbita Hot Springs on the southeast flank of a small knoll referred to as Bunker Hill. Historical resources indicate that a 547-foot-deep well was drilled in 1926 and had a temperature of 37 degrees Celsius.

Harlem and Rabel Hot Springs[7]

The Harlem Hot Springs are located north of the Baseline Road and Victoria Avenue intersection far east of the Tri-City Project Area. Natural hot springs originally flowed into Warm Creek. Historical resources indicate that in 1989 the first well was drilled to 300 feet and produced water of 46 degrees Celsius. The hot springs were then developed as a recreation park and picnic area and provided mineral water and mud baths. Use of the hot spring eventually let to deterioration.

The Rabel Hot Springs were located approximately 0.25 miles west of the Harlem Hot Springs. Development of the hot springs closely paralleled that of the Harlem Hot Springs. Rabel Hot Springs was operated as a spa in the late 1800s and offered mineral mud baths, but was closed as a spa in 1912. Immediately afterwards, the site was operated as a hog ranch until the Baseline Laundry was opened in 1916. The operating well on the property is used heavily by the laundry. The temperature of the well was measured at 28 degree Celsius on April 22, 1981. Historical newspapers from 1966 detail that water levels at the Harlem Hot Springs and Rabel Hot Springs have dropped 160 to 170 feet and water once hot, is now lukewarm. Both hot springs were originally naturally flowing springs which comprised the principle source of flow in Warm Creek. The apparent historical decrease in the geothermal area may suggest that the available geothermal resource there has a finite volume.

SOILS

Twenty-two soil series were identified in the City of San Bernardino; refer to *Table 5.9-1*, *Soil Characteristics*.

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6 Ibid.

7 City of San Bernardino Final General Plan Update and Associated Specific Plans EIR, prepared by The Planning Center, dated September 30, 2005.

Table 5.9-1
Soil Characteristics

Soil (Symbol)	Texture	Potential Limitations
Cieneba (CnD)	Sandy Loam	High erosion
Cieneba (Cr)	Rock Outcrop	Slope
Delhi (Db)	Fine Sand	High blowing soil
Friant (Fr)	Rock Outcrop	High erosion
Grangerville (Gr)	Fine Sandy Loam	None
Grangerville (Gs)	Fine Sandy Loam	None
Greenfield (GtC)	Sandy Loam	None
Greenfield (GrD)	Sandy Loam	High erosion
Hanford (HaC)	Coarse Sandy Loam	None
Hanford (HaD)	Coarse Sandy Loam	High erosion
Hanford (HbA)	Sandy Loam	None
Psamments/Fluvents (Ps)	-	Flooding
Ramona (RmC)	Sandy Loam	None
Ramona (RmD)	Sandy Loam	High erosion
Ramona (RmE2)	Sandy Loam	High erosion
Saugus (ShF)	Sandy Loam	High erosion
Soboba (SoC)	Gravelly Loamy Sand	None
Soboba (SpC)	Stony Loamy Sand	None
Tujunga (TuB)	Gravelly Loamy Sand	None
Tujunga (TvC)	Gravelly Loamy Sand	High blowing soil
Vista (Vr)	Rock Outcrop	Slope
Wasteland (W)	Variable	Slope

Source: *City of San Bernardino General Plan Update Technical Background Report*, Chapter 5, Hazards, prepared by Envicom Corporation, dated February 1988.

FAULTS AND FAULT ZONES

An earthquake fault is a fracture in the crust of the earth along which land on one side has moved relative to land on the other side. Most faults are the result of repeated displacements over a long period of time. A fault trace is the line on the earth's surface defining the fault.

Exhibit 5.9-2, *Regional Fault Map* and illustrates the major fault zones and their relationship to the City of San Bernardino. As indicated in *Exhibit 5.9-2* San Bernardino is traversed by numerous earthquake faults. The City is located between several active fault zones including: the San Andreas Fault, the San Jacinto Fault, the Glen Helen Fault, and the Loma Linda Fault. The San Jacinto Fault traverses the South Valle and Southeast Industrial Park Project Areas. Each of these faults is classified as Alquist Priolo Special Study Zones under the Alquist-Priolo Earthquakes Fault Zoning Act; refer to *Exhibit 5.9-3*, *Alquist-Priolo Earthquake Fault Zones*.

The California Division of Mines and Geology (CDMG) has designated specific faults within the Project Area as a part of the State of California Alquist-Priolo Special Study Zones. These zones extend parallel approximately 200 to 500 feet from designated faults.[8]

[8] City of San Bernardino General Plan, prepared by The Planning Center, dated November 1, 2005.

Active Faults

An active fault is defined by the State Mining and Geology Board as a fault that has "had surface displacement within Holocene times (about the last 11,000 years)." This definition does not mean that faults lacking evidence of surface displacement within Holocene times are necessarily inactive. A fault may be presumed to be inactive based on satisfactory geologic evidence; however, the evidence necessary to prove inactivity is sometimes difficult to obtain and locally may not exist. A potentially active fault is a fault that shows evidence of surface displacement during Quaternary time (last 1.6 million years).

Active faults and historically destructive earthquakes are generally characteristic of southern California. The City is located between several active faults. The San Andreas Fault traverses the City in a northwest to southeast direction, following the foothills along the northern edge of the City. The San Jacinto Fault (includes the Glen Helen and Loma Linda Faults) further traverse the City, also in a northwest to southeast direction, through the lower middle and southern portions of the City.

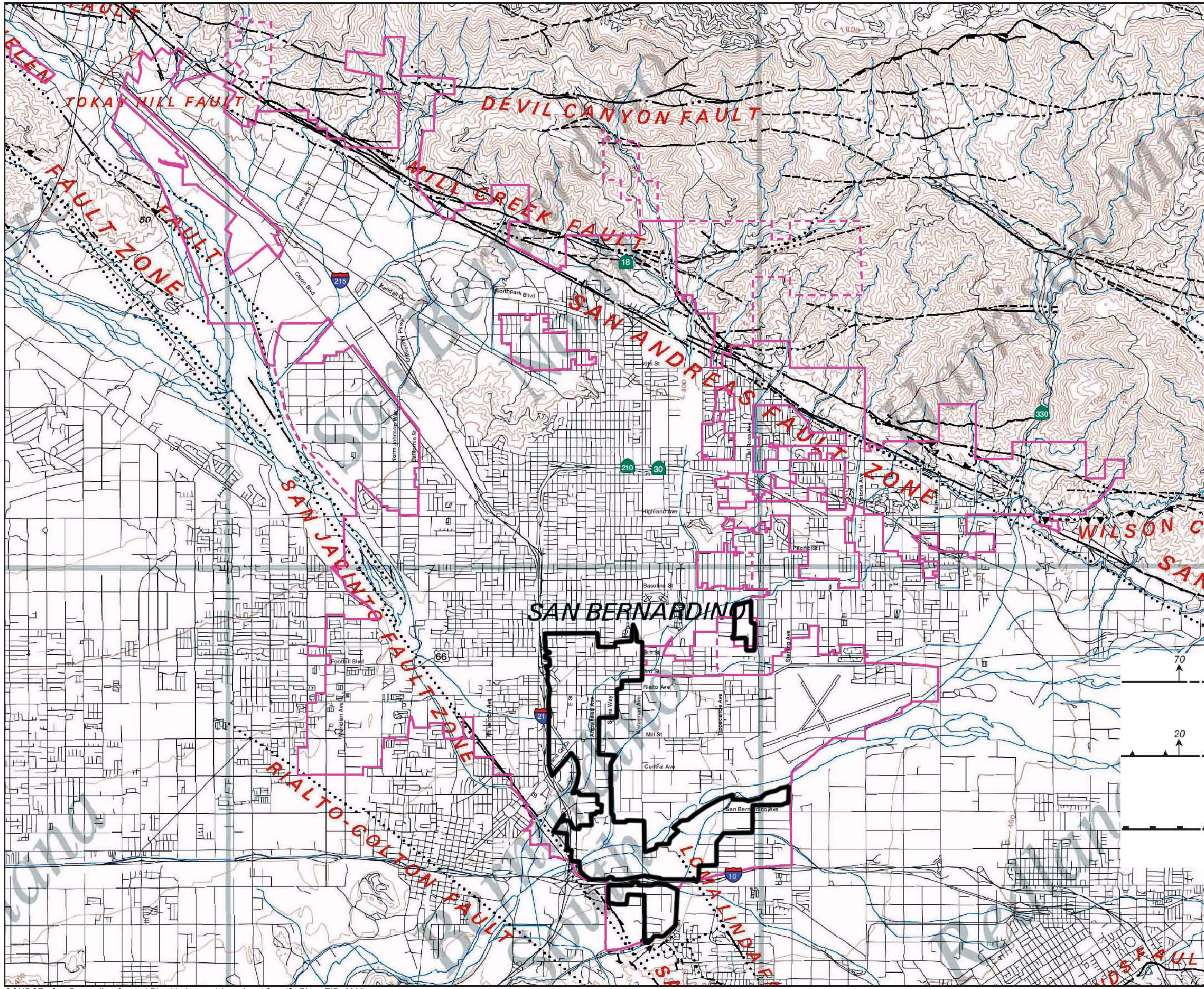
The UBC Seismic Zone Map divides the United States into zones of potential earthquake damage. The four UBC Seismic Zones are Zone 0 (no damage), Zone 1 (minor damage), Zone 2 (moderate damage), and Zone 3 (major damage), and Zone 4 (major damage caused by near-by fault movements) was added. The City of San Bernardino is located in Seismic Zone 4.[9] *Table 5.9-2*, *Principal Active Faults*, lists the maximum credible earthquake magnitude of each fault. The faults classified as active that affect the City are described below.

Table 5.9-2
Principal Active Faults

Fault	Maximum Credible Earthquake Magnitude (magnitude/peak g's)
San Andreas	8.5
San Jacinto (includes Glen Helen and Loma Linda) **(Located within South Valle and Southeast Industrial Park)**	7.5
Cucamonga-Sierra Madre	6.5+
Whittier-Elsinore	7.5-7.0
San Fernando	7.0
Hollywood-Raymond Hills	7.0
Newport-Inglewood	7.0
Santa Monica	7.0
Rialto-Colton	6.5
Helendale	7.0
Cleghorn	6.7
North Frontal	7.0
Crafton	6.4
Banning	6.9
Red Hill	6.5

Source: *City of San Bernardino General Plan Update Technical Background Report*, Chapter 5, Hazards, prepared by Envicom Corporation, dated February 1988.

[9] City of San Bernardino Final General Plan Update and Associated Specific Plans EIR, prepared by The Planning Center, dated September 30, 2005.



City Boundary

Sphere of Influence Boundary

Project Area

Note: The Project Area boundary is approximate. Refer to Exhibit I-2 in the *San Bernardino Merged Area A Merger & Amendments Preliminary Report* for the Merged Area A boundary.

70

Fault—Solid where accurately located, dashed where approximately located, dotted where concealed. Includes strike slip, normal, reverse, oblique, and unspecified slip. Arrow and number indicate direction and amount of dip.

20

Thrust fault—Teeth on upper plate; solid where accurately located, dashed where approximately located, dotted where concealed. Arrow and number indicate direction and amount of dip.

Rotational slip normal fault—Bars on hanging wall side; solid where accurately located, dashed where approximately located, dotted where concealed.

SOURCE: San Bernardino General Plan Update and Associated Specific Plans EIR, 2005.

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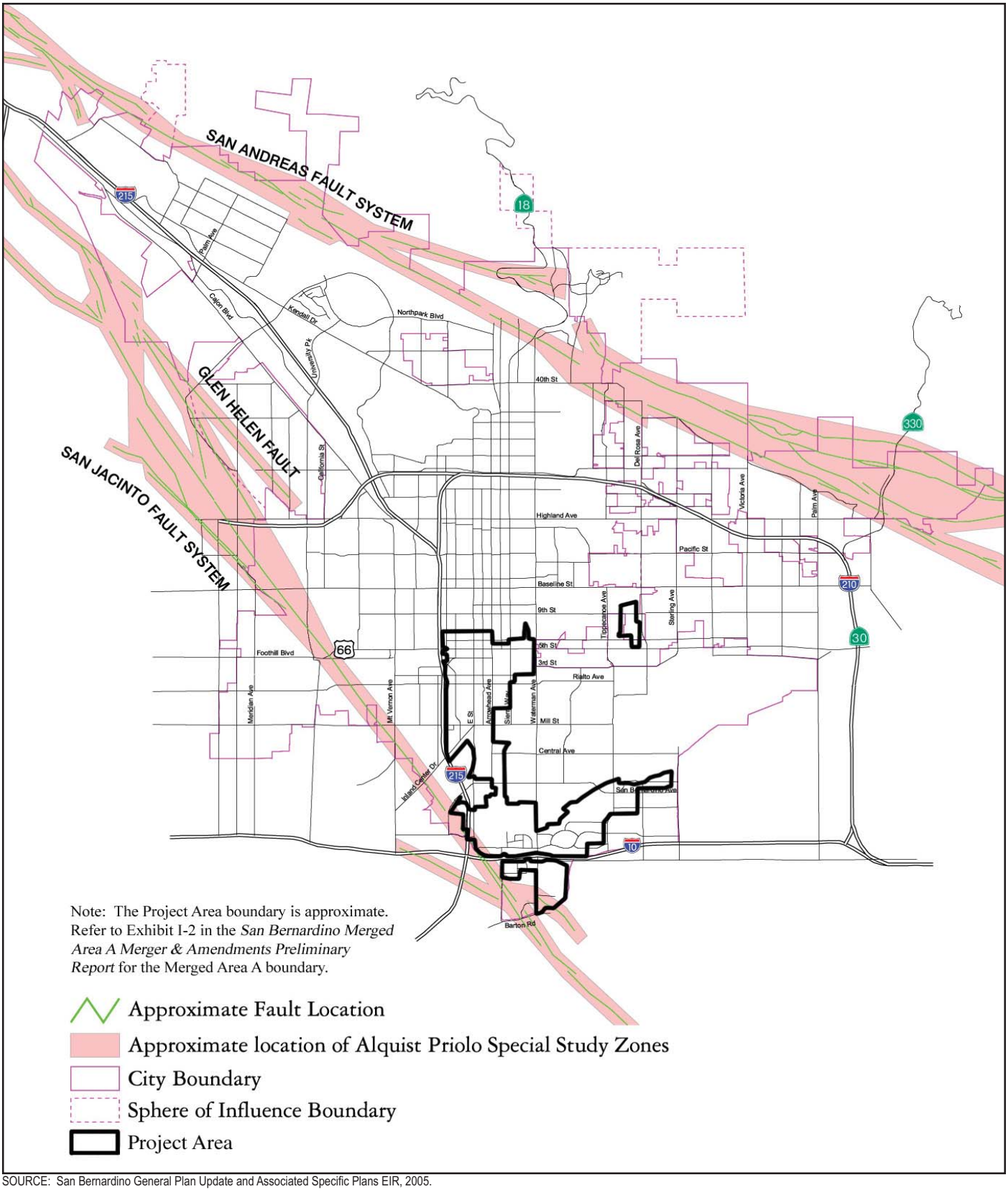
SAN BERNARDINO MERGED AREA A – MERGER AND AMENDMENTS

Regional Fault Map

Exhibit 5.9-2

Back of 11 X 17 Color Exhibit



SOURCE: San Bernardino General Plan Update and Associated Specific Plans EIR, 2005.

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SAN BERNARDINO MERGED AREA A – MERGER AND AMENDMENTS

Alquist-Priolo Earthquake Fault Zones

Exhibit 5.9-3

San Andreas Fault Zone[10]

The San Andreas Fault system, including the north and south branches, forms the dominant fault feature within the City of San Bernardino. Three of California's largest historic earthquakes have occurred along this fault in 1857 near Fort Tejon, 1906 near San Francisco, and 1989 near Santa Cruz. The fault segment that affects the City of San Bernardino begins at the Salton Sea, runs along the southern base of the San Bernardino Mountains, crosses through the Cajon Pass and continues to run northwest along the northern base of the San Gabriel Mountains. The fault segment southeast of the Cajon Pass and within the San Bernardino area has not experienced a major earthquake for at least 265 years and possibly for as long as 600 years. Future predictions of magnitude and displacement currently cannot accurately be determined along the San Andreas Fault. However, regional studies indicate that a magnitude of 8.0 or larger earthquake could be expected to occur in the future and should be considered for planning and design purposes.

San Jacinto Fault Zone[11]

The San Jacinto Fault system includes the Glen Helen, San Jacinto, and Loma Linda Faults within the City of San Bernardino. The San Jacinto Fault traverses the South Valle and Southeast Industrial Park Project Areas. These faults display Late Quaternary to Holocene activity with small earthquakes evident near their fault traces. The San Jacinto Fault zone has been most prolific in historical time. Approximately 10 events have taken place from 1895 to 1980 over a fault length of 120 miles, with about one-half of these events causing damage in San Bernardino-Riverside area. Regional studies suggest that a magnitude 7.0 to 7.5 earthquake is possible on the San Jacinto Fault system that would affect the City of San Bernardino.

Cucamonga-Sierra Madre Fault Zone[12]

The Cucamonga-Sierra Madre fault system is part of a reverse and thrust fault zone that bounds the southern margin of the eastern San Gabriel Mountains, approximately 10 miles northwest of the central City area. The fault is known to have generated a significant earthquake in historic time, but a series of fault scarps in the Holocene alluvial fan deposits at the southeastern base of the San Gabriel Mountains indicates a succession of ground-rupturing earthquakes in the past. Earthquake scenarios that could affect the San Bernardino planning area range from magnitude 6.5 to 6.75.

Whittier-Elsinore Fault Zone[13]

The Whittier-Elsinore fault system is located approximately 25 miles west of the City of San Bernardino. The Elsinore Fault system extends approximately 120 miles from the Mexican border areas, northwest, beyond the Santa Ana Mountains. The Whittier Fault extends further

[10] City of San Bernardino Final General Plan Update and Associated Specific Plans EIR, prepared by The Planning Center, dated September 30, 2005.
[11] Ibid.
[12] Ibid.
[13] City of San Bernardino Final General Plan Update and Associated Specific Plans EIR, prepared by The Planning Center, dated September 30, 2005.

northwest from the Elsinore fault zone. A magnitude 6.5 design earthquake is considered to be reasonable for these faults.

San Fernando Fault Zone[14]

The San Fernando Fault is located approximately 64 miles west of the City of San Bernardino. The fault is a reverse fault near the back of the San Gabriel Mountains that is approximately 9 miles long and was the source of the 1971 magnitude 6.6 San Fernando earthquake.

Hollywood-Raymond Fault[15]

The eastern terminus portion of the Hollywood-Raymond Hills fault system is located approximately 42 miles west of the City of San Bernardino. The Hollywood-Raymond Hills Fault system extends in an east-west direction along the south side of the Santa Monica Mountains and may be continuous with the Raymond Fault in the vicinity of Glendale. The Raymond Fault exhibits fault scarps, sag ponds, and deformation and offset of Holocene strata.

Newport-Inglewood Fault Zone[16]

The Newport-Inglewood Fault is a northwest trending fault displaying a complex zone of deformation from Beverly Hills to south of Laguna Beach. The Newport-Inglewood Fault has been the source of damaging earthquakes such as the magnitude 6.3 in 1933 at Long Beach. This fault is located approximately 57 miles west of the City of San Bernardino.

Santa Monica Fault[17]

The Santa Monica Fault is a part of a major east-west trending system of reverse faults that extend from northeast of Santa Monica into the Santa Barbara Channel. Late Quaternary offset is evident and probable of earthquake magnitudes of 6.5 could be expected along this fault, located approximately 70 miles west of the City of San Bernardino.

Rialto-Colton Fault[18]

The Rialto-Colton Fault consists of two echelon strands with a total length of approximately 16 miles that trend in a northwest direction. No surface offset is evident for this fault but small earthquakes have occurred near its subsurface trace. The fault is located approximately 4 miles from the City of San Bernardino.

Helendale Fault[19]

The Helendale Fault consists of numerous echelon strands up to 2.5 miles long trending northwest. Total length of the strands is approximately 54 miles. Holocene surface faulting and

[14] Ibid.
[15] Ibid.
[16] Ibid.
[17] Ibid.
[18] Ibid.
[19] City of San Bernardino Final General Plan Update and Associated Specific Plans EIR, prepared by The Planning Center, dated September 30, 2005.

associated small earthquakes is evident. The fault is located approximately 38 miles from the City and is located along the north side of the San Bernardino Mountains and east of Victorville.

Cleghorn Fault[20]

The Cleghorn Fault is a single strand trending northwest with probable Holocene offset and numerous small earthquakes associated with the eastern end of the 14-mile long trace. The fault is located along the northwest end of the San Bernardino Mountains and approximately 13 miles northwest of the City of San Bernardino.

North Frontal Fault[21]

The North Frontal Fault zone is comprised of numerous discontinuous acuate strands averaging 1.5 to 2.5 miles in length with a total overall length of approximately 30 miles. Late Quaternary offset occurs along the fault zone; however, overlying Holocene alluvial fans are not faulted. Numerous closely associated small earthquakes have been recorded near the eastern end of the fault zone. The zone is located along the north front of the San Bernardino Mountains approximately 17 miles north of the City of San Bernardino.

Crafton Fault[22]

The Crafton Fault consists of accurate echelon strands approximately 5 miles in length with evidence of Late Quaternary offset. The fault is located approximately 7 miles south of the City of San Bernardino.

Banning Fault[23]

The Banning Fault zone consists of two or three strands in a zone approximately 2.5 miles wide trending from northwest to west with a total length of approximately 27 miles. Holocene strate are offset in the fault zone and numerous small earthquakes are also closely associated with the zone. The fault zone is located approximately 16 miles south-southeast of the City of San Bernardino.

Red Hill Fault[24]

The Red Hill Fault is a presumed single strand fault trending northwest to nearly east-west with a length of approximately 9 miles. The fault extends through the Pomona area about 10 miles west of the City of San Bernardino. Holocene strata have been offset at the eastern end and scattered small earthquakes have occurred near the fault trace.

[20] Ibid.
[21] Ibid.
[22] Ibid.
[23] Ibid.
[24] Ibid.

SEISMIC HAZARDS

There are potential primary and secondary seismic hazards associated with earthquakes. The primary seismic hazard associated with earthquakes is strong groundshaking. The secondary seismic hazards are surface fault rupture, ground failure (i.e., earthquake-induced land sliding, fracturing/cracking/fissuring, compaction/subsidence/uplift, and liquefaction), and tsunamis/seiche. The following discussion addresses the primary and secondary seismic hazards.

Groundshaking

Groundshaking is the motion felt on the earth's surface caused by seismic waves generated by the earthquake. It is the primary cause of earthquake damage. The degree of groundshaking that would occur in the City is dependent on the particular fault, fault location, distance from the City, and magnitude of the earthquake. Additionally, the soil and geologic structure underlying the City influences the amount of damage that the City may experience. Buildings on poorly consolidated and thick soils will typically see more damage than buildings on consolidated soils and bedrock. Alluvium deposits that may become unstable during intense ground shaking underlie the City.

The City has been regionally designated as a high severity zone where major probable damage of maximum IX or X, as defined by the Mercalli Intensity Scale, may occur from a maximum expectable earthquake. The Mercalli Intensity Scale differs from the Richter Magnitude Scale in that the effects of any one earthquake vary greatly from place to place, so there may be many intensity values measured from one earthquake. On the other hand, each earthquake should have just one magnitude, although the several methods of estimating it will yield slightly different values. Typical structural damage on the Modified Mercalli Intensity Scale for IX and X includes masonry severely damaged if reinforced, and destroyed if unreinforced, and general damage to wood frame structures.[25]

Surface Fault Rupture

Surface fault rupture occurs when movement on a fault deep within the earth breaks through to the surface. A surface fault rupture may occur suddenly during an earthquake or slowly in the form of fault creep. Sudden displacements are more damaging to structures, because they are accompanied by shaking. Fault creep is the slow rupture of the earth's crust. As indicated in *Exhibit 5.9-2,* the City is located between several active fault zones (San Andreas Fault, San Jacinto Fault, Glen Helen Fault, and Loma Linda Fault) of which are classified as Alquist Priolo Special Study Zones under the Alquist-Priolo Earthquakes Fault Zoning Act; refer to *Exhibit 5.9-3*. The San Jacinto Fault traverses the South Valle and Southeast Industrial Park Project Areas. Therefore, surface fault rupture may occur in the City.

[25] City of San Bernardino Final General Plan Update and Associated Specific Plans EIR, prepared by The Planning Center, dated September 30, 2005.

Seismic-Related Ground Failure

Various types of seismic-related ground failures accompany earthquakes, including the following:

- Earthquake-induced landsliding;
- Fracturing, cracking, and fissuring;
- Compaction and uplift; and
- Liquefaction and lateral spreading.

The potential for these types of ground failures to occur within the City are discussed below.

Earthquake-Induced Landsliding

Earthquake-induced landslides are secondary earthquake hazards that occur from ground shaking. They can destroy the roads, buildings, utilities, and other critical facilities necessary to respond and recover from an earthquake. Several communities in Southern California have a high likelihood of encountering such risks, especially in areas with steep slopes. Currently, the City of San Bernardino is located outside a mapped area for Seismic Hazard Zones, which establishes regulatory zones that encompass areas prone to earthquake-induced landslides and liquefaction (failure of water-saturated soil). According to the Preliminary Soil-Slip Susceptibility Map for the southern half of San Bernardino, portions of the City of San Bernardino, including the Project Area, are located within areas designated as having either low, moderate, or high soil-slip susceptibility which could be induced seismically.[26]

Fracturing, Cracking, and Fissuring

Groundshaking, settling, compaction, and sliding produce irregular fractures, cracks, and fissures from a few inches to many feet in length. Such fractures may displace soil and earth in a manner similar to faults. Fractures of this type are rare in bedrock, but are most significant in weathered rocks, alluvium, and alluvial basins up to 75 to 80 miles from the epicenter of a great earthquake surface. Fracturing, cracking, and fissuring may occur within the City and Project Area.

Compaction and Uplift

Compaction of loose soils and poorly consolidated alluvium occur as a result of strong seismic shaking. The amount of compaction may vary from a few inches to several feet and may be significant in areas of thick soil cover. Furthermore, tectonic subsidence, uplift tilting, and warping may occur within the City and Project Area.

Liquefaction and Lateral Spreading

Liquefaction is a hazard associated with intense ground shaking. During seismic events, the earth accelerates and soils can destabilize, particularly when sufficient water is present in the soil. The destabilized soil and water can mix, resulting in liquefaction. Liquefaction is generally associated with shallow ground water conditions and the presence of loose and sandy soils or

[26] City of San Bernardino Final General Plan Update and Associated Specific Plans EIR, prepared by The Planning Center, dated September 30, 2005.

alluvial deposits. Lateral spreading results from liquefaction or plastic deformation of soil occurring on gently sloping ground during an earthquake. The conditions occur when blocks of mostly intact surficial soil are displaced down slope along a sheer zone that has formed within liquefied sediment. As previously mentioned above, the City is currently located outside a mapped area for Seismic Hazard Zones, which established regulatory zones that encompass areas prone to liquefaction and earthquake-induced landslides. However, two general zones have been identified within the regional area, "high" and "moderately high to moderate" zones based on past technical studies. High zones are located adjacent to the San Andreas Fault zone north and northeast of the City and in the old artesian area between the San Andreas and San Jacinto Faults in the central and southern parts of the City. These particular zones delineate regional susceptibility; however, the zones can vary greatly due to groundwater level changes[27]. The Southeast Industrial Park, Meadowbrook/Central City, Central City North, Central City South, and Central City East Project Areas are approximately located within areas of high liquefaction susceptibility. The South Valle, Southeast Industrial Park, and Tri-City Project Areas are approximately located within areas of both moderately high to moderate liquefaction susceptibility; refer to *Exhibit 5.9-4, Liquefaction Susceptibility*.

Tsunamis and Seiches

A tsunami is a seismic sea-wave caused by sea-bottom deformations that are associated with earthquakes, landslides, or volcanic activity beneath the ocean floor. The hazard from tsunamis is considered to be remote given that the City is located sufficiently inland. A seiche is defined as a wave that oscillates in lakes, bays, or gulfs from a few minutes to a few hours, as a result of seismic or atmospheric disturbances. The City is not located downslope of any large bodies of water. Therefore, the likelihood of an earthquake-induced seiche is considered remote.

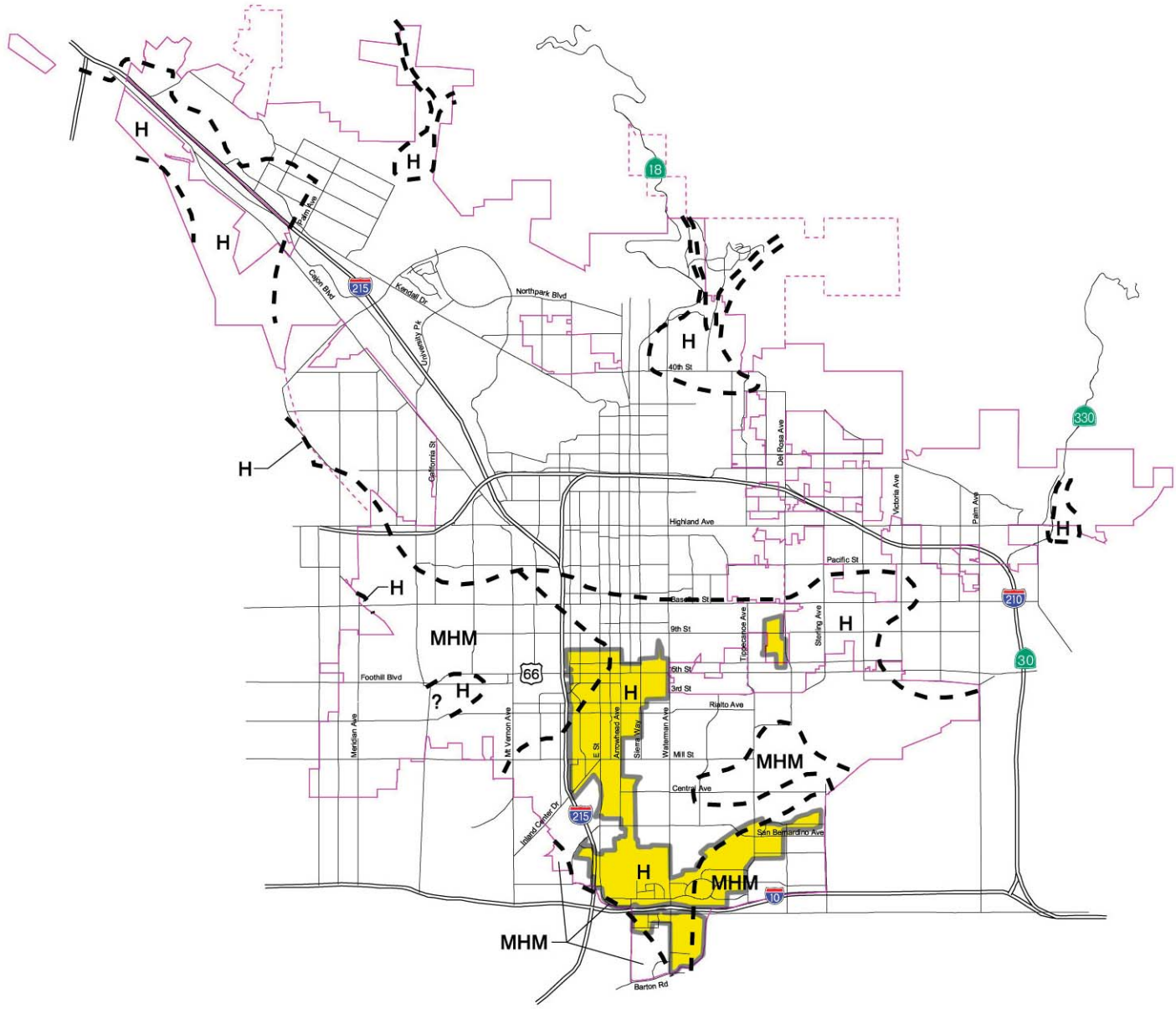
GEOLOGIC HAZARDS

Potential geologic hazards include slope instability, compressible soils, ground subsidence, and soil erosion hazards.

Landslides/Slope Instability[28]

General slope stability is determined by a number of factors including slope, vegetative cover, bedrock, soil, precipitation, wildfire, and human alteration. Slopes may be in temporary equilibrium until one of the above factors is modified by natural or human activity resulting in an unstable condition and potential failure. *Exhibit 5.9-5, Soil-Slip Susceptibility*, depicts areas in the City of San Bernardino which are potentially susceptible to slope failure. According to the Preliminary Soil-Slip Susceptibility Map for the southern portion of San Bernardino, portions of the City are located within areas designated as either having low, moderate, or high soil-slip susceptibility. The Project Area is located within in a flat area and is not susceptible to landslides or slope instability.

[27] City of San Bernardino Final General Plan Update and Associated Specific Plans EIR, prepared by The Planning Center, dated September 30, 2005.
[28] Ibid.



H Approximate Location of Areas of High Liquefaction Susceptibility

MHM Approximate Location of Areas of Moderately High to Moderate Liquefaction Susceptibility

City Boundary

Sphere of Influence Boundary

Project Area

Note: The Project Area boundary is approximate. Refer to Exhibit I-2 in the *San Bernardino Merged Area A Merger & Amendments Preliminary Report* for the Merged Area A boundary.

Note: Not to be used as a substitute for site-specific geotechnical iquefaction induced ground failures should be addressed. Boundaries between susceptibility zones will shift if ground water conditions raise or lower over time. Zonations based on sub-surface geology, ground water levels, and maximum credible earthquakes on the San Andreas Fault System, the San Jacinto Fault System and the Cucamonga Fault. (After Matti and Carson, 1986)

SOURCE: San Bernardino General Plan Update and Associated Specific Plans EIR, 2005.

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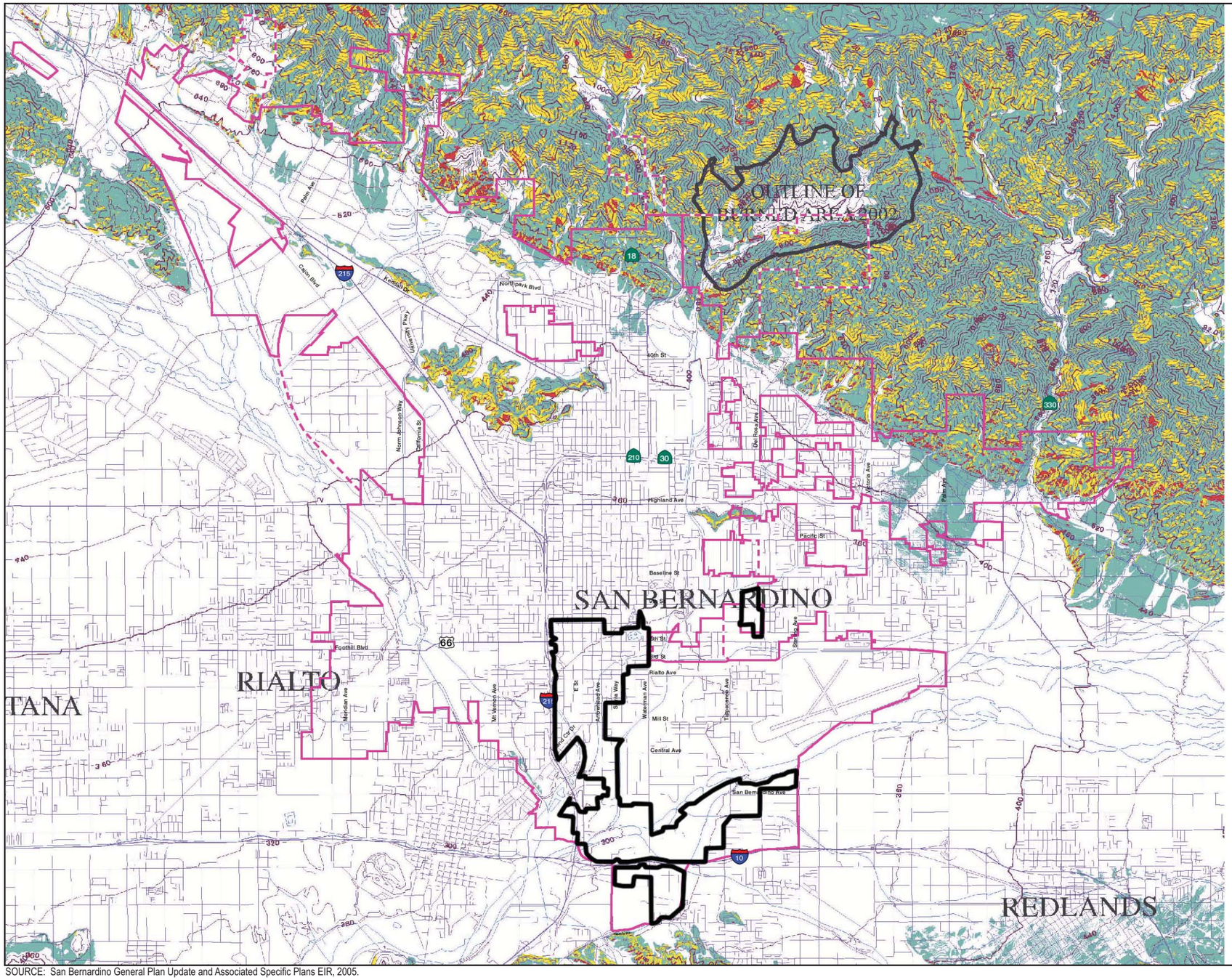
ENVIRONMENTAL IMPACT REPORT
SAN BERNARDINO MERGED AREA A – MERGER AND AMENDMENTS

Liquefaction Susceptibility

Exhibit 5.9-4



Low Susceptibility

Moderate Susceptibility

High Susceptibility

Uncolored areas have zero soil-slip susceptibility values.

City Boundary

Sphere of Influence Boundary

Project Area

Note: The Project Area boundary is approximate. Refer to Exhibit I-2 in the *San Bernardino Merged Area A Merger & Amendments Preliminary Report* for the Merged Area A boundary.

SOURCE: San Bernardino General Plan Update and Associated Specific Plans EIR, 2005.

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ENVIRONMENTAL IMPACT REPORT
SAN BERNARDINO MERGED AREA A – MERGER AND AMENDMENTS

Soil-Slip Susceptibility

Exhibit 5.9-5

Back of 11 x 17 color exhibit

Compressible Soils[29]

Poorly consolidated or highly compressible soils are expected to have low bearing capacities and therefore liable to different settlement. With highly compressible soils, water drains faster than cohesive soils and the load is transferred immediately. This process is known as compression, or settlement. The amount of settlement is dependent on the applied load, structure, and moisture content of the soil. Compression of the soils brought about by an increase in stress from construction, foundation or other results in a deformation and relocation of soil particles, and expulsion of water or air from void spaces. Additionally, younger soils, which include textured sandy and silty soils, contain less well compacted sediments and are therefore more susceptible to settlement.

Ground Subsidence[30]

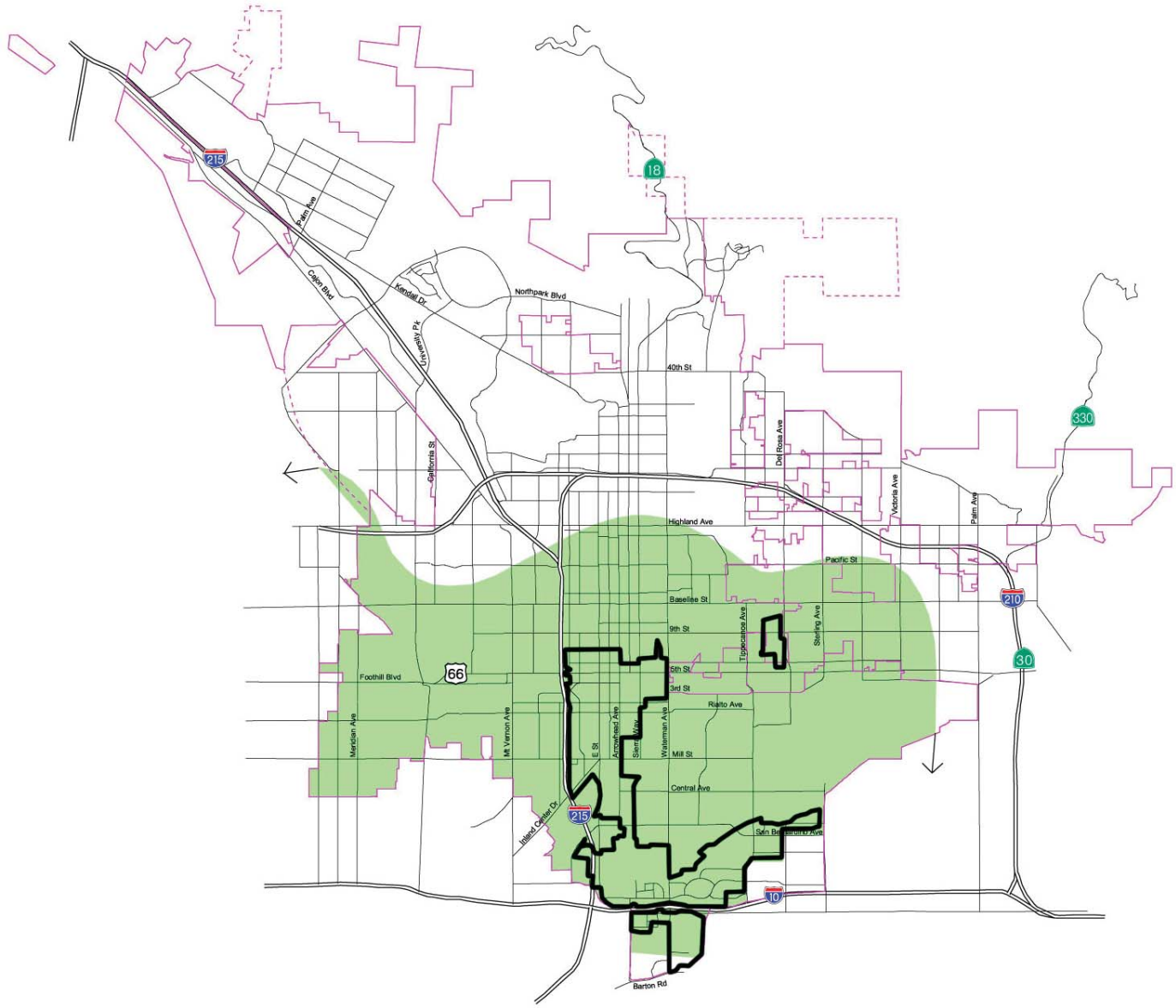
In California, subsidence related to man's activities has been attributed to withdrawal of subsurface fluids such as oil and groundwater, oxidation of organic materials such as coal and peat, and by hydroconsolidation of loose, dry soils in a semi-arid climate. Ground subsidence can affect structures sensitive to slight changes in elevation or slope such as highways, railroads, canals, sewers, and pipelines. Subsidence commonly occurs in such slight magnitude and over large areas that it is not perceptible to an observer without detailed regional surveying studies. Smaller buildings within a uniform subsidence area may not sustain damage unless differential subsidence should occur. Differential subsidence may adversely affect the integrity of structures built within these areas.

Historically, up to one foot of subsidence may have occurred within the City of San Bernardino. The historic area of subsidence was within the thick poorly consolidated alluvial and marsh deposits of the old artesian area north of Loma Linda. The potential subsidence in the area could potentially be as great as five to eight feet if ground water is depleted from the Bunker Hill (San Timoteo Basin). In the San Bernardino area, the potential for subsidence has been significantly reduced since 1972, when the San Bernardino Municipal Water District began to maintain groundwater levels from recharge to percolation basins, which in turn filter back into the alluvial deposits. The entire Project Area is susceptible to subsidence; refer to *Exhibit 5.9-6, Potential Subsidence Areas*.

Erosion

Soil erosion is a naturally occurring process on all land. The agents of soil erosion are water and wind. Soil erosion may be a slow process that continues relatively unnoticed, or it may occur at an alarming rate causing serious loss of topsoil. The rate and magnitude of soil erosion by water is controlled by the following factors: rainfall intensity and runoff; slope gradient; soil erodibility; and length; and vegetation cover.

[29] City of San Bernardino Final General Plan Update and Associated Specific Plans EIR, prepared by The Planning Center, dated September 30, 2005.
[30] Ibid.



Areas of Potential Ground Subsidence

City Boundary

Sphere of Influence Boundary

Project Area

Note: The Project Area boundary is approximate. Refer to Exhibit I-2 in the *San Bernardino Merged Area A Merger & Amendments Preliminary Report* for the Merged Area A boundary.

Note: Degree of subsidence dependent on groundwater levels. Historic subsidence may have occurred in above area. (After Fife and others, 1976)

SOURCE: San Bernardino General Plan Update and Associated Specific Plans EIR, 2005.

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ENVIRONMENTAL IMPACT REPORT
SAN BERNARDINO MERGED AREA A – MERGER AND AMENDMENTS

Potential Subsidence Areas

Exhibit 5.9-6

Soil erodibility is an estimate of the ability of soils to resist erosion, based on the physical characteristics of each soil. Some soil types are more susceptible to wind and rain erosion than others; refer to *Table 5.9-1*. The Delhi fine sand and Tujunga loamy sand are both susceptible to wind erosion if left exposed without adequate vegetative cover. Delhi fine sand and Tujunga loamy sand are found on old alluvial fans or floodplain areas on slopes ranging 0 to 15 percent. The fine sandy texture is especially prone to erosion during periods of high winds that frequent the area. The Cienaba sandy loam, Friant rock outcrop, Greenfield sandy loam, and Saugus sandy loam are all susceptible to water erosion. The Cienaba sandy loam, Friant rock outcrop, Greenfield sand loam, and Saugus sandy loam are found on variable slopes ranging from 2 to 50 percent depending on particular soil type. These soils commonly occur on alluvial fans, hills, and at the base of the San Bernardino Mountain front. Rapid precipitation runoff, denudations, and sandy soil texture can lead to potential water erosion of these soils. Hillside grading without proper erosion control plans, and off-road vehicle use in areas of erosion-prone soils may increase the hazards.[31]

5.9.3 SIGNIFICANCE THRESHOLD CRITERIA

The environmental analysis in this section is patterned after the Initial Study Checklist recommended by the *CEQA Guidelines*, as amended, and used by the City of San Bernardino in its environmental review process, and is contained in Appendix A of this EIR. The Initial Study Checklist includes questions relating to geology and seismic hazards. The issues presented in the Initial Study Checklist have been utilized as thresholds of significance in this section. Accordingly, a project may create a significant environmental impact if it causes one or more of the following to occur:

- Involve earth movement (cut and/or fill) based on information included in the Project Description Form.
- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death.
- Be located within an Alquist-Priolo Earthquake Fault Zone.
- Result in substantial soil erosion or the loss of topsoil.
- Be located within an area subject to landslides, mudslides, subsidence, or other similar hazards as identified in the City's General Plan.
- Be located within an area subject to liquefaction as identified in the City's General Plan.
- Modify any unique physical feature based on a site survey/evaluation (refer to Section 8.0, Effects Found Not To Be Significant).
- Result in erosion, dust, or unstable soil conditions from excavation, grading, fill, or other construction activities (refer to Section 8.0, Effects Found Not To Be Significant);.

[31] City of San Bernardino Final General Plan Update and Associated Specific Plans EIR, The Planning Center, September 30, 2005.

Based on these standards, the effects of the proposed project have been categorized as either a "less than significant impact" or a "potentially significant impact." Mitigation measures are recommended for potentially significant impacts. If a potentially significant impact cannot be reduced to a less than significant level through the application of mitigation, it is categorized as a significant unavoidable impact.

5.9.4 PROJECT IMPACTS AND MITIGATION MEASURES

EARTH MOVEMENT

- **IMPLEMENTATION OF THE PROPOSED PROJECT COULD INVOLVE EARTH MOVEMENT (CUT AND/OR FILL).**

Level of Significance Before Mitigation: Potentially Significant Impact.

Impact Analysis: The proposed project does not involve earth movement (cut and/or fill). However, as a part of the proposed project, a series of infrastructure facilities (i.e., roadway, storm drain, curb and gutter, sewer/water improvements) may be constructed, which could involve earth movement. Mitigation has been recommended in order to reduce impacts associated with earth movement to less than significant levels. Numerous controls would be imposed on future development through the plan checking and permitting process that would further lessen impacts associated with earthwork. All future development would be subject to compliance with applicable building codes (i.e., City *Building Code*, *Uniform Building Code*, *California Building Code*) and recommended mitigation, which would lessen potential impacts associated with earthwork to less than significant levels.

General Plan Goals and Policies: Not Applicable.

Mitigation Measures:

GEO-1 Prior to issuance of a Grading Permit for each development project, a geotechnical engineer shall prepare an area-specific Geologic Report, which shall be submitted to the Community Development (Building and Safety) for approval. The Geologic Report shall specify the measures necessary to mitigate impacts related to liquefaction, expansion, and other geologic and seismic hazards, if any. All recommendations in the Geologic Report shall be implemented during area preparation, grading, and construction.

GEO-2 Prior to issuance of any Grading Permit, applicants of development projects shall comply with each of the recommendations detailed in the Geotechnical Report, and other such measure(s) as the City deems necessary to adequately mitigate potential seismic and geotechnical hazards.

GEO-3 All grading, landform modifications, and construction shall be in conformance with Title 15, Division 1 of the San Bernardino Municipal Code. Typical standard minimum guidelines regarding regulations to control excavations, grading, earthwork construction, including fills and embankments and provisions for approval of plans and inspection of grading construction are set from the latest version of the California Building Code. Compliance with these standards shall

be evident on grading and structural plans. This measure will be monitored by the City Building and Safety Division through periodic site inspections.

Level of Significance After Mitigation: Less Than Significant Impact.

SEISMIC GROUNDSHAKING

- **IMPLEMENTATION OF THE PROPOSED PROJECT COULD EXPOSE PEOPLE AND STRUCTURES TO POTENTIALLY SUBSTANTIAL ADVERSE EFFECTS INVOLVING STRONG SEISMIC GROUNDSHAKING OR BE LOCATED WITHIN AN ALQUIST-PRIOLO EARTHQUAKE FAULT ZONE.**

Level of Significance Before Mitigation: Potentially Significant Impact.

Impact Analysis: The City of San Bernardino is located within a seismically active region of southern California. The City is located between several active faults. The San Andreas Fault traverses the City in a northwest to southeast direction, following the foothills along the northern edge of the City. The San Jacinto Fault (includes the Glen Helen and Loma Linda Faults) further traverses the City within the South Valle and Southeast Industrial Project Areas. The San Jacinto Fault traverses in a northwest to southeast direction through the lower middle and southern portions of the City. Each of these faults is classified as Alquist Priolo Special Study Zones under the Alquist-Priolo Earthquakes Fault Zoning Act; refer to *Exhibit 5.9-3.* The CDMG has designated specific faults within the Project Area as a part of the State of California Alquist-Priolo Special Study Zones. Additionally, several other active faults located nearby can generate ground shaking in San Bernardino; refer to *Table 5.9-2*. The City is located in Seismic Zone 4, the highest hazard zone, and therefore susceptible to strong groundshaking. The southern portion of the Project Area, predominantly the Southeast Industrial Park and South Valle Project Areas, closest to the I-10/I-215 interchange is considered to have the highest potential for fault rupture. The City has been regionally designated as a high severity zone where major probable damage of maximum IX or X, as defined by the Mercalli Intensity Scale, may occur from a maximum expectable earthquake.[32]

The intensity of groundshaking would depend upon the magnitude of the earthquake, distance to the epicenter and the geology of the area between the epicenter and the City. The project proposes the consolidation of seven individual redevelopment Project Areas into one area. Implementation of the proposed project would result in the addition of 1,833 dwelling units and 6,200,590 square feet of non-residential development, which could induce population growth, thereby potentially exposing more residents and employees to the effects of ground shaking from locally and regionally generated earthquakes.

Strong seismic groundshaking could result in substantial damage to some new buildings within the City. The effects of groundshaking would be sufficiently mitigated for buildings designed and constructed in conformance with current building codes and engineering standards. However, there is the possibility of partial to total collapse of buildings built prior to 1933 and some tilt-up concrete block buildings built prior to 1972. Structural vulnerabilities in older buildings that are less earthquake resistant are most likely to contribute to the largest source of

[32] City of San Bernardino Final General Plan Update and Associated Specific Plans EIR, prepared by The Planning Center, dated September 30, 2005.

injury and economic loss as a result of an earthquake. In accordance with the Unreinforced Masonry Law the City has identified structures within the City, which may be hazardous in the event of surface rupture. Structures and persons residing in these structures within the Earthquake Fault Zone and within close proximity to other active faults within the City may be exposed to substantial adverse effects, such as potential structural collapse, in the event of surface rupture.[33]

Implementation of the proposed project could expose people or structures to potential substantial adverse effects as a result of strong seismic groundshaking. Impacts associated with seismically induced groundshaking would be considered significant, unless mitigated. Mitigation has been recommended in order to reduce impacts associated with seismically induced groundshaking to less than significant levels. The mitigation involves compliance with the recommendations detailed in site-specific Geotechnical Studies conducted as part of future development. Also, numerous controls would be imposed on future development through the permitting process that would further lessen impacts associated with seismically-induced groundshaking. Additionally, the *General Plan* Safety Element includes goals and policies to protect the community from risks associated with seismic hazards. These measures acknowledge safety concerns pertaining to seismic ground shaking. All future development would be subject to compliance with applicable building codes (i.e., *City Building Code*, *Uniform Building Code*, *California Building Code*), *General Plan* goals and policies, the *Emergency Management Plan*, the *Hazards Mitigation Plan*, and Mitigation Measures GEO-1 and GEO-2, which would lessen potential impacts associated with strong seismic groundshaking to less than significant levels.

General Plan Goals and Policies:

SAFETY ELEMENT

Goal 10.7 **Protect life, essential lifelines, and property from damage resulting from seismic activity.**

Policy 10.7.1 Minimize the risk of life and property through the identification of potentially hazardous areas, establishment of proper construction design criteria, and provision of public information.

Policy 10.7.2 Require geologic and geotechnical investigations for new development in areas adjacent to known fault locations and approximate fault locations (General Plan Figure S-3) as part of the environmental and/or development review process and enforce structural setbacks from faults identified through those investigations.

Policy 10.7.3 Enforce the requirements of the California Seismic Hazards Mapping and Alquist-Priolo Earthquake Fault Zoning Acts when siting, evaluating, and constructing new projects within the City.

[33] City of San Bernardino Final General Plan Update and Associated Specific Plans EIR, prepared by The Planning Center, dated September 30, 2005.

Policy 10.7.4 Determine the liquefaction potential at a site prior to development, and require that specific measures be taken, as necessary, to prevent or reduce damage in an earthquake.

Goal 10.8 Prevent the loss of life, serious injuries, and major disruption caused by the collapse of or sever damage to vulnerable buildings in an earthquake.

Policy 10.8.1 Enforce the requirements of the California Seismic Hazards Mapping and Alquist-Priolo Earthquake Fault Zoning Acts when siting, evaluating, and constructing new projects within the City.

Policy 10.8.2 Require that lifelines crossing a fault be designed to resist the occurrence of fault rupture.

Policy 10.8.3 Adopt a program for the orderly and effective upgrading of seismically hazardous buildings in the City for the protection of health and safety. Compliance with the Unreinforced Masonry Law shall include the enactment of an effective program for seismic upgrading of unreinforced masonry buildings within the City.

Goal 10.9 Minimize exposure to and risks from geologic activities.

Policy 10.9.1 Minimize risk to life and property by properly identifying hazardous areas, establishing proper construction design criteria, and distribution of public information.

Policy 10.9.2 Require geologic and geotechnical investigations in areas of potential geologic hazards as part of environmental and/or development review process for all new structures.

Policy 10.9.3 Require that new construction and significant alterations to structures located within potential landslide areas (General Plan Figure S-7) be evaluated for site stability, including potential impact to other properties during project design and review.

Mitigation Measures: Refer to Mitigation Measures GEO-1 and GEO-2. No additional mitigation measures are required.

Level of Significance After Mitigation: Less Than Significant Impact.

SEISMIC-RELATED GROUND FAILURE

◆ **IMPLEMENTATION OF THE PROPOSED PROJECT COULD EXPOSE PEOPLE AND STRUCTURES TO POTENTIAL SUBSTANTIAL ADVERSE EFFECTS INVOLVING SEISMIC-RELATED GROUND FAILURE (I.E., LANDSLIDES, SUBSIDENCE, AND LIQUEFACTION).**

Level of Significance Before Mitigation: Potentially Significant Impact.

Impact Analysis: Implementation of the proposed project would result in potentially significant impacts involving the exposure of people or structures to potential substantial adverse effects involving:

- Earthquake-induced landsliding;
- Fracturing, cracking, or fissuring; and
- Compaction, liquefaction, subsidence, or uplift.

Several communities in Southern California have a high likelihood of encountering earthquake-induced landslides, especially in areas with steep slopes. Currently, the City of San Bernardino is located outside a mapped area for Seismic Hazard Zones, which establishes regulatory zones that encompass areas prone to earthquake-induced landslides and liquefaction (failure of water-saturated soil). According to the Preliminary Soil-Slip Susceptibility Map for the southern half of San Bernardino, portions of the City of San Bernardino, including the Project Area, are located within areas designated as having either low, moderate, or high soil-slip susceptibility which could be induced seismically.[34]

Groundshaking, settling, compaction, and sliding produce irregular fractures, cracks, and fissures from a few inches to many feet in length and are rare in bedrock, but are most significant in weathered rocks, alluvium, and alluvial basins up to 75 to 80 miles from the epicenter of a great earthquake surface. Fracturing, cracking, and fissuring may occur within the City and Project Area.

Compaction of loose soils and poorly consolidated alluvium occur as a result of strong seismic shaking. The amount of compaction may vary from a few inches to several feet and may be significant in areas of thick soil cover. Furthermore, tectonic subsidence, uplift tilting, and warping may occur within the City and the Project Area.

Liquefaction is a hazard associated with intense ground shaking. As previously mentioned above, the City is currently located outside a mapped area for Seismic Hazard Zones. However, two general zones have been identified within the regional area, “high” and “moderately high to moderate” zones based on past technical studies. High zones are located adjacent to the San Andreas Fault zone north and northeast of the City and in the old artesian area between the San Andreas and San Jacinto Faults in the central and southern parts of the City. These particular zones delineate regional susceptibility; however, the zones can vary greatly due to groundwater level changes[35]. The Southeast Industrial Park,

[34] City of San Bernardino Final General Plan Update and Associated Specific Plans EIR, prepared by The Planning Center, dated September 30, 2005.
[35] Ibid.

Meadowbrook/Central City, Central City North, Central City South, and Central City East Project Areas are approximately located within areas of high liquefaction susceptibility. The South Valle, Southeast Industrial Park, and Tri-City Project Areas are approximately located within areas of both moderately high to moderate liquefaction susceptibility; refer to *Exhibit 5.9-4*. Therefore, implementation of the proposed project could expose people or structures to potential substantial adverse effects involving landslides, subsidence, and liquefaction. This impact is considered significant unless mitigated. Mitigation Measure GEO-1 requires site-specific geologic investigation of liquefaction potential for development projects within the City and Mitigation Measure GEO-2 requires the implementation of recommended measures identified in a Geotechnical Study to reduce impacts. Further, the Seismic Hazards Mapping Act specifies that the lead agency may withhold development permits until geologic or soils investigations are conducted for specific sites and mitigation measures are incorporated into plans to reduce hazards associated with seismicity and unstable soils. If a geologic report concludes landslides, subsidence, and liquefaction impacts cannot be reduced to less than significant with mitigation as necessary, development would not be permitted. Therefore, following compliance with applicable building codes, *General Plan* goals and policies, the *Emergency Management Plan,* the *Hazards Mitigation Plan,* and recommended mitigation, impacts would be less than significant in this regard.

General Plan Goals and Policies: Refer to the goals and policies identified above.

Mitigation Measures: Refer to Mitigation Measures GEO-1 and GEO-2. No additional mitigation measures are required.

Level of Significance After Mitigation: Less Than Significant Impact.

SOIL EROSION

◆ **IMPLEMENTATION OF THE PROPOSED PROJECT COULD RESULT IN IMPACTS RELATED TO SOIL EROSION OR THE LOSS OF TOPSOIL.**

Level of Significance Before Mitigation: Less Than Significant Impact.

Impact Analysis: Construction activities within the Project Area have the potential to result in soil erosion during excavation, grading and soil stockpiling, subsequent siltation, and conveyance of other pollutants into municipal storm drains. Construction associated with future development (1,833 dwelling units and 6,200,590 square feet of non-residential development) would be required to comply with the requirements of the Municipal National Pollutant Discharge Elimination System (NPDES) Construction Permit and would implement City grading permit regulations that include compliance with erosion control measures, including grading and dust control measures.

Specifically, construction associated with future development projects would occur in accordance with Chapter 8.80 Storm Water Drainage System, of the City's *Municipal Code*, which requires necessary permits, plans, plan checks, and inspections to reduce the effects of sedimentation and erosion. In addition, construction associated with future development projects would be required to have erosion control plans approved by the City of San Bernardino Department of Building and Safety, as well as Storm Water Pollution Prevention Plans (SWPPP). As part of these requirements, Best Management Practices (BMPs) would be

implemented during construction activities to reduce soil erosion to the maximum extent possible. Furthermore, all construction activities would be required to comply with SCAQMD Rule 403 regarding the control of fugitive dust. Compliance with the City's applicable building regulations regarding erosion control and SCAQMD Rule 403 would ensure that impacts related to soil erosion during construction phases of future development would be less than significant.

General Plan Goals and Policies: Refer to the goals and policies identified above.

Mitigation Measures: No mitigation measures beyond the goals and policies identified in the General Plan and existing regulatory requirements are required.

Level of Significance After Mitigation: Not Applicable.

EXPANSIVE SOILS

- **DEVELOPMENT ASSOCIATED WITH IMPLEMENTATION OF THE PROPOSED PROJECT COULD BE LOCATED ON EXPANSIVE SOILS CREATING POTENTIAL RISK TO LIFE OR PROPERTY.**

Level of Significance Before Mitigation: Potentially Significant Impact.

Impact Analysis: The City lies on a broad, gently sloping lowland that flanks the southwest margin of the San Bernardino Mountains. The lowland is underlain by alluvial sediments eroded from bedrock in the adjacent mountains and washed by rivers and creeks into the valley region where they have accumulated in layers of sand, silt, gravel, and clay.[36] Soils with a percentage of clay have the potential to expand when water is added and shrink when water is lost, resulting in what is called expansive soils. Expansive soils can result in damage to overlying structures and infrastructure. Future development projects (1,833 dwelling units and 6,200,590 square feet of non-residential development) associated with implementation of the proposed project would be required to comply with applicable building codes (i.e., City *Building Code*, *Uniform Building Code*, and *California Building Code*) and Mitigation Measures GEO-1 and GEO-2, which would reduce impacts regarding expansive soils to a less than significant level.

General Plan Goals and Policies: Refer to the goals and policies identified above.

Mitigation Measures: Refer to Mitigation Measures GEO-1 and GEO-2. No additional mitigation measures are required.

Level of Significance After Mitigation: Less Than Significant Impact.

[36] City of San Bernardino Final General Plan Update and Associated Specific Plans EIR, prepared by The Planning Center, dated September 30, 2005.

5.9.5 CUMULATIVE IMPACTS AND MITIGATION MEASURES

- **IMPLEMENTATION OF THE PROPOSED PROJECT COULD RESULT IN CUMULATIVELY CONSIDERABLE IMPACTS RELATED TO GEOLOGIC, SOILS, AND SEISMIC HAZARDS.**

Level of Significance Before Mitigation: Potentially Significant Impact.

Impact Analysis: Although geologic and seismic hazard conditions occur regionally, the potential increased exposure of the human population to these hazards resulting from implementation of the proposed project would be specific to the City of San Bernardino. However, increased growth within the subregion, as a result of the proposed project and other projects, would contribute to the cumulative exposure of the regional population to seismic hazards. Unsafe geologic, soils, and seismic conditions exist throughout southern California and new development in such areas would be considered significant. These potential impacts are evaluated on a project-by-project basis in accordance with CEQA. If a specific site were determined to create a significant impact that could not be feasibly mitigated the site would not be appropriate for development. Development of cumulative projects would incrementally increase the number of people and structures potentially subject to a seismic event. However, such exposure would be minimized through strict engineering guidelines for development at each respective area. Future development projects would be subject to compliance with the City's *Building Code*, *California Building Code*, and *Uniform Building Code*. Additionally, mitigation would be incorporated on a project-by-project basis to reduce cumulative geology and soil impacts to a less than significant level.

Future development areas within the City of San Bernardino may exhibit constraints to development that would be addressed at the geotechnical engineering level. Individual development projects under the proposed project would undergo site-specific evaluation to determine threat and the cumulative threat of geologic and seismic hazards in the region. As concluded above, implementation of the proposed project would be less than significant with adherence to the *General Plan* goals and policies, compliance with the City's *Building Code*, *California Building Code*, and *Uniform Building Code*, and recommended mitigation measures. Therefore, implementation of the proposed project would not result in cumulatively considerable geology and seismic hazards impacts.

General Plan Goals and Policies: Refer to the goals and policies identified above.

Mitigation Measures: Refer to Mitigation Measures GEO-1 and GEO-2. No additional mitigation measures are required.

Level of Significance After Mitigation: Less Than Significant Impact.

5.9.6 SIGNIFICANT UNAVOIDABLE IMPACTS

Geologic and seismic hazard impacts associated with implementation of the proposed project would be less than significant with compliance with the *General Plan* goals and policies and the recommended mitigation measures. Therefore, no significant unavoidable geologic and seismic hazards impacts would occur as a result of the proposed project.

5.9.7 SOURCES CITED

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