2.4 Geology and Soils

This section discusses the existing geology and soils in Imperial County. The regulatory environment and existing conditions have been assessed and analyzed to determine associated constraints and opportunities for updating the COSE for the County.

2.4.1 Terminology

The following is a summary of geology and soils terminology discussed in this section.

- **Corrosive Soils** – Soil corrosion is a complex phenomenon. Chemical reactions between existing elements take place in soils, many of which are not fully understood. The relative importance of variables changes for different materials, making a universal guide to corrosion impossible.
- **Expansive Soils** – Composed of a significant amount of clay particles, which can expand (absorb water) or contract (release water). These shrink and swell characteristics can result in structural stress and place other loads on these soils. Expansive soils are often associated with geological units having marginal stability and can occur in low-lying alluvial basins and along hillsides.
- **Facies** – A distinctive rock feature with specific characteristics that form under certain conditions of sedimentation.
- **Fault Rupture** – The California Geological Survey places active faults with surface expression in a zone referred to as an Alquist-Priolo Earthquake Fault Zone. Earthquake Fault Zones are regulatory zones around active faults. These zones are defined by turning points connected by straight lines. The delineation of the Earthquake Fault Zones is intended to prohibit construction of new habitable structures near or on active faults in California for the purpose of protecting human health and safety.
- **Ground Lurching** – Typically results where loose to poorly consolidated soil deposits on or adjacent to steep slopes move laterally as the result of strong ground shaking during a seismic event. Areas that are underlain by steep contacts of dissimilar bearing materials at depth, such as compacted fill caps that have been placed over a transition from bedrock to Holocene age alluvium, are also subject to lurching.
- **Landslides** – Large movements of the underlying ground that include rock falls, shallow slumping and sliding of soil, and deep rotational or transitional movement of soil or rock.
- **Imperial Fault Zone** – A right lateral-moving strike-slip fault, representing the northernmost fault associated with the East Pacific Rise. The Imperial Fault Zone is connected to the San Andreas Fault Zone.
- **Lateral Spreading** – Caused by the lateral displacement of surficial blocks of sediment as a result of liquefaction in subsurface layers. Lateral spreading is associated with areas prone to liquefaction.
- **Liquefaction** – Seismic ground shaking of relatively loose, granular soils that are saturated or submerged can cause underlying soils to liquefy and temporarily behave as a dense fluid. For liquefaction to occur, intense seismic shaking, the presence of loose granular soils prone to liquefaction, and the saturation of soils due to shallow groundwater need to occur simultaneously.
- **San Andreas Fault Zone** – Because of its relatively frequent, large earthquakes, the San Andreas Fault is considered the Master Fault, controlling the seismic hazard in Southern California. In the vicinity of Imperial County, the San Andreas Fault Zone comprises three segments.

- **Seismically Induced Ground Settlement** – Ground shaking can result in ground settlement as sediment particles become more tightly packed, thereby reducing pore space. Such unconsolidated, loosely packed alluvial deposits are especially susceptible to seismically induced ground shaking. In addition, artificial fills are especially susceptible to seismically induced ground shaking. Artificial fills that are poorly compacted may also be subject to seismically induced settlement.
- **Subsidence** – The overdrafting of aquifers is the major cause of subsidence in the southwestern United States, and as groundwater pumping increases, land subsidence also will increase. In many aquifers, groundwater is pumped from pore spaces between grains of sand and gravel. If an aquifer has beds of clay or silt in or next to it, the lowered water pressure in the sand and gravel causes slow drainage of water from the clay and silt beds. The reduced water pressure is a loss of support for the clay and silt beds. Because these beds are compressible, they compact (become thinner), and the effects are seen as lowering of the land surface. The lowering of land surface elevation from this process is permanent.

2.4.2 Regulatory Environment

The following is a list of laws, policies, and plans relevant to geology and soils.

Federal

- Earthquake Hazards Reduction Act (1977)

State

- Alquist-Priolo Earthquake Fault Zoning Act (1972)
- Natural Hazards Disclosure Act (1998)
- Seismic Hazards Mapping Act (1990)

Local

- Imperial County General Plan

2.4.3 Existing Conditions

Imperial County lies within the Imperial Valley, a lowland region in southeastern California. Elevations in the County range from 235 feet below sea level at the surface of the Salton Sea to 4,548 above mean sea level at Blue Angel Peak (County of Imperial 2013). On average the elevation range in Imperial County is between 1,000 to 2,000 feet above mean sea level.

Imperial County is underlain by three natural geomorphic provinces: the Peninsular Ranges, the Colorado Desert, and the Mojave Desert. Each of these provinces is a naturally defined geologic region that displays a distinct landscape or landform with defining features based on geology, faults, topographic relief, and climate. The Peninsular Ranges geomorphic province occupies the southwestern portion of the County and is composed of a series of ranges separated by northwest-trending valleys. The geology of the Peninsular Ranges province is similar to the Sierra Nevada, with granitic rock intruding into the older metamorphic rocks. The Colorado Desert geomorphic province spans the majority of central Imperial County and is dominated by the Salton Sea and the Imperial Valley; the province is composed of a low-lying barren desert basin situated between alluvium-covered, active branches of the San Andreas Fault. The Mojave Desert geomorphic province occupies the north-central and northeastern portions of the County. The Mojave is a broad, arid region that contains isolated mountain ranges separated by desert plains (CGS 2014b).

Mexico lies to the south of the County; the County of San Diego lies to the west; the County of Yuma, Arizona, lies to the east; and the County of Riverside lies to the north. Most of the central part of the Imperial Valley drains northwest from Mexico to the Salton Sea. To the west of the County lie the Laguna Mountains, the San Felipe Hills, and the Vallecito Mountains. The Chuckwalla Mountains border the County on the north, and the Trigo Mountains and the Colorado River border the County on the east.

The western portion of the County contains the Fish Creek Mountains, the Superstition Hills, the Superstition Mountains, and the Yuha Buttes. The southeastern portion of the County contains the Algodones Dunes, a belt of sand dunes approximately 6 miles wide by 45 miles long that runs northwest to southeast. The northeastern portion of County includes several mountain ranges, including the Palo Verde Mountains and a northwest-by-southeast-trending mountain range known as the Chocolate Mountains, a low-level mountain chain that includes pre-Tertiary plutonic and metamorphic rocks. The mountain range generally reaches 2,500 feet in elevation. Four low volcanic hills rise 100 feet above the lakebed along the southeast edge of the Salton Sea.

Soils

Soils in Imperial County are formed by stratified alluvial deposits. A large portion of the County includes fine-textured lakebed sediments. Approximately 28 known soil types occur in Imperial County: Aco, Antho, Carrizo, Carsitas, Chuckwalla, Cibola, Coachella, Fluvaquents, Gadsden, Gilman, Glenbar, Holtville, Imperial, Indio, Kofa, Lagunita, Laposa, Laveen, Mecca, Meloland, Niland, Orita, Ripley, Rositas, Salorthids, Superstition, Torriorthents, and Vint. Figure 2.4-1 provides an overview of soil types found in the County (all figures are provided at the end of this subsection). Parent material includes Glenbar, Holtville, and Imperial soils. Indio, Vint, Meloland, and Rositas soils are derived from windblown and channel silts. Rositas and Carsitas soils were formed in beach deposits. Sand and gravelly fan materials are the parent materials of Carsitas and Rositas soils.

The clay material deposited in riverine environments during the formation of the Colorado River delta terrace is the source of the Holtville and Imperial soils. Niland soils occur in clayey lakebed. Several large gullies have formed from runoff water leading into the Salton Sea. The Antho, Laveen, Niland, and Superstition soils were formed from fan sediment. Fine-textured basin deposits provide the source material for Glenbar, Holtville, and Imperial soils.

Geology

The Imperial Formation is a geologic area that occurs in Imperial County and is exposed in the southeast Coyote Mountains on three major facies. Facies A includes shoreline deposits associated with alluvial fans. Facies B includes supratidal gypsum to low-tide terraces. Facies C includes siltstones and clays, indicating a filling of the Salton Trough by fine clastic material from the Colorado River. Figure 2.4-2 shows the geology of Imperial County.

Rock units in Imperial County can be described as Precambrian and placed into two groups, the Chuckwalla complex and the Orocopia Schist. The rocks in the Chuckwalla complex include quartz biotite gneiss and various foliated hybrid granitic rocks and granophyres that range in composition from gabbro to granite. Rocks in the Orocopia Schist include weatherized mica-covered surfaces. The rock units are sericite-albite schist, quartz sericite schist, phyllite, and quartzite. Marble occurs in the schist in the Orocopia Mountains. Rock types or geological material known to occur in Imperial County include alluvium, andesite, basalt, conglomerate, dune sand, gneiss, granodiorite, limestone, mica schist, plutonic rock, rhyolite, sandstone, schist, and tonalite.

Geologic Activity

Existing conditions for geologic activity in Imperial County include earthquakes, the principal geologic activity affecting public safety in the County. An earthquake is a triggering event that permits the force of gravity to operate and creates many secondary hazards from ground shaking, including (1) differential ground settlement, soil liquefaction, rock and mudslides, ground lurching, and avalanches; (2) ground displacement along the fault; (3) floods from dam and levee failure and seiches; (4) fires; and (5) the various adverse results of disruption of essential facilities and systems—water, sewer, gas, electricity, transportation, and communication (and notably in the Imperial Valley, the irrigation and drainage system). Active faults are defined as historic faults (displacement in the last 200 years) and Holocene faults (displacement in the last 11,700 years). Imperial County contains several major active faults, including the Brawley Fault Zone, the Coyote Creek Fault and the Elmore Ranch Fault (in the San Jacinto Fault Zone), the Elsinore Fault, the Imperial Fault, the Laguna Salada Fault (in the Elsinore Fault Zone), the San Andreas Fault, the Superstition Hills Fault, and the Wienert Fault (in the San Jacinto Fault Zone). Figure 2.4-3 shows the major faults and seismic hazard ratings in Imperial County. There are no mapped areas of landslide or liquefaction zones in the County (CGS 2014b).

2.4.4 Constraints and Opportunities

This section discusses the potential constraints due to geology and soils regulatory requirements and existing conditions and potential opportunities for the COSE.

2.4.4.1 Constraints Due to Regulatory Requirements

There are no regulatory requirements related to geology and soils that would directly constrain the designation of open space in the COSE. However, regulations concerning the conservation of prime agricultural soils, such as the California Land Conservation Act of 1965 (also known as the Williamson Act), seek to prevent incompatible development on important agricultural soils. The County of Imperial is ending the Williamson Act Program in 2018. Conservation of open space would not strictly conflict with the conservation of important agricultural soils.

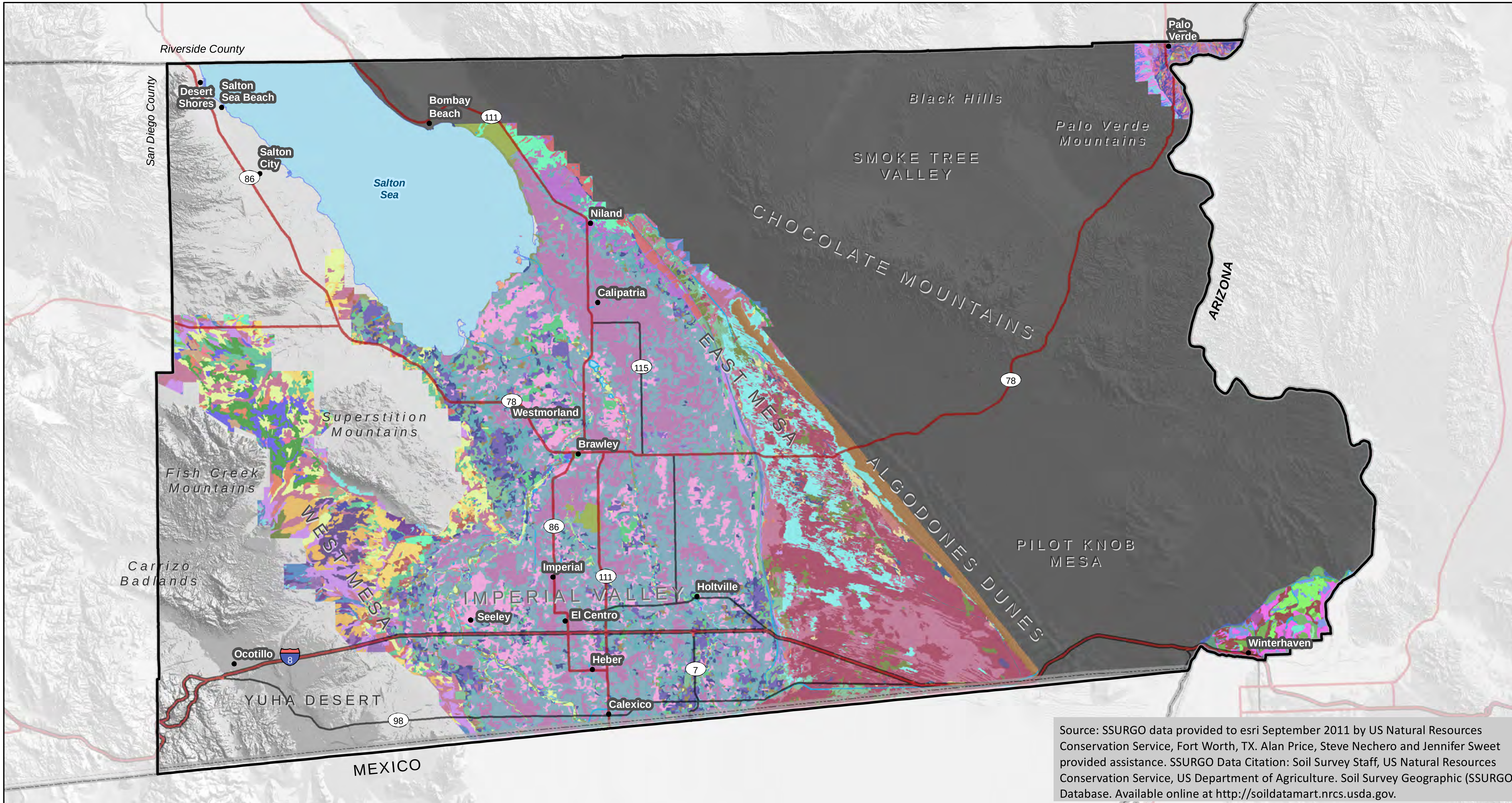
2.4.4.2 Constraints Due to Existing Conditions

No geologic or soil conditions would constrain the conservation of open space in the COSE. However, the Imperial Valley, south of the Salton Sea, contains important agricultural soils that are extensively developed for agriculture. Although these soils are generally reserved for agriculture and protected from incompatible land uses (such as residential and urban development), the agricultural use of this land may not be compatible with all of the anticipated uses and benefits of open space conservation. Furthermore, the Imperial Valley contains active geothermal areas. The All American Canal from the Colorado River provides hydroelectric power. In previous years, steam wells have been drilled to provide output of steam generation. Due to these natural resources and the County's goals and objectives for economic growth, such areas provide constraints for assigning conservation areas and the preservation of open space.

2.4.4.3 Opportunities

Opportunities are lands in the County's jurisdiction that would provide new protection for geology and soils or expand existing conservation areas to further benefit the protection and preservation of geology and soils. Areas of opportunity for the COSE include areas of unique geologic formations, particularly inholdings under County jurisdiction that fall within areas of federal or state land containing unique geologic formations, such as County inholdings on BLM land in the Algodones Dunes, the Imperial Sand Dunes, and the Shell Beds in the Yuha Basin. The Salton Buttes in the Salton Sea Geothermal Field are also a unique geologic formation that would benefit from open space conservation of surrounding lands.

Additional opportunities for conservation of open space include lands in the County's jurisdiction that include or are near to Earthquake Fault Zones, such as the Imperial Fault Zone and the San Andreas Fault Zone. Seismic hazards in Imperial County are shown on Figure 2.4-3. Areas that are prone to seismic hazards such as strong ground shaking and fault rupture should also be avoided for residential and urban development. Additionally, areas within Imperial County prone to lateral spreading, liquefaction, and subsidence would be suitable for open space designation. These areas represent priority conservation opportunities for open space.



Source: SSURGO data provided to esri September 2011 by US Natural Resources Conservation Service, Fort Worth, TX. Alan Price, Steve Nechero and Jennifer Sweet provided assistance. SSURGO Data Citation: Soil Survey Staff, US Natural Resources Conservation Service, US Department of Agriculture. Soil Survey Geographic (SSURGO) Database. Available online at http://soildatamart.nrcs.usda.gov.

N

0 7.5 15 Miles

Major Highways
Highways
Major Roads
Imperial County Boundary

* Please see Figure 2.4-1a for Soils Legend

Figure 2.4-1

Imperial County General Soils

General Soils Map Legend

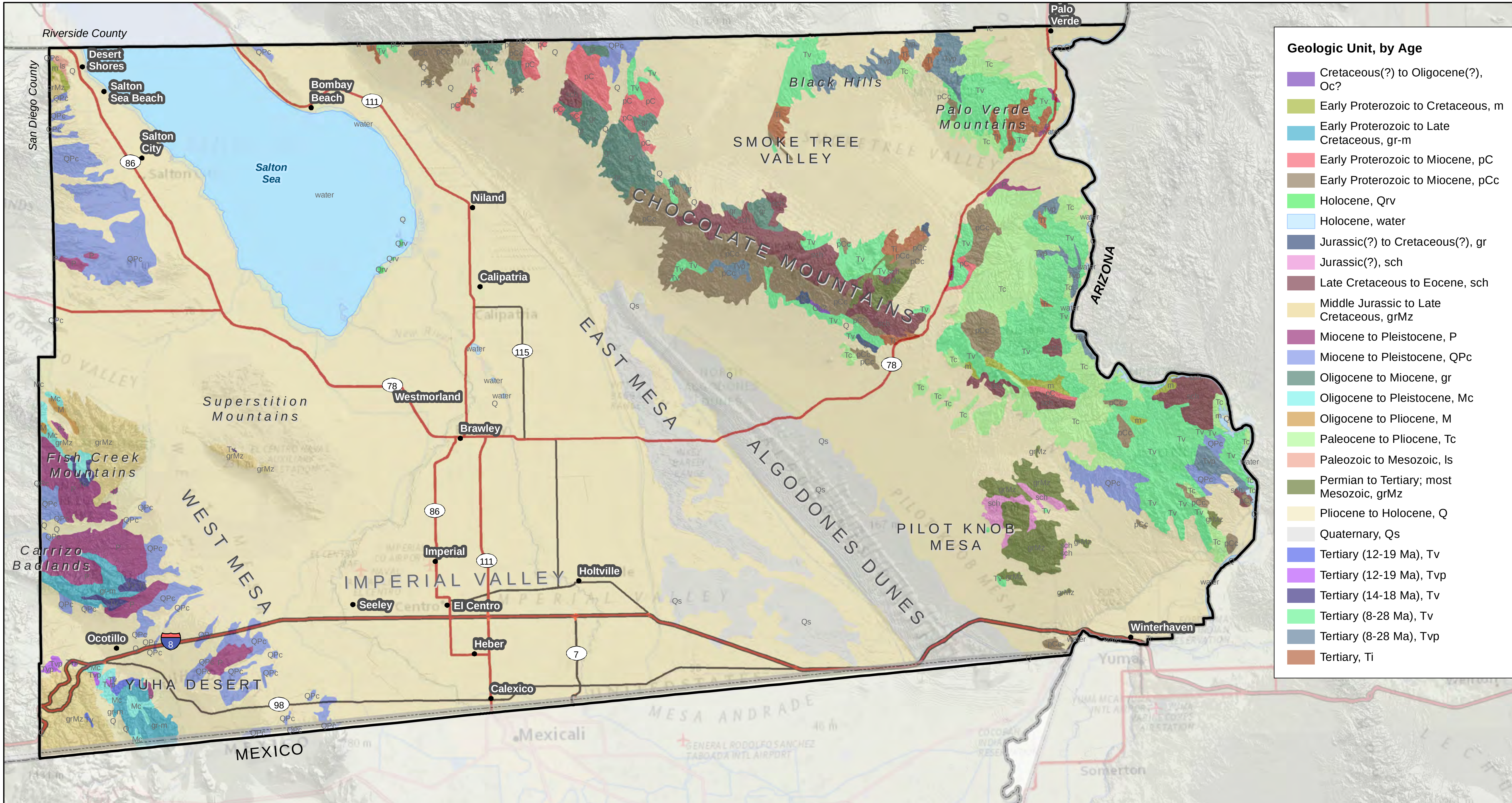
Map Unit Name

- Aco Sandy Loam
- Antho Loamy Fine Sand
- Antho-Superstition Complex
- Badland
- Borrow Pits
- Carrizo Gravelly Sand
- Carrizo Very Gravelly Sand, 0 To 9 Percent Slopes
- Carsitas Cobbly Sand, 2 To 9 Percent Slopes
- Carsitas Gravelly Sand, 0 To 5 Percent Slopes
- Carsitas Gravelly Sand, 0 To 9 Percent Slopes
- Chuckawalla Very Gravelly Silt Loam
- Cibola Fine Sandy Loam
- Cibola Silty Clay Loam
- Coachella Fine Sand, Wet, 0 To 2 Percent Slopes
- Dam
- Duneland
- Fluvaquents, Saline
- Gadsden Clay
- Gilman Fine Sandy Loam
- Gilman Fine Sandy Loam, Wet, 0 To 2 Percent Slopes
- Gilman Silty Clay Loam
- Glenbar Clay Loam
- Glenbar Clay Loam, Wet
- Glenbar Complex
- Glenbar Silty Clay Loam
- Holtville Clay
- Holtville Fine Sandy Loam
- Holtville Loam
- Holtville Silty Clay
- Holtville Silty Clay, Wet
- Holtville-Imperial Silty Clay Loams
- Imperial Fine Sandy Loam
- Imperial Silty Clay
- Imperial Silty Clay, Saline
- Imperial Silty Clay, Wet
- Imperial-Glenbar Silty Clay Loams, 2 To 5 Percent Slope S
- Imperial-Glenbar Silty Clay Loams, Wet, 0 To 2 Percent Slopes
- Indio Fine Sandy Loam, Wet
- Indio Loam
- Indio Loam, Wet
- Indio Silt Loam
- Indio Silt Loam, Saline
- Indio Silt Loam, Saline, 0 To 2 Percent Slopes
- Indio Silt Loam, Strongly Saline
- Indio Silty Clay Loam
- Indio Very Fine Sandy Loam
- Indio-Lagunita-Ripley Complex
- Indio-Vint Complex
- Kofa Clay
- Lagunita Loamy Sand
- Lagunita Silt Loam
- Laposa-Rock Outcrop Complex, 15 To 75 Percent Slopes
- Laveen Loam
- Mapping Not Complete
- Mecca Coarse Sandy Loam, 0 To 2 Percent Slopes
- Meloland And Holtville Loams,
- Meloland Fine Sand
- Meloland Fine Sandy Loam
- Meloland Silty Clay Laom
- Meloland Very Fine Sandy Loam, Wet
- Miscellaneous Water
- Niland Fine Sand
- Niland Gravelly Sand
- Niland Gravelly Sand, Wet
- Niland Loamy Fine Sand
- Niland-Imperial Complex, Wet
- Orita Gravelly Fine Sandy Loam
- Pits
- Ripley Silt Loam
- Ripley Silty Clay Loam
- Ripley Very Fine Sandy Loam
- Riverwash
- Rositas Fine Sand, 0 To 2 Percent Slopes
- Rositas Fine Sand, 2 To 9 Percent Slopes
- Rositas Fine Sand, 9 To 30 Percent Slopes
- Rositas Fine Sand, Wet, 0 To 2 Percent Slopes
- Rositas Loamy Coarse Sand, 0 To 2 Percent Slopes
- Rositas Loamy Coarse Sand, 2 To 9 Percent Slopes
- Rositas Loamy Fine Sand, 0 To 2 Percent Slopes
- Rositas Sand
- Rositas Sand, 0 To 2 Percent Slopes
- Rositas Sand, 2 To 5 Percent Slopes
- Rositas Silt Loam, 0 To 2 Percent Slopes
- Rositas Silty Clay Loam, 0 To 2 Percent Slopes
- Rositas-Superstition Loamy Fine Sands
- Salorthids, Nearly Level
- Sloping Gullied Land
- Superstition Loamy Fine Sand
- Torriorthents And Orthids, 5 To 30 Percent Slopes
- Torriorthents-Rock Outcrop Complex, 5 To 60 Percent Slo Pes
- Torriorthents-Torrifluvents Complex, 1 To 50 Percent Slopes
- Vint And Indio Very Fine Sandy Loams,
- Vint Fine Sandy Loam
- Vint Loamy Very Fine Sand, Wet
- Water

Figure 2.4-1a

Imperial County
General Soils Legend

* Please see Figure 2.4-1 for Soils Map



Major Highways

Highways

Major Roads

Imperial County Boundary

0 7.5 15 Miles

Source: U.S. Geological Survey, Arizona Geological Survey

Figure 2.4-2

Imperial County Geology

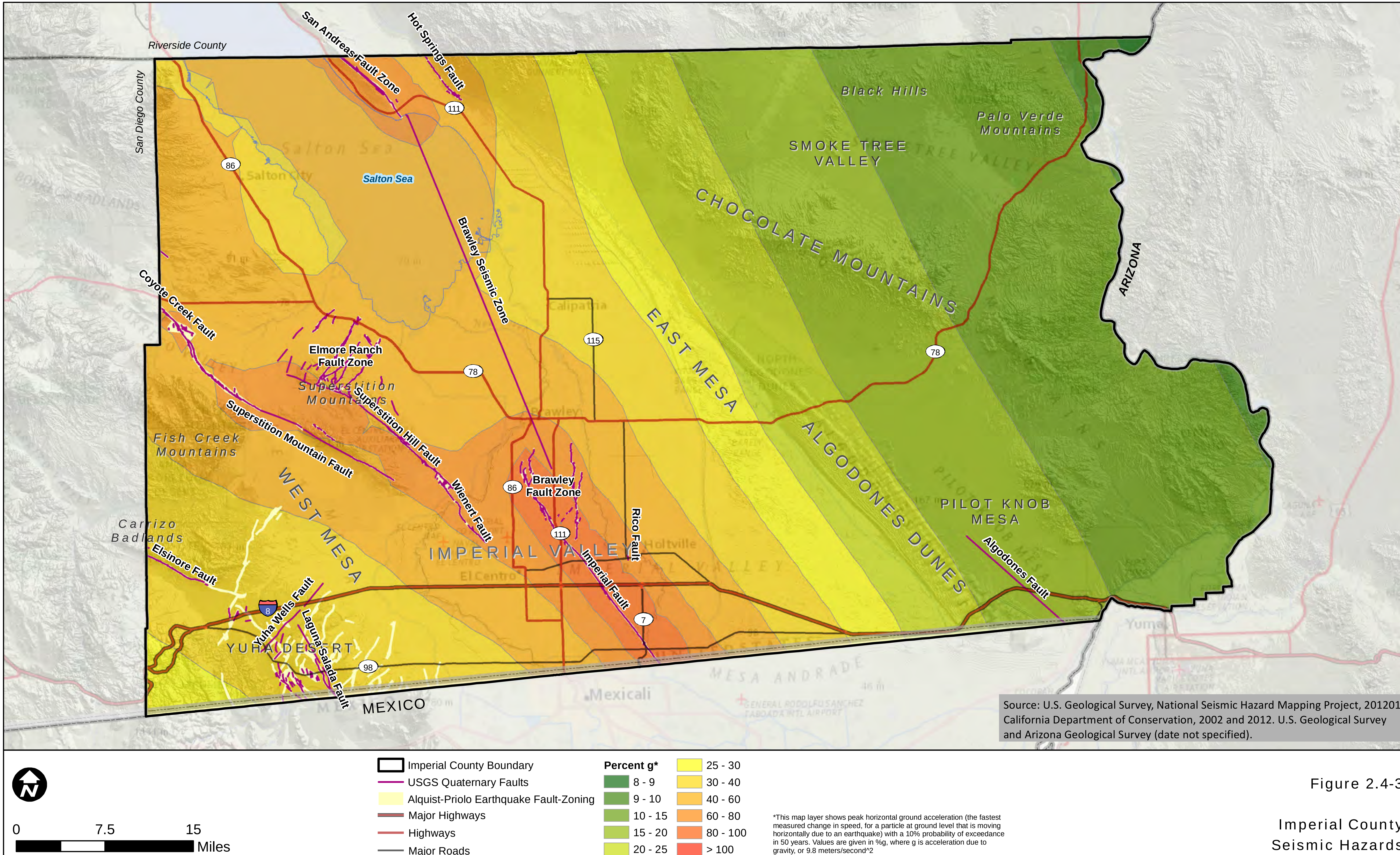


Figure 2.4-3

Imperial County Seismic Hazards