2. Physical Environment

This section discusses the existing environmental conditions related to the following physical environment topics:

- Air Resources,
- Climate Change,
- Geology and Soil Resources,
- Water Resources,
- Noise, and
- Paleontology.

Unless otherwise specified, the “study area” encompasses the general area from Pisgah Crater west along the I-40/old Route 66 corridor to the Daggett area, and south through Stoddard Valley, North Lucerne Valley, western Lucerne Valley, and Apple Valley to Hesperia (see Figure 1-1).

2.1 Air Resources

The environmental setting for air quality in the study area, including available representative ambient air pollutant data, was determined through a review of existing literature from local, State, and federal resources, which included but were not limited to, the following:

- The United States Environmental Protection Agency (USEPA),
- State of California, Air Resources Board (CARB),
- The Mojave Desert Air Quality Management District (MDAQMD), and
- SCE’s Proponent’s Environmental Assessment (PEA).

The study area is located in the high desert, specifically within the Mojave Desert Planning Area, which is a sub region of the Mojave Desert Air Basin (MDAB) that is in non-attainment of the federal ozone and particulate ambient air quality standards, and is under the jurisdiction of the MDAQMD. An area that is in non-attainment is considered to have air quality that is worse than the National Ambient Air Quality (NAAQ) standards, as defined by the Clean Air Act Amendments of 1970.

The air quality area of influence for the study area includes the MDAB, which consists of the small, urbanized areas of Victorville/Hesperia and Barstow, and the transport of emissions into the MDAB from the South Coast Air Basin includes the major urbanized areas of Los Angeles, Riverside, San Bernardino, and Orange Counties.

2.1.1 Regional Climate and Meteorology

The study area is located in the high desert of San Bernardino County (see Figure 1-1) and has a climate that is characterized by warm, dry summers and cool winters with a small amount of seasonal precipitation that occurs primarily during the winter months. Summers typically have clear skies, warm temperatures, and low humidity. Prevailing winds in the MDAB are out of the west and southwest, with high wind events occurring frequently. A monthly climate summary was conducted for the City of Hesperia and the unincorporated community of Daggett, which are at either end of the study area, and were selected to characterize the climate. As described in Table 2.1-1, average summer (June to September) high and low temperatures in the study area range from 104ºF to 56ºF. Average winter (December to March) high and low temperatures range from 72ºF to 31ºF. The average annual precipitation is approximately 6 and 4 inches, respectively, for Hesperia and Daggett, with 69 percent of the Hesperia precipitation occurring between December and March. There is a slightly higher summer monsoon precipitation influence in Daggett that reduces the winter rainfall to 58 percent of the annual total.

Table 2.1-1. Hesperia and Daggett Monthly Average Temperatures and Precipitation

Month	Temperature (ºF)		Precipitation
	Maximum	Minimum	
Hesperia			
January	60	32	1.09
February	63	35	1.26
March	69	39	0.88
April	75	44	0.35
May	85	50	0.14
June	94	56	0.05
July	99	62	0.19
August	99	62	0.20
September	93	56	0.18
October	81	46	0.36
November	69	37	0.47
December	60	31	1.02
Daggett			
January	61	36	0.60
February	65	40	0.68
March	72	45	0.50
April	79	51	0.17
May	89	59	0.05
June	98	67	0.06
July	104	73	0.46
August	103	72	0.26
September	95	65	0.21
October	82	54	0.18
November	69	42	0.34
December	60	35	0.57

Source: WC, 2014

2.1.2 Air Pollutants and Monitoring Data

Air pollutants are defined as two general types: (1) "criteria" pollutants, representing six pollutants for which national and State health- and welfare-based ambient air quality standards have been established; and (2) toxic air contaminants (TACs), which may lead to serious illness or increased mortality even when present at relatively low concentrations. Generally, TACs do not have ambient air quality standards. The three TACs that do have ambient air quality standards (lead, vinyl chloride, and hydrogen sulfide) are pollutants that are not relevant to this study area.

2.1.2.1 Criteria Air Pollutants

The following is a general description of the criteria air pollutants, which may be emitted by general construction activities; the current attainment status of those pollutants; and a summary of the monitored concentrations for each pollutant at sites near the study area. The National and California Ambient Air Quality Standards (NAAQS and CAAQS) relevant to the study area are provided in Table 2.1-2.

Table 2.1-2. National and California Ambient Air Quality Standards

Pollutant	Averaging Time	California Standards	National Standards	Health Effects
Ozone (O_3)	1-hour	0.09 ppm	--	Breathing difficulties, lung tissue damage
	8-hour	0.070 ppm	0.075 ppm	
Respirable particulate matter (PM10)	24-hour	50 μg/m^3	150 μg/m^3	Increased respiratory disease, lung damage, cancer, premature death
	Annual	20 μg/m^3	--	
Fine particulate matter (PM2.5)	24-hour	--	35 μg/m^3	Increased respiratory disease, lung damage, cancer, premature death
	Annual [1]	12 μg/m^3	12 μg/m^3	
Carbon monoxide (CO)	1-hour	20 ppm	35 ppm	Chest pain in heart patients, headaches, reduced mental alertness
	8-hour	9.0 ppm	9 ppm	
Nitrogen dioxide (NO_2)	1-hour	0.18 ppm	0.100 ppm [2]	Lung irritation and damage
	Annual	0.030 ppm	0.053 ppm	
Sulfur dioxide (SO_2)	1-hour	0.25 ppm	0.075 ppm [2]	Increases lung disease and breathing problems for asthmatics
	3-hour	--	0.5 ppm	
	24-hour	0.04 ppm	--	

Source: CARB, 2014a

Note(s): ppm = parts per million; μg/m^3 = micrograms per cubic meter; "--" = no standards

1. The federal standard shown is the primary standard, the secondary standard is 15 μg/m3.
2. The new federal 1-hour NO2 and SO2 standards are based on the 98th and 99th percentile of daily hourly maximum values, respectively.

The ambient air quality standards shown in Table 2.1-2 are health-based standards established by the CARB and USEPA. The ambient air quality standards are set at levels to adequately protect the health of all members of the public, including those most sensitive to adverse air quality impacts such as the elderly, people with existing illnesses, children, and infants, including a margin of safety.

The USEPA, CARB, and local air districts classify an area as attainment, unclassified, or non-attainment depending on whether or not the monitored ambient air quality data shows compliance, insufficient data available, or non-compliance with the ambient air quality standards, respectively. Table 2.1-3 summarizes the federal and State attainment status of criteria pollutants for the MDAB surrounding the study area based on the NAAQS and CAAQS, respectively.

Table 2.1-3. Attainment Status for the MDAB [1]		
	Attainment Status [2]	
Pollutant	**Federal**	**State**
Ozone	Severe Nonattainment	Moderate Nonattainment
PM10	Moderate Nonattainment	Nonattainment
PM2.5	Attainment	Nonattainment
CO	Attainment	Attainment
NO_2	Attainment	Attainment
SO_2	Attainment	Attainment

Source: CARB, 2014b; USEPA, 2014

1. For the portion of the MDAB surrounding the study area.
2. The Attainment designations shown in this table may actually be unclassified/unclassifiable or cannot be classified designations that for regulatory purposes are the same as an attainment designation.

The MDAB has 14 monitoring stations that measure air quality. The most representative monitoring sites to the study area would be the four stations located in Victorville, Hesperia, Barstow, and Lucerne Valley. The pollutants monitored at these four stations include: Victorville – all pollutants provided in Table 2.1-3; Barstow – NO_2, CO, ozone, and PM10; Hesperia – ozone and PM10; and Lucerne Valley – PM10. Table 2.1-4 presents the maximum pollutant levels measured from these four monitoring stations from 2010 through 2012, meaning that the highest concentrations obtained from these stations are shown when there are multiple stations that are monitoring a specific pollutant, and the highest of the national and California concentrations are shown when they are different.

Table 2.1-4. Background Ambient Air Quality Data				
		Maximum Concentration (ppm or µg/m³) [1]		
Pollutant	**Averaging Time**	**2010**	**2011**	**2012**
Ozone	1-hour	0.119	0.132	0.116
	8-hour	0.102	0.114	0.097
PM10	24-hour	49.0	110.2	45.0
	Annual	21.8	22.1	23.3
PM2.5	24-hour	20.0	16.0	12.0
	Annual	7.6	--	--
CO	8-hour	5.17	1.51	1.83
NO_2	1-hour	0.137	0.077	0.146
	1-hour (98th percentile)	0.065	0.062	0.098
	Annual	0.017	0.017	0.017
SO_2	24-hour	0.007	0.007	0.003
	Annual	0.000	0.001	--

Source: CARB, 2014c

Note(s): ppm = parts per million; µg/m³ = micrograms per cubic meter; "—" = no data

1. Gaseous pollutant (ozone, SO_2, NO_2, and CO) concentrations are shown in ppm and particulate (PM10 and PM2.5) concentrations are shown in µg/m³.

The ambient air quality data shown above in Table 2.1-4 indicates that during 2010 to 2012, the local study area experienced exceedances of the federal and State ozone and PM10 standards. There are also measured exceedances of the State and federal NO_2 standards; however, the entire MDAB continues to be designated as in attainment of these standards. No exceedances of the federal or State standards of PM2.5, CO, or SO_2 were measured during 2010 to 2012 at the monitoring stations surrounding the study area.

2.1.2.2 Toxic Air Contaminants (TACs)

TACs are compounds that are known or suspected to cause adverse long-term (cancer and chronic) and/or short-term (acute) health effects. The Health and Safety Code defines a TAC as an air pollutant which may cause or contribute to an increase in mortality or serious illness, or which may pose a present or potential hazard to human health. Individual TACs vary greatly in the health risk they present; at a given level of exposure, one TAC may pose a hazard that is many times greater than another's. There are almost 200 compounds designated in California regulations as TACs (17 CCR §§ 93000-93001). The list of TACs also includes the substances defined in federal statute as hazardous air pollutants (HAPs) pursuant to Section 112 (b) of the federal Clean Air Act (42 U.S.C. Section 7412(b)). Some of the TACs are groups of compounds containing many individual substances (e.g., copper compounds, polycyclic aromatic compounds). TACs are emitted from mobile sources, including diesel engines; industrial processes and stationary sources, such as dry cleaners, gasoline stations, paint and solvent operations, and stationary fossil fuel-burning combustion. Ambient TACs concentrations tend to be highest in urbanized and industrial areas near major TACs emissions sources or near major mobile TACs emissions sources, such as heavily traveled highways or major airports/seaports. Unlike for criteria pollutants, no monitoring studies of ambient TACs concentrations have been performed in the high desert portion of the MDAB.

2.1.3 Sensitive Receptors

The impact of air emissions on sensitive members of the population is a special concern. Sensitive receptor groups include children and infants, pregnant women, the elderly, and the acutely and chronically ill. According to MDAQMD CEQA guidance (MDAQMD, 2011), sensitive receptor locations include residences, schools, daycare centers, playgrounds, and medical facilities.

Recreational land uses are considered moderately sensitive to air pollution. Although exposure periods are generally short, exercise places a high demand on respiratory functions, which can be impaired by air pollution. In addition, noticeable air pollution can detract from the enjoyment of recreation. Industrial and commercial areas are considered the least sensitive to air pollution. Exposure periods are relatively short and intermittent, as the majority of the workers tend to stay indoors most of the time. In addition, the working population is generally the healthiest segment of the public.

A land use survey was conducted to identify sensitive receptors (e.g., local residences, schools, hospitals, churches, recreational facilities) in the general vicinity of the study area. Most of the area is undeveloped with only a few scattered rural residences; however, the southern end of the study area includes populated areas of Hesperia, where there are several schools and daycare centers.

Local Jurisdiction

The MDAQMD is primarily responsible for planning, implementing, and enforcing federal and State ambient standards within this portion of the MDAB. As part of its planning responsibilities, the MDAQMD prepares Air Quality Management Plans and Attainment Plans as necessary based on the attainment status of the air basins within its jurisdiction. The MDAQMD is also responsible for permitting and controlling stationary source criteria and air toxic pollutants as delegated by the USEPA.

The MDAQMD first adopted a Federal Particulate Matter (PM10) Attainment Plan in July 31, 1995 (MDAQMD, 1995). This attainment plan states that "the air quality of the MDAQMD is impacted by both fugitive dust from local sources and occasionally by region-wide windblown dust during moderate to high wind episodes. This region-wide or "regional" event includes contributions from both local and distant dust sources which frequently result in violations of the NAAQS that are multi-district and interstate in scope. It also states that "it is not feasible to implement control measures to reduce dust from regional wind events." Therefore, no measures are applicable to the study area, and compliance with existing MDAQMD rules and regulations would ensure compliance with this plan.

The MDAQMD adopted the MDAQMD 2004 Ozone Attainment Plan (approved by the USEPA), and has updated it with the MDAQMD Federal 8-hour Ozone Attainment Plan 2008 to demonstrate that the MDAQMD will meet the required federal ozone planning milestones and attain the 8-hour ozone NAAQS by June 2021 (MDAQMD, 2004; MDAQMD, 2008). There are no additional control measures for direct ozone precursor reductions required as part of the update. However, the MDAQMD is committed to having all applicable Federal Reasonably Available Control Technology (RACT) rules as proposed in their 8-hour RACT State Implementation Plan Analysis adopted in 2006 and supplemented in 2014 (MDAQMD, 2006; MDAQMD, 2014a). In addition, the MDAQMD updated and identified new measures in 2007, to be adopted through 2014, as the State of California mandates, including all feasible ozone precursor control measures.

Through the attainment planning process, the MDAQMD develops the MDAQMD Rules and Regulations to regulate sources of air pollution in the MDAB (MDAQMD, 2014b). The MDAQMD rules that are applicable to the study area are listed below.

- Regulation II – Permits. This regulation includes rule requirements for obtaining necessary permits to construct and operate that will be applicable to the study area's proposed emergency generator.
- Rule 401 – Visible Emissions. This rule prohibits discharge of air contaminants or other material, which are as dark or darker in shade as that designated No. 1 on the Ringelmann Chart.
- Rule 402 – Nuisance. This rule prohibits discharge of air contaminants or other material that cause injury, detriment, nuisance, or annoyance to any considerable number of persons or to the public; or that endanger the comfort, repose, health, or safety of any such persons or the public; or that cause, or have a natural tendency to cause, injury or damage to business or property.
- Rule 403 – Fugitive Dust. The purpose of this rule is to control the amount of PM entrained in the atmosphere from manmade sources of fugitive dust. The rule prohibits emissions of fugitive dust from any active operation, open storage pile, or disturbed surface area to be visible beyond the emission source's property line. This rule also requires other reasonable precautions be taken to minimize dust during construction activities and prevent track-out upon public roadways.
- Rule 403.2 – Fugitive Dust Control for the Mojave Desert Planning Area. This rule requires additional fugitive dust control measures as contained in the Mojave Desert Planning Area Federal PM10 Attainment Plan. The study area is wholly contained within the Mojave Desert Planning Area and this rule is specifically applicable to construction/demolition and activities on BLM-administered lands. The specific requirements of this rule include periodic watering of disturbed areas, controlling track-out onto paved surfaces, covering haul vehicle, stabilizing graded surfaces, and reducing activities during high wind events. In addition, dust control plans with additional specific dust control measures must be prepared and submitted to the MDAQMD for construction/demolition sources disturbing 100 acres or more.
- Rule 900 – Standards for Performance for New Stationary Sources (NSPS). NSPS Subpart IIII is applicable to the study area's proposed emergency standby engine. This subpart establishes

emission standards, fuel requirements, hour meter requirements, limits maintenance and testing and requires proper maintenance for the engines and control devices. The Applicant (SCE) would need to comply with the latest USEPA Tier Certification level for the applicable horsepower range, CARB-certified fuel, installation of non-reset hour meter, maintenance and testing limitations, and proper maintenance. The USEPA has delegated enforcement of this regulation to MDAQMD.

- Rule 1113 – Architectural Coatings Rule. This rule limits the volatile organic compound (VOC) content of paints applied to various surfaces that would be applicable to any construction painting operation.
- Rule 1160 – Internal Combustion Engines. This rule establishes emissions limits for emergency, portable, standby, or stationary internal combustion engines rated at 500 or more brake horsepower (bhp), when located within the Federal Ozone Non-attainment Area.

USEPA has a number of other regulations under the authority of the federal Clean Air Act (CAA) (such as New Source Review, Prevention of Significant Deterioration, Title V permitting program, etc.) that have been delegated to MDAQMD for enforcement. For example, the federal CAA identifies some wildernesses, Class I areas, for special protection from long-term air pollution emitted by stationary sources. Additionally, it is also known that air pollutants emitted by this study area, like nitrogen oxides (NOx), ozone and fugitive dust have impacts on visibility and the aquatic and terrestrial ecosystem of these wildernesses. There are at least a half a dozen Class I areas located within 100 kilometers of the study area route. However, the Prevention of Significant Deterioration regulation requirement to evaluate impacts to Class I areas does not apply to this study area because it would have no operating stationary emission sources, other than one emergency standby generator. Also, while the emergency standby engine would require an air quality permit, it does not constitute a major stationary source of air pollution that would trigger MDAQMD's Regulation XIII - New Source Review requirements.

There are no other rules currently proposed by the MDAQMD that would be applicable to the study area (MDAQMD, 2014c).

The MDAQMD in their *California Environmental Quality Act (CEQA) and Federal Conformity Guidelines* document has recommended air quality analysis methodologies and has established recommended CEQA significant emissions levels for applicable criteria pollutant emissions as follows:

- Carbon Monoxide (CO) – 100 tons per year
- Oxides of Nitrogen (NOx) – 25 tons per year
- Volatile Organic Compounds (VOC) – 25 tons per year
- Oxides of Sulfur (SOx) – 25 tons per year
- Particulate Matter (PM10) – 15 tons per year
- Particulate Matter (PM2.5) – 15 tons per year (MDAQMD, 2011)

Many of the local jurisdictions (city and county) within the study area have adopted General Plans or other planning documents. San Bernardino County has developed a General Plan and development code that include air quality related goals, policies, and codes (San Bernardino County, 2013a and 2014). Also, the City of Hesperia, the City of Barstow, and the Town of Apple Valley have developed General Plans that include air quality related goals and policies (City of Hesperia, 2011; City of Barstow, 1997; Town of Apple Valley, 2009).

Other local plans jurisdictions covered by the study area were evaluated, such as the Lucerne Valley Community Plan and the Oak Hills Community Plan, but none of these local plans included air quality elements that are relevant to the study area (San Bernardino County, 2007 and 2013b).

2.2 Climate Change

This section describes the environmental setting for global climate change (GCC) within the study area. GCC is expressed as changes in the average weather of the Earth, as measured by change in wind patterns, storms, precipitation, and temperature. Much scientific research has indicated that the human-related emissions of greenhouse gases (GHGs) above natural levels are likely a significant contributor to GCC. Because the direct environmental effect of GHG emissions is the increase in average global temperatures, which in turn has numerous indirect effects on the environment and humans, the area of influence for GHG impacts associated with a project in the study area would be global. However, those cumulative global impacts would manifest as impacts on resources and ecosystems in California, as well as across the United States. The environmental setting for climate change, including available estimates of State, federal, and international GHG emissions, were determined through a review of existing literature from international and domestic resources, which included but were not limited to, the following:

- United States Geological Survey (USGS),
- National Oceanic and Atmospheric Administration (NOAA),
- National Aeronautics and Space Administration (NASA),
- The United States Environmental Protection Agency (USEPA),
- State of California, Air Resources Board (CARB),
- State of California, Energy Commission (CEC),
- State of California, Environmental Protection Agency (CalEPA),
- The Intergovernmental Panel on Climate Change (IPCC),
- European Commission, Emission Database for Global Atmospheric Research (EDGAR), and
- SCE’s Proponent’s Environmental Assessment (PEA).

Data obtained and presented are based on the latest available existing data from the above sources.

The study area is located in the Mojave Desert between Hesperia and Daggett, California, which is within the MDAB and is under the local air quality jurisdiction of the MDAQMD.

2.2.1 Climate Change

While climate change has been a concern since at least 1998, as evidenced by the establishment of the United Nations and World Meteorological Organization’s Intergovernmental Panel on Climate Change (IPCC), efforts devoted to GHG emissions reduction and climate change research and policy have increased dramatically in recent years. GCC refers to the impacts that occur from the accumulation of GHGs in the atmosphere combined with other sources of atmospheric warming. The accumulation of GHGs in the atmosphere regulates the Earth’s temperature. Without these natural GHGs, the Earth’s surface would be approximately 61°F cooler (CalEPA, 2006); however, emissions from fossil fuel combustion for activities, such as electricity production and vehicular transportation, have elevated the concentration of GHGs in the atmosphere above natural levels. Scientific evidence indicates a trend of increasing global temperatures near the Earth's surface over the past century due to increased human-induced levels of GHGs. Worldwide over the past 132-year record, the ten warmest years have all occurred since 1998, with the two hottest years on record being 2010 and 2005 (NASA, 2014). According to "The Future Is Now: An Update on Climate Change Science Impacts and Response Options for California," a California Energy Commission document, the American West is heating up faster than other regions of the United States (CEC, 2009). The California Climate Change Center reports that, by the end of this century, average global surface temperatures could rise by 4.7°F to 10.5°F due to increased GHG emissions (CCCC, 2006a).

According to NOAA, the atmospheric concentration of Carbon Dioxide (CO_2) measured at Mauna Loa, Hawaii in March 2014 was 399.65 parts per million (ppm) (NOAA, 2014) compared to the pre-industrial levels of 280 ppm +/- 20 ppm (IPCC, 2007a). NOAA's Mauna Loa data also show that the mean annual CO_2 concentration growth rate is accelerating, where in the 1960s it was about 0.9 ppm per year and in the first decade of the 2000s it was almost 2 ppm per year. The IPCC constructed several emission trajectories of GHGs needed to stabilize global temperatures and climate change impacts. It concluded that stabilization of GHGs below approximately 400 ppm carbon dioxide equivalent (CO_2e) concentration is required to keep long-term global mean warming below 3.6°F from pre-industrial levels, which is assumed to be necessary to avoid a large contribution to sea level rise from the West Antarctic Ice Sheet (IPCC, 2007a).

The impact to climate change due to the increase in ambient concentrations of GHGs differ from criteria pollutants (air quality) in that GHG emissions from a specific project do not cause direct adverse localized human health effects. Rather, the direct environmental effect of GHG emissions is the cumulative effect of an overall increase in global temperatures, which in turn has numerous indirect effects on the environment and humans. The impacts of climate change include potential physical, economic and social effects. These effects could include: inundation of settled areas near the coast from rises in sea level associated with melting of land-based glacial ice sheets, exposure to more frequent and powerful climate events, changes in suitability of certain areas for agriculture, reduction in Artic sea ice, thawing permafrost, later freezing and earlier breakup of ice on rivers and lakes, a lengthened growing season, shifts in plant and animal ranges, earlier spring events such as the flowering of trees, and a substantial reduction in winter snowpack (IPCC, 2007b).

Specifically, California could experience unprecedented heat, longer and more extreme heat waves, greater intensity and frequency of heat waves, and longer dry periods. More specifically, it is predicted that California could witness the following events by the end of the century: (CCCC, 2006a)

- Temperature rises between 3 and 10.5°F,
- 6 to 30 inches or greater rise in sea level,
- 2 to 4 times as many heat-wave days in major urban centers,
- 2 to 6 times as many heat-related deaths in major urban centers,
- 1.5 to 2.5 times more critically dry years,
- 30 to 90 percent loss in Sierra snowpack,
- 25 to 85 percent increase in days conducive to ozone formation,
- 3 to 20 percent increase in electricity demand,
- 7 to 30 percent decrease in forest yields (pine), and
- 10 to 55 percent increase in the risk of wildfires.

Similar major changes to existing weather patterns and associated impacts could occur worldwide, but these climate changes will not always result in less rainfall or warmer temperatures. In some areas, rainfall would increase and average temperatures would drop. However, it is not specifically drought or increased temperatures that create the environmental, social, and economic impacts from climate change; rather, it is the significant change from existing weather patterns and conditions that causes these impacts.

2.2.2 Greenhouse Gas Emissions

GHGs are gases that trap heat in the atmosphere and are emitted by natural processes and human activities. Examples of GHGs that are produced both by natural processes and industry include CO_2, Methane (CH_4), and Nitrous Oxide (N_2O). The State of California and the USEPA have identified six GHGs generated by human activity that are believed to be the primary contributors to manmade global warming: (1) CO_2, (2) CH_4, (3) N_2O, (4) hydrofluorocarbons (HFCs), (5) perfluorocarbons (PFCs), and (6) sulfur hexafluoride (SF_6).

- Carbon Dioxide (CO_2): CO_2 enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and chemical reactions (e.g., the manufacture of cement). CO_2 is also removed from the atmosphere (or “sequestered”) when it is absorbed by plants as part of the biological carbon cycle.
- Methane (CH_4): CH_4 is emitted during the production and transport of coal, natural gas, and oil. CH_4 emissions also result from livestock and agricultural practices and the decay of organic waste in municipal solid waste landfills.
- Nitrous Oxide (N_2O): N_2O is emitted during agricultural and industrial activities as well as during combustion of fossil fuels and solid waste.
- Fluorinated Gases: HFCs, PFCs, and SF_6 are synthetic, powerful climate-change gases that are emitted from a variety of industrial processes. Fluorinated gases are often used as substitutes for ozone-depleting substances (i.e., chlorofluorocarbons, hydrochloro-fluorocarbons, and halons). These gases are typically emitted in smaller quantities, but because they are potent climate-change gases, they are sometimes referred to as high “Global Warming Potential” (GWP) gases.

GHGs have varying amounts of GWP, where the GWP is the ability of a gas or aerosol to trap heat in the atmosphere. By convention, CO_2 is assigned a GWP of 1. In comparison, SF_6 has a GWP of 22,800, which means that it has a global warming effect 22,800 times greater than CO_2 on an equal-mass basis. To account for their GWP, GHG emissions are often reported as CO_2 equivalent (CO_2e). The CO_2e for a source is calculated by multiplying each GHG emission by its GWP, and then adding the results together to produce a single, combined emission rate representing all GHGs.

GHG emissions in the United States and the State of California come mostly from energy use. Energy-related CO_2 emissions, resulting from fossil fuel exploration and use account for approximately three-quarters of the human-generated GHG emissions in the United States, primarily in the form of CO_2 emissions from burning fossil fuels. More than half the energy-related emissions within the United States come from large stationary sources, such as power plants; approximately a third comes from transportation; while agriculture and forestry, and other land uses (residential and commercial) make up a majority of the remainder of sources (USEPA, 2014a). The United States and State of California emissions of GHGs in 1990 and later years are summarized in Table 2.2-1.

Table 2.2-1. United States and California Greenhouse Gas Emissions (million metric tons CO_2e)

Inventory Sector [1]	1990	2005	2008	2009	2010	2011	2012
United States Emissions [2]							
Electric Power Industry	1,866.1	2,445.7	2,401.8	2,187.0	2,302.5	2,200.9	2,064.9
Transportation	1,553.2	2,012.3	1,916.5	1,839.1	1,853.5	1,832.2	1,815.5
Industry	1,527.9	1,403.5	1,367.6	1,217.2	1,297.3	1,290.5	1,273.9
Agriculture	518.1	583.6	615.3	605.3	600.9	612.7	614.1
Commercial	385.3	370.4	379.2	381.9	376.6	378.4	353.2
Residential	345.4	371.3	365.4	357.9	359.9	353.9	322.0
U.S. Territories	33.7	58.2	49.8	47.9	58.0	57.9	57.9
United States Total	**6,229.6**	**7,244.9**	**7,095.5**	**6,636.3**	**6,848.6**	**6,726.6**	**6,501.5**
State of California Emissions [3]							
Electricity Generation	110.6	108.2	120.4	103.8	90.3	86.8	---
Transportation	150.7	191.6	180.1	174.7	173.8	171.6	---
Industry	103.7	101.9	97.7	93.0	100.2	102.68	---
Commercial	14.4	17.4	19.9	20.5	21.5	21.9	---
Residential	29.7	30.1	31.0	30.8	31.9	32.7	---
Agriculture & Forestry	16.9	32.8	33.9	31.7	31.7	32.2	---
Not Specified	1.3	0.2	0.2	0.2	0.2	0.2	---
California Total	**433.3**	**482.1**	**483.2**	**454.7**	**449.6**	**448.1**	**---**

Source: USEPA, 2014a; CARB, 2007; CARB, 2013

Note(s):

1. Sectors are as provided in each of the references used, with the in-state and out–of-state electricity generation values totaled.
2. Does not include the emissions sinks presented in this reference.
3. Emissions are the non-excluded emissions totals, not including emissions sinks, provided in the first two pages of the respective references rounded to the nearest tenth of a million metric ton. 2012 data is not available for California.

For comparison with the emission data given above in Table 2.2-1, the estimated global emissions of CO_2e in 2010 are 50,101 million metric tons (EDGAR, 2014). This indicates that the United States, which has about 4.4 percent of the global population, emits roughly 14 percent of the total global GHG emissions. The State of California, which has approximately 0.55 percent of the global population, emits just less than 0.9 percent of the total global GHG emissions.

A critical interpretation of the data provided in Table 2.2-1, along with knowledge regarding other current events, regulatory actions, and population levels, provides for several potential conclusions regarding the California and United States GHG emission trends, such as:

- After peaking earlier in the first decade of this millennia, emissions from electricity generation are dropping, which is likely due to both the increased use of natural gas, reduced reliance on coal, and the increase in renewable power (e.g., solar, wind, etc.).
- Transportation emissions are dropping, likely primarily due to the impact of increased vehicle fuel efficiency standards.
- Residential and agricultural emissions are increasing along with the increase in population.

- GHG emissions can fluctuate from year to year, where such fluctuations may be based on economic conditions, severe weather conditions, or other factors that relate to fuel consumption and consumer habits.
- California has a significantly lower per capita GHG emissions footprint than the United States average (about 45 percent lower based on 2010 emissions and population).

2.3 Geology and Soils

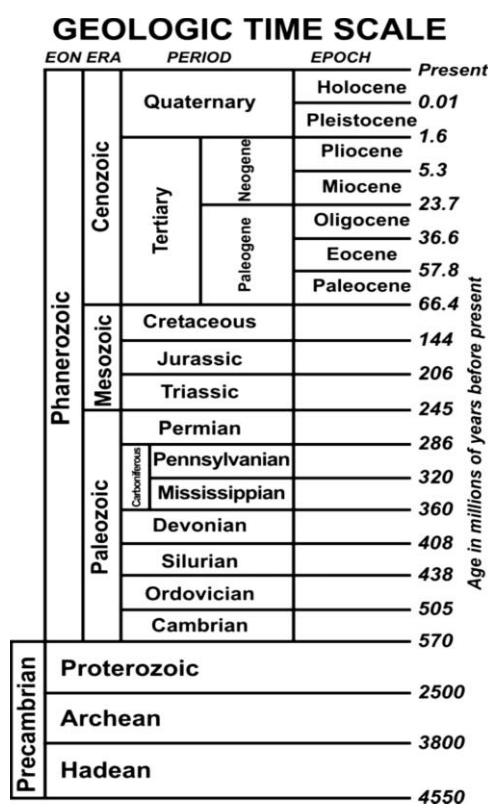
This section describes the environmental conditions related to geology and soil resources in the study area. The study area is defined as the former CLTP corridor and the area immediately adjacent to the corridor with the following exception. The study area related to seismically induced ground shaking issues includes significant regional active and potentially active faults within 50 miles of the former CLTP corridor.

Baseline geologic, seismic, and soils information were collected from published and unpublished literature, GIS data, and online sources for the study area. Data sources included the following: the Proponent's Environmental Assessment, geologic literature from the U.S. Geological Survey and California Geological Survey, geologic and soils GIS data, available geotechnical reports for the area, and online reference materials. The literature and data review was supplemented by field reconnaissance. The literature review and field reconnaissance focused on the identification of specific geologic and seismic hazards with the study area.

2.3.1 Geologic Setting

The study area is located in the south-central portion of the Mojave Desert geomorphic province. The Mojave Desert geomorphic province, commonly referred to as the Mojave block, is a region of isolated mountain ranges separated by expanses of desert plains. The Mojave Desert province is wedge shaped, bounded on the north by the Garlock Fault and its extension to the east, the San Andreas Fault and the Transverse Ranges on the west, the Colorado River and California-Nevada border on the east, and the San Gabriel Mountains, San Bernardino Mountains, and the San Andreas Fault on the south. It has an interior enclosed drainage and many playas. The topography of the central portion of the Mojave area is dominated by the prominent NW-SE trending faults and generally NW-SE trending mountain ranges. The Mojave region exhibits a wide variety of geomorphic landforms, which represent the varying erosional, depositional, and tectonic processes the area is undergoing, including: volcanic features such as basaltic flows and cones; erosional and depositional features such as pediments, alluvial fans, playas, badlands, desert pavement; and tectonic (faulting) features such as scarps, offset streams, and sags and sag ponds.

Figure 2.3-1



The study area is underlain by lacustrine and playa deposits, alluvial plains and valleys, alluvial fans and pediments, mountain passes, and hills. The study area is underlain by geologic units ranging in age from Quaternary (approximately the last 1.6 million years) to Pre-Cenozoic (greater than 65 million years). In particular, the study area is underlain primarily by sedimentary units ranging in age from Holocene to Pleistocene, with lesser amounts of Plio-Pleistocene- to Paleozoic-aged sediments. Figure 2.3-1 shows the geologic time scale indicating the breakdown of geologic time units and corresponding ages. The study area generally traverses alluvial plains, alluvial fans and pediments, badlands, and hills. General descriptions of the geologic materials, listed chronologically, crossed by the former CLTP corridors are summarized in Table 2.3-1. Geology within the region is presented in Figure 2.3-2.

Table 2.3-1. Summary of Geologic Units along the Former CLTP Corridors

Formation	General Geographic Location	Age	Description/Comment	Excavation Characteristics[1]
Q - Alluvium	Entire Study Area	Holocene	Unconsolidated, poorly sorted stream, fan, and basin deposits, clay to boulder sized clasts.	Easy to moderate
Qw – Wash Deposits	Hesperia Area	Holocene	Alluvial deposits occurring in modern washes of rivers and streams may include some older wash deposits.	Easy
Qs – Wind-blown Sand	I-40/Old Route 66 Corridor	Holocene	Dune sand, including both active and stabilized dunes.	Easy
Ql – Lake Deposits	I-40/Old Route 66 Corridor, Lucerne Valley	Holocene	Clay, silt, and fine sand with minor evaporate lenses. In part interbedded with alluvium.	Easy
Qo - Older Alluvium	West Lucerne Valley, So. Apple Valley, Ord Mtns., Summit Valley, and Hesperia	Pleistocene	Dissected alluvial deposits.	Easy
Qv – Basalt	I-40/Old Route 66 Corridor	Pleistocene	Includes basalt of Pisgah crater, cinder cones, and basalt flows.	Difficult
Qod – Alluvial Fans	Barstow-Daggett, Stoddard Valley, North and West Lucerne Valley, Ord Mtns. and Summit Valley, Hesperia	Pleistocene	Well to very well dissected alluvial fan deposits.	Easy
Mv – Miocene Volcanic Rocks	Stoddard Valley	Miocene	Andesite, basalt, dacite to rhyolite, and pyroclastic rocks and lahars.	Difficult
Mc – Unnamed Miocene Continental Deposits	Stoddard Valley	Miocene	Sandstone, conglomerate, siltstone, and mudstone; minor limestone. Commonly interbedded with volcanic flows and tuff.	Moderate to difficult
KJqm – Quartz Monzonite	Stoddard Valley, North and West Lucerne Valley, So. Apple Valley, Ord Mtns. and Summit Valley	Cretaceous/ Jurassic	Granitic rock consisting primarily of quartz monzonite.	Difficult
JKgr – Granite	West Lucerne Valley and So. Apple Valley	Cretaceous/ Jurassic	Granitic rock consisting primarily of granite.	Difficult

Table 2.3-1. Summary of Geologic Units along the Former CLTP Corridors				
Formation	**General Geographic Location**	**Age**	**Description/Comment**	**Excavation Characteristics[1]**
Jqd – Quartz Diorite	West Lucerne Valley, So. Apple Valley, Ord Mtns. and Summit Valley	Jurassic	Quartz diorite.	Difficult
Jhd – Hornblende Diorite	Stoddard Valley	Jurassic	Hornblende diorite and minor gabbro.	Difficult
Mzv – Metavolcanic Rocks	Barstow-Daggett, Lucerne Valley	Mesozoic	Undifferentiated metavolcanic rocks.	Difficult
Trmz - Monzonite	West Lucerne Valley, So. Apple Valley	Triassic	Monzonite	Difficult
m – Sheared and deformed metamorphic rocks	Barstow-Daggett, Stoddard Valley	Mesozoic and pre-Mesozoic, age uncertain	Includes gneissic rocks, in part cataclastically deformed; minor undeformed to slightly deformed plutonic rocks and migmatite.	Difficult
Pzls – Limestone and Marble	West Lucerne Valley, So. Apple Valley	Upper Paleozoic	Limestone and marble.	Difficult
Єls – Crystalline Limestone	Ord Mountains and Summit Valley	Cambrian and uppermost Precambrian	Metasedimentary crystalline limestone.	Difficult
Єq – Quartzite	Ord Mountains and Summit Valley	Cambrian and uppermost Precambrian	Metasedimentary quartzite.	Difficult

Source: CGS, 1986

Note(s):

1. Excavation characteristics are very generally defined as “easy,” “moderate,” or “difficult” based on increasing hardness of the rock unit. Excavation characteristic descriptions are general in nature and the actual ease of excavation may vary widely depending on site-specific subsurface conditions.

2.3.2 Physiography

The study area traverses numerous different physiographic areas, including Mojave Valley, Newberry Mountains, Stoddard Valley, West Ord Mountains, North Lucerne Valley, Granite Mountains, the northern edge of Lucerne Valley, Fifteenmile Valley, the northwestern edge of the San Bernardino Mountains, and Apple Valley. Elevations vary from approximately 1,770 to 4,900 feet above mean seal level (msl) with the lowest elevations in the Mojave Valley area and the highest elevations within the northwestern San Bernardino Mountains.

Beginning along the I-40/Old Route 66 corridor, the study area traverses an alluvial plain/valley along the northern edge of the Newberry and Rodman Mountains at elevations ranging from 1,770 to 2,080 feet msl, with the lowest elevation where it crosses the Troy Lake playa southwest of the Cady Mountains.

The northern end of the study area then enters the Mojave Valley near Coolwater Switchyard at an elevation of approximately 2,000 feet msl. It then travels south from near the Coolwater Switchyard across the alluvial fans of the southern edge of the Mojave Valley at elevations ranging from approximately 1,950 to 2,100 feet msl. It then traverses southwest across the Newberry Mountains and Stoddard Valley with elevations ranging from 2,400 to 3,400 feet msl. The portions of the study area within the Barstow-Daggett region traverse west across the Mojave Valley over heavily dissected alluvial fans north of Daggett Ridge; elevation within the area is relatively uniform at about 2,150 feet and ranges from approximately 2,100 to 2,800 feet msl. The portions of the study area within Stoddard Valley travel south from the Barstow-Daggett area, crossing low hills and alluvial valleys at the northwest end of Stoddard Valley at elevations from 2,800 feet msl on the northern end climbing to about 3,300 feet msl on the southern end.

The portions of the study area which lie within the Stoddard Valley cross south to southeast through a gap between Stoddard Mountain and Stoddard Ridge and then pass southeast through the northern half of North Lucerne Valley; elevations range from about 3,100 to 3,800 feet msl along this region. Elevations along the Stoddard Valley range from about 2,900 feet to 4,300 feet msl. From the Stoddard Valley, the study area then travels south through the southern portion of the North Lucerne Valley, with Lucerne Valley located along the western edge of the valley adjacent to the foothills of the Granite Mountains; elevations for both regions are very similar, ranging from approximately 2,900 to 3,200 feet msl.

The study area then travels southwest through the Lucerne Valley, primarily along the southeastern edge of the Granite Mountains and into Fifteenmile Valley. This area crosses along alluvial fans and low hills along the edge of the Granite Mountains, passing northwest of Lucerne Lake playa. In Fifteenmile Valley, the study area crosses the northern edge of the Rabbit Lake playa. Elevations within the West Lucerne Valley range from about 2,900 to 3,500 feet msl. The study area around the city of Hesperia continues southwest from West Lucerne Valley across gently sloping alluvial fans and plains along the southern edge of the Apple Valley and across the Mojave River and its associated floodplain.

2.3.3 Slope Stability

Important factors that affect the slope stability of an area include the steepness of the slope, the relative strength of the underlying rock material, and the thickness and cohesion of the overlying colluvium. The steeper the slope and/or the weaker the rock, the more likely the area is susceptible to landslides. The steeper the slope and the thicker the colluvium, the more likely the area is susceptible to debris flows. Another indication of unstable slopes is the presence of old or recent landslides or debris flows.

Most of the study area crosses gently sloping to flat terrain with some gently sloping hills and does not cross any large areas identified as existing landslide or landslide hazard. Although the San Bernardino County General Plan Geologic Hazard Overlays indicate a few existing landslides ***in*** the study area near Ord Mountains, none of the study area is mapped as having susceptibility to landslides (San Bernardino County, 2010). However, where the study area crosses along moderately sloping hills of the West Ord Mountains, Granite Mountains, and San Bernardino Mountains, unmapped landslides and areas of localized slope instability may be encountered.

2.3.4 Soils

The soils in the study area reflect the underlying rock type, the extent of weathering of the rock, the degree of slope, and the degree of human modification. Potential hazards/impacts from soils include erosion, shrink-swell (expansive soils), and corrosion. Soil mapping by the USDA National Resource Conservation Service (NRCS) U.S. Department of Agriculture, Soil Conservation Service, was reviewed for information about unsuitable characteristics of surface and near-surface subsurface soil materials. GIS spatial and tabular data for the San Bernardino County, California, Mojave River Area SSURGO soil survey (NRCS, 2013) and the State of California STATSGO (NRCS, 2006) survey were reviewed. A summary of the significant characteristics of the soil units and their locations within the study area are presented in Table 2.3-2. Figure 2.3-3 shows the distribution of these soil associations within the study area.

Table 2.3-2. Soil Units Underlying the Study Area

Unit ID	Unit Name	Geographic Region	Erosion Class		Expansion Potential (Shrink-Swell)	Corrosion Potential	
			Water	Wind		Uncoated Steel	Concrete
100	Arizo Gravelly Loamy Sand, 2 to 9 Percent Slopes	Barstow-Daggett Area, I-40/old Route 66 Corridor	Slight	Moderate	Low	Moderate	Low
101	Arrastre-Rock Outcrop Complex, 30 to 50 Percent Slopes	Ord Moutnains and Summit Valley and Hesperia Region	Moderate	Moderate	Low	Low	Low
102	Avawatz-Oak Glen Association, Gently Sloping	Ord Mountains	Slight to Moderate	Moderate	Low	Low	Low
104	Bousic Clay	Lucerne Valley, Apple Valley, I-40/old Route 66 corridor	Slight	Slight	High	High	High
105	Bryman Loamy Fine Sand, 0 to 2 Percent Slopes	Hesperia, Apple Valley	Slight	High	Low to Moderate	Moderate	Low
106	Bryman Loamy Fine Sand, 2 to 5 Percent Slopes	Lucerne Valley, Ord Mountains, Summit Valley, Hesperia, Apple Valley	Slight	High	Low to Moderate	Moderate	Low
107	Bryman Loamy Fine Sand, 5 to 9 Percent Slopes	Hesperia	Slight	High	Low to Moderate	Moderate	Low
108	Bryman Loamy Fine Sand, 9 to 15 Percent Slopes	Hesperia, Apple Valley	Moderate	High	Low to Moderate	Moderate	Low
110	Bryman-Cajon Association, Rolling	Ord Mountains, Summit Valley, Hesperia	Slight to Moderate	Slight	Low to Moderate	Moderate	Low
112	Cajon Sand, 0 to 2 Percent Slopes	Lucerne Valley, Apple Valley, Barstow-Daggett, I-40/old Route 66 corridor	Slight	Very High	Low	Low	Low
113	Cajon Sand, 2 to 9 Percent Slopes	Barstow-Daggett, Lucerne Valley, Apple Valley, Ord Mountains, Summit Valley, Hesperia, Stoddard Valley, I-40/old Route 66 corridor	Slight to Moderate	High	Low	Low	Low
114	Cajon Sand, 9 to 15 Percent Slopes	Lucerne Valley, Apple Valley, Ord Mountains, Summit Valley	Slight to Moderate	High	Low	Low	Low
115	Cajon Gravelly Sand, 2 to 15 Percent Slopes	Barstow-Daggett, Stoddard Valley, Lucerne Valley, Apple Valley, Ord Mountains, Summit Valley, I-60/old Route 66 corridor	Slight	Slight	Low	Low	Low
118	Cajon-Arizo Complex, 2 to 15 Percent Slopes	Barstow-Daggett, Lucerne Valley, Stoddard Valley	Sight to Moderate	Slight	Low	Low to Moderate	Low
119	Cajon-Wasco, Cool Complex, 2 to 9 Percent Slopes	Ord Mountains, Summit Valley, Hesperia	Slight to Moderate	High	Low	Low to Moderate	Low

Table 2.3-2. Soil Units Underlying the Study Area

Unit ID	Unit Name	Geographic Region	Erosion Class		Expansion Potential (Shrink-Swell)	Corrosion Potential	
			Water	Wind		Uncoated Steel	Concrete
122	Cushenbury-Crafton-Rock Outcrop Complex, 15 to 50 Percent Slopes	Ord Mountains, Summit Valley	Moderate	Moderate	Low	Low	Low to Moderate
126	Gullied Land-Haploxerlafs Association	Ord Mountains, Summit Valley	Moderate to High	--	--	--	--
127	Halloran Sandy Loam	I-40/old Route 66 corridor	Slight	Very High	Low	High	High
128	Halloran-Duneland Complex, 0 to 15 Percent Slopes	I-40/old Route 66 corridor	Slight	Very High	Low	High	High
130	Haplargids-Calciorthids Complex, 15 to 50 Percent Slopes	Ord Mountains, Summit Valley, Hesperia	Moderate to High	Moderate to High	--	--	--
131	Helendale Loamy Sand, 0 to 2 Percent Slopes	Apple Valley	Slight	High	Low	Moderate	Low
132	Helendale-Loamy Sand, 2 to 5 Percent Slopes	Hesperia	Slight	High	Low	Moderate	Low
133	Helendale-Bryman Loamy Sands, 2 to 5 Percent Slopes	Stoddard Valley, Barstow-Daggett, Lucerne Valley, Ord Mountains, Summit Valley, Hesperia	Slight	High	Low	Moderate	Low
134	Hesperia Loamy Fine Sand, 2 to 5 Percent Slopes	Ord Mountains, Summit Valley, Hesperia	Slight	High	Low	Moderate	Low
137	Kimberlina Loamy Fine Sand, Cool, 0 to 2 Percent Slopes	Stoddard Valley, Lucerne Valley, Apple Valley; I-40/old Route 66 corridor	Slight	High	Low to Moderate	Moderate	Moderate
138	Kimberlina Loamy Fine Sand, Cool, 2 to 5 Percent Slopes	Apple Valley	Slight	High	Low	Moderate	Moderate
139	Kimberlina Gravelly Sandy Loam, Cool, 2 to 5 Percent Slopes	Lucerne Valley	Slight	Slight	Low	Moderate	Moderate
140	Lavic Loamy Fine Sand	Lucerne Valley, Apple Valley	Slight	High	Low	High	Moderate
142	Lucerne Sandy Loam, 0 to 2 Percent Slopes	Lucerne Valley, Apple Valley, Hesperia	Slight	Moderate	Low	Low	Low
143	Lucerne Sandy Loam, 2 to 5 Percent Slopes	Lucerne Valley, Apple Valley, Ord Mountains, Summit Valley, Hesperia	Slight	Moderate	Low	Low	Low
148	Mirage Sandy Loam, 2 to 5 Percent Slopes	Stoddard Valley and Lucerne Valley	Slight	Slight	Low to Moderate	High	High
149	Mirage-Joshua Complex, 2 to 5 Percent Slopes	Stoddard Valley and Lucerne Valley	Moderate	Low to Moderate	Low to Moderate	High	High

Table 2.3-2. Soil Units Underlying the Study Area

Unit ID	Unit Name	Geographic Region	Erosion Class		Expansion Potential (Shrink-Swell)	Corrosion Potential	
			Water	Wind		Uncoated Steel	Concrete
151	Nebona-Cuddeback Complex, 2 to 9 Percent Slopes	Stoddard Valley, Barstow-Daggett, I-40 old Route 66 corridor	Slight to Moderate	Slight	Low	High	High to Moderate
155	Pits	Stoddard Valley, Lucerne Valley, Apple Valley, Barstow-Daggett, I-40/old Route 66 corridor	--	--	--	--	--
156	Playas	West Lucerne Valley; I-40/Old Route 66 corridor	Slight	Very High	--	--	--
157	Riverwash	Ord Mountains	--	--	--	--	--
158	Rock Outcrop-Lithic Torriorthents Complex, 15 to 50 Percent Slopes	Barstow-Daggett area, Stoddard Valley, Lucerne Valley, Apple Valley, I-40/Old Route 66 corridor	High	Slight	--	--	--
159	Rosamond Loam, Saline-Alkali	West Lucerne Valley, I-40/Old Route 66 corridor	Slight	Moderate	Low to Moderate	High	High
160	Rosamond Loam, Strongly Saline-Alkali	I-40/Old Route 66 corridor	Moderate	Moderate to High	Low to Moderate	High	High
162	Sparkhule-Rock Outcrop Complex, 15 to 50 Percent Slopes	Barstow-Daggett, Stoddard Valley, Lucerne Valley	Slight to Moderate	Slight	Low to Moderate	Moderate	Low
168	Typic Haplargids-Yermo Complex, 8 to 30 Percent Slopes	Barstow-Daggett	Moderate to High	Moderate to High	Low	Moderate	Low
173	Wasco Sandy Loam, Cool, 0 to 2 Percent Slopes	Lucerne Valley, Apple Valley, and Hesperia	Slight	Moderate	Low	Moderate	Low
174	Wasco Sandy Loam, Cool, 2 to 5 Percent Slopes	West Lucerne Valley, Apple Valley	Slight	Moderate	Low	Moderate	Low
177	Yermo-Kmberlina, Cool, Association, Sloping	Stoddard Valley	Moderate	Slight	Low	Moderate	Low
s1007	Nebona-Mirage-Joshua-Cajon	Stoddard Valley	--	--	--	--	--
s1024	Wasco-Rosamond-Cajon	I-40/Old Route 66 corridor	--	--	--	--	--
s1038	Playas	I-40/Old Route 66 corridor	--	--	--	--	--
s1127	Upspring-Sparkhule-Rock outcrop	I-40/Old Route 66 corridor	--	--	--	--	--
s1142	Nickel-Bitter-Arizo	I-40/Old Route 66 corridor	--	--	--	--	--

Sources: Modified from SCE PEA Table 4.6-3 (SCE, 2013). NRCS SSURGO Soil Survey GIS Data San Bernardino County, California, Mojave River Area (2013) and NRCS STATSGO California GIS data, 2006.

Potential soil erosion hazards vary depending on the use, conditions, and textures of the soils. The properties of soil that influence erosion by rainfall and runoff affect the infiltration capacity of a soil, as well as the resistance of a soil to detachment and being carried away by falling or flowing water. Soils on steeper slopes would be more susceptible to erosion due to the effects of increased surface flow (runoff) on slopes where there is little time for water to infiltrate before runoff occurs. Soils containing high percentages of fine sands and silt and that are low in density are generally the most erodible. As the clay and organic matter content of soils increases, the potential for erosion decreases. Clays act as a binder to soil particles, thus reducing the potential for erosion. Erosion due to either water or wind (or both) varies along the Project from slight to high for both wind and water, as presented in Table 2.3-2. Many of the soils within the study area contain high percentages of sand and are particularly susceptible to wind erosion.

Expansive soils are characterized by their ability to undergo significant volume change (shrink and swell) due to variation in soil moisture content. Changes in soil moisture could result from a number of factors, including rainfall, landscape irrigation, utility leakage, and/or perched groundwater. Expansive soils are typically very fine grained with a high to very high percentage of clay. Soils with moderate to high shrink-swell potential would be classified as expansive soils. Most of the soils in the study area are granular with high percentages of sand and have a low potential for expansion. However, some soils with more clay have been identified as having a low to moderate expansion potential within the Stoddard Valley, Lucerne Valley, Summit Valley, and Hesperia, and one soil type located in Lucerne Valley and along the I-40/old Route 66 corridor, the Bousic Clay, has a high expansion potential.

Corrosivity of soils is generally related to the following key parameters: soil resistivity; presence of chlorides and sulfates; oxygen content; and pH. Typically, the most corrosive soils are those with the lowest pH and highest concentration of chlorides and sulfates. High sulfate soils are corrosive to concrete and may prevent complete curing, reducing its strength considerably. Low pH and/or low resistivity soils could corrode buried or partially buried metal structures. The corrosion potential for soils within the study area ranges from low to high for corrosion to both metal and concrete. Most of the soils with high corrosion potential are located in the northern half of the study area (Barstow-Daggett area and I-40/old Route 66 corridor).

2.3.5 Subsidence

Land subsidence can occur in valleys containing aquifer systems that are, in part, made up of fine-grained sediments and that have undergone extensive ground-water development (USGS, 2003). As the groundwater is withdrawn, the pore-fluid pressure in the sediments decreases allowing the weight of the overlying sediment to permanently compact or compress the fine-grained units. This effect is most pronounced in younger, unconsolidated sediments. Land subsidence is generally characterized by a broad zone of deformation where differential settlements are small. Depth to groundwater within the study area varies from approximately 25 feet below ground surface (bgs) to greater than 200 feet bgs (USGS, 2014a).

Subsidence within the study area is found in the vicinity of dry lakebeds. Land subsidence studies conducted by the USGS on the Mojave River and Morongo groundwater basins for the period of 2004 to 2009 indicate that subsidence has occurred at Lucerne Lake and at Troy Lake (USGS, 2014a). At Lucerne and Troy Lakes, the entire dry lakebed area is subsiding, with the subsidence likely a result of the compaction of the subsurface fine-grained paleo-lakebed sediments due to groundwater withdrawal in these areas (USGS, 2014a). Two areas of land surface subsidence were noted in the vicinity of Lucerne Lake for the period of 2004 to 2009, 1.75 inches (at approximately 7 mm/yr.) near the western margin and 2.76 inches (at approximately 13mm/yr.) located south of the current dry lake bed. The area of maximum subsidence within the Lucerne Lake area is located approximately 2.5 miles southwest of West Lucerne Valley. The secondary area of subsidence within the Lucerne Lake area is located along the northwestern margin of the lake, approximately 0.4 to 0.8 miles southwest of West Lucerne Valley. Land surface subsidence observed for 2004 to 2009 for the Troy Lake area was a maximum of about 1.96 inches at an average rate of about 9 millimeters per year on and adjacent to the western and southern shores of Troy Lake near Newberry Springs. Lesser subsidence of 0.39 inches to 0.98 inches has also been observed in the Troy Lake area. The I-40/old Route 66 corridor traverses the southern portion of Troy Lake where the maximum amount of subsidence is occurring.

2.3.6 Faults and Seismicity

The seismicity of Southern California is dominated by the intersection of the north-northwest trending San Andreas fault system and the east-west trending Transverse Ranges fault system. Both systems are responding to strain produced by the relative motions of the Pacific and North American Tectonic Plates. This strain is relieved by right-lateral strike-slip faulting on the San Andreas and related faults, left-lateral strike slip on the Garlock Fault, and by vertical, reverse-slip or left-lateral strike-slip displacement on faults in the Transverse Ranges. The effects of this deformation include mountain building, basin development, deformation of Quaternary marine terraces, widespread regional uplift, and generation of earthquakes. Both the Transverse Ranges and northern Los Angeles County area are characterized by numerous geologically young faults. These faults can be classified as historically active, active, potentially active, or inactive, based on the following criteria (CGS, 1999):

- Faults that have generated earthquakes accompanied by surface rupture during historic time (approximately the last 200 years) and faults that exhibit aseismic fault creep are defined as Historically Active.
- Faults that show geologic evidence of movement within Holocene time (approximately the last 11,000 years) are defined as Active.
- Faults that show geologic evidence of movement during the Quaternary time (approximately the last 1.6 million years) are defined as Potentially Active.
- Faults that show direct geologic evidence of inactivity during all of Quaternary time or longer are classified as Inactive.

Although it is difficult to quantify the probability that an earthquake will occur on a specific fault, this classification is based on the assumption that if a fault has moved during the Holocene epoch, it is likely to produce earthquakes in the future. Blind thrust faults do not intersect the ground surface, and thus they are not classified as active or potentially active in the same manner as faults that are present at the earth's surface. Blind thrust faults are seismogenic structures and thus the activity classification of these faults is predominantly based on historic earthquakes and microseismic activity along the fault.

Since periodic earthquakes accompanied by surface displacement can be expected to continue in the study area, the effects of strong ground shaking and fault rupture are of primary concern to safe and reliable operation of any proposed projects in the study area.

The study area will be subject to ground shaking associated with earthquakes on faults of the San Andreas, Garlock, Eastern California Shear Zone, and Transverse Ranges fault systems. Active faults of the San Andreas system are predominantly strike-slip faults accommodating translational movement. Active reverse or thrust faults in the Transverse Ranges include blind thrust faults responsible for the 1987 Whittier Narrows Earthquake and 1994 Northridge Earthquake, and the range-front faults responsible for uplift of the Santa Susana and San Gabriel Mountains. The Transverse Ranges fault system consists primarily of blind, reverse, and thrust faults accommodating tectonic compressional stresses in the region. Blind faults have no surface expression and have been located using subsurface geologic and geophysical methods. This combination of translational and compressional stresses gives rise to diffuse seismicity across the region.

The significant faults in the study area are faults of the Eastern California Shear Zone (ECSZ) and the San Andreas fault zone. The Eastern California Shear Zone is a region of active, predominantly strike-slip, deformation east of the San Andreas Fault that extends from the southern Mojave Desert along the east side of the Sierra Nevada and into western Nevada. The Eastern California Shear Zone accommodates approximately 20 to 25 percent of relative plate motion between the Pacific and North America plates and is bounded on the east by the diffuse extensional deformation of the Basin and Range region and in the Mojave area by the San Andreas fault zone on the west. Local faults of the ECSZ include the Lenwood-Lockhart, the Helendale-South Lockhart, the Calico-Hidalgo fault zone, the Pisgah-Bullion fault zone, the Lavic Lake fault zone, and the Camp Rock-Emerson-Copper Mtn. fault zone. The San Andreas fault zone is a 680-mile active right-lateral strike-slip complex of faults that has been responsible for many of the damaging earthquakes in southern California in historical times. The San Andreas fault zone is the longest active fault in California and represents the boundary between the Pacific and North American plates. Historically, both the ECSZ and the San Andreas fault zone have produced significant earthquakes that have caused surface rupture and damage in the study area.

Since periodic earthquakes accompanied by surface displacement can be expected to continue in the study area, the effects of strong ground shaking and fault rupture are of primary concern. Active faults that represent a significant seismic threat to the region are listed in Table 2.3-3. Data presented in this table include estimated earthquake magnitude, and type of fault. Figure 2.3-4 shows locations of significant active faults and historic earthquakes in the study area and surrounding region.

Table 2.3-3. Significant Active and Potentially Active Faults in the Study Area Vicinity

Name	Approximate Distance to Study Area[1]	Geographic Region	Estimated Max. Earthquake Magnitude[2]	Fault Type and Dip Direction[3]
Lenwood – Lockhart fault zone	0	Barstow-Daggett, Stoddard Valley	7.5	Right Lateral Strike Slip, 90°
North Frontal thrust system, west	0	So. Apple Valley, Hesperia, Ord Mtns. and Summit Valley	7.2	Reverse, 49°S
Helendale – South Lockhart fault zone	0	North Lucerne Valley	7.4	Right Lateral Strike Slip, 90°
Calico-Hidalgo fault zone	0	I-40/old Route 66 corridor	7.4	Right Lateral Strike Slip, 90°
Pisgah-Bullion fault zone	0	I-40/old Route 66 corridor	7.3	Right Lateral Strike Slip, 90°
Lavic Lake fault zone	0	I-40/old Route 66 corridor	--	Right Lateral Strike Slip, 90°
Camp Rock-Emerson-Copper Mtn. fault zone	3.5	Stoddard Valley	7.1	Right Lateral Strike Slip, 90°

Table 2.3-3. Significant Active and Potentially Active Faults in the Study Area Vicinity

Name	Approximate Distance to Study Area[1]	Geographic Region	Estimated Max. Earthquake Magnitude[2]	Fault Type and Dip Direction[3]
San Andreas fault zone, San Bernardino Mtns. section	8.5	Hesperia, Ord Mtns. and Summit Valley	6.9	Right Lateral Strike Slip, 90°
San Andreas fault zone, Mojave section	9.2	Hesperia, Ord Mtns. and Summit Valley	7.3	Right Lateral Strike Slip, 90°
San Jacinto fault zone, San Bernardino section	9.5	Hesperia, Ord Mtns. and Summit Valley	7.1	Right Lateral Strike Slip, 90°
Sierra Madre fault zone	13.5	Hesperia, Ord Mtns. and Summit Valley	7.2	Thrust, 43-60°N
Johnson Valley Fault	14.5	North Lucerne Valley and West Lucerne Valley	6.9	Right Lateral Strike Slip, 90°
Puente Hills Blind Thrust	34.5	Hesperia, Ord Mtns. and Summit Valley	7.0	Blind Thrust, 25°N
Elsinore fault zone, Glen Ivy section	38.0	Ord Mtns. and Summit Valley	6.9	Right Lateral Strike Slip, 90°
Whittier fault zone	38.5	Ord Mtns. and Summit Valley	7.0	right lateral reverse oblique, 75°N
Raymond Fault	39	Hesperia, Ord Mtns. and Summit Valley	6.8	Left Lateral Reverse Oblique, 70-80°N
Garlock fault zone, central section	49.5	Barstow-Daggett	7.3	Left Lateral Strike Slip, 90°

Note(s):

1. Fault distances obtained from USGS GIS Quaternary fault data (USGS and CGS, 2010).
2. Maximum Earthquake Magnitude – the maximum earthquake that appears capable of occurring under the presently known tectonic framework, magnitude listed is “Ellsworth-B” magnitude from USGS OF08 1128 (Documentation for the 2008 Update of the U.S. National Seismic Hazard Maps) unless otherwise noted. Magnitude varies by rupture strategy, one or several segments of the fault rupturing in the same event.
3. Fault parmeters from the 2008 National Seismic Hazard Maps – Fault Parameters website (USGS, 2014b).

2.3.7 Fault Rupture

Fault rupture is the surface displacement that occurs when movement on a fault deep within the earth breaks through to the surface. Fault rupture and displacement almost always follow preexisting faults, which are zones of weakness; however, not all earthquakes result in surface rupture (i.e., earthquakes that occur on blind thrusts do not result in surface fault rupture). Rupture may occur suddenly during an earthquake or slowly in the form of fault creep. In addition to damage caused by ground shaking from an earthquake, fault rupture is damaging to buildings and other structures due to the differential displacement and deformation of the ground surface that occurs from the fault offset leading to damage or structural failure of structures across this zone. Perhaps the most important single factor to be considered in the seismic design of a project in the vicinity of active faults is the amount and type of potential ground surface displacement.

The study area crosses several known active faults, including the: North Frontal thrust system, Helendale-South Lockhart, Lenwood-Lockhart, Calico-Hidalgo, Pisgah-Bullion, and Lavic Lake fault zones. All of these faults have mapped Alquist-Priolo zones in the study area. The presence of these mapped zones indicates significant potential for fault rupture in the areas where a project would cross the “zones”.

Fault rupture has occurred historically within the general study area. The 1999 magnitude M7.1 Hector Mine Earthquake caused 26 miles of surface rupture along the Lavic Lake and Bullion Faults, and the 1992 magnitude M7.3 Landers Earthquake resulted in 53 miles of rupture along five separate faults including the Johnson Valley, Landers, Homestead Valley, Emerson, and Camp Rock Faults, with fault offset of generally 6 feet up to a maximum offset of 18 feet.

Although future earthquakes could occur anywhere along the length of the San Andreas, Eastern California Shear Zone, and Transverse Range faults, only local or nearby regional strike-slip earthquakes of magnitude 6.0 or greater are likely to be associated with surface fault rupture and offset (CGS, 1996). It is also important to note that earthquake activity and resulting ground rupture from unmapped subsurface faults is a possibility that is currently not predictable.

2.3.8 Strong Ground Shaking

An earthquake is classified by the amount of energy released, which traditionally has been quantified using the Richter scale. Recently, seismologists have begun using a Moment Magnitude (M) scale because it provides a more accurate measurement of the size of major and great earthquakes. For earthquakes of less than M 7.0, the Moment and Richter Magnitude scales are nearly identical. For earthquake magnitudes greater than M 7.0, readings on the Moment Magnitude scale are slightly greater than a corresponding Richter Magnitude.

The intensity of the seismic shaking, or strong ground motion, during an earthquake is dependent on the distance between a project and the epicenter of the earthquake, the magnitude of the earthquake, and the geologic conditions underlying and surrounding the project area. Earthquakes occurring on faults closest to the study area would most likely generate the largest ground motion.

The intensity of earthquake-induced ground motions can be described using peak site accelerations, represented as a fraction of the acceleration of gravity (g). GIS data based on the USGS Probabilistic Seismic Hazard Assessment (PSHA) Maps were used to estimate peak ground accelerations (PGAs) within the study area. PSHA Maps depict peak ground accelerations with a two percent probability of exceedance in 50 years, which corresponds to a return interval of 2,475 years for a maximum considered earthquake. Peak ground acceleration is the maximum acceleration experienced by a particle on the Earth's surface during the course of an earthquake, and the units of acceleration are most commonly measured in terms of fractions of g, the acceleration due to gravity (980 cm/sec^2). Peak ground accelerations within the study area range from 0.4 to 1.2 g, and are presented in Table 2.3-4.

Table 2.3-4. Peak Ground Accelerations along the Study Area

Geographic Area	Range of PGAs along Region (2% probability of exceedance in 50 yrs.)
Barstow-Daggett	0.5-0.6g 0.40.5g
I-40/Old Route 66 Corridor	0.4-0.5g 0.5-0.6g 0.6-0.8g
Stoddard Valley	0.4-0.5g 0.5-0.6g 0.6-0.8g
North Lucerne Valley	0.4-0.5g 0.5-0.6g
West Lucerne Valley	0.5-0.6g
Southern Apple Valley	0.5-0.6g 0.6-0.8g
Hesperia	0.6-0.8g
Ord Mountains and Summit Valley	0.6-0.8g 0.8 to 1.2g 0.6-0.8g

A review of historic earthquake activity from 1769 to 2014 indicates that ten earthquakes of magnitude M 6.0 or greater have occurred within 50 miles (80 kilometers) of the study area, including the M 7.3 Landers Earthquake and several of its aftershocks, which include the 6.5 Big Bear Earthquake (SCEDC, 2014) (USGS, 2014c). Many of these earthquakes also had numerous aftershocks, some measuring greater than M 6.0, which caused further damage in the affected areas. These earthquakes are shown on Figure 2.3-4. A summary of significant M 6.0 or greater earthquake events is presented in Table 2.3-5; the M 5.9 Whittier Narrows Earthquake is also included in the table because it resulted in significant damage and fatalities.

Table 2.3-5. Significant or Damaging Historic Earthquakes

Date	Earthquake Magnitude[1]	Earthquake Name or General Location	Fault Involved, if Known
October 16, 1999	7.1	Hector Mine earthquake	Lavic Lake and Bullion
October 1, 1987	5.9	Whittier Narrows Earthquake	Puente Hills blind thrust
June 28, 1992	6.5	Big Bear Earthquake – aftershock of the Landers Earthquake	Unnamed fault
June 28, 1992	7.3	Landers Earthquake	Johnson Valley, Landers, Homestead Valley, Emerson, Camp Rock, and others
April 10, 1947	6.5	Manix Earthquake	Manix
December 25, 1899	6.5	San Jacinto Fault Earthquake, located southeast of San Jacinto	San Jacinto
July 22, 1899	6.4	Cajon Pass Earthquake	Uncertain
July 29, 1894	6.2	Lytle Creek region	San Jacinto or San Andreas
January 16, 1857	6.3	Palmdale area – aftershock of the Fort Tejon Earthquake	San Andreas
July 11, 1855	6.0	Los Angeles Region	Raymond
December 8, 1812	7.5	Wrightwood Earthquake	San Andreas

Source: SCEDC Website, 2014

Note(s): Magnitude is moment magnitude (M) for earthquakes after 1911. For earthquakes before 1911, magnitudes are estimated from observed shaking intensity. Earthquake magnitudes and locations before 1932 are estimated based on reports of damage and felt effects.

2.3.9 Liquefaction

Liquefaction is the phenomenon in which saturated granular sediments temporarily lose their shear strength during periods of earthquake-induced strong ground shaking. The susceptibility of a site to liquefaction is a function of the depth, density, and water content of the granular sediments and the magnitude and frequency of earthquakes in the surrounding region. Saturated, unconsolidated silts, sands, and silty sands within 50 feet of the ground surface are most susceptible to liquefaction. Liquefaction-related phenomena include lateral spreading, ground oscillation, flow failures, loss of bearing strength, subsidence, and buoyancy effects (Youd and Perkins, 1978). In addition, densification of the soil resulting in vertical settlement of the ground can also occur.

In order to determine liquefaction susceptibility of a region, three major factors must be analyzed. These include: (a) the density and textural characteristics of the alluvial sediments; (b) the intensity and duration of ground shaking; and (c) the depth to groundwater. Most of the alluvial deposits underlying the study area are not generally expected to be liquefiable due to deep groundwater levels, generally greater than 200 feet bgs. However, there are several locations within the study area where shallow groundwater, less than 50 feet bgs, occurs or is likely to occur: Lucerne Lake (West Lucerne

Valley), Troy Lake (I-40/Old Route 66 Corridor), Rabbit Lake (West Lucerne Valley), and along the Mojave River. Older consolidated sedimentary deposits, fine or coarse grained deposits, and/or well-drained sedimentary materials are not susceptible to liquefaction.

2.3.10 Seismic Slope Instability

Other forms of seismically induced ground failures which may affect the study area include ground cracking, and seismically induced landslides. Landslides triggered by earthquakes have been a significant cause of earthquake damage; in Southern California large earthquakes such as the 1971 San Fernando and 1994 Northridge earthquakes triggered landslides that were responsible for destroying or damaging numerous structures, blocking major transportation corridors, and damaging life-line infrastructure. Areas that are most susceptible to earthquake-induced landslides are steep slopes in poorly cemented or highly fractured rocks, areas underlain by loose, weak soils, and areas on or adjacent to existing landslide deposits. No areas of landslide susceptibility are indicated within the study area on the County of San Bernardino Geologic Hazard Overlays (San Bernardino County, 2010); however, along the moderately sloping hills of the West Ord Mountains (Stoddard Valley), the Granite Mountains (West Lucerne Valley), and the San Bernardino Mountains (Ord Mountains) strong ground shaking could potentially trigger slope failures.

2.4 Water Resources

This section describes the environmental conditions related to water resources in the study area.

The environmental setting for water resources within the study area has been characterized based on review of existing literature from local, State, and federal resources, which included the following:

- California Department of Water Resources (DWR),
- U.S. Geological Survey (USGS),
- U.S. Environmental Protection Agency (USEPA),
- Federal Emergency Management Agency (FEMA),
- State Water Resources Control Board (SWRCB),
- Lahontan and Colorado River Regional Water Quality Control Boards (RWQCBs),
- San Bernardino County Plan,
- City of Hesperia 2010 General Plan, and
- Town of Apple Valley 2009 General Plan.

The latest available data from the above-mentioned sources were used in characterizing the affected environment for water resources. The study area addressed in this section includes land containing surface water features, watersheds, or groundwater basins that are transected by or directly adjacent to the study area.

The study area is located within the jurisdiction of two of the nine RWQCBs: the Lahonton RWQCB and the Colorado River RWQCB. The study area is also located entirely within the jurisdiction of the Mojave Water Agency (MWA). In addition to these factors, the environmental setting for water resources is comprised of climate, surface waters, Flood Hazard Areas, and groundwater resources. These features are discussed below.

2.4.1 Climate

The study area is located in the Mojave Desert, where the climate is dominantly arid with hot, dry summers and winters that are mild, short, and dry. These conditions are due to the vast mountain ranges surrounding the area, including the Sierra Nevada, San Bernardino, and San Jacinto Mountains; these mountains create a rain shadow, or a physical blockage to the migration of precipitation events, which results in wet conditions on one side of the mountains and desert conditions on the other side. Annual precipitation ranges from three to six inches in the study area and mainly occurs in the winter and spring months. Unique years can generate increased rainfall, when subtropical air from the south moves into the area and creates monsoonal thunderstorms (DWR, 2013). Alternatively, years of drought can yield average rainfall of less than one inch for the entire year (WC, 2014).

2.4.2 Surface Waters

The study area crosses through a series of watersheds (see Figure 2.4-1). The State of California uses a hierarchical naming and numbering convention to define watershed areas for management purposes. Watershed boundaries are defined according to size and topography, with multiple sub-watersheds within larger watersheds. A general description of how watershed levels are defined is provided in Table 2.4-1. The National Resources Conservation Service, which is part of the U.S. Department of Agriculture, is responsible for maintaining the California Interagency Watershed Mapping Committee (IWMC), formerly the CalWater Committee. The IWMC has defined a set of naming and numbering conventions applicable to all watershed areas in the State, for the purposes of interagency cooperation and management.

Table 2.4-1. State of California Watershed Hierarchy Classifications

Watershed Level	Approximate Square Miles	Description
Hydrologic Region (HR)	12,735	Defined by large-scale topographic and geologic considerations. The State of California is divided into ten HRs.
Hydrologic Unit (HU)	672	Defined by surface drainage; may include a major river watershed, groundwater basin, or closed drainage.
Hydrologic Area (HA)	244	Major subdivisions of hydrologic units, such as by major tributaries, groundwater attributes, or stream components.
Hydrologic Sub-area (HSA)	195	A major segment of an HA with significant geographical characteristics or hydrological homogeneity.

Source: FEMA, 2011

Table 2.4-1 shows the primary watershed classification levels used by the State of California, as defined by the IWMC. Table 2.4-2 identifies the watersheds that the study area transects (see Figure 2.4-1).

Table 2.4-2. Study Area Watersheds

Watershed Level	Name	Name	Name	Name	Name
Hydrologic Region (HR)	South Lahontan	Colorado River			
Hydrologic Unit (HU)	Mojave	Lucerne Lake			
Hydrologic Area (HA)	New Berry Springs	Lower Mojave	Middle Mojave	-	Upper Mojave
Hydrologic Sub-area (HSA)	Troy Valley	-	-	-	-

Source: IWMC, 2009

As shown in Table 2.4-2, the study area traverses the South Lahontan Hydrologic Region and the Colorado River Hydrologic Region, as well as numerous sub-watershed areas.

Due to the area's climate being generally dry and arid, a majority of the drainages are ephemeral, meaning that they typically only contain flow during and directly after a precipitation period. The topographic layout of the area includes bajadas and alluvial fans, or broad plains at the base of mountains, which allow the numerous ephemeral drainages to form and convey flow.

The Mojave River runs through the Project study area. The Mojave River is the largest drainage system in the Mojave Desert, though the flow is largely ephemeral, and only present in response to winter and spring storms (USGS, 2014). The section of the Mojave River that is located in the study area is identified on the Clean Water Act (CWA) Section 303(d) impairment list (2010) for the following constituents: fluoride, sulfates, and total dissolved solids (TDS). These impairments were identified with consideration to the designated Beneficial Use of Cold Freshwater Habitat for fish, shellfish, and wildlife protection and propagation (USEPA, 2010). Total Maximum Daily Load (TMDL) limits have not yet been designated for this portion of the Mojave River, but will be done so in accordance with the CWA Section 303(d) (USEPA, 2010). A TMDL is the maximum amount of a pollutant that a particular waterbody can receive while still meeting water quality standards (for Beneficial Uses), or an allocation of that water pollutant deemed acceptable to receiving waters. The sources of water quality impairments in the Mojave River are largely nonpoint, or diffuse sources such as agricultural runoff. Natural sources are also called out as a cause of impairment for fluoride and sulfates.

Other named surface water features (see Figure 2.4-1) in the study area include the Daggett Wash and the California Aqueduct (USGS, 2014).

The study area also contains several dry lakes, or playa lakes. These features are ancient basins that serve as ephemeral lakebeds, collecting and holding water after a precipitation period. These lakes are endorheic, meaning they are a closed basin with no outlet. Lucerne Dry Lake and Rabbit Springs Dry Lake both lie in the western portion of the Lucerne Valley.

2.4.3 Flood Hazard Areas

Flood Hazard Areas are defined by FEMA on Floor Insurance Rate Maps (FIRMs), prepared under the National Flood Insurance Program. These maps define the predicted boundaries of 100-year floods, or areas anticipated to be inundated during a 100-year storm event, or storms with a one percent chance of occurring each year. Generally within these areas surface water runoff tends to occur as sheet flow across wide areas. Not all surface waters have mapped Flood Hazard Areas; unmapped areas are not free of flood hazards, but rather have not yet been assessed for such hazards. Table 2.4-3 summarizes the different types of flood zones identified on FIRMs to characterize flood hazards in a given area.

Table 2.4-3. FEMA Flood Zones Within the Study Area

Zone	Description
A	Areas subject to flooding by the 1 percent annual chance flood event. Because detailed hydraulic analyses have not been performed, no Base Flood Elevation (BFE) or flood depths are shown.
D	Unstudied areas where flood hazards are undetermined, but flood is possible. No mandatory flood insurance purchase requirements apply, but coverage is available in participating communities.
X	Areas that have been determined to be located outside of the 1 percent and 5 percent annual chance flood events.

Table 2.4-3. FEMA Flood Zones Within the Study Area	
Zone	**Description**
X (500)	Areas subject to flooding by the 5 percent annual chance flood events; Areas subject to flooding by the 1 percent annual chance flood events with average depths of less than 1 foot, or with drainage areas less than 1 square mile; and areas protected by levees from 1 percent annual chance flood events.

Source: Digital Media Services, 2013

A majority of the study area traverses regions mapped as Zone D, indicating that flood hazards are undetermined but flooding is possible (see Figure 2.4-2). Portions of the study area within the Barstow-Daggett region are mapped as Zone A, or an area expected to be inundated during a 100-year storm event. A portion of the study area near Hesperia includes both Zone A and Zone X regions, where Zone X areas are located outside both the 100-year storm inundation area and the 20-year storm inundation area (flood area associated with the magnitude storm expected to occur once every 20 years, or with a five percent chance of occurring in any given year). The Summit Valley portion of the study area includes Zone X regions to the south, which is the floodplain area surrounding the Mojave River.

2.4.4 Groundwater

The study area includes a series of defined groundwater basins, each of which is summarized below (see Figure 2.4-3).

The majority of the study area is located within the Mojave Basin Area, an area of adjudication that encompasses about 3,400 square miles, bounded by the San Bernardino and San Gabriel Mountains to the south, Afton Canyon to the northeast, just beyond Lucerne Valley in the east and the Antelope Valley to the west. The Adjudication Judgment separates the area into five hydrologic subareas for management purposes; subarea names and boundaries do not correlate with the groundwater basin names and boundaries used by DWR, as described below and shown on Figure 2.4-3. The descriptions provided below indicate which groundwater basins are located within the adjudicated Mojave Basin Area. Historic information provided by the DWR indicate varied reports of overdraft conditions for these groundwater basins; however, the Mojave Basin Area Adjudication Judgment and recent studies cited by the MWA confirm that overdraft conditions currently exist throughout much of the region. (MWA, 2014a, 2014b)

Overall, groundwater quality varies throughout the Lahontan and Colorado River Hydrologic Regions. Several basins within the region have high TDS and fluoride, as well as sulfate found at levels above drinking water standards (DWR, 2003b). Nitrate content is common throughout the region, as is typical for agricultural areas. Water quality is discussed below per basin, based on available data.

2.4.4.1 Lavic Valley Groundwater Basin

The I-40/old Route 66 corridor travels through the Lavic Valley Groundwater Basin; this basin is not shown on Figure 2.4-3 due to the scale of the figure. This basin has a surface area of 102,000 acres and is bounded by nonwater-bearing rocks of the Cady Mountains on the north and east, of the Bullion Mountains on the south and east, of the Lava Bed Mountains on the southwest, and by the Pisgah Fault on the west. Average precipitation within this area is four to six inches per year. Recharge is provided to the basin by percolation of runoff from surrounding mountains, alluvial fans, and desert washes. Additional recharge may be provided through subsurface flow from adjoining basins. The northern part of the basin flows toward Hector Siding, while the southern part flows toward Lavic Lake.

There may also be groundwater flow eastward out of the basin, beneath a surface draining divide. (DWR, 2004a)

The total storage capacity of the Lavic Valley Groundwater Basin is estimated to be 270,000 acre-feet (AF), with a natural recharge of 300 acre-feet per year (AFY) (DWR, 2004c). However, the total amount of groundwater in storage is not known, and groundwater level trends are also not known. Overdraft conditions may or may not be present in this basin. The Lavic Valley Groundwater Basin is not adjudicated, and there are no restrictions to pumping by water rights holders (landowners) within the basin.

Groundwater in this basin has been historically affected by high levels of sodium sulfate and TDS. Drinking water standards in this basin have also been exceeded for sulfate, chloride, and TDS content. (DWR, 2004a)

2.4.4.2 Lower Mojave River Valley Groundwater Basin

The I-40/Old Route 66 corridor and portions of the study area in the Barstow-Daggett area and Stoddard Valley pass through the Lower Mojave River Valley Groundwater Basin. This basin has a surface area of 286,000 acres and is bounded by Camp Rock Harper Lake fault zone on the west and the Pisgah Fault on the southeast. An arbitrary divide between the adjacent Coyote Lake Valley Basin and Caves Canyon Valley Basin lies to the northeast. Average precipitation within this area averages near four inches per year. Recharge is provided to the basin by percolation of direct precipitation and ephemeral stream flow, as well as underflow from the Mojave River into the basin from the west. When the Mojave River is flowing, recharge to this groundwater basin is substantially higher (as described above, the Mojave River is largely ephemeral). Irrigation waters, septic tank effluent, and treated wastewater effluent also contribute to the recharge, through ground percolation and subsurface migration. (DWR, 2004b)

Not enough data exist to compile a detailed groundwater budget for the Lower Mojave River Valley Groundwater Basin. However, this basin is located within the adjudicated Mojave Basin Area, meaning that a court judgment has identified each water rights holder within the basin, and the quantity of groundwater available to each such party, as well as a Watermaster responsible for administering this judgment. The MWA is the Watermaster responsible for administering the court’s adjudication order for this basin. The MWA monitors and studies the basin for extractions and estimated recharge rates. The MWA also implements three strategies to reduce and eliminate overdraft in the groundwater basin, including: water conservation, water supply enhancement, and water allocation (DWR, 2004c). Any use of water from the Lower Mojave River Valley Groundwater Basin is evaluated and approved of by the MWA, ensuring consistency with the adjudication judgment.

Both fluoride and boron impairments have been present in the past, as well as numerous sites in the Barstow area where leaking underground storage tanks are a source of contamination. (DWR, 2004b)

2.4.4.3 Middle Mojave River Valley Groundwater Basin

The Barstow-Daggett area, North Lucerne Valley, and Stoddard Valley overlie the Middle Mojave River Valley Groundwater Basin. This basin has a surface area of 211,000 acres and is bounded by a combination of surface and subsurface divides to the north, including the Helendale Fault, and the contact between Quaternary alluvium and consolidated basement rocks of the Kramer Hills and Iron Mountain. To the south lies outcropping basement rock near Helendale, to basement rock in the Shadow Mountains, following a rough east-west line. To the east is Camp Rock-Harper Lake fault zone and on the west are surface drainage divides and basement outcrops of the Shadow Mountains northward to the Kramer Hills area. Average precipitation within this area nears six inches per year. Recharge is provided to the basin by percolation of direct precipitation and ephemeral stream flow, as well as underflow from the Mojave River into the basin from the southwest. When the Mojave River is flowing, the recharge rate to this groundwater basin is substantially higher. Irrigation waters, septic tank effluent, and treated wastewater effluent also contribute to the recharge, through ground percolation and subsurface migration. (DWR, 2003a)

Not enough data exist to compile a detailed groundwater budget for the Middle Mojave River Valley Groundwater Basin. As with the Lower Mojave River Valley Groundwater Basin, this basin is adjudicated and managed per the direction of the MWA as the court-appointed Watermaster. Any use of water from the Middle Mojave River Valley Groundwater Basin is evaluated and approved of by the MWA, ensuring consistency with the adjudication judgment.

Volatile organic compounds (VOCs), salts, and nitrates have leached into the basin from the Lenwood Landfill in the past. Irrigation with effluent from the Barstow wastewater reclamation facility, and other naturally occurring nitrates and salts, are other sources of possible impairment. (DWR, 2003b)

2.4.4.4 Lucerne Valley Groundwater Basin

The North and West Lucerne Valley portions of the study area overlie the Lucerne Valley Groundwater Basin. This basin has a surface area of 148,000 acres and is bounded by the San Bernardino Mountains to the south and by both the Helendale Fault and Granite Mountains to the west. To the north lies the Ord Mountains, with Camp Rock Fault and Kane Wash Area Groundwater Basin to the east, and the Fry Mountains to the southeast. Average precipitation within this area ranges from four to six inches per year in the lower part of the valley, and six to eight inches per year in the upper part of the valley. Recharge is provided to the basin by percolation of runoff from the San Bernardino Mountains, and less so by percolation of runoff from the Granite, Ord, and Fry Mountains. Flow in the groundwater basin is generally toward Lucerne Lake, from the areas of recharge. The total storage capacity is estimated to be between 2,000,000 and 4,740,000 AF, with a natural recharge of 1,000 AFY. (DWR, 2004c)

The Lucerne Valley Groundwater Basin is not adjudicated, and there are no restrictions to pumping by water rights holders (landowners) in the basin. Overdraft conditions have historically been present in this basin, with 1976 data indicating recharge of 1,000 AFY and discharge of 10,000 AFY, resulting in a negative change in storage of 9,000 AFY. Water levels have declined in both unconfined and confined aquifers throughout the basin. Land subsidence was also recorded in 1977, and had been occurring in parts of the basin for many years prior, as a result of overdraft. Current overdraft conditions have not been defined, but it is reasonably assumed that the basin continues to exist in overdraft. (DWR, 2004c)

Lucerne Valley Groundwater Basin has had high nitrate and TDS levels in the shallow aquifer zone, associated with irrigation. Calcium-magnesium bicarbonate water is found in the southwestern part of the basin. Groundwater near Lucerne Lake is sodium chloride in character and also has high TDS concentrations. (DWR, 2004c)

2.4.4.5 Upper Mojave River Valley Groundwater Basin

The portions of the study area that lie within the West Lucerne Valley and Hesperia region overlie the Upper Mojave River Valley Groundwater Basin. This basin has a surface area of 413,000 acres and is bounded by Helendale Fault to the southeast and by nearby mountain basement exposures to the east. A surface drainage divide between this basin and El Mirage Valley Basin, and a contact between alluvium and basement rocks that form the Shadow Mountains, lies to the west. Average precipitation within this area nears 12 inches per year. Recharge is provided to the basin by percolation of direct precipitation and ephemeral stream flow, as well as underflow from the Mojave River from the southwest. When the Mojave River is flowing the recharge rate to this basin is substantially higher. Irrigation waters, septic tank effluent, two fish hatchery operations effluent, and treated wastewater effluent also contribute to recharge, through ground percolation and subsurface migration. The total storage capacity is estimated to be 13,000,000 AF, with a natural recharge of 105,000 AFY. (DWR, 2004d)

Not enough data exist to compile a detailed groundwater budget for the Upper Mojave River Valley Groundwater Basin. As with the Lower and Middle Mojave River Valley Groundwater Basins, this basin is adjudicated and managed per the direction of the MWA as the court-appointed Watermaster. Any use of water from the Upper Mojave River Valley Groundwater Basin is evaluated and approved of by the MWA, ensuring consistency with the adjudication judgment.

High nitrate levels are present within the southern region of the basin, while levels of iron and manganese levels are found near Oro Grande. Trichloroethane contamination has occurred from the former George Air Force Base, which is now a Superfund site. Leaking underground storage tanks around the Victorville area have also contributed to water quality impairments associated with fuel additives. (DWR, 2004d)

2.5 Noise

This section describes the environmental conditions related to noise in the study area. Table 2.5-1 provides definitions for technical terms related to noise.

Table 2.5-1. Summary of Acoustical Terms

Term	Definition
Decibel (dB)	A unit of measure for the intensity of a sound or a degree of loudness. The ear can detect changes in pressure which displace the eardrum. The ear responds to pressure changes over a range of 10^{14} to 1. To deal with the extreme range of pressures the ear can detect, the amount of acoustical energy of a sound is expressed by comparing the measured sound pressure to a reference pressure, then taking the logarithm (base 10) of the square of that number. The decibel is equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micropascals (20 micronewtons per square meter).
A-Weighted Sound Level (dBA)	The sound level in decibels as measured on a sound level meter using the A-weighted filter network. The A-weighted filter de-emphasizes the very low and very high frequency components of sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise. All sound levels in this report are A-weighted.
Ambient Noise Level	The composite noise from all sources resulting in the existing normal level of environmental noise at a given location.
Equivalent Noise Level (Leq)	The average dBA level, on an equal energy basis, during the measurement period.
Maximum Noise Level (Lmax)	The maximum noise level during a sound measurement period.
Minimum Noise Level (Lmin)	The minimum noise level during a sound measurement period.
Percentile Noise Level (Ln)	The noise level exceeded during 'n' percent of the measurement period, where 'n' is a number between 0 and 100 (e.g., L90 refers to the dBA level occurring 90 percent of the time during a sound measurement period)

2.5.1 Noise-Sensitive Receptors

An example of noise sensitive receptors would be schools, hospitals, residences, and recreational facilities. Sensitive receptors in the study area are primarily residential. Urbanized areas with higher concentrations of residential development are generally located within city limits, whereas outside city boundaries residential development becomes more scattered and rural in nature. Minimal, if any, residential development occurs on Bureau of Land Management (BLM) managed lands within the study area.

Table 2.5-2 provides details of sensitive receptors in the study area.

Table 2.5-2. General Summary of Sensitive Receptors in the Study Area

Area	Sensitive Receptors
I-40/Old Route 66 Corridor	Properties are generally zoned residential or open space. The nearest residences are located in the community of Newberry Springs. There are also several residences in a neighborhood southeast of the Barstow-Daggett Airport and other, more remote residences scattered throughout the area.
Barstow-Daggett Area	South of Coolwater Switchyard is generally BLM-managed lands, which are zoned as open space; no residences. Sensitive receptors may include recreationists. The nearest noise-sensitive land uses include residences northwest of the intersection of Barstow Road (SR-247) and Chuckwagon Road, and to the north in Daggett and Barstow. Between the I-40 and Daggett Ridge properties are zoned for residential, agricultural, military, and open space. Scattered rural residences are located near I-40, with no residences to the south (BLM-managed lands).
Stoddard Valley	Generally BLM-managed lands with recreationists as sensitive receptors. Along Stoddard Wells Road properties are zoned for residential and agricultural land uses. There are no existing homes or other sensitive receptors in this area. Along Barstow Road/SR-247 the area is generally zoned as open space; however, there are several rural residences located along SR-247.
North Lucerne Valley	This area is generally BLM-managed lands zoned as open space, with scattered rural residences. The Lucerne Valley Cutoff south to the existing Lugo-Mohave 500-kV and Lugo-Pisgah No. 1 220-kV lines includes properties zoned for residential and agricultural land uses. The nearest noise-sensitive land uses are residences located near the intersection of Spinel Street and SR-247.
West Lucerne Valley	The West Lucerne Valley includes properties zoned for utilities, open space, residential, and agricultural land uses. Sensitive receptors include residences, which are scattered throughout the area, as well as a Recreational Vehicle Park/Campground, known as Sundowner Ranch. The nearest residences are located near Essex Street and Sussex Avenue.
Southern Apple Valley	Existing land uses include a transmission line corridor, rural residential, and undeveloped lands
Hesperia	West of the Mojave River in the City of Hesperia, land uses including an existing transmission line corridor and increasingly urban residential development. .
Ord Mountains and Summit Valley	In the vicinity of the El Dorado-Lugo 500-kV transmission line corridor, there are a variety of lands zoned for institutional, utilities, open space, urban mixed, residential, and agricultural uses. Scattered rural residences are located within this area. The density of the residences increases as the area approaches Hesperia.

Source: SCE, 2013

2.5.2 Existing Ambient Noise Levels

Both long-term and short-term noise measurements were conducted between August 5 (Tuesday) and August 7 (Thursday), 2014, documenting the existing ambient noise conditions in the study area. The measurement locations were chosen to capture areas where there are the greatest numbers of residential receptors. The results of these measurements are provided in Tables 2.5-3 and 2.5-4. The locations of these noise measurements are provided in Figures 2.5-1 and 2.5-2, respectively (located at the end of this section).

Ambient measurement locations were selected based on the proximity of existing residential receptors in or near the study area. These locations do not represent all proximate residential receptors, but areas with the highest number of residences. While measurements were not conducted at some locations that contain scattered residences (refer to Table 2.5-2), those areas not measured are expected to have similar ambient noise conditions as the lower range of recorded conditions. Therefore, L90 noise levels in the remaining study area can be expected to range from 35 to 45 dBA Leq. This range is based on the information provided in Tables 2.5-3 and 2.5-4.

Table 2.5-3. Measured Long-Term (24-Hour) Ambient Noise Levels, dBA

24-Hour			
	Range of Hourly Noise Levels		
Location	Leq	Lmax	L90
A	34.5-56.3	50.5-81.9	29.8-40.7
B	49.5-59.4	69.1-88.0	30.5-47.4
C	37.0-66.4	50.6-86.5	30.3-44.3
D	37.0-54.1	52.4-66.3	28.8-48.2
E	24.7-50.4	38.7-63.1	22.2-41.5
F	37.5-58.2	62.8-83.7	22.8-46.5

Daytime Average (7:00 a.m. – 7:00 p.m.)				
Location	Leq	Lmax	Lmin	L90
A	44.9	66.3	31.8	35.5
B	55.0	77.0	36.8	41.6
C	48.2	68.1	34.2	38.7
D	44.2	58.9	31.8	36.8
E	37.7	51.8	25.7	29.8
F	53.4	73.2	31.2	36.4
Nighttime Average (7:00 p.m. – 7:00 a.m.)				
Location	Leq	Lmax	Lmin	L90
A	46.7	69.7	34.8	37.1
B	54.8	71.9	33.7	38.8
C	45.8	65.8	32.5	35.6
D	42.6	59.1	31.2	33.9
E	30.8	47.8	23.4	25.4
F	47.5	69.5	26.3	29.9

Source: BBA, 2014

Table 2.5-4. Measured Short-Term (15-Minute) Ambient Noise Levels, dBA

Location	Time	Leq	Lmax	L90
G	4:04 p.m.	45.7	61.9	35.8
G	1:08 p.m.	45.5	60.8	34.7
H	3:16 p.m.	42.5	56.1	28.7
H	12:18 p.m.	43.3	60.4	30.1
I	12:48 p.m.	35.0	49.8	24.4
J	11:57 a.m.	35.0	49.7	29.8
K	12:18 p.m.	39.9	54.7	27.1
L	11:32 a.m.	46.4	63.9	30.1

Table 2.5-4. Measured Short-Term (15-Minute) Ambient Noise Levels, dBA				
Location	Time	Leq	Lmax	L90
M	10:59 a.m.	61.3	80.8	29.5
N	10:36 a.m.	39.8	57.3	31.0
O	10:14 a.m.	57.3	76.7	31.7
O	4:41 p.m.	59.2	71.8	32.2
P	9:53 a.m.	52.0	58.2	37.8
P	4:18 p.m.	46.0	59.1	35.9
Q	9:33 a.m.	43.8	62.4	31.2
Q	3:52 p.m.	45.0	66.4	31.1
R	9:00 a.m.	48.6	68.9	35.8
R	3:33 p.m.	46.2	66.6	33.9
S	8:34 a.m.	58.4	73.7	44.4
S	3:11 p.m.	56.7	64.4	41.9
T	8:10 a.m.	46.3	63.6	36.6
T	2:46 p.m.	53.3	68.5	39.5
U	7:51 a.m.	52.2	66.4	41.4
U	2:22 p.m.	52.6	62.8	40.6
V	7:30 a.m.	60.0	76.9	38.8
V	2:01 p.m.	61.4	80.9	37.2

Source: BBA, 2014

2.6 Paleontology

This section provides contextual information on the paleontological resources located within the study area. The information presented in this section was derived from the *Confidential Paleontological Survey Report: Southern California Edison Coolwater-Lugo Transmission Line Project*, prepared by Paleo Solutions (2013). Subsequent addendums to the survey report were also used in preparation of this section (Paleo Solutions, 2014a, 2014b). Due to the confidential nature of the location of paleontological resources, this section does not include maps or location descriptions.

Paleontology is a multidisciplinary science that combines elements of geology, biology, chemistry, and physics in an effort to understand the history of life on earth. Paleontological resources, or fossils, are the evidence of once-living organisms preserved in the rock record. They include both the fossilized remains of ancient plants and animals and the traces thereof (e.g., trackways, imprints, burrows, etc.). In general, fossils are considered to be greater than 5,000 years old (Middle Holocene) and are typically preserved in sedimentary rocks. Although rare, fossils can also be preserved in volcanic rocks and low-grade metamorphic rocks under certain conditions (SVP, 2010). Paleontological resources can provide important taphonomic, taxonomic, phylogenetic, paleoecologic, stratigraphic, or biochronological data (Scott and Springer, 2003).

Paleontological resources are not found in “soil” but are contained within the geologic deposits or bedrock that underlies the soil layer. Therefore, in order to ascertain whether or not a particular study area has the potential to contain significant fossil resources at the subsurface, it is necessary to review relevant scientific literature and geologic mapping to determine the geology and stratigraphy of the area. Further, to delineate the boundaries of an area of paleontological sensitivity, it is necessary to determine the extent of the entire geologic unit because paleontological sensitivity is not limited to surface exposures of fossil material.

Geologic units underlying the study area were identified using the following published maps:

- Geologic Map of the Apple Valley and Ord Mountains 15-Minute Quadrangles, San Bernardino County, California 1:62,500 (Dibblee, 2008a)
- Geologic Map of the Barstow and Daggett 15-Minute Quadrangles, San Bernardino County, California 1:62,500 (Dibblee, 2008b)
- Geologic Map of the Lake Arrowhead and Lucerne Valley 15-Minute Quadrangles, San Bernardino County, California 1:62,500 (Dibblee, 2008c)
- Geologic Map of the San Bernardino and Santa Ana 30' X 60' Quadrangles, California 1:62,500 (Morton and Miller, 2006)
- Preliminary Surficial Geologic Map of the Newberry Springs 30' X 60' Quadrangle, California 1:62,500 (Phelps et al*.,* 2012)

Additionally, paleontological collections records searches were conducted at the following museum repositories:

- The San Bernardino County Museum (SBCM), Division of Geological Sciences, Regional Paleontological Locality Inventory; and
- The Los Angeles County Museum of Natural History (LACM), Vertebrate Paleontology Section.

The detailed review of museum collections records was performed to determine whether any identified fossil localities occur within or adjacent to the study area, and ascertain the abundance and taxonomic diversity of fossils collected from the same geologic formations elsewhere in this part of the San Bernardino County. This led to the identification of the units underlying the study area and a determination of the paleontological sensitivity ratings of those geologic units.

2.6.1 Paleontological Sensitivity

The Bureau of Land Management's (BLM) Potential Fossil Yield Classification (PFYC) (BLM, 2007) criteria establishes the paleontological sensitivity of a given geologic unit. The PFYC is generally only used on federal lands, but has been applied to all geologic units within the study area. The PFYC sensitivity guidelines are provided below, as excerpted from BLM Instruction Memorandum No. 2008-009 (BLM, 2007):

> **Class 1 – Very Low**. Typically, these are igneous or high-grade metamorphic geologic units, which are not likely to contain recognizable fossil remains due to the high heat and/or pressure of their formation.
>
> **Class 2 – Low**. Sedimentary geologic units that are not likely to contain vertebrate fossils or scientifically significant non-vertebrate fossils because the deposits are generally younger than 10,000 years before present, are eolian deposits, exhibit significant diagenetic alteration, or are known to lack or have rare significant fossils.
>
> **Class 3 – Moderate (3a) or Unknown (3b)**. A fossiliferous rock unit with moderate potential is a sedimentary deposit where the significance, abundance, and predictability of recovery of fossils vary. In some cases, available literature on a particular geologic unit will be scarce and a determination of whether or not it is fossiliferous or potentially fossiliferous will be difficult to make. Under these circumstances, the sensitivity is unknown and further study is needed to determine the unit's paleontological resource potential.

Class 4 – High. Geologic units containing a high occurrence of significant fossils. Vertebrate fossils or scientifically significant invertebrate or plant fossils are known to occur and have been documented, but may vary in occurrence and predictability. Surface-disturbing activities may adversely affect paleontological resources in many cases.

Class 5 – Very High. Highly fossiliferous geologic units that consistently and predictably produce vertebrate fossils or scientifically significant invertebrate or plant fossils, and that are at risk of human caused adverse impacts or natural degradation.

2.6.2 Regional Geologic Setting

The study area is situated within the Mojave Desert geomorphic province in southeastern California (Norris and Webb, 1976). A geomorphic province is a region of unique topography and geology that is readily distinguished from other regions based on its landforms and diastrophic history. The Mojave Desert geomorphic province extends from the San Andreas and Garlock Faults towards the Basin and Range Province and Colorado Desert (Dibblee, 1967). The Mojave Desert was formed as a result of Proterozoic (2,500 million years ago [Ma] to 542 Ma) and Paleozoic (542 to 252 Ma) subsidence and sediment accumulation; Mesozoic (252 to 66 Ma) volcanism, plutonic intrusion, regional uplift, and metamorphism; and ongoing Cenozoic (66 Ma to present) uplift, depression, erosion, volcanism, and crustal deformation associated with movement along the Garlock and San Andreas Faults (Dibblee, 1967). The western Mojave Desert is situated on top of an uplifted basement block consisting of Proterozoic to Mesozoic crystalline rocks covered by a thin veneer of Cenozoic sedimentary rocks and Quaternary (2.6 Ma to present) alluvium (Garfunkel, 1974). In general, the Mojave Desert is dominated by broad alluvial basins and uplifted, unroofed basement rock; late Cenozoic basaltic and rhyolitic volcanic rocks; sedimentation from the Pleistocene Mojave River and pluvial lakes; and active faulting, including the right-lateral, northwest-trending Lenwood-Lockhart Fault and Mount General Fault near the study area (Amoroso and Miller, 2012). The Mojave Desert is entirely landlocked and averages 2,500 feet above mean sea level in elevation (Norris and Webb, 1976).

2.6.3 Geology and Paleontology of the Study Area

The study area is mapped at a scale of 1:62,500 by Dibblee (2008c), Morton and Miller (2006) and Phelps et al. (2012), among others. The lithology of the study area consists of Paleozoic to Mesozoic aged undifferentiated igneous and metamorphic rocks, the Paleozoic Furnace limestone and dolomite, Miocene terrestrial sediments, and Quaternary alluvial and eolian deposits. Brief descriptions of these geologic units are provided in this section. Table 2.6-1 summarizes the geologic units within the study area and their PFYC rankings, which range from very low to high (Classes 1-4).

Table 2.6-1. Geologic Units and Their PFYC within the Study Area

Geologic Unit	Age	PFYC/Paleontological Sensitivity
Undifferentiated Igneous and Metamorphic	Proterozoic-Mesozoic	Class 1 – very low
Furnace Limestone	Mississippian-Pennsylvanian	Class 3b – unknown
Crowder Formation	Miocene	Class 4 – high
Barstow Formation	Miocene	Class 4 – high
Quaternary very old deposits	Early to Middle Pleistocene	Class 3a and 3b – moderate to unknown

Table 2.6-1. Geologic Units and Their PFYC within the Study Area

Geologic Unit	Age	PFYC/Paleontological Sensitivity
Quaternary older deposits	Middle to Late Pleistocene	Class 3b – unknown
Quaternary young deposits	Late Pleistocene to Holocene	Class 2-3 – low to moderate

Source: Paleo Solutions, 2013

2.6.3.1 Undifferentiated Igneous and Metamorphic Rocks

Several units of Mesozoic, Paleozoic, and Proterozoic igneous and metasedimentary rocks are found throughout the study area. Lithologic units in the southern portion of the study area primarily consist of Mesozoic granodiorites, and smaller areas of late Proterozoic to Pennsylvanian marble and limestone. The central portion of the study area also consists mostly of Mesozoic granodiorites, with areas underlain by Triassic to Cretaceous felsic and intermediate volcanic rocks. The northern portion of the study area consists mostly of Mesozoic granodiorite and small areas underlain by early Proterozoic to late Cretaceous phaneritic plutonic rocks. Mesozoic plutonic, volcanic, and metamorphic rocks (with the exception of some limestone to marble units as discussed below) found within the study area are not suitable for the preservation of fossil remains, and have a very low paleontological sensitivity (PFYC Class 1) (Paleo Solutions, 2013).

2.6.3.2 Paleozoic Furnace Limestone

Several exposures of the Paleozoic age limestone/dolomite to marble unit are situated along the southern margin of the study area, particularly in the Ord Mountains and Summit Valley area. These rocks are pale gray to blue and contain ichnofossils and possibly vertebrate and invertebrate fossils. The portions that have been metamorphosed to marble may assist in further constraining the age of onset of high pressure and temperature metamorphosis due to the initiation of the San Andreas Fault. As a result, this unit is considered to be scientifically valuable. However, because little is known about the potential fossil yield of this unit, it has been assigned an unknown paleontological sensitivity (PFYC Class 3b) (Paleo Solutions, 2013).

2.6.3.3 Crowder Formation Sandstone

The Miocene age Crowder Formation is exposed at the very southwest tip of the study area and just east of the active Mojave River (Hesperia, Ord Mountain, and Summit Valley areas). Lithologies include light tan to nearly white, bedded, fine to coarse grained, arkosic, poorly sorted sandstone, which contains clasts derived from granitic and gneissic sources. This unit may also be found at depth beneath adjacent younger alluvium (Paleo Solutions, 2013).

The Crowder Formation has yielded an abundant and diverse fauna that includes 40 mammalian species, two of which are type specimens, as well as reptiles, birds, mollusks, and trace fossils. In all, more than 12,000 fossils have been recovered from this formation. Three new local faunas have been described from within the Crowder Formation and include the Wye Local Fauna (LF) and Squaw Peak LF (late Hemingfordian North American Land Mammal Age [NALMA]), and the Sulfur Spring LF (Barstovian NALMA). A fourth unnamed LF, positioned stratigraphically higher than the others, has also been recognized in the Crowder Formation and is assigned middle Hemphillian NALMA. The fossil taxa representing these local faunas were found within more than 20 paleosols interbedded throughout the formation (Applied EarthWorks, Inc., 2013). The Crowder Formation is considered to have high paleontological sensitivity (PFYC Class 4).

2.6.3.4 Barstow Formation, Non-Marine Fanglomerate

Exposures of Miocene age fanglomerates belonging to the regionally broad Barstow Formation are found along the northeastern portion of the study area, along the northern skirts of Daggett Ridge. The Barstow Formation was deposited during the middle Miocene in an elongate extensional basin. The unit is composed of fluvio-lacustrine deposits up to 4,000 feet thick that generally consist of well-bedded, tan to red, arkosic fine- to medium-grained sandstone; poorly consolidated brown to yellow conglomeratic sandstone; crudely-bedded green-grey granitic conglomerate; and subordinate green-grey to brown claystone, limestone, tuffaceous bentonite, and white to red rhyolitic tuff (Dibblee, 1968; Woodburne et al., 1990). The fanglomerates comprise tan/gray/greenish to reddish brown, fine to coarse-grained sands with silts, subrounded to subangular plutonic and metamorphic clasts, and multiple sequences of ash and volcanic debris flows.

The Barstow Formation is highly fossiliferous and has yielded Hemingfordian and Barstovian vertebrate faunal assemblages, including the Red Division Fauna, Rak Division Fauna, Green Hills Fauna, Second Division Fauna, and the Barstow Fauna (McLeod, 2014; Pagnac, 2009; Woodburne et al., 1990). The Barstovian NALMA is named for the type assemblage from the Barstow Formation, which was recovered from within a fossiliferous tuff deposit in the Mud Hills. Vertebrate fossils from the Barstow Formation include specimens of tortoise, falcon, duck, proboscidean, bear-dog, dog, marten, rabbit, horse, oreodont (fossil mammal- extinct herbivore), rhinoceros, pronghorn antelope, and camel (McLeod, 2014). This unit is considered to have high paleontological sensitivity (PFYC Class 4) and may also be found at depth below older Pleistocene age alluvium in the study area.

2.6.3.5 Quaternary Very Old Deposits

Quaternary very old deposits in the study area include Early Pleistocene age alluvial fan deposits belonging to the Victorville Fan, as well as Pliocene to Pleistocene age alluvial deposits. These terrestrial deposits are exposed in the central and southwestern portions of the study area, particularly in Stoddard Valley, Hesperia, Ord Mountains and Summit Valley areas. The very old alluvial fan deposits consist of sandy alluvium or gravel that is generally reddish-brown, often well-indurated, and often well-dissected. Pleistocene alluvial fan sediments present at the surface and at the subsurface in the Victorville region were laid down by two separate depositional regimes: the ancestral Mojave River and the Victorville Fan. The Early Pleistocene Harold Formation and Shoemaker Gravel, along with the Early to Middle Pleistocene very old alluvial fan deposits comprise the Victorville Fan. According to museum records, the Shoemaker Gravel of the Pleistocene Victorville Fan deposits have proven to contain abundant terrestrial mammals including mammoth, bison, camel, and horse (DeBusk and Corsetti, 2007).

Previous paleontological investigations have repeatedly demonstrated the high paleontological sensitivity of the ancient Mojave River sediments in the Victorville region of the Mojave Desert (Paleo Solutions, 2013). Additionally, finer-grained older alluvium deposited in association with the ancestral Mojave River drainage system has yielded significant vertebrate fossils. Early to Middle Pleistocene-age fauna such as mammoth, ground sloth, camel, horse, bear, llama, mouse, rat, rabbit, shrews, squirrels, and reptiles such as lizards and snakes have been found in the channel, bank, and flood deposits belonging to the ancestral Mojave River (DeBusk and Corsetti, 2007). Although these units have no previously recorded fossil localities within the study area, they have the potential to contain paleontologically sensitive sediments and thus are assigned a moderate to unknown paleontological sensitivity (PFYC Class 3a to 3b).

2.6.3.6 Quaternary Older Deposits

Quaternary older deposits (Middle to Late Pleistocene) within the study area include fan, alluvium, and gravel and cobble terrace deposits. Older alluvial fans are comprised of gray-brown, poorly sorted sub-rounded gravels derived from plutonic and gneissic sources. These deposits are constrained to the northern and central portions of the study area, particularly the Barstow-Daggett and Stoddard Valley areas. Old alluvial deposits are brown, moderately consolidated, fine- to medium-grained sand and fine to medium gravel from inactive alluvial fans. Surfaces are smooth, slightly varnished pavements composed of sand and angular gravel clasts, consisting of slightly metamorphosed sedimentary units, volcanic rocks derived from the Sidewinder Volcanic series, and minor plutonic clasts. Surfaces are imprinted by modern ephemeral minor washes. Quaternary gravel and cobble terrace units are poorly bedded high-energy deposits found in the southern portion of the study area, adjacent to the Mojave River (Paleo Solutions, 2013).

Quaternary alluvial, fluvial, and lacustrine deposits of Pleistocene age have yielded significant vertebrate fossil localities throughout California and near the study area. Numerous terrestrial vertebrate fossils have been recovered from within Pleistocene-age alluvial deposits in the Mojave Desert within San Bernardino County. South of the study area near Victorville, vertebrate fossil remains have been recovered within Pleistocene Mojave River deposits, including specimens of mammoth. Additional Pleistocene-age vertebrate fauna, including horse, camel, lama, pronghorn, deer, sheep, and bison, were recovered from the Calico Hills, Newberry Mountains, Fort Irwin, Daggett, Yermo, and the Kramer Hills (Applied EarthWorks, 2014).

All older Quaternary sedimentary units in the study area are assigned a paleontological sensitivity of moderate or unknown (Class 3a or 3b), depending upon the specific position in the study area and proximity to previously recorded localities.

2.6.3.7 Quaternary Younger Deposits

Quaternary younger deposits (Late Pleistocene to Holocene) in the study area include alluvium, colluvium, fan, eolian, wash, and playa deposits. Younger alluvial deposits are unconsolidated to moderately consolidated, pale-brown silt, sand, and gravel. Quaternary young colluvial deposits are unconsolidated sand, gravel, and rock fragments flanking bedrock slopes that are deposited by down-slope creep or slope wash. Young eolian deposits are unconsolidated wind-blown deposits of fine to medium sand and silt. Young alluvial fan deposits (Holocene to Late Pleistocene) are slightly to moderately consolidated silt, sand, and gravel deposits, to unconsolidated to moderately consolidated alluvial fan deposits having slightly to moderately dissected surfaces and incised ephemeral wash channels (Morton and Miller, 2006). Young lacustrine playa deposits are unconsolidated to slightly consolidated, fine grained sand, silt, mud and clay derived from lakes/playas. Wash deposits are unconsolidated fine to coarse grained sand and fine gravel, very pale brown, angular to subangular grains, and are derived from local bedrock. These units are too young to contain significant fossils, but may shallowly overlie units of higher paleontological significance; therefore, they are assigned a low to moderate to unknown paleontological sensitivity (PFYC 2, 3a, and 3b, respectively), depending upon the specific location in the study area and proximity to previously recorded localities (Paleo Solutions, 2013).

2.6.4 Study Area Findings Summary

The results of the paleontological resources records searches revealed 14 previously recorded localities. All previously recorded localities are in the highly sensitive Crowder and Barstow Formations and the low to moderately sensitive Quaternary older to younger alluvium. The findings of the paleontological records searches are summarized in Table 2.6-2. In addition, the paleontological field reconnaissance survey, which was limited to the former CLTP corridor, identified three vertebrate fossil localities, which yielded a molar tooth fragment of a mid-sized camelid, likely Miocene in age, found ex-situ as float on the surface of desert pavement; indeterminate vertebrate bone fragments found ex-situ as float on the surface of deposits mapped as Miocene-age fanglomerate; and an indeterminate vertebrate bone as well as an indeterminate vertebrate bone fragments recorded within Quaternary older alluvium (Paleo Solutions, 2013, 2014b).

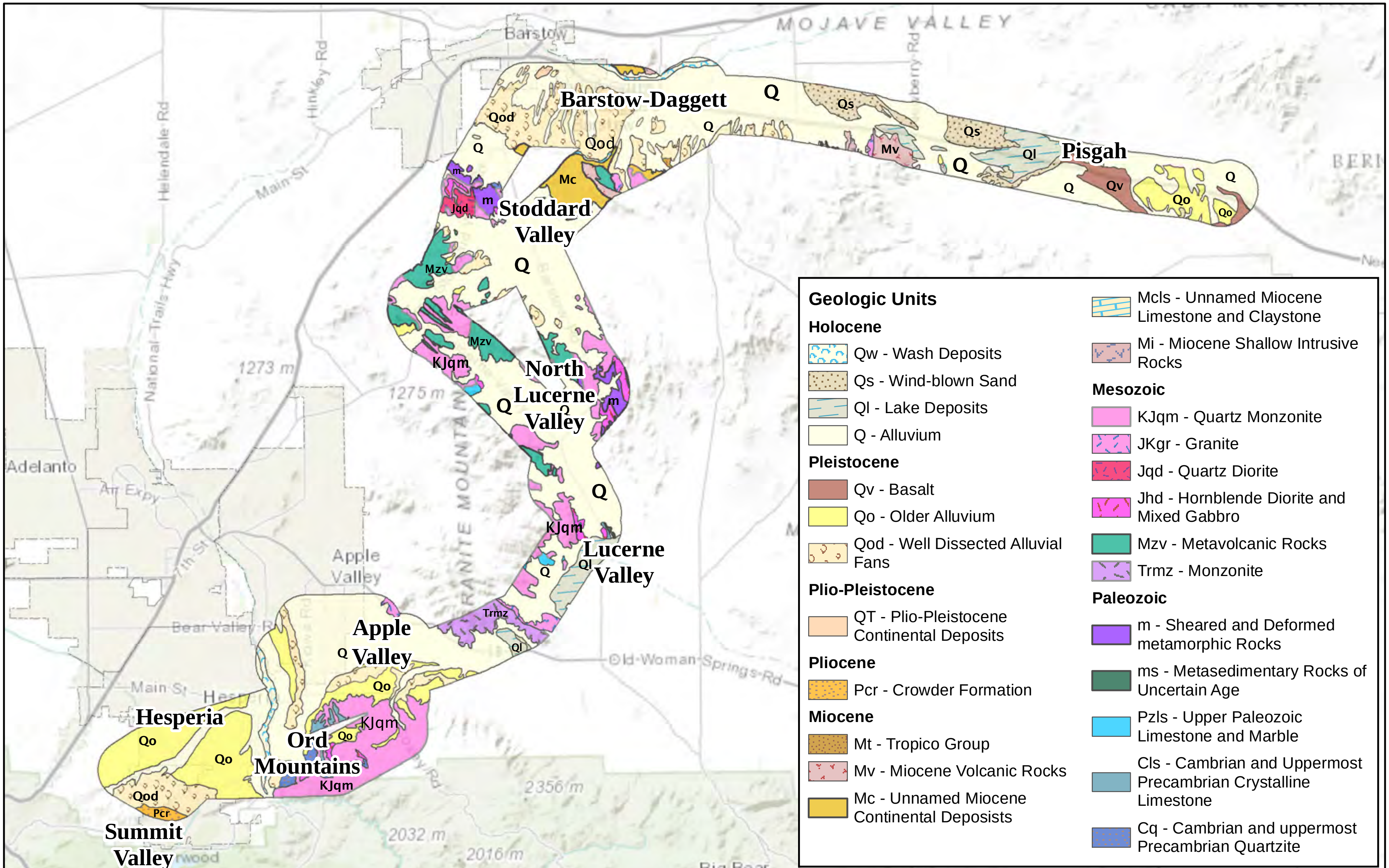
Table 2.6-2. Vertebrate Localities Reported from within the Geologic Units in the Study Area, San Bernardino County

Locality Number	Geologic Unit	Age	Taxa
SBCM 1.109.1	Quaternary older deposits	Pleistocene	Camelidae (camel)
SBCM 1.109.2	Quaternary younger deposits	Holocene – Pleistocene	*Heterocypris* sp. (ostracod), Serpentes (indeterminate snake), *Calamagras* sp. (boa), Lacertilia (indeterminate lizard), *Miospermophilus* sp. (squirrel), *Cupidinimus nebraskensis* (rodent), *Cupidinimus n*. (rodent), *Mojavemys* cf. *lophatus* (rodent), *Peridiomys* sp.(rodent), *Proheteromys sulculus* (rodent), *Mookomys altifluminus* (rodent), *Perognathus furlong* (pocket mouse), *Perognathus minutus* (pocket mouse), Amphicyonidae (indeterminate bear dog), Canidae (indeterminate dog), Machairodontinae (indeterminate saber tooth cat), Felidae (indeterminate cat), Camelidae, *Merycodus* sp. (pronghorn), Artiodactyla (indeterminate ungulate), *Archaeohippus* (horse), *Merychippus* cf. *carrizoensis* (horse), *Merychippus stylodontus* (horse), *Merychippus* sp. (horse)
SBCM 1.109.3	Quaternary younger deposits	Holocene – Pleistocene	Rodentia, Gila
SBCM 1.109.4	Quaternary younger deposits	Holocene - Pleistocene	Gila, *Cupidinimus cf. nebraskensis*, Camelidae
SBCM 1.109.5	Quaternary older deposits	Pleistocene	Sciuridae, Rodentia
SBCM 1.109.6	Quaternary younger deposits/Quaternary older deposits	Pleistocene	Camelidae
LACM 1224	Quaternary older deposits	Pleistocene	*Camelops* sp. (camel)
LACM (CIT) 402	Crowder Formation	Miocene	Testudinata (tortoise), Camelidae, *Merychippus tehachapienis* (horse), *Parapliohippus carrizoensis* (horse)
Bob Reynolds LVL 1-3 (3)	Quaternary younger deposits/Barstow Formation	Holocene – Pleistocene	Cat and camel tracks, Mammalia
Bob Reynolds R12-25-1	Barstow Formation/ Quaternary older deposits	Pleistocene	Rodentia, Insecta

Table 2.6-2. Vertebrate Localities Reported from within the Geologic Units in the Study Area, San Bernardino County

Locality Number	Geologic Unit	Age	Taxa
Bob Reynolds R12-25-2	Barstow Formation	Miocene	Camel tracks
Bob Reynolds Personal Notes	Quaternary younger deposits	Holocene – Pleistocene	Fish

Source: Paleo Solutions, 2013

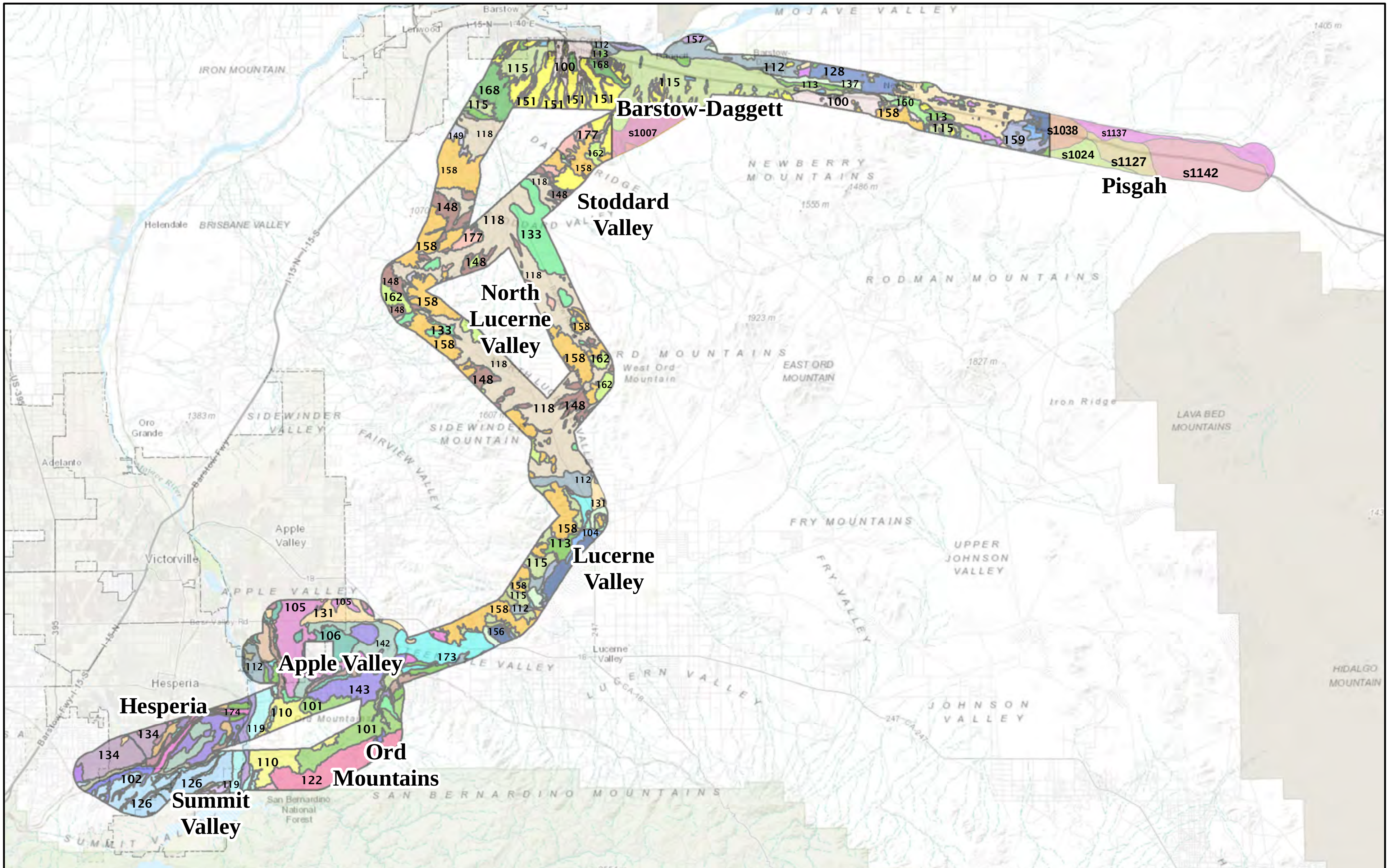


Regional Geology

City Boundaries

0 5 10 Miles

Figure 2.3-2



Soils

City Boundaries

0 5 10 Miles

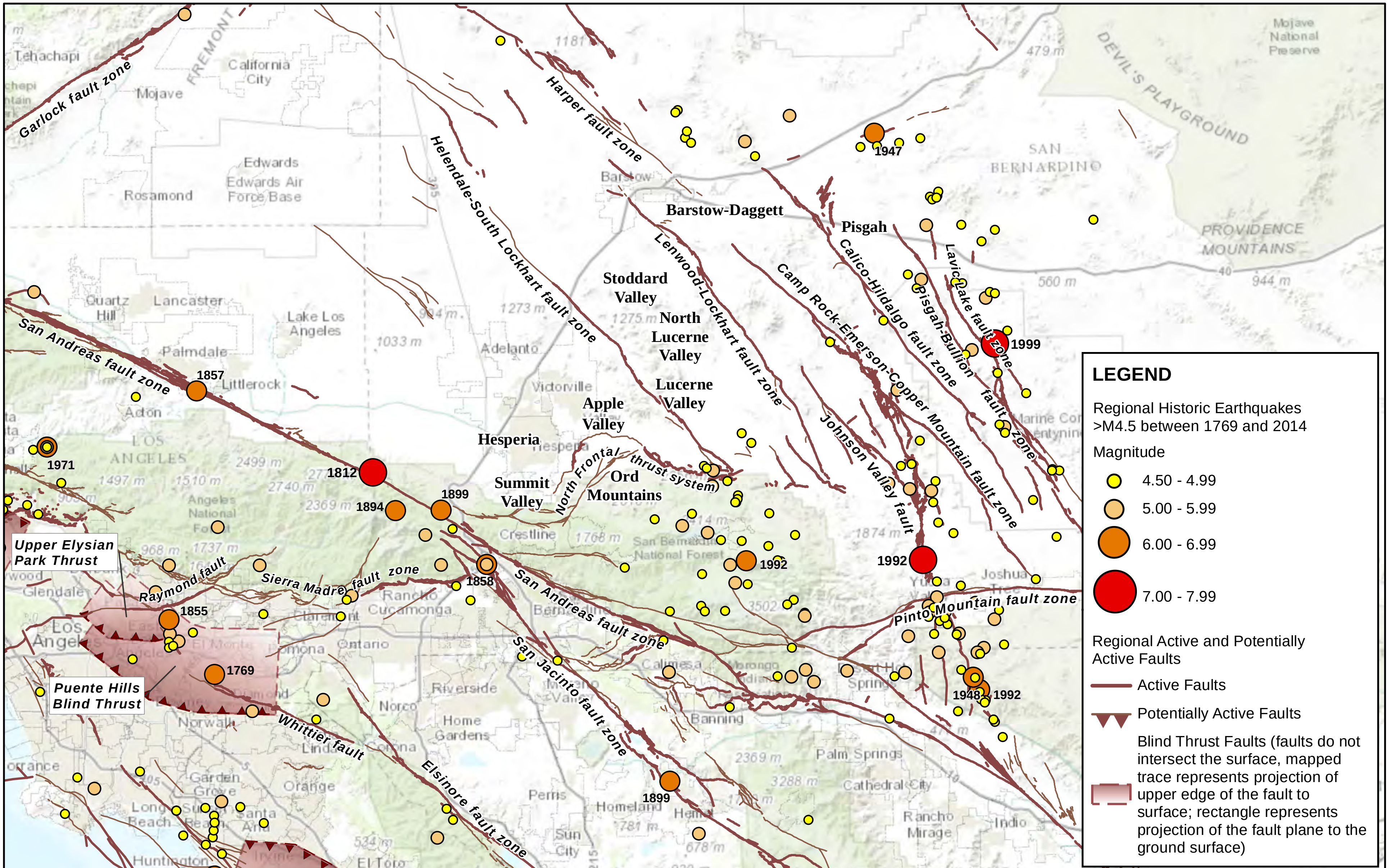
Figure 2.3-3a

Soil Units in the Study

- 100 - Arizo Gravelly Loamy Sand, 2 to 9 Percent Slopes
- 101 - Arrastre-Rock Outcrop Complex, 30 to 50 Percent Slopes
- 102 -Avawatz-Oak Glen Association, Gently Sloping
- 103 - Badland
- 104 - Bousic Clay
- 105 - Bryman Loamy Fine Sand, 0 to 2 Percent Slopes
- 106 - Bryman Loamy Fine Sand, 2 to 5 Percent Slopes
- 107 - Bryman Loamy Fine Sand, 5 to 9 Percent Slopes
- 108 - Bryman Loamy Fine Sand, 9 to 15 Percent Slopes
- 110 - Bryman-Cajon Association, Rolling
- 111 - Bull Trail-Typic Xerorthents Association, Moderately Steep
- 112 - Cajon Sand, 0 to 2 Percent Slopes
- 113 - Cajon Sand, 2 to 9 Percent Slopes
- 114 - Cajon Sand, 2 to 9 Percent Slopes
- 115 - Cajon Gravelly Sand, 2 to 15 Percent Slopes
- 117 - Cajon Loamy Sand, Loamy Substratum, 0 to 2 Percent Slopes
- 118 - Cajon-Arizo Complex, 2 to 15 Percent Slopes
- 119 - Cajon-Wasco, Cool Complex, 2 to 9 Percent Slopes
- 120 - Cave Loam, Dry, 0 to 2 Percent Slopes
- 121 - Crafton-Sheephead-Rock Outcrop Association, Steep
- 122 - Cushenbury-Crafton-Rock Outcrop Complex, 15 to 50 Percent Slopes
- 123 - Dune Land
- 126 - Gullied Land-Haploxerlafs Association
- 127 - Halloran Sandy Loam
- 128 - Halloran-Duneland Complex, 0 to 15 Percent Slopes
- 130 - Haplargids-Calciorthids Complex, 15 to 50 Percent Slopes
- 131 - Helendale Loamy Sand, 0 to 2 Percent Slopes
- 132 - Helendale-Loamy Sand, 2 to 5 Percent Slopes
- 133 - Helendale-Bryman Loamy Sands, 2 to 5 Percent Slopes
- 134 - Hesperia Loamy Fine Sand, 2 to 5 Percent Slopes
- 135 - Joshua Loam, 2 to 5 Percent Slopes
- 136 - Joshua Loam, 9 to 15 Percent Slopes
- 137 - Kimberlina Loamy Fine Sand, Cool, 0 to 2 Percent Slopes
- 138 - Kimberlina Loamy Fine Sand, Cool, 2 to 5 Percent Slopes
- 139 - Kimberlina Gravelly Sandy Loam, Cool, 2 to 5 Percent Slopes
- 140 - Lavic Loamy Fine Sand
- 142 - Lucerne Sandy Loam, 0 to 2 Percent Slopes
- 143 - Lucerne Sandy Loam, 2 to 5 Percent Slopes
- 148 - Mirage Sandy Loam, 2 to 5 Percent Slopes
- 149 - Mirage-Joshua Complex, 2 to 5 Percent Slopes
- 151 - Nebona-Cuddeback Complex, 2 to 9 Percent Slopes
- 155 - Pits
- 156 - Playas
- 157 - Riverwash
- 158 - Rock Outcrop-Lithic Torriorthents Complex, 15 to 50 Percent Slopes
- 159 - Rosamond Loam, Saline-Alkali
- 160 - Rosamond Loam, Strongly Saline-Alkali
- 162 - Sparkhule-Rock Outcrop Complex, 15 to 50 Percent Slopes
- 165 - Trigger-Sparkhule-Rock Outcrop Association, Steep
- 168 - Typic Haplargids-Yermo Complex, 8 to 30 Percent Slopes
- 169 - Victorville Sandy Loam
- 171 - Villa Loamy Sand
- 173 - Wasco Sandy Loam, Cool, 0 to 2 Percent Slopes
- 174 - Wasco Sandy Loam, Cool, 2 to 5 Percent Slopes
- 175 - Wrightwood-Bull Trail Association, Sloping
- 177 - Yermo-Kimberlina, Cool, Association, Sloping
- s1007 - Nebona-Mirage-Joshua-Cajon
- s1024 - Wasco-Rosamond-Cajon
- s1038 - Playas
- s1127 - Upspring-Sparkhule-Rock outcrop
- s1134 - Trigger-Rock outcrop-Calvista
- s1137 - Rositas-Carrizo
- s1142 - Nickel-Bitter-Arizo

Soils Legend

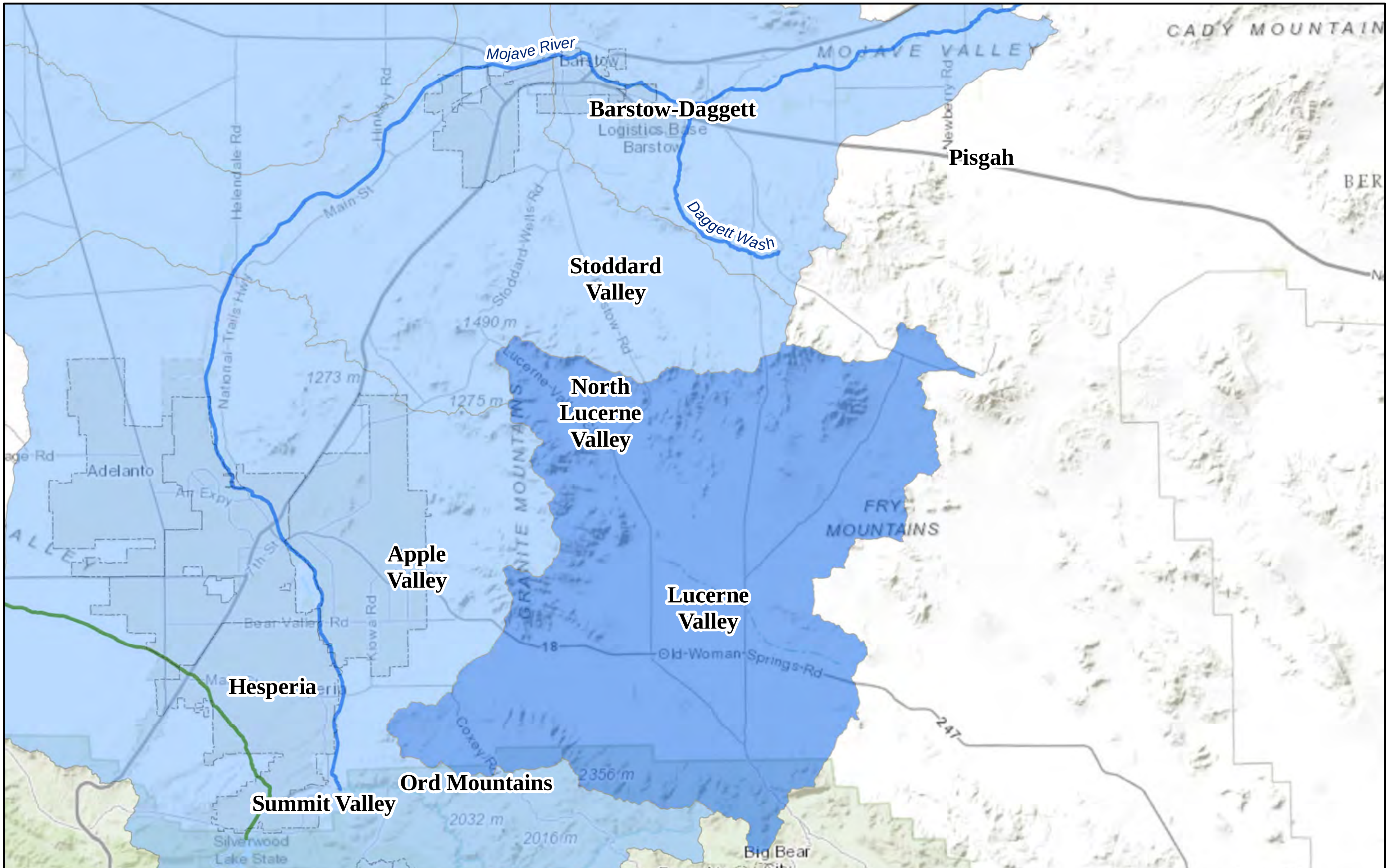
Figure 2.3-3b



City Boundaries

Regional Faults

Figure 2.3-4

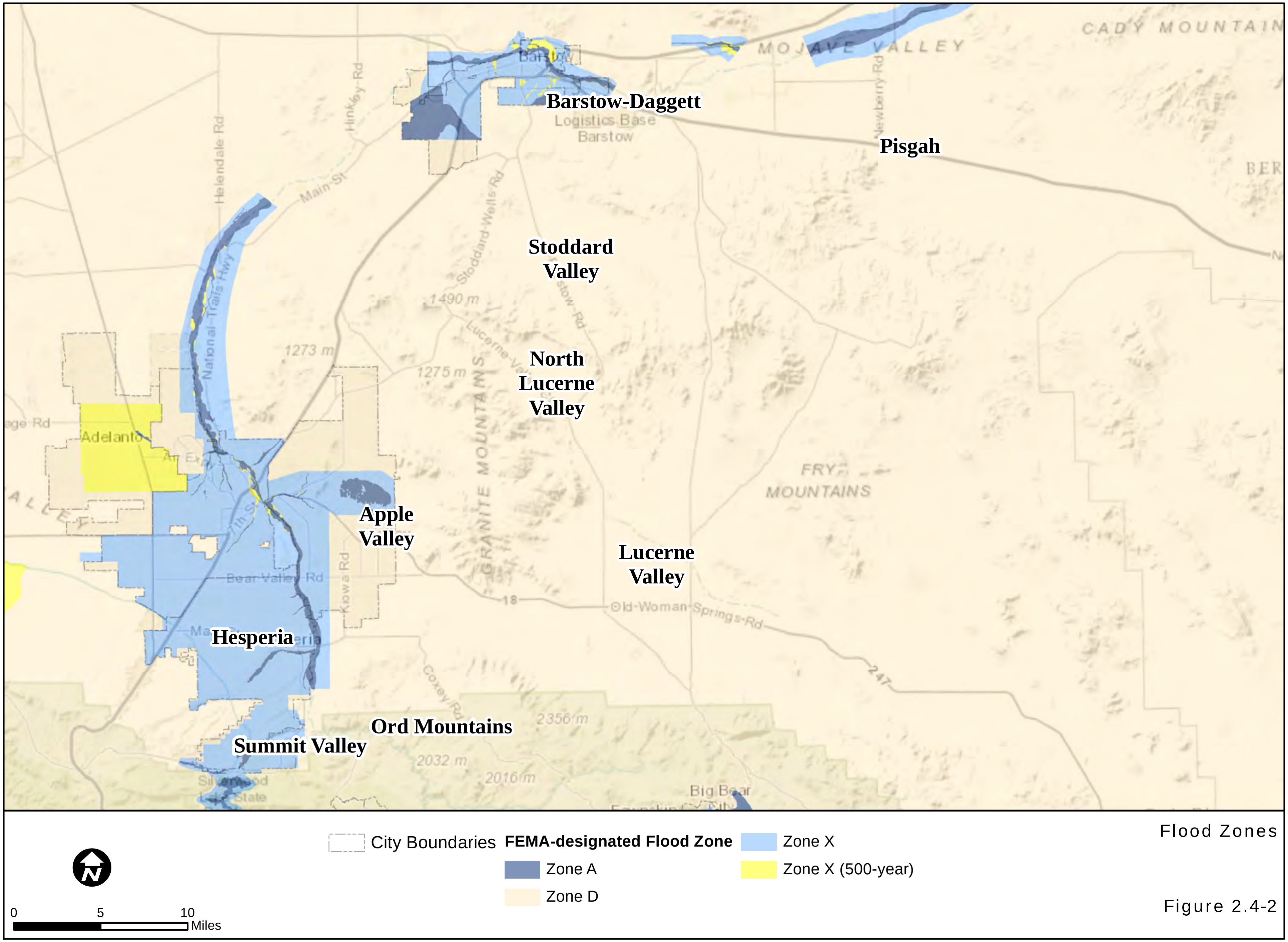


City Boundaries
Major River
California Aqueduct
Basins
Lucerne Lake
Mojave

0 5 10 Miles

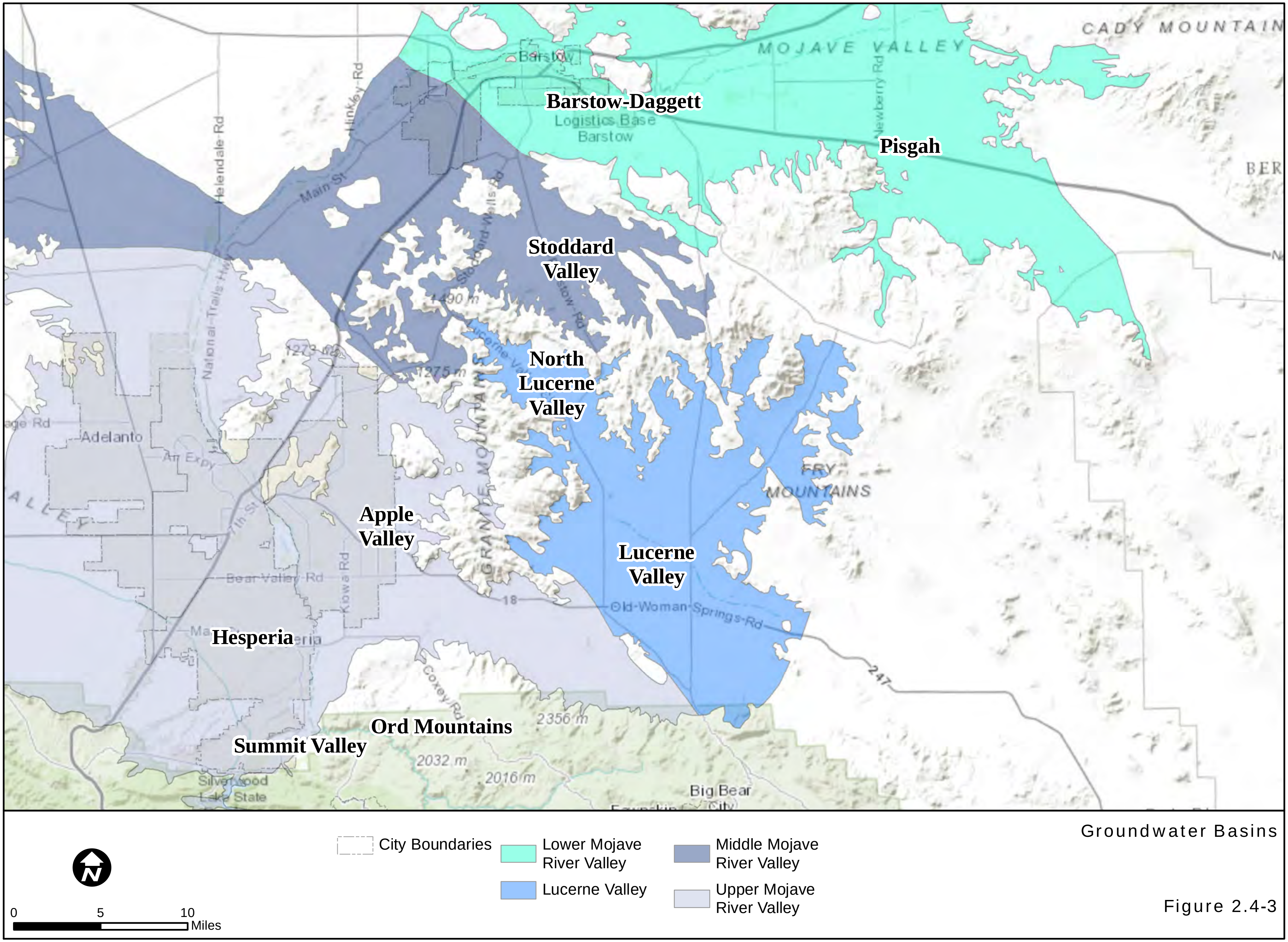
Surface Water

Figure 2.4-1



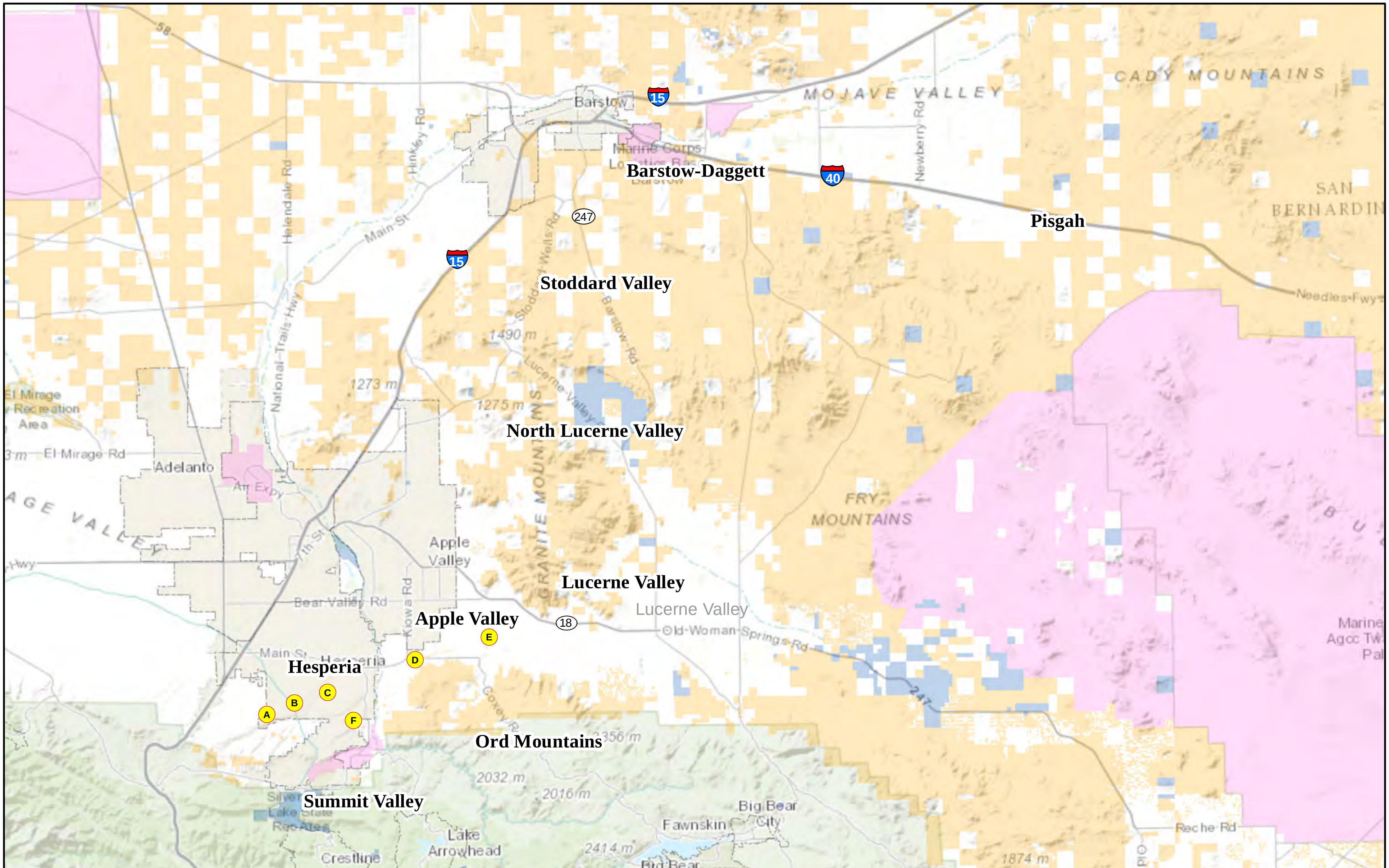
Flood Zones

Figure 2.4-2



Groundwater Basins

Figure 2.4-3



Noise Measurement Location

City Boundaries

Land Ownership

Bureau of Land Management

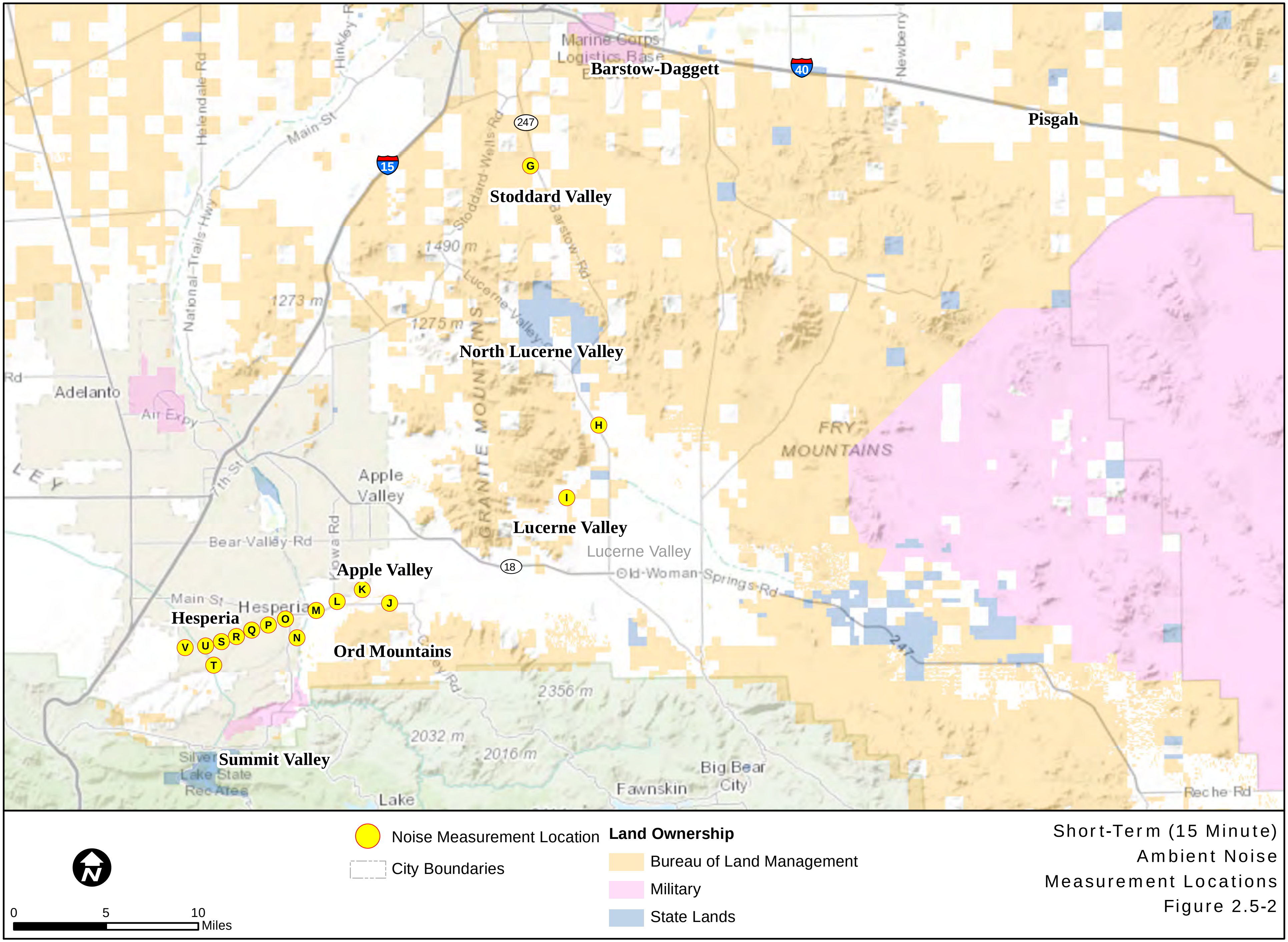
Military

State Lands

0 5 10 Miles

Long-Term (24 Hour) Ambient Noise Measurement Locations

Figure 2.5-1



Short-Term (15 Minute) Ambient Noise Measurement Locations
Figure 2.5-2