

4.7 GEOLOGY, SOILS, AND PALEONTOLOGICAL RESOURCES

This section evaluates the geology, soils, and paleontological resources impacts of the proposed Plan.

4.7.1 EXISTING CONDITIONS

GEOLOGY AND SOILS

Geologic Conditions

The San Diego region lies across two California geomorphic provinces: (1) the Peninsular Ranges and (2) the Colorado Desert, which contains the Salton Trough. The majority of the region is in the Peninsular Ranges. The Peninsular Ranges encompass an area that roughly extends from the Transverse Ranges and the Los Angeles Basin, south to the Mexican border, and another approximately 800 miles to the tip of Baja California where it makes up the Baja California Peninsula (Harden 1998). Extending east of Julian and Jacumba, the Peninsular Ranges province abruptly ends along a series of faults. The geomorphic province varies in width from approximately 30 to 100 miles in the San Diego region, most of which is characterized by northwest-trending mountain ranges separated by subparallel fault zones. In general, the Peninsular Ranges are underlain by Jurassic-age metavolcanic and metasedimentary rocks and by Cretaceous-age igneous rocks of the southern California batholith. Geologic cover over the basement rocks in the westernmost portion of the province in the San Diego region generally consists of Upper Cretaceous-, Tertiary-, and Quaternary-age sedimentary rocks. (Figure 4.7-1)

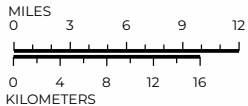
Structurally, the Peninsular Ranges are traversed by several major active faults. The Elsinore, San Jacinto, and San Andreas faults are major active fault systems located northeast of metropolitan San Diego, and the Rose Canyon, San Diego Trough, Coronado Bank, and San Clemente faults are major active faults located within or west-southwest of metropolitan San Diego. Major tectonic activity associated with these and other faults within this regional tectonic framework is generally right-lateral strike-slip movement. The area to the east of the faults is known as the Salton Trough–Gulf of California depression, which formed during the separation of Baja California from the Mexico mainland. The Salton Trough, being lower than the surrounding landscape, became an area of deposition with sediments being carried to the depressed area by drainages of the peninsular ranges and the Colorado River. Occasionally, the Salton Trough was inundated with marine waters from the Gulf of California, adding marine deposits to the sediment (Peterson 1977), and has been repeatedly filled by floods from the Colorado River.

The coastal plain province extends from the western edge of the Peninsular Ranges to the coastline. The coastal plain ranges in elevation from sea level to approximately 600 feet above mean sea level. Most of the incorporated cities in the San Diego region are in the coastal plain. The province is composed of dissected, mesa-like terraces that graduate inland into rolling hills. The terrain is underlain by sedimentary rocks composed mainly of Late Mesozoic, Tertiary, and Quaternary sandstone, shale, and conglomerate beds, reflecting the erosion mountain ranges to the east prior to the uplift of the Peninsular ranges (Figure 4.7-1) (Peterson 1977).

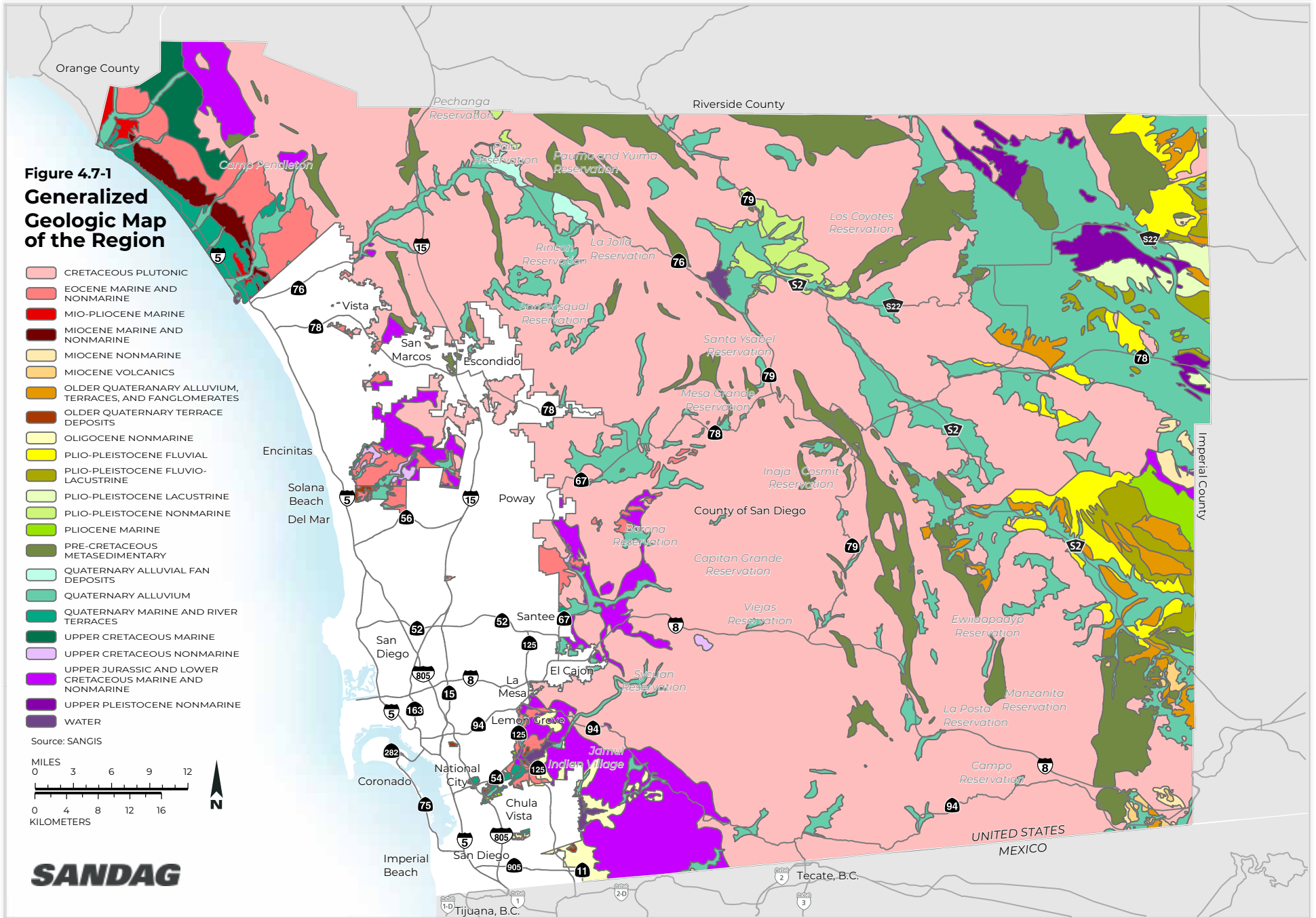
**Figure 4.7-1
Generalized
Geologic Map
of the Region**

- CRETACEOUS PLUTONIC
- EOCENE MARINE AND NONMARINE
- MIO-PLIOCENE MARINE
- MIOCENE MARINE AND NONMARINE
- MIOCENE NONMARINE
- MIOCENE VOLCANICS
- OLDER QUATERNARY ALLUVIUM, TERRACES, AND FANGLOMERATES
- OLDER QUATERNARY TERRACE DEPOSITS
- OLIGOCENE NONMARINE
- PLIO-PLIOCENE FLUVIAL
- PLIO-PLIOCENE FLUVIO-LACUSTRINE
- PLIO-PLIOCENE LACUSTRINE
- PLIO-PLIOCENE NONMARINE
- PLIOCENE MARINE
- PRE-CRETACEOUS METASEDIMENTARY
- QUATERNARY ALLUVIAL FAN DEPOSITS
- QUATERNARY ALLUVIUM
- QUATERNARY MARINE AND RIVER TERRACES
- UPPER CRETACEOUS MARINE
- UPPER CRETACEOUS NONMARINE
- UPPER JURASSIC AND LOWER CRETACEOUS MARINE AND NONMARINE
- UPPER PLEISTOCENE NONMARINE
- WATER

Source: SANGIS



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Seismic Setting

Primarily northwest-to-southeast trending faults traverse Southern California and mark the boundary between the North American and Pacific tectonic plates. The majority of the plate motion is taken up on the San Andreas fault zone. The remaining plate motion is taken up by subsidiary faults, many of which are located across the San Diego region and the nearshore Pacific Ocean. These faults have the potential for generating strong ground motions in the San Diego region. Most recorded earthquakes and fault ruptures in Southern California have occurred along faults associated with the San Andreas fault zone. The San Andreas fault zone and the associated faults that define the plate boundary are called the San Andreas fault system.

The entire San Andreas fault zone is more than 800 miles long. In detail, the fault is a complex zone of crushed and broken rock from a few hundred feet to a mile wide (USGS 2016). It is located to the east of the San Diego region, along the east side of the Coachella and Imperial valleys. Since high-magnitude shocks transmit energy over large areas, faults located outside of the San Diego region (such as the San Andreas) can cause ground shaking inside the region during earthquakes. The nearest inhabited sections of the San Diego region are approximately 30 miles from the San Andreas fault.







Known active faults and Alquist-Priolo special studies zones in the San Diego region are shown on Figure 4.7-2.¹ Earthquakes in the San Diego region occur when the plate motion causes the ground to move in opposite directions on either side of a fault deep in the earth. Most earthquakes in the San Diego region originate at least 10 miles below the ground surface. That movement creates shock waves that move through the ground causing it to shake. In general, the larger the earthquake the more intense the ground shaking and the more potential for damage. Because earthquake shaking decreases in intensity with distance from the epicenter of the earthquake, knowing the locations and seismic history of individual faults is important for designing earthquake resistant structures.

The San Jacinto fault is the largest of the active faults in San Diego region. The fault extends approximately 125 miles from Imperial Valley to San Bernardino (California Geologic Survey 2010). The Coyote Creek fault and Borrego Mountain faults in the northeastern San Diego region are segments of the San Jacinto fault. Historical activity associated with the San Jacinto fault occurred in 1890, 1899, 1968, and 1979 (Rasmussen 1982). The 1968 quake had a recorded magnitude of 6.8 and was centered near Ocotillo Wells (Figure 4.7-2).

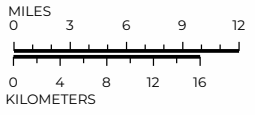
The Elsinore fault represents a serious earthquake hazard for most of the populated areas of the San Diego region. This fault is approximately 135 miles long and is located about 40 miles from downtown San Diego. This fault can register large earthquakes between magnitude 6.9 to 7.0 with a recurrence interval of approximately 100 years (Figure 4.7-2) (City of San Diego 2007).

¹ Note that the California Geological Survey is in the process of updating fault zones in the region, with an anticipated completion later this year in 2021. If the information becomes available prior to certification of the Final EIR then the data will be updated in this document. officially finalized updates to the fault zone maps for the region on September 23, 2021.

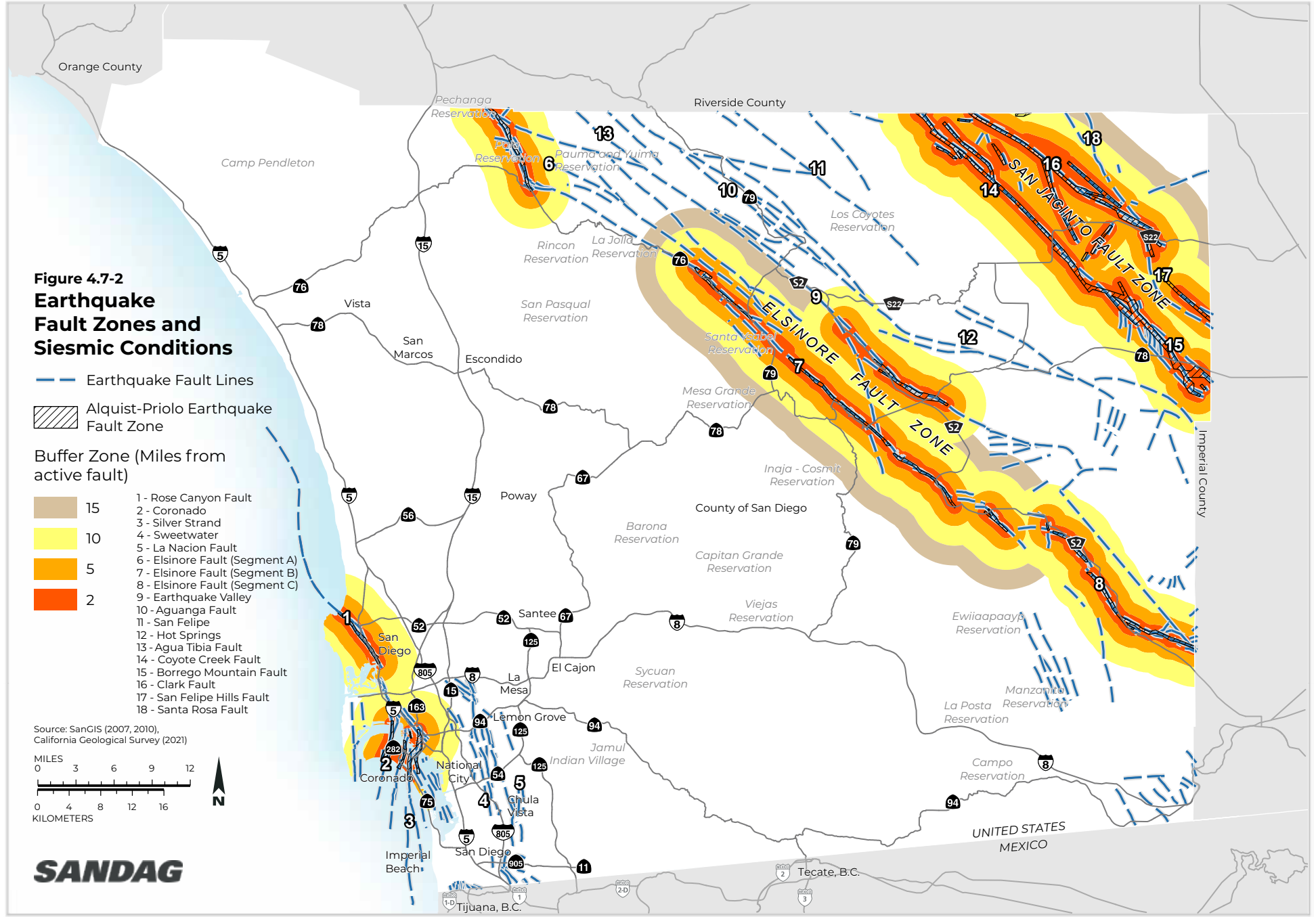
**Figure 4.7-2
Earthquake
Fault Zones and
Siesmic Conditions**

-  Earthquake Fault Lines
 -  Alquist-Priolo Earthquake Fault Zone
 - Buffer Zone (Miles from active fault)
 -  15
 -  10
 -  5
 -  2
- 1 - Rose Canyon Fault
 - 2 - Coronado
 - 3 - Silver Strand
 - 4 - Sweetwater
 - 5 - La Nacion Fault
 - 6 - Elsinore Fault (Segment A)
 - 7 - Elsinore Fault (Segment B)
 - 8 - Elsinore Fault (Segment C)
 - 9 - Earthquake Valley
 - 10 - Aguanga Fault
 - 11 - San Felipe
 - 12 - Hot Springs
 - 13 - Agua Tibia Fault
 - 14 - Coyote Creek Fault
 - 15 - Borrego Mountain Fault
 - 16 - Clark Fault
 - 17 - San Felipe Hills Fault
 - 18 - Santa Rosa Fault

Source: SanGIS (2007, 2010),
California Geological Survey (2021)



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The Rose Canyon fault zone is an active offshore/onshore fault capable of generating an earthquake of magnitude 6.2 to 7.0. The fault zone lies partially offshore as part of the Newport/Inglewood fault zone and parallels the northern coastline of the San Diego region at a distance of approximately 2 to 6 miles until coming ashore near La Jolla Shores. The onshore segment trends through Rose Canyon and Old Town San Diego and separates into at least three active faults beneath the San Diego Airport, San Diego Bay, Coronado, and North Island faults. The fault zone is composed of individual mappable fault segments, including the Rose Canyon, San Diego, Downtown San Diego Graben, Silver Strand, Coronado and Spanish Bight faults (Figure 4.7-2) (Treiman 1993).

The major offshore fault zones are the San Clemente, San Diego Trough, and Coronado Bank. The San Clemente fault zone, located approximately 40 miles off La Jolla, is the largest offshore fault (Figure 4.7.2). Tsunamis are a potential hazard associated with seismic setting and fault zones, and are described in Section 4.10, *Hydrology and Water Quality*.

Fault Rupture

If an earthquake is large enough, the motion on the fault can propagate up to the ground surface. Fault rupture is defined as the breakage of ground along the fault at the intersection of the fault with the Earth's surface. Earthquakes can cause large vertical and/or horizontal displacement of the ground along the fault. Ground rupture can severely damage structures straddling active faults by rupturing foundations or by tilting foundation slabs and walls, as well as damage buried and above ground utilities. Drinking water can be lost, and the loss of water lines or water pressure can affect emergency services, including firefighting ability. Research of historical earthquakes has shown that, although only a few structures have been ripped apart by fault rupture, this hazard can produce severe damage to structures built across active fault lines (Figure 4.7-2) (California Geological Survey 2018).

Ground Shaking

Ground shaking produces the vast majority of damage in an earthquake. Several factors control how ground motion interacts with structures, making the hazard of ground shaking difficult to predict. Seismic waves propagating through the Earth's crust are responsible for the ground vibrations normally felt during an earthquake. Seismic waves can vibrate in any direction, and at different frequencies, depending on the content of the earthquake rupture mechanism and the path and material through which the waves are propagating. The earthquake rupture mechanism is the distance from the earthquake source, or epicenter, to an affected site. The potential damage to public and private buildings and infrastructure from seismic ground shaking can threaten public safety and result in significant economic loss.

Slope Failure/Landslides

Slope failure, also referred to as mass wasting, is the downslope movement of soil and rock material in response to gravitational stresses. Landslides are the most common naturally occurring type of slope failure in the San Diego region. The term *landslide* describes a wide variety of processes that result in the downward and outward movement of slope-forming materials. Landslides are categorized by the type of material (rock or soil), and landslide movement is categorized by the type of movement (falls, topples, slides, or flows). Earthquakes can intensify or activate an unstable slope. Loosely and weakly consolidated soils, steepened slopes caused by either human activities or natural causes, and saturated earth materials create a fragile situation easily affected by an earthquake. Landslides in the San Diego region generally occur in sedimentary rocks such as sandstone,

siltstone, mudstone, and claystone. Heavy rainfall can exacerbate conditions for landsliding. The most common landslides triggered by winter storms are debris flows (popularly called *mudslides*), which are shallow landslides of water-saturated soil and rock fragments that travel downslope rapidly as muddy slurries. The flowing mud carries rocks, vegetation, and other natural and human-made debris as it rushes down the slopes (USGS 2005).

Major landslides have occurred within the incorporated cities of the region that are located on hillside terrain or on coastal bluffs. Previous landslides and landslide-prone sedimentary formations are mostly located in the western portion of the region. Landslides have also occurred in the granitic terrain in the eastern portion of the San Diego region. Reactivations of existing landslides can be triggered by a variety of factors, such as heavy rainfall or irrigation, seismic shaking, and grading (Peterson 1977).

The California Department of Conservation (CDC) maps and describes landslide hazards in the region on two map sets containing eight mapped quadrangles each. The scale on the maps is used to designate susceptibility to slope hazards and includes four different levels (areas) (CDC 2018a):

- **Area 1 – Least Susceptible.** Landslides and other features related to slope instability are non-existent to very rare within this area primarily due to lack of steep slopes.
- **Area 2 – Marginally Susceptible.** Landslides and other slope failures are rare within this area although slope hazards are possible on steeper slopes within the area or along its borders.
- **Area 3 – Generally Susceptible.** This category contains two subareas. In Subarea 3-1, although most slopes herein do not contain landslide deposits, they can be expected to fail, locally, when adversely modified. In Subarea 3-2 slopes are less stable and more susceptible to landslide and slope failure.
- **Area 4 – Most Susceptible.** The area is characterized by unstable slopes and includes all landslides shown on the maps (whether active or not) and slopes where there is evidence of downslope creep of surface materials. These slopes are considered naturally unstable and subject to failure even in the absence of human activity. This category contains two subareas. Subarea 4-1 contains observable unstable slopes underlain by both weak materials and adverse geologic structure. Beach areas exposed to sea waves are not included as beach erosion is not considered a slope hazard. Subarea 4-2 includes definite landslides mapped by the CDC, and nearby unstable areas.

Areas in the region mapped as Area 4 include portions of the southeastern Imperial Beach Quadrangle, which align with southwest portions of the Otay Mesa Quadrangle. The southern tip of Point Loma, along the eastern side of the peninsula, is also an Area 4 region. Area 4 regions are throughout the La Jolla Quadrangle and the La Mesa Quadrangle, in various parts of the San Diego Metropolitan area, and throughout the Del Mar Quadrangle and the southern part of the Rancho Santa Fe Quadrangle. The Oceanside and San Luis Rey, Jamul Mountains, National City, El Cajon, Poway, Escondido, Encinitas, San Marcos, and Valley Center quadrangles are partially located within Area 4 in smaller concentrations compared to those listed above.

Areas prone to landslides are underlain by the Ardath Shale, Friars, Mission Valley, San Diego, and Otay rock formations. The Ardath Shale Formation extends from Torrey Pines State Park to Mission Bay and is composed of interbedded sandstone and weak claystone. The Friars Formation occurs from Mission Valley to Carmel Valley. The formation is composed of expandable clays with properties similar to those of bentonite. The Mission Valley Formation is found from Otay Valley to Rancho Bernardo and is composed of fine to medium grained sandstone with cobble, claystone, and expansive clays (Brown 2018). The San Diego Formation occurs throughout the coastal mesas from Mission Valley southward to the Mexican border. The Otay Formation is

found in the southwestern portion of the San Diego region and is composed of slide-resistant sandstone with occasional thin interbedding of bentonite clay (CDC 2018b).

Liquefaction

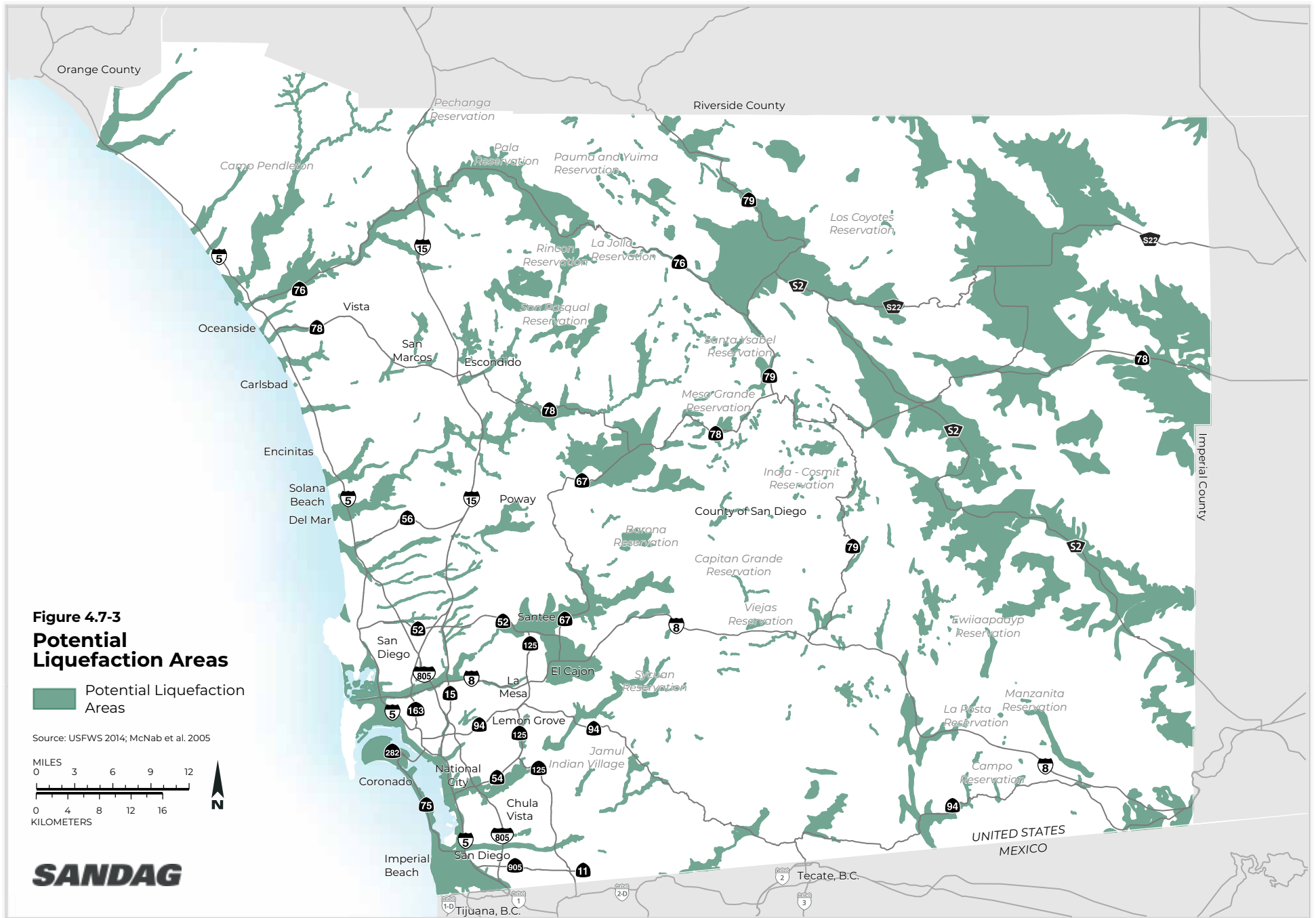
Liquefaction is a phenomenon whereby unconsolidated and/or near-saturated soils lose cohesion as a result of severe vibratory motion. The relatively rapid loss of soil shear strength during strong earthquake shaking results in temporary, fluid-like behavior of the soil. Soil liquefaction causes ground failure that can damage roads, pipelines, underground cables, and buildings with shallow foundations. Research and historical data indicate that loose granular soils and non-plastic silts that are saturated by a relatively shallow groundwater table are susceptible to liquefaction. Sites underlain by relatively loose sandy soils and saturated deposits of fill combined with a shallow groundwater table, which typically are located in alluvial river valleys/basins, floodplains, beach and bay shorelines, and hydraulic fills are susceptible to liquefaction. Large areas within the region known to be subject to liquefaction are, for the most part, found in the eastern parts of the region. However, liquefaction-prone areas are also associated with hydraulic fills along the shorelines of San Diego Bay, Mission Bay, and the estuaries along the San Diego coastline (Figure 4.7-3) (County of San Diego 2009a).

Expansive Soils

Expansive soils contain minerals such as smectite clays that are capable of absorbing water. When they absorb water, they increase in volume. The more water they absorb the more their volume increases; for example, an expansion of 10 percent is not uncommon. This change in volume can exert enough force on a building or other structure to cause damage.

Expansive soils will also shrink when they lose moisture or dry out. This shrinkage can remove support from structures and result in damage when structures are not designed to withstand changing soil pressures. Fissures in the soil can also develop. These fissures can facilitate dispersion of water when moist conditions or runoff occurs. This produces a cycle of shrinkage and swelling that places repetitive stress on structures. Expansive soils occur throughout the San Diego region. Areas with potential to have expansive soils within the region occur predominately in the coastal plains, an area of dissected marine terraces and uplands. They can also be found in valleys and on slopes in the foothills and mountains of the Peninsular Ranges province and, to a lesser extent, in the desert portions of the San Diego region (Peterson 1977).

Expansive soils primarily consist of clayey soils that have a potential for significant volume changes (shrinking and swelling) with moisture fluctuations. According to the National Geologic Map Database's Swelling Clays Map of the conterminous United States, coastal San Diego lies in an area described as "part of the unit, generally less than fifty percent, consists of clays of slight to moderate swelling potential." The remaining areas of the San Diego region are typically underlain by soils with little or no clays with swelling potential (Olive et al. 1989).



Erosion and Loss of Topsoil

Erosion is defined as a combination of processes in which the materials of the Earth's surface are loosened, dissolved, or worn away, and transported from one place to another by natural agents. Erosion potential in soils is influenced primarily by loose soil texture and steep slopes. Steep slopes and bluffs resulting from beach side erosion and wave action are found along the coastal cities in the northern part of the San Diego region, particularly in and near La Jolla Del Mar, Solana Beach, and Encinitas. (Kuhn, G. G., Shepard, F. P., 1984) Areas of potential slope failure or high erodibility are potentially hazardous. Loose soils and topsoil can be eroded by water or wind forces, whereas soils with high clay content are generally susceptible only to water erosion. The potential for erosion and loss of topsoil generally increases due to human activity, primarily through construction activities, the development of structures and impervious surfaces, and the removal of vegetative cover. (Brady and Weil 1999, United States Department of Agriculture 2000)

Erosion or loss of topsoil can cause loss of arable land, clogged and polluted waterways, and increased flooding. When topsoil is mobilized, or moved, it is put into the hydrological system as silt and eventually washes out to sea. Erosion is the term given to soil loss due to the mobilization of topsoil by the forces of water and wind. Wind and water move the eroded particles to some other location, where it is deposited as sediment (University of Michigan 2010). The rate of this process, as stated, is highly dependent on human activity. Natural rates of soil erosion are lower for soil with a good cover of vegetation than for bare soil. In addition to the factors listed above, human actions that uncover soil include farming, logging, building, overgrazing, off-road vehicles, and fires, all of which greatly enhance soil erosion rates.

Septic Systems

Areas not serviced by wastewater districts typically have septic systems, also referred to as Onsite Wastewater Treatment Systems (OWTS), for wastewater disposal. The most common type of septic system found in the San Diego region consists of a septic tank connected to leach lines (County of San Diego 2020). Areas with OWTS, rather than sewer connections, include the unincorporated County communities of North Mountain, Ramona, Rainbow, San Dieguito, Spring Valley, Sweetwater, Valley Center, Alpine, Bonsall, Fallbrook, Central Mountain, North County Metro, Mountain Empire, Julian, Desert, and Crest/Dehesa.

PALEONTOLOGICAL RESOURCES

Paleontological resources represent a limited, nonrenewable, and impact-sensitive scientific and educational resource. *Paleontological resources* (i.e., fossils) are defined herein as the remains and/or traces of prehistoric plant and animal life. Fossils such as bones, teeth, shells, and leaves are found in geologic deposits (rock formations) within which they were originally buried. Paleontological resources include not only fossils themselves, but also the associated rocks or organic matter.

Paleontological resources vary widely in their relative abundance and distribution, and not all are regarded as significant. One of the questions listed in the CEQA Environmental Checklist is: "Would the project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?" However, CEQA does not include a definition for "unique paleontological resource." Absent specific agency guidelines, most professional paleontologists in California adhere to guidelines set forth by the Society of Vertebrate Paleontology (SVP), which defines a significant paleontological resources as "fossils and fossiliferous deposits...consisting of identifiable vertebrate fossils, large or small, uncommon invertebrate, plant, and trace

fossils, and other data that provide taphonomic, taxonomic, phylogenetic, paleoecologic, stratigraphic, and/or biochronologic information” (SVP 2010).

Known paleontological resources found in regions of moderate to high paleontological sensitivity throughout the San Diego region are presented in Table 4.7-1. San Diego County assigns a high paleontological sensitivity to geologic units known to contain paleontological localities with rare, well-preserved, critical fossil materials for stratigraphic or paleoenvironmental interpretation, and fossils providing information about the paleoclimatic, paleobiological and/or evolutionary history (phylogeny) of animal and plant groups (County of San Diego 2009b). A moderate paleontological sensitivity is assigned to geologic units known to contain paleontological localities and that have been judged to have a strong, but often unproven, potential for producing unique fossil remains (County of San Diego 2009b).

**Table 4.7-1
Paleontological Resources**

Geologic Unit	Age	Sensitivity	Paleontological Resources Found
Coastal Plain Region			
Unnamed River Terrace Deposits	Late Pleistocene	Moderate	<ul style="list-style-type: none"> • Terrestrial vertebrates (i.e., pond turtle, passenger pigeon, hawk, shrew, mole, mice, gopher, squirrel, rabbit, ground sloth, wolf, camel, deer, horse, mastodon, and mammoth)
Unnamed Marine Terrace Deposits	Late Pleistocene	Moderate to High	<ul style="list-style-type: none"> • Marine invertebrate fossils (e.g., mollusks, crustaceans, and echinoids) • Marine vertebrates (e.g., sharks, rays, and bony fish) • Terrestrial mammals (e.g., camel, horse, and mammoth)
Bay Point Formation	Late Pleistocene	High	<ul style="list-style-type: none"> • Invertebrate fossils (primarily mollusks) • Marine vertebrates (i.e., sharks, rays, and bony fishes)
Lindavista Formation	Early Pleistocene	Moderate	<ul style="list-style-type: none"> • Invertebrate fossils (i.e., clams, scallops, snails, barnacles, and sand dollars) • Marine vertebrates (i.e., sharks and baleen whales)
San Diego Formation	Late Pliocene	High	<ul style="list-style-type: none"> • Marine vertebrates and invertebrates (i.e., clams, scallops, snails, crabs, barnacles, sand dollars, sharks, rays, bony fishes, sea birds, walrus, fur seal, sea cow, dolphins, and baleen whales) • Terrestrial mammals (e.g., cat, wolf, skunk, peccary, camel, antelope, deer, horse, and gomphothere) • Fossil wood and leaves (e.g., pine, oak, laurel, cottonwood, and avocado)

Geologic Unit	Age	Sensitivity	Paleontological Resources Found
San Mateo Formation	Late Pliocene to Late Miocene	High	<ul style="list-style-type: none"> Marine vertebrates (e.g., rays, sharks, bony fishes, sea birds, dolphins, sperm whale, baleen whales, sea cow, fur seals, walrus, and sea otter) Terrestrial mammal remains (e.g., horse, camel, llama, and peccary) Marine invertebrates (e.g., clams, scallops, snails, and sea urchins)
Capistrano Formation	Late Miocene	High	<ul style="list-style-type: none"> Marine vertebrates (e.g., sharks, rays, bony fishes, sea birds, toothed whales, baleen whales, sea cow, fur seals, and walruses) (Orange County)
San Onofre Breccia	Middle Miocene	Moderate	<ul style="list-style-type: none"> Poorly preserved remains of nearshore marine foraminifers, bivalve mollusks, and unidentified mammals
Otay Formation	Late Oligocene	High (upper sandstone); Moderate (lower gritstone and fanglomerate)	<ul style="list-style-type: none"> Terrestrial vertebrates (e.g., tortoise, lizards, snake, birds, shrews, rodents, rabbit, dog, fox, rhinoceros, camels, mouse-deer, and oreodonts)
Sweetwater Formation	Late to Middle Eocene	High	<ul style="list-style-type: none"> Dental remains of opossums, insectivores, and rodents (lower part of the formation) A few nondiagnostic mammal teeth (upper part of the formation)
Pomerado Conglomerate	Middle to Late Eocene	High	<ul style="list-style-type: none"> Terrestrial mammals (e.g., insectivores, primates, rodents, opossums, oreodonts [<i>Protoreodon</i> and <i>Leptoreodon</i>] and other artiodactyls [<i>Hypertragulus</i>], extinct carnivorous mammals [<i>Hyaenodontid</i> and <i>Miacis</i>], and horse [<i>Mesohippus</i>]) Nearshore marine mollusks (e.g., clams and snails)
Mission Valley Formation	Eocene	High	<ul style="list-style-type: none"> Marine microfossils (e.g., foraminifers) and macroinvertebrates (e.g., clams, snails, crustaceans, and sea urchins) Marine vertebrates (e.g., sharks, rays, and bony fish) Petrified wood Terrestrial mammals (e.g., opossums, insectivores, bats, primates, rodents, artiodactyls, and perissodactyls)

Geologic Unit	Age	Sensitivity	Paleontological Resources Found
Stadium Conglomerate (Upper)	Middle Eocene	Moderate to High	<ul style="list-style-type: none"> Fossil foraminifers, marine mollusks, opossums, insectivores, primates, rodents, carnivores, rhinoceros, and artiodactyls Petrified wood
Stadium Conglomerate (Lower)	Middle Eocene	High	<ul style="list-style-type: none"> Sparse marine fossil remains and benthic foraminifers Unusual and scientifically important terrestrial mammal assemblage
Friars Formation	Middle Eocene	High	<ul style="list-style-type: none"> Terrestrial vertebrates; especially terrestrial mammals (e.g., opossums, insectivores, primates, rodents, artiodactyls, and perissodactyls) Marine microfossils and macroinvertebrates Fossil leaves
Scripps Formation	Middle Eocene	High	<ul style="list-style-type: none"> Marine invertebrates and vertebrates (e.g., clams, snails, crabs, sharks, rays, and bony fish) Terrestrial mammals (e.g., uintatheres, brontothere, rhinoceros, and artiodactyl) Reptiles (e.g., crocodile and turtle). Petrified wood
Santiago Formation (Member C)	Middle Eocene	High	<ul style="list-style-type: none"> Vertebrate fossils: turtles, snakes, lizards, crocodiles, birds, and mammals (e.g., opossums, insectivores, primates, rodents, brontotheres, tapirs, protoreodonts, and other early artiodactyls) Marine organisms (e.g., calcareous nannoplankton and mollusks)
Santiago Formation (Member B)	Middle Eocene	High	<ul style="list-style-type: none"> Terrestrial vertebrates (e.g., opossums, insectivores, primates, rodents, brontothere, rhinoceros, and uintathere) Marine and estuarine mollusks
Santiago Formation (Member A)	Middle Eocene	Moderate	<ul style="list-style-type: none"> Member "A" has yet to produce any fossils, but the discovery of any diagnostic fossils in this rock unit would be of great importance in resolving the age and stratigraphic significance of the Santiago Formation
Ardath Shale	Middle Eocene	High	<ul style="list-style-type: none"> Diverse and well-preserved assemblages of marine microfossils, macroinvertebrates, and vertebrates (e.g., sharks, rays, and bony fish)

Geologic Unit	Age	Sensitivity	Paleontological Resources Found
Torrey Sandstone	Early Middle Eocene	Moderate	<ul style="list-style-type: none"> Plant remains (mostly leaves) Invertebrate fossils primarily consist of nearshore marine taxa (e.g., clams, oysters, snails, and barnacles) Vertebrate fossil remains are rare and include teeth of crocodiles, sharks, and rays
Delmar Formation	Late Early to Early Middle Eocene	High	<ul style="list-style-type: none"> Estuarine invertebrates (e.g., clams, oysters, and snails) Estuarine vertebrates (e.g., sharks and rays) Well-preserved skull remains of aquatic reptiles (e.g., crocodile) and terrestrial mammals (e.g., tillodont and early rhinoceros)
Mount Soledad Formation	Late Early to Early Middle Eocene	Moderate (lower resource sensitivity in the lower conglomeratic portion of the formation)	<ul style="list-style-type: none"> Marine organisms (e.g., mollusks, planktonic foraminifers, benthonic foraminifers, and pollen)
Unnamed Formation	Early Eocene	High	<ul style="list-style-type: none"> Dental remains of multituberculates, opossums, insectivores, primates, “condylarths,” and rodents
Cabrillo Formation	Late Cretaceous	Moderate	<ul style="list-style-type: none"> Marine invertebrates (e.g., clams, snails, and ammonites) Marine vertebrates (e.g., sharks)
Point Loma Formation	Late Cretaceous	High	<ul style="list-style-type: none"> Marine invertebrates (e.g., clams, snails, nautiloids, ammonites, crabs, and sea urchins) Marine vertebrates (e.g., sharks and mosasaurs) Terrestrial plants (leaves and wood) Dinosaurs, including armored dinosaur (nodosaur) and duck-billed dinosaur (hadrosaur)
Lusardi Formation	Late Cretaceous	Moderate	<ul style="list-style-type: none"> Fragments of plant material The Cretaceous age of this rock unit coupled with its terrestrial depositional setting suggests the potential presence of dinosaurs and other terrestrial vertebrates
Peninsular Ranges Region			
Older Quaternary Alluvial Fan Deposits	Late Pleistocene	Moderate	<ul style="list-style-type: none"> Scattered vertebrate remains of late Pleistocene age

Geologic Unit	Age	Sensitivity	Paleontological Resources Found
Pauba Formation	Late Pleistocene	Moderate	<ul style="list-style-type: none"> Terrestrial mammals (e.g., shrew, rabbit, kangaroo rat, gopher, mice, deer, pronghorn, camel, horse, and elephant) Freshwater diatoms
Temecula Arkose	Pleistocene	High	<ul style="list-style-type: none"> Terrestrial mammals (e.g., rabbits, rodents, wolf, badger, bobcat, elephant, horse, camel, deer, and antelope) Freshwater diatoms and snails
Jacumba Volcanics	Early Miocene	Moderate (tuffaceous sandstone); Zero (volcanic plugs, lava flows, etc.)	<ul style="list-style-type: none"> Fossil bone fragments in fine-grained tuffaceous sandstone Identifiable fossils should eventually be found in the tuffaceous sandstone sediments
Table Mountain Gravels	Early to Middle Eocene	High	<ul style="list-style-type: none"> Terrestrial mammals (e.g., rodents, rabbits, and large hoofed mammals [camel and unidentified artiodactyls]) including teeth, limb bones, and miscellaneous bone fragments
Santiago Peak Volcanics	Early Cretaceous	High (metasedimentary rocks); Marginal (metavolcanics rocks)	<ul style="list-style-type: none"> Volcanic breccias have produced petrified wood Metasedimentary rocks have produced microfossils (e.g., radiolarians) and marine macroinvertebrates (e.g., belemnites and clams)
Salton Trough Region			
Later Quaternary Alluvium	Holocene	Moderate	<ul style="list-style-type: none"> Only subfossils are expected. Lake Cahuilla deposits have produced well-preserved subfossil remains of freshwater clams, snails, and fish
Older Terraces, Fanglomerates, and Valley Fill Alluvium	Late Pleistocene to Holocene	Moderate	<ul style="list-style-type: none"> No fossils are known from these deposits but are possibly present based on the sediment age and sedimentary origin
Brawley Formation	Early to Middle Pleistocene	Moderate	<ul style="list-style-type: none"> Lacustrine invertebrate fauna (e.g., mollusks and diatoms) Rare freshwater vertebrates
Ocotillo Conglomerate	Early Pleistocene	High	<ul style="list-style-type: none"> Terrestrial vertebrates (e.g., turtle, bird, ground sloth, rabbit, rodents, wolf, bear, bobcat, lion, sabertooth cat, mammoth, zebra, horse, camel, llama, deer, antelope, and ox)
Borrego Formation	Early Pleistocene	High	<ul style="list-style-type: none"> Mollusks, ostracods, and rare foraminifers Terrestrial vertebrates

Geologic Unit	Age	Sensitivity	Paleontological Resources Found
Canebrake Conglomerate	Late Pliocene to Early Pleistocene	Moderate	<ul style="list-style-type: none"> Has not yet yielded any fossils
Palm Springs Formation	Late Pliocene to Early Pleistocene	High	<ul style="list-style-type: none"> Over 100 species of Plio-Pleistocene terrestrial vertebrates (e.g., turtles, snakes, lizards, hawk, eagle, vulture, ground sloth, shrews, rodents, mastodon, camel, llama, and horse)
Imperial Formation	Late Miocene to Early Pliocene	High	<ul style="list-style-type: none"> Over 200 species of marine fossils, (e.g., foraminifers, corals, clams, snails, ostracods, barnacles, crabs, sand dollars, and sea urchins) Marine vertebrates (e.g., sharks, rays, bony fish, sea cow, baleen whale, and walrus)
Split Mountain Formation	Late Miocene to Early Pliocene	Moderate	<ul style="list-style-type: none"> Marine microfossils such as foraminifers
Alverson Volcanics	Middle Miocene	Moderate	<ul style="list-style-type: none"> Algae, pollen, petrified wood, mollusks, and a vertebrate bone fragment
Anza Formation	Early to Middle Miocene	Moderate	<ul style="list-style-type: none"> Unidentifiable bone fragments

Source: Deméré and Walsh 2011.

UNIQUE GEOLOGIC FEATURES

A unique geologic feature may be the best example of its kind locally or regionally; it may illustrate a geologic principle, it may provide a key piece of geologic information, it may be the “type locality” of a fossil or formation, or it may have high aesthetic appeal. Unique geologic features may be exposed or created from natural weathering and erosion processes or from human-made excavations. These unique geological features provide aesthetic, scientific, educational, and recreational value. Unique geological features throughout the San Diego region were documented in the 1975 San Diego County General Plan. This inventory from the 1975 General Plan is listed in Table 4.7-2 and provides more detailed information than the more recent General Plan Update adopted in 2011.

Table 4.7-2
Unique Geologic Features

Unique Geological Feature	Location
Indian Mountain Leucogranodiorite	Banks of San Luis Rey River, a few miles southwest of Pala
Pliocene San Mateo Formation	Along San Mateo Creek
San Onofre Breccia	San Onofre Hills
Monterey Shale	Along sea cliffs southeast of San Onofre
Bonsall Tonalite	Bonsall, west central San Luis Rey Quad

Unique Geological Feature	Location
Petrified forest with logs in exposures of the prebatholithic volcanics and sedimentary rocks containing leaf imprints	Lusardi Canyon near Rancho Santa Fe near junction with San Dieguito River
Prebatholithic folded slates	Lusardi Canyon near Rancho Santa Fe near junction with San Dieguito River
The Lusardi Formation consisting of a conglomerate unit	Lusardi Canyon near Rancho Santa Fe near junction with San Dieguito River
Lake Wohlford Leucogranodiorite	Lake Wohlford, between Escondido and Lake Wohlford
San Marcos Gabbro	San Marcos Mountains, San Luis Rey Quad
Woodson Mountain Granodiorite	Woodson Mountain, a few miles southwest of Ramona
Swarm of distinctly oriented inclusion in Lakewood Mountain Tonalite composing outer ring dike; core is Green Valley Tonalite	East of Ramona
Area of prebatholithic metamorphics, quartzite exhibiting swirls of magnetite and biotite, which may represent relic crossbedding	Vicinity Highway 78 and San Pasqual
Green Valley Tonalite	Southeast San Luis Rey Quad; Green Valley between State Route (SR) 395 and Ramona
Elsinore Fault, canyon eroded along fault, and tributaries offset in a right lateral sense; typical exposure of Julian Schist	Julian, Santa Ysabel Quadrangle
Split Mountain Formation	Split Mountain Gorge, south of Ocotillo, west side of Imperial Valley
Localities indicating age of peak volcanics: at (a) <i>Buchia piochii</i> belemnoids, and ammonite were found; at (b) there are belemnoids, flame structures, flute castes, and graded bedding	(a) Los Peñasquitos; (b) San Santiago Dieguito, vicinity of San Dieguito River
Eocene vertebrate fossil locality	Bank of San Diego River near Grantville
Eocene vertebrate fossil locality	Bank of San Diego River near Friars Road and Ulric Street
Exposures of fossiliferous Eocene and Pliocene strata; the Pliocene rocks are preserved by down faulting and contain sharks teeth, whale bones, and delicate <i>Glottidia albida</i>	Tecolote Creek
Bay Point Formation	West shore of Bay Point Mission Bay
Type area of the Rose Canyon Shale	Rose Canyon
Eocene foraminifera area	Old Murray Canyon Quarry
Green Eocene mudstones, containing large leaf imprints, petrified logs, and pelecypod molds	Black Mountain

Unique Geological Feature	Location
Black Mountain Volcanics, greenstones with primary structures; quartzose pseudomorphs of gastropods	Black Mountain
Exposure of San Diego Formation containing whole bones and sharks teeth	Vicinity of Miramar Reservoir
Type locality of <i>Spatangus rarus Israelsky</i> ; known only from type locality	Pacific Beach
Type localities of <i>Pecten (patinopecten) healeyi</i> , <i>Pecten (Pecten) stearsi</i> , <i>Pecten (argopecten) subdolosus</i> , and <i>Pecten (Pecten) bellus hemphilli</i>	Pacific Beach
Delmar Formation	Sea cliff and short canyon in Del Mar
Mount Soledad Formation	West of intersection of Ardath Road and Interstate (I-) 5
Mission Valley Formation	South wall of Mission Valley on west side of SR 163 at the junction of I-8
Stadium Conglomerate	North wall of Mission Valley west of Murphy Canyon Road from Friars Road
Scripps Formation	Torrey Pines Grade
Friars Formation	North wall of Mission Valley along Friars Road
Torrey Sandstone	Torrey Pines Grade
Ardath Shale	East side of Rose Canyon south of intersection of Ardath Road and I-5
Exposures of Santiago Peak Volcanics showing unique stratigraphic and structural relationships between many units typical of formation; also, type locality when first named Black Mountain Volcanics	North of Black Mountain, La Jolla Quadrangle
Exposure of an old “unnamed” fanglomerate composed of metamorphic rocks, one of the highest surfaces of the “high terrace” cut into Stadium Conglomerate, and a “contact breccia” migmatite zone	Vicinity of I-8, west of San Vicente Reservoir
Basal contact of Ballena Gravels eastward; mechanically just folded border of Woodson Mountain Granodiorite against narrow screen of metamorphic rocks and banded structures in gabbro on other side	Vicinity of Wildcat Canyon Road sloping just east of San Vicente Creek
An unusual occurrence of dumortierite, similanite, and associated minerals	Dehesa Toad and Tavern Road, Alpine
An unusual occurrence of orbicular gabbro	Dehesa Road west of the Harbison Canyon Road intersection Alpine

Unique Geological Feature	Location
Prebatholithic metavolcanics, in selected places coarse pyroclastic and blastoporphyrific fabrics as well as original bedding are visible; often very gneissic	Vicinity of I-8 south of Lake Jennings
Mixed and roof pendants in the prebatholithic metavolcanics	Vicinity of La Cresta Road, El Cajon
Contact of Woodson Mountain Granodiorite and Green Valley Tonalite	Vicinity of La Cresta Road, El Cajon
Roof pendant of metavolcanics in the Green Valley Tonalite	Vicinity of San Diego River west of El Capitan Reservoir
Stonewall Quartz Diorite	Stonewall Peak in Cuyamaca Region
Exposure of Bay Point Formation fauna	Vicinity of the U.S./Mexican border 1/4 mile from the coast
Pliocene San Diego Formation fossils	Vicinity of the U.S./Mexican border 2 miles from the coast
Cabrillo Formation	Sea cliff in Point Loma
Point Loma Formation	Along Point Loma Peninsula at southern end
La Posta Quartz Diorite	La Posta Valley
Stratigraphic relationship between Jacumba volcanic rock (Alverson Andesite) and "Table Mountain Gravels" and reworked younger gravels	West of Jacumba

Source: County of San Diego 1975.

ANTICIPATED EFFECTS FROM CLIMATE CHANGE

Climate change may threaten geology, soils (including soil health, productivity and carbon sequestration), and paleontological resources due to sea-level rise submerging coastal lands, more frequent and severe precipitation events, higher temperatures, and higher incidence of wildfire. The San Diego region is likely to experience sea-level rise of up to 1.2 feet by 2050, wetter winters and more intense precipitation that can lead to increased flooding, more intense heat waves and annual average temperatures increases of up to 4.8°F by 2050, and a longer and less predictable fire season. More details on future climate projections are available in Appendix C.

Climate change could increase the occurrence of landslides in Southern California by worsening the weather conditions that lead to their occurrence. Periods of dryness followed by extreme precipitation events can cause conditions suitable for landslides. Also, wildfires in summer can burn away trees or vegetation that hold soil in place on slopes, and heavy rainfall in the winter may create a debris flow that then results in a landslide (Highland 2005). Both wildfires and storm intensity are projected to increase in the San Diego region by 2050, creating conditions that could bring more landslides to the area.

Climate change may also influence the geology of the land by worsening land subsidence, which occurs with excessive extraction of groundwater. Increased stress on groundwater supplies could result from longer and more intense droughts, increased evaporation, higher temperatures, and decreased precipitation and streamflow, all of which are expected to occur in the region. In 2017, the San Diego County Water Authority sourced 3 percent of its supplies from groundwater. However, it intends to double this number by 2035 in an attempt to diversify its supply portfolio (SDCWA 2016).

Wildfires and heavy storms can damage soil structure, decrease moisture retention, and increase soil erosion. These changes can especially harm topsoil, which is important to the health of crops and vegetation (County of San Diego 2018), and also remove soil that otherwise acts as carbon storage. Other effects of climate change, such as the warming of soils, may lead to higher decomposition rates, which release more carbon dioxide into the atmosphere (Melillo et al. 2014). However, the consequences of climate change on soils in the San Diego region have not yet been quantified.

Along the coast, sea-level rise in the region is expected to result in cliff erosion, further altering the geology. A projected increase in sea level of 1.6 to 6.6 feet along the Southern California coast could result in cliff retreats ranging from 62 to 135 feet by 2100 (Limber et al. 2018); those sea-level rise projections for all of Southern California are slightly higher than projections for just the San Diego region. Coastal bluff erosion rates vary depending on sea-level rise, wave energy, coastal slope, beach width and height, and rock strength. Marine erosion can be concentrated at points due to wave refraction, and occurs more quickly in weaker rocks (Johnsson 2003). The timing of coastal bluff retreat or collapse is also dependent on specific geologic conditions: it may occur catastrophically through sudden slope failure or more gradually through erosion by marine, subaerial, and groundwater processes (Johnsson 2003). In 2018, U.S. Geological Survey (USGS) researchers combined five different computer models that forecast how cliffs retreat, producing a range of values for each section of coastline instead of each model yielding one number, as shown in Figure 4.7-4 (Limber et al. 2018). A USGS research geologist noted that sea-level rise combined with coastal change, cliff retreat, and extreme storms could expose more than 250,000 residents and \$50 billion in property to erosion or flooding in Southern California by the end of the century (USGS 2018).

One limit in the USGS study is that it does not factor in the linkage of long-term cliff retreat rates to annual landslide probabilities. Projected increases in extreme heat days, combined with decreased precipitation projected in the summer, can increase evaporation and the likelihood of drought and wildfires. Wildfires may precondition the landscape for cascading climate hazard events, with implications for both the proposed Plan and surrounding study area. For example, wildfires clear landscape and vegetation, which destabilizes the ground and can create hydrophobic soil (or water-repellant soil, due to the combustion of vegetative materials' resulting gas, which condenses and forms a waxy coating on the ground). In turn, hydrophobic soils increase the likelihood of a landslide during heavy precipitation events. Landslide sediments are often subjected to increased groundwater percolation, which tends to have a negative effect on the preservation of fossils, and gravitationally induced movements of sediment can also destroy fossil remains through abrasion and breakage. Further, when the original stratigraphic position of the sediments and fossils contained within are disturbed, there are varying degrees of scientific information loss with the severity of changes to the slide mass.

It is possible that sea-level rise, along with disaster events like flooding and wildfire, could damage paleontological resources. As with cultural resources, more intense and frequent wildfires and the fire recovery process could have negative impacts on resources within the zone (Waechter 2012). Impacts similar to those discussed under *Cultural Resources* could also adversely affect paleontological resources, although such impacts have not been discussed in the literature. For example, changes in temperature and precipitation could also damage paleontological resources by speeding deterioration and decay and causing thermal stress (Rockman et al. 2016). Additionally, heavy precipitation and flooding could cause erosion or direct damage to the resources. However, no studies investigate the extent to which paleontological resources could be affected by climate change.



4.7.2 REGULATORY SETTING

FEDERAL LAWS, REGULATIONS, PLANS, AND POLICIES

Earthquake Hazards Reduction Act

In 1977, Congress passed the Earthquake Hazards Reduction Act (EHRA, amended 2004) (Public Law 95-124) establishing the National Earthquake Hazards Reduction Program as a long-term earthquake risk reduction program for the United States. The program initially focused on research, led by the USGS and National Science Foundation (NSF), toward understanding and ultimately predicting earthquakes. The current program activities are focused on four broad areas:

- Developing effective measures to reduce earthquake hazards.
- Promoting the adoption of earthquake hazard reduction activities by federal, state, and local governments; national building standards and model building code organizations; and engineers, architects, building owners, and others who play a role in planning and constructing buildings, bridges, structures, and critical infrastructure or “lifelines.”
- Improving the basic understanding of earthquakes and their effects on communities, buildings, structures and lifelines, through interdisciplinary research involving engineering, natural sciences, and social, economic, and decision sciences.
- Developing, operating, and maintaining the Advanced National Seismic Research and Monitoring System, the George E. Brown Jr. Network for Earthquake Engineering Simulation, and the Global Seismographic Network. (EHRA 1977)

U.S. Geological Survey Landslide Hazard Program

The USGS created the Landslide Hazard Program in fulfillment of the requirements of Public Law 106-113 (1999). The primary objective of the Program is to reduce long-term losses from landslide hazards by improving the understanding of the causes of ground failure and suggesting mitigation strategies. The federal government takes the lead role in funding and conducting this research, whereas the reduction of losses due to geologic hazards is primarily a state and local responsibility.

Antiquities Act of 1906

The Antiquities Act of 1906 (16 U.S. Code [USC] 431-433) states, in part:

That any person who shall appropriate, excavate, injure or destroy any historic or prehistoric ruin or monument, or any object of antiquity, situated on lands owned or controlled by the Government of the United States, without the permission of the Secretary of the Department of the Government having jurisdiction over the lands on which said antiquities are situated, shall upon conviction, be fined in a sum of not more than five hundred dollars or be imprisoned for a period of not more than ninety days, or shall suffer both fine and imprisonment, in the discretion of the court.

Although there is no specific mention of natural or paleontological resources in the Act itself, or in the Act's uniform rules and regulations (Code of Federal Regulations Title 43, Part 3), the term "objects of antiquity" has been interpreted to include fossils by the National Park Service, the Bureau of Land Management, the Forest Service, and other federal agencies. Permits to collect fossils on lands administered by federal agencies are

authorized under this Act. However, due to the large gray areas left open to interpretation due to the imprecision of the wording, agencies are hesitant to interpret the Act as governing paleontological resources.

Archaeological and Paleontological Salvage

Archaeological and Paleontological Salvage Statute (23 USC 305) amends the Antiquities Act of 1906. Specifically, it states:

Funds authorized to be appropriated to carry out this title to the extent approved as necessary, by the highway department of any State, may be used for archaeological and paleontological salvage in that state in compliance with the Act entitled "An Act for the preservation of American Antiquities," approved June 8, 1906 (Pub. L. 59-209; 16 USC 431-433), and State laws where applicable.

This statute allows funding for mitigation of paleontological resources recovered pursuant to federal aid highway projects, provided that "excavated objects and information are to be used for public purposes without private gain to any individual or organization" (46 *Federal Register* 19, 9570).

Paleontological Resources Preservation Act

The Paleontological Resources Preservation Act (PRPA)—Title VI, Subtitle D in the Omnibus Public Lands Act of 2009, Public Law 111-011—establishes that the Secretary of Interior and Secretary of Agriculture must manage and protect paleontological resources on federal land using scientific principles and expertise. With the passage of the PRPA, Congress officially recognized the importance of paleontological resources on federal lands (U.S. Department of the Interior, US Department of Agriculture) by declaring that fossils from federal lands are federal property that must be preserved and protected using scientific principles and expertise. The PRPA provides:

- Uniform definitions for "paleontological resources" and "casual collecting."
- Uniform minimum requirements for paleontological resource use permit issuance (terms, conditions, and qualifications of applicants).
- Uniform criminal and civil penalties for illegal sale and transport, and theft and vandalism of fossils from Federal lands.
- Uniform requirements for curation of federal fossils in approved repositories.

STATE LAWS, REGULATIONS, PLANS, AND POLICIES

Alquist-Priolo Earthquake Fault Zoning Act

The purpose of the Alquist-Priolo Earthquake Fault Zoning Act of 1972 (renamed in 1994), Public Resources Code Section 2621 et seq., is "to regulate development near active faults so as to mitigate the hazard of surface fault rupture." The State Geologist, Chief of the Division of Mines and Geology (DMG), is required to delineate Earthquake Fault Zones (formerly known as "Special Studies Zones") along known active faults. As defined by the DMG, an active fault is one that has had surface displacement within Holocene time (roughly the last 11,000 years) and/or has an instrumental record of seismic activity. Potentially active faults are those that show evidence of surface displacement during Quaternary time (roughly the last 2 million years), but for which evidence of Holocene movement has not been established. The DMG evaluates faults on an individual basis to determine if a fault will be classified as an Alquist-Priolo Earthquake Fault Zone. In general, faults must meet

certain DMG criteria, including seismic activity, historic rupture, and geologic evidence to be zoned as an Earthquake Fault Zone. Cities and counties affected by the zones must regulate certain development within the zones. They must withhold development permits for sites within the zones until geologic investigations demonstrate that the sites are not threatened by surface displacement from future faulting. Typically, structures for human occupancy are not allowed within 50 feet of the trace of an active fault. If a property within a zone is not currently developed, a fault study may be required prior to the subdivision of the property or prior to any structure being permitted on the property.

Seismic Hazards Mapping Act of 1990

The Seismic Hazards Mapping Act (SHMA) of 1990 (Public Resources Code Section 2690–2699.6) directs the California Geological Survey to identify and map areas prone to earthquake hazards of liquefaction, earthquake-induced landslides, and amplified ground shaking. The purpose of the SHMA is to reduce the threat to public safety and to minimize the loss of life and property by identifying and mitigating these seismic hazards. The SHMA was passed by the legislature following the 1989 Loma Prieta earthquake. Staff geologists in the Seismic Hazard Mapping Program gather existing geological, geophysical and geotechnical data from numerous sources to compile the Seismic Hazard Zone Maps. They integrate and interpret these data regionally to evaluate the severity of the seismic hazards and designate Zones of Required Investigation for areas prone to liquefaction and earthquake-induced landslides and determine whether structural design or modification of the project site is necessary to ensure safer development. Site-specific geotechnical investigations are conducted to identify and evaluate seismic hazards and formulate mitigation measures prior to permitting most development designed for human occupancy. Cities and counties are then required to use the Seismic Hazard Zone Maps in their land use planning and building permit processes .

California Building Code

Chapter 16A, Division IV of the California Building Code (CBC), titled “Structural Design,” states that the “purpose of the earthquake provisions herein is primarily to safeguard against major structural failures or loss of life.” The CBC regulates the design and construction of excavations, foundations, building frames, retaining walls, and other building elements to mitigate the effects of seismic shaking and adverse soil conditions. The procedures and limitations for the design of structures are based on site characteristics, occupancy type, configuration, structural system height, and seismic zoning. Seismic zones are mapped areas that are based on proximity to known active faults and the potential for future earthquakes and intensity of seismic shaking. Seismic zones range from 0 to 4, with areas mapped as Zone 4 being potentially subject to the highest accelerations due to seismic shaking and the shortest recurrence intervals. According to the CBC, the entire San Diego region is within seismic Zone 4.

The CBC also contains (1) specific provisions to classify soils as expansive, (2) exploratory boring procedures, (3) soil boring reporting procedures, and (4) special building foundation and investigation requirements. Section 1613A.1 describes earthquake loads and states that “every structure, and portion thereof, including nonstructural components that are permanently attached to structures and their supports and attachments, shall be designed and constructed to resist the effects of earthquake motions.” Additionally, structures that require special consideration of their response characteristics and environment that are not addressed by this code and for which other regulations provide seismic criteria include vehicular bridges, electrical transmission towers, hydraulic structures, buried utility lines and their appurtenances and nuclear reactors (CBC 2016).

Construction General Permit

Dischargers whose projects disturb 1 or more acres of soil, or less than 1 acre but are part of a larger common plan of development that in total disturbs 1 or more acres, are required to obtain coverage under the SWRCB's Order 2009-0009-DWQ (as amended by Orders 2010-0014-DWQ and 2012- 0006-DWQ), the Construction General Permit (SWRCB 2009). Construction and demolition activities subject to this permit include clearing, grading, grubbing, and excavation, or any other activity that results in a land disturbance equal to or greater than one acre.

Permit applicants are required to submit a Notice of Intent to the SWRCB and to prepare a Storm Water Prevention Pollution Plan (SWPPP). The SWPPP must identify BMPs that are to be implemented to reduce construction impacts on receiving water quality based on potential pollutants. The SWPPP also must include descriptions of the BMPs to reduce pollutants in stormwater discharges after all construction phases are completed at a site (post-construction BMPs). The Construction General Permit also includes requirements for risk-level assessment for construction sites, a stormwater effluent monitoring and reporting program, rain event action plans, and numeric action levels for pH and turbidity.

California Coastal Act

The California Coastal Act (Public Resources Code Section 30253) provides for the minimization of adverse impacts, including assuring stability and structural integrity, and neither creating nor contributing significantly to erosion, geologic instability, or destruction of the site or surrounding area or in any way requiring the construction of protective devices that would substantially alter natural landforms along bluffs and cliffs. The California Coastal Commission has found that siting new development away from eroding bluffs is the preferred means of assuring compliance with this section of the Act so developments will not be endangered by erosion nor require the construction of coastal armoring to protect them from erosion over their design life (Johnsson 2003).

Water Quality Control Policy for Siting, Design, Operation, and Maintenance of Onsite Wastewater Treatment Systems

On June 19, 2012, the SWRCB adopted Resolution No. 2012-0032, adopting the Water Quality Control Policy for Siting, Design, Operation, and Maintenance of OWTS Policy. This Policy establishes a statewide, risk-based, tiered approach for the regulation and management of OWTS installations and replacements and sets the level of performance and protection expected from OWTS (SWRCB 2012).

In accordance with Water Code Section 13290 et seq., the Policy sets standards for OWTS that are constructed or replaced, that are subject to a major repair, that pool or discharge waste to the surface of the ground, and that have affected, or will affect, groundwater or surface water to a degree that makes it unfit for drinking water or other uses or cause a health or other public nuisance condition. The OWTS Policy also includes minimum operating requirements for OWTS that may include siting, construction, and performance requirements; requirements for OWTS near certain waters listed as impaired under Section 303(d) of the Clean Water Act; requirements authorizing local agency implementation of the requirements; corrective action requirements; minimum monitoring requirements; exemption criteria; requirements for determining when an existing OWTS is subject to major repair; and a conditional waiver of waste discharge requirements.

On April 15, 2015, the San Diego Regional Water Quality Control Board (RWQCB) adopted a Basin Plan amendment that changed water quality objectives for nitrate in groundwater basins. The Basin Plan Amendment also incorporates the State Water Quality Control Policy for Siting, Designing, Operation, and Maintenance of Onsite Wastewater Treatment Systems and made updates related to implementation of waste discharge requirements and adopted resolutions (Gorham 2015). The Basin Plan Amendment incorporates the OWTS Policy into the Basin Plan and amends the criteria to be used by the San Diego Water Board and local agencies to regulate OWTS in the San Diego region (San Diego RWQCB 2015).

State Laws Protecting Paleontological Resources

Public Resources Code Sections 5097 and 30244 include state-level requirements for the assessment and management of paleontological resources. These statutes require reasonable mitigation of adverse impacts on paleontological resources resulting from development on State lands, and define the excavation, destruction, or removal of paleontological “sites” or “features” from public lands without the express permission of the jurisdictional agency as a misdemeanor. As used in Section 5097, *State lands* refer to lands owned by, or under the jurisdiction of, the State or any State agency. *Public lands* is defined as lands owned by, or under the jurisdiction of, the State, or any city, county, district, authority, or public corporation, or any agency thereof.

Conservation and Safety Elements

Under Government Code Section 65302(d)(1), a general plan must include “[a] conservation element for the conservation, development, and utilization of natural resources including water and its hydraulic force, forests, soils, rivers and other waters, harbors, fisheries, wildlife, minerals, and other natural resources”. Under Government Code Section 65302(g)(1) a general plan must include “[a] safety element for the protection of the community from any unreasonable risks associated with the effects of seismically induced surface rupture, ground shaking, ground failure, tsunami, seiche, and dam failure; slope instability leading to mudslides and landslides; subsidence; liquefaction; and other seismic hazards..., and other geologic hazards known to the legislative body...The safety element shall include mapping of known seismic and other geologic hazards.” The cities and County government within the San Diego region include these elements within their general plans, and most contain additional information on disaster relief and emergency preparedness for geologic and seismic hazards.

REGIONAL AND LOCAL LAWS, REGULATIONS, PLANS, AND POLICIES

County Septic Tank Regulations

The San Diego RWQCB authorizes the County of San Diego Department of Environmental Health to issue septic system (OWTS) permits throughout the San Diego region. The purpose of regulating the design, installation, and maintenance of septic systems is to prevent public health nuisance conditions caused by failing septic systems. The program’s goals are as follows:

- Ensure that these systems can operate in all weather conditions with minimal maintenance.
- Prevent the contamination of groundwater from improperly designed onsite wastewater treatment systems.
- Prevent the contamination of surface water from improperly designed onsite wastewater treatment systems.

- Prevent premature failure of onsite wastewater treatment systems (DEH 2015).

Grading and Erosion Regulations

Consistent with State law, local jurisdictions contain grading and erosion control regulations in their municipal codes. These regulations establish minimum requirements for grading, including clearing and grubbing of vegetation. These regulations ensure compatibility of graded land development sites with surrounding land forms and land uses; and prevent unnecessary and unauthorized grading.

Additionally, Local jurisdictions have grading and erosion control ordinances that are intended to control erosion and sedimentation caused by construction activities. A grading permit is typically required for construction-related projects. As part of the permit, project applicants usually must submit a grading and erosion control plan, vicinity and site maps, and other supplemental information. Standard conditions in the grading permit include a description of BMPs similar to those contained in a SWPPP.

Seismic Standards

Many geologic and seismic hazard goals, policies, and mitigation measures are listed in the safety elements of local general plans, and aim to minimize injury, loss of life, and damage to property resulting from potential geologic and seismic disasters. For example, the San Diego County General Plan Safety Element contains goals and policies to minimize personal injury and property damage resulting from seismic hazards (County of San Diego 2011a).

Additionally, the Alquist-Priolo Earthquake Fault Zoning Act, described above, requires that before a project can be permitted, cities and counties must require a geologic investigation to demonstrate that proposed buildings will not be constructed across active faults (Alquist-Priolo 1972).

County of San Diego, Grading Ordinance

Section 87.430 of the Grading Ordinance states that a qualified paleontologist may be required by the County Official to be present during all grading activities for monitoring purposes. If a fossil greater than 12 inches in any diameter is found, all grading operations must be suspended and the County Official must be notified immediately. The County Official will analyze the resource and determine the proper course of action, to be carried out by the permittee, prior to the County Official's authorization to resume normal grading operations.

Local Jurisdictions' Protection Policies for Protecting Against Geologic and Seismic Hazards

To comply with Government Code Section 65302, a general plan must include "A safety element for the protection of the community from any unreasonable risks associated with the effects of seismically induced surface rupture, ground shaking, ground failure, tsunami, seiche, and dam failure; slope instability leading to mudslides and landslides; subsidence; liquefaction; and other seismic hazards identified pursuant to Chapter 7.8 (commencing with Section 2690) of Division 2 of the Public Resources Code, and other geologic hazards known to the legislative body... The safety element shall include mapping of known seismic and other geologic hazards." (GCS 65302 (g)). The incorporated cities and County government within San Diego region contain safety elements within their general plans, and most contain additional information on disaster relief and emergency preparedness for geologic and seismic hazards.

Selected local government policies related to safety and geological hazards are listed in Table 4.7-3.

**Table 4.7-3
Local Policies Concerning Geologic and Seismic Hazards**

Jurisdiction	Policies
Carlsbad	The Public Safety Element of the Carlsbad General Plan does not contain policies specific to geologic hazards. The General Plan for Carlsbad references Chapter 18.07 of the Carlsbad Municipal Code which establishes guidelines for the seismic upgrade of unreinforced masonry buildings.
Chula Vista	The Environment Element of the Chula Vista General Plan contains Policy E 14.1 through E 14.5 to protect against injury, loss of life, and major property damage through engineering analyses of potential seismic hazards; prohibit subdivision, grading, or development of lands subject to potential geologic hazards; require site-specific geotechnical investigations; promote programs to identify buildings and structures that would be at risk during seismic events; and to discontinue, remove, or relocate structures determined to be unsafe from geologic hazards.
Coronado	The Safety Element of the Coronado General Plan contains goals and policies related to fault zone development, inundation hazard from tsunami or seiche, an emergency warning system, and public education for disaster preparedness.
Del Mar	The Environmental Constraints Section of the Del Mar Community Plan contains discussion about floodplain overlay and bluff, slope, and canyon overlay zones used by the City to protect the public safety and welfare from hazards such as fire, flooding, landslides, and erosion. <u>The Safety Element of the Community Plan also contains the Sea Level Rise Adaptation Plan, which is intended to guide policy decisions related to future development in areas that are identified as vulnerable to projected sea-level rise, flooding, and erosion. In addition, the City of Del Mar's Municipal Code contains the City's Local Coastal Program Implementing Ordinances related to geology and soils. Specifically, Del Mar Municipal Code Chapter 30.52, Bluff, Slope, Canyon Overlay Zone, is designed to protect the health, safety, and general welfare, and to protect downstream resources. Del Mar Municipal Code Chapter 30.55, Coastal Bluff Overlay Zone, is intended to protect Del Mar's fragile coastal bluffs as a visual resource and avoid the risks to life and property associated with bluff failure and shoreline erosion. Del Mar Municipal Code Chapter 30.56, Floodplain Overlay Zone, is intended to avoid hazards related to flood hazards. Finally, Del Mar Municipal Code Chapter 23.33, Land Conservation Ordinance, which regulates soil disturbances of existing or natural terrain and vegetation, and does not create soil erosion, silting of lower slopes, slide damage, flooding problems, or severe cutting or scarring.</u>
El Cajon	The Safety Element of the City of El Cajon General Plan includes discussion regarding fault zones and surface ruptures, ground shaking and failure, flooding, and disaster preparedness as it relates to the city.
Encinitas	The Public Safety Element of the Encinitas General Plan contains policies to prevent and respond to geologic hazards.
Escondido	The Community Protection Element of the Escondido General Plan contains goals and policies including Policy 7.1 through Policy 7.5 to minimize adverse effects to residents, property, and critical facilities caused by geologic and seismic hazards.

Jurisdiction	Policies
Imperial Beach	The Safety Element of the City of Imperial Beach General Plan and Local Coastal Plan contain policies specific to geologic hazards including Policy S-1 which requires geo-technical investigations and recommendations; Policy S-5 which restricts construction near fault traces; and Policy S-6 which restricts cliff top development.
La Mesa	The Safety Element of the La Mesa General Plan contain goals, objectives, and policies to offer protection from risks associated with geologic and seismic hazards.
Lemon Grove	The Safety Element of the Lemon Grove General Plan contains Policies 1.1, 1.2, and 1.3 to minimize risk of injury and property from seismic and other geologic conditions.
National City	The Safety Element of the National City General Plan contains Policies S-1.1 through S-1.7, to minimized risk to the community from earthquakes, seismic, and geologic hazards.
Oceanside	The Public Safety Element of the Oceanside General Plan contains goals and objectives to ensure an acceptable level of public safety for prevention and reduction of loss of life and personal property at risk from seismic and geologic hazards.
Poway	The Emergency Services Element of the City of Poway General Plan contains Policy B to protect against hazards associated with geologic formations through proper land use policies and mitigation, and Policy C to control seismic hazards to a level of acceptable risk through the identification and recognition of potentially hazardous conditions and areas.
City of San Diego	The Public Facilities, Services, and Safety Element of the City of San Diego General Plan includes Policy PF-Q.1 to protect public health and safety through the application of effective seismic, geologic and structural considerations. Policy PF-Q.2 maintains or improves the integrity of structures to protect residents and preserve communities.
San Marcos	The Safety Element of the City of San Marcos General Plan includes Policy S-1.1 which reduces the risk of impacts from geologic and seismic hazards by applying current and proper land use planning, development engineering, building construction, and retrofitting requirements. Policy S-1.2 includes the investigation specific groundwater levels and geologic conditions underlying all new development or redevelopment proposals in areas where potential fault rupture, liquefaction, or other geologic hazards are suspected.
Santee	The Safety Element of the Santee General Plan includes Policies 2.1, 2.2, and 2.3 which minimize the loss of life and destruction of property in Santee caused by seismic and geologic hazards.

Jurisdiction	Policies
Solana Beach	The Safety Element City of Solana Beach General Plan contains Objective 1.0 to ensure that geologic hazards in all areas for human use or habitation are mitigated properly or avoided prior to or during development. Policies 1.a through 1.e require geo-technical investigations; review of geotechnical reports; require construction to be in conformance with the Uniform Building Code; increased awareness of seismic and geologic hazards; and encourage programs to abate or modify structures deemed hazardous to human habitation. <u>In addition, Chapter 4, Sections 1 through 4, of the Solana Beach Local Coastal Program Land Use Plan includes policies to minimize risks related to life and property from geologic, flood, or fire hazards; shoreline management strategies; shoreline erosion and protection; and beach sand replenishment and retention.</u>
Vista	The Public Safety, Facilities, and Services Element of the City of Vista General Plan contains PSFS Goal 3 to reduce damage, losses, and the risk to the community caused by seismic and other geologic hazards. The General Plan contains PSFS Policies 3.1 through 3.9 to minimize geologic hazard risks.
County of San Diego	The San Diego County General Plan includes Goal S-87 and S-9 in the Safety Element, which requires minimized personal injury and property damage resulting from seismic hazards, and damage caused by mudslides, landslides, or rock falls.

Sources: City of Carlsbad 2015, City of Chula Vista 2020, City of Coronado 2003, City of Del Mar 1985, City of El Cajon 2001, City of Encinitas 2012, City of Escondido 2012, City of La Mesa 2013, City of Lemon Grove 1995, City of National City 2011, City of Oceanside 2002, City of San Diego 2015, City of Santee 2003, City of Solana Beach 2014, City of Vista 2014, County of San Diego 2020.

Local Jurisdictions' Protection Policies for Unique Geological and Paleontological Features

Selected local government policies protecting unique geological and paleontological features are listed in Table 4.7-4.

Table 4.7-4
Local Policies Concerning Unique Geological and Paleontological Features

Jurisdiction	Policies
Carlsbad	The Open Space and Conservation Element of the Carlsbad General Plan contains Policy B.3, which preserves areas of unique scenic, historical, archaeological, paleontological, and cultural value, and where possible, provides public access to these areas; and Policy B.7, which minimizes impacts from new development on hillsides, ridges, valleys, canyons, lagoons, beaches and other unique resources that provide visual and physical relief to the cityscape. The General Plan for Carlsbad is being updated as of January 2015; however, these policies will be unaffected according to the draft document.
Chula Vista	The Environment Element of the Chula Vista General Plan contains Policy E 10.1 to continue to assess and mitigate the potential impacts of private development and public facilities and infrastructure on paleontological resources in accordance with the California Environmental Quality Act.
Coronado	The Conservation Element of the Coronado General Plan contains objectives to preserve the shoreline from erosion.

Jurisdiction	Policies
Del Mar	The Del Mar Community Plan contains objectives to preserve the integrity of the coastal bluffs and prevent erosion on steep slopes. The Bluff, Slope, and Canyon Specific Plan provides the implementation strategy to protect these natural resources. <u>In addition, Del Mar Municipal Code Chapter 30.52, Bluff, Slope, Canyon Overlay Zone, is designed to protect the health, safety, and general welfare, and to control the development of properties within the designated zone in order to preserve the scenic sandstone bluffs and related canyons and steep slopes that characterize the area within the zone; and Chapter 30.60, Open Space Overlay Zone, is intended, in part, to preserve scenic vistas and particularly unique natural features in specific neighborhoods.</u>
El Cajon	The City of El Cajon General Plan does not contain policies or regulations specific to unique geological features.
Encinitas	The Resource Management Element of the Encinitas General Plan contains policies to document and preserve paleontological resources.
Escondido	The Land Use and Community Form and Resource Conservation Elements of the Escondido General Plan contain policies to conserve hillsides, ridgelines, and paleontological resources.
Imperial Beach	The City of Imperial Beach General Plan and Local Coastal Plan does not contain policies or regulations specific to unique geological features or landforms.
La Mesa	The Conservation and Sustainability Element and Recreation and Open Space Element of the La Mesa General Plan contain policies and conservation objectives to protect natural landforms and significant physical features.
Lemon Grove	The Conservation and Recreation Element of the Lemon Grove General Plan contains Policy 2.1, which protects significant fossils and prehistoric artifacts from development impacts.
National City	The Open Space and Agriculture Element of the National City General Plan contains Policy OS-1.1, which protects and conserves the landforms and open spaces that define the city's urban form, provide public views/vistas, serve as core biological areas and wildlife linkages, or are wetland habitats; and Policy OS-8.8, which requires monitoring for sub-surface cultural and paleontological resources during grading and construction activities for all development projects.
Oceanside	The Environmental Resource Management Element of the Oceanside General Plan contains implementation strategies and policies for reducing erosion and other environmentally damaging impacts.
Poway	The <u>Natural Resources Element of the City of Poway General Plan and the City of Poway's Habitat Conservation Plan</u> does not <u>contains descriptions of unique geological features and landforms and related policies that include the preservation of rock outcroppings, open space, hillsides, ridgelines, and cultural, historical, and paleontological resources.</u> contain policies or regulations specific to unique geological features or landforms.
City of San Diego	The Conservation Element of the City of San Diego General Plan includes the goal for the preservation and long-term management of the natural landforms and open spaces that help make San Diego unique. Policy CE-B.1 protects and conserves important landforms, canyon lands, and open spaces.

Jurisdiction	Policies
San Marcos	The City of San Marcos General Plan, in the Conservation Element, includes Policies COS-2.4 and COS-2.5, which preserve prominent landforms through conservation and management policies. Implementing strategies establish provisions for limiting environmental impacts on landforms, reducing erosion and runoff, and utilizing techniques for open space conservation.
Santee	The Santee General Plan includes Policy 1.1, which encourages significant natural landforms to be maintained during development whenever possible, and Policy 10.2, which encourages the preservation of significant natural features, such as watercourses, ridgelines, steep canyons, and major rock outcroppings through the Development Review process.
Solana Beach	The City of Solana Beach Municipal Code contains Objective 2.0 to preserve the city's hillside areas and natural landforms in their present state to the greatest extent possible. As of January 2015, the City of Solana Beach is in the process of updating its general plan, which may lead to new or different policies regarding unique geological and paleontological features.
Vista	The City of Vista General Plan contains RCS Goals 11, 12, and 13 to provide for the protection of cultural, historical, and paleontological resources. The General Plan also contains provisions to protect important geological features.
County of San Diego	The San Diego County General Plan includes Goal COS-9 in the Conservation and Open Space Element, which requires the conservation of unique geologic features. <u>Policy COS-9.1 requires the salvage and preservation of unique paleontological resources when exposed to the elements during excavation or grading activities or other development processes.</u> Policy COS-9.2 requires future development to minimize impacts on unique geologic features.

Sources: City of Carlsbad 2015, City of Chula Vista 2020, City of Coronado 2003, City of Del Mar 1985, City of El Cajon 2001, City of Encinitas 2012, City of Escondido 2012, City of La Mesa 2013, City of National City 2011, City of Oceanside 2002, City of San Diego 2015, City of Santee 2003, City of Solana Beach 2014, City of Vista 2014, County of San Diego 2020.

4.7.3 SIGNIFICANCE CRITERIA

Appendix G of the CEQA Guidelines provides criteria for determining the significance of a project's environmental impacts, in the form of Initial Study checklist questions. Unless otherwise noted, the significance criteria specifically developed for this EIR are based on the checklist questions that address the criteria in CEQA Guidelines Appendix G. In some cases, SANDAG has combined checklist questions, edited their wording, or changed their location in the document in an effort to develop significance criteria that reflect the programmatic level of analysis in this EIR and the unique characteristics of the proposed Plan and EIR.

Checklist questions for geology and soils are found in Section VII of the CEQA Guidelines. Sections that have been combined and modified are criterion VII(c) related to project location on unstable geologic units or soils and criterion VII(d) related to project location on expansive soils, which are combined as GEO-2 herein.

For the purposes of this EIR, implementation of the proposed Plan would have a significant geologic or soils, impact if it would:

- GEO-1** Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving:

- Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area, or based on other substantial evidence showing an earthquake fault is active;
 - Strong seismic ground shaking;
 - Seismic-related ground failure, including liquefaction; and
 - Landslides.
- GEO-2** Locate projects on a geologic unit or soil that is expansive or unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse, creating substantial direct or indirect risks to life or property.
- GEO-3** Result in substantial soil erosion or the loss of topsoil.
- GEO-4** Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater, potentially causing adverse groundwater impacts.
- PALEO-1** Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.

4.7.4 ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

- GEO-1 DIRECTLY OR INDIRECTLY CAUSE POTENTIAL SUBSTANTIAL ADVERSE EFFECTS, INCLUDING THE RISK OF LOSS, INJURY, OR DEATH INVOLVING:**
- **RUPTURE OF A KNOWN EARTHQUAKE FAULT, AS DELINEATED ON THE MOST RECENT ALQUIST-PRIOLO EARTHQUAKE FAULT ZONING MAP ISSUED BY THE STATE GEOLOGIST FOR THE AREA, OR BASED ON OTHER SUBSTANTIAL EVIDENCE SHOWING AN EARTHQUAKE FAULT IS ACTIVE;**
 - **STRONG SEISMIC GROUND SHAKING;**
 - **SEISMIC-RELATED GROUND FAILURE, INCLUDING LIQUEFACTION; AND**
 - **LANDSLIDES.**

ANALYSIS METHODOLOGY

This analysis acknowledges that the entire San Diego region is subject to strong groundshaking during an earthquake on a fault or fault zone inside or outside of the region. It identifies the location of forecasted regional growth and land use change and planned transportation network improvements as part of the proposed Plan in relation to known earthquake faults in the San Diego region, including Alquist-Priolo Earthquake Fault Zones. This analysis also identifies the location of forecasted regional growth and land use change or planned transportation network improvements in relation to areas subject to seismic-related ground failure, including liquefaction, and seismically induced landslides. The analysis then qualitatively discusses the potential to directly or indirectly cause substantial adverse effects, including the risk of loss, injury, or death involving earthquakes and related seismic hazards as a result of forecasted development and planned transportation network improvements. Finally, the analysis assesses the ability of specific requirements of existing laws and

regulations (as described in the regulatory setting) to minimize any substantial adverse direct or indirect effects.

IMPACT ANALYSIS

2025

Regional Growth and Land Use Change

From 2016 to 2025, the region is forecasted to increase by 161,338 people (5 percent), 97,661 housing units (8 percent), and 115,328 jobs (7 percent). Approximately 79 percent of the forecasted regional population increase between 2016 and 2025 is in the City of San Diego (58 percent), City of Chula Vista (12 percent), and City of Escondido (9 percent).

As shown in Figure 4.7-2, several active fault lines and Alquist-Priolo Earthquake Fault Zones are located in areas that are currently developed and that are forecasted to develop between 2016 and 2025. Areas that contain or are in proximity to Alquist-Priolo Earthquake Fault Zones include downtown San Diego, Coronado, and communities along I-5 from I-8 to SR 52. Additionally, several earthquake fault lines are located in the western third of the region. New development and infrastructure planned to occur between 2016 and 2025 would increase the number of people and structures located in or near areas containing Alquist-Priolo Earthquake Fault Zones, earthquake fault lines, and other geologic hazards. Earthquakes within 60 miles of the San Diego region are capable of generating strong ground shaking. This ground shaking could be generated along the San Clemente, San Diego Trough, Coronado Bank, Rose Canyon, Elsinore, San Jacinto, and Sweetwater fault zones. Surface rupture and severe ground shaking could cause catastrophic damage to new development associated with implementation of the proposed Plan, including catastrophic damage to structures.

As described above in Section 4.7.1, *Existing Conditions*, Area 4 landslide susceptibility zones are scattered throughout the region. Additionally, areas prone to liquefaction also occur throughout the region. Some of these liquefaction and landslide susceptible areas are located in developed areas and areas that are forecasted to develop as a result of regional growth and land use change between 2016 and 2025. Therefore, implementation of the proposed Plan would expose people and structures to the adverse effects of landslides and liquefaction.

Earthquakes and related seismic hazards, such as landslides and liquefaction, can lead to indirect effects such as fires. Long-term effects associated with earthquakes include phenomena such as regional subsidence or emergence of landmasses and regional changes in groundwater level. As a result of forecasted regional growth and land use change, the proposed Plan would increase the risk of loss, injury, or death associated with earthquakes and seismic hazards.

Earthquake-resistant designs employed on new structures can minimize the impact on public safety from seismic events. As discussed in Section 4.7.2, *Regulatory Setting*, there are numerous federal, State, and local laws, regulations, and programs in place to avoid or reduce impacts from earthquakes and other geologic hazards. The Alquist-Priolo Earthquake Fault Zoning Act, described in Section 4.7.2, requires that before a project can be permitted, cities and counties must require a geologic investigation to demonstrate that proposed buildings will not be constructed across active faults. An evaluation and written report of a specific site must be prepared by a licensed geologist, and if an active fault is found, a structure for human occupancy cannot be placed over the fault and must be set back, generally 50 feet from the fault.

All projects would be required to adhere to standard design, grading, and construction practices described in the California Building Code, which regulates the design and construction of excavations, foundations, building frames, retaining walls, and other building elements. This along with all other standard geotechnical investigation, design, grading, and construction standards and practices would mitigate the effects of seismic shaking and adverse soil conditions and avoid or reduce impacts from earthquakes, ground shaking, ground failure, and landslides. Adherence to the Seismic Hazards Mapping Act would reduce threats to public safety by identifying and mitigating for seismic hazards.

Regulatory agencies with oversight on development associated with the proposed Plan have developed regulations and engineering design specifications to consider and compensate for site-level geological and seismic conditions. Adherence to these laws and regulations would ensure impacts from land use changes between 2016 and 2025 would not expose people or structures to substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, strong seismic ground shaking, seismic-related ground failure including liquefaction, or seismically induced landslides. Therefore, this impact is less than significant.

Transportation Network Improvements and Programs

Major transportation network improvements between 2016 and 2025 include new Managed Lanes on I-5 from Manchester Avenue to Vandegrift; new toll lanes on SR 11 to the Otay Mesa Port of Entry (POE); Interchange and Arterial Operational improvements at SR 94 and SR 125, and the Otay Mesa POE Commercial Vehicle Enforcement Facility (CVEG); and tolling equipment and Regional Border Management System investments on SR 11. Other major network improvements include double-tracking at certain locations on the Los Angeles–San Diego–San Luis Obispo (LOSSAN) rail corridor, along with a station addition in the Gaslamp Quarter, San Diego.

The majority of improvements by 2025 would be located in proximity to several fault lines and Alquist-Priolo Earthquake Fault Zones, which would result in increased exposure of people and structures to risk of loss, injury, or death from earthquakes and other geologic hazards. Specific transportation facilities that would be most at risk for damage from seismic effects include those in downtown San Diego and improvements along the I-5 and SR 94 corridors. Due to historic activity of faults in the region, the potential for surface rupture and ground-shaking remains.

As described above in Section 4.7.1, Area 4 landslide susceptibility zones are scattered throughout the region. Additionally, areas prone to liquefaction also occur throughout the region. Some of these liquefaction and landslide susceptible areas are located in areas in which transportation network improvements are planned between 2016 and 2025; therefore, implementation of the proposed Plan would expose people and structures to the adverse effects of landslides and liquefaction.

As discussed above, existing federal, State, and local laws, regulations, and programs included in Section 4.7.2 would require each improvement or project to be reviewed by appropriate regulatory agencies prior to construction and would require each improvement or project to adhere to design standards described in the CBC and all standard design, grading, and construction practices to avoid or reduce impacts from geologic hazards. Adherence to these laws and regulations would ensure impacts from transportation network improvements in place between 2016 and 2025 would not expose people or structures to substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, strong seismic

ground shaking, seismic-related ground failure including liquefaction, or seismically induced landslides. Therefore, this impact is less than significant.

2025 Conclusion

By 2025, implementation of the proposed Plan would result in land use changes and the construction of transportation network improvements that would expose a greater number of people and structures to impacts from seismic activity, including earthquakes, ground shaking, ground failure, and landslides. However, adherence to the laws, regulations, and programs included in Section 4.7.2 would ensure people or structures would not be exposed to substantial adverse effects, and these impacts would therefore be less than significant.

2035

Regional Growth and Land Use Change

From 2026 to 2035, the region is forecasted to increase by 149,500 people (4 percent), 121,650 housing units (9 percent), and 159,728 jobs (9 percent). Approximately 80 percent of the forecasted regional population increase between 2026 and 2035 is in the City of San Diego (71 percent), National City (7 percent), and City of Chula Vista (2 percent).

Growth between 2026 and 2035 would be more susceptible to seismic activity than growth between 2016 and 2025 as more development and redevelopment activities would be located in areas in proximity to Alquist-Priolo Earthquake Fault Zones, such as downtown San Diego and nearby coastal communities and Area 4 landslide susceptibility zones scattered throughout the region. Some of these liquefaction and landslide susceptible areas are located in developed areas and areas that are forecasted to develop as a result of regional growth and land use change between 2026 and 2035. Implementation of the proposed Plan would expose people and structures to the adverse effects of landslides and liquefaction. As stated in the 2025 analysis, seismic activity can lead to indirect effects such as fires.

As discussed in the 2025 analysis, existing federal, State, and local laws, regulations, programs, and ordinances included in Section 4.7.2 would require new structures to adhere to design standards described in the Uniform Building Code and CBC and ensure impacts from seismic activity and other geologic hazards would not expose people or structures to substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, strong seismic ground shaking, seismic-related ground failure including liquefaction, or seismically induced landslides. Therefore, this impact is less than significant.

Transportation Network Improvements and Programs

The transportation network improvements that would be implemented between 2026 and 2035 include new Managed Lanes and Managed Lane Connectors on SR 15, SR 52, SR 94, SR 78, SR 163, SR 125, I-5, I-8, I-15, and I-805. Double-tracking of the LOSSAN rail corridor will continue between 2026 and 2035. During this period, two intermodal transit center Mobility Hub projects will be constructed: the Central Mobility Hub (CMH) in downtown San Diego and the San Ysidro Mobility Hub (SYMh) at the U.S.-Mexico border.

Similar to the 2025 analysis, many of these improvements would be located in areas containing Alquist-Priolo Earthquake Fault Zones and other earthquake fault lines, such as improvements located near downtown San Diego. Given the location of these improvements, additional people or structures would be at risk of loss, injury, or death from earthquakes and other geologic hazards.

As discussed above, existing federal, State, and local laws, regulations, and programs included in Section 4.7.2 would require each improvement or project to be reviewed by appropriate regulatory agencies prior to construction and would require each improvement or project to adhere to design standards described in the CBC and all standard design, grading, and construction practices to avoid or reduce impacts from geologic hazards. Adherence to these laws and regulations would ensure impacts would not expose people or structures to substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, strong seismic ground shaking, seismic-related ground failure including liquefaction, or seismically induced landslides. Therefore, this impact is less than significant.

2035 Conclusion

Between 2016 and 2035, implementation of the proposed Plan would result in land use changes and the construction of transportation network improvements that would expose a greater number of people and structures to impacts from seismic activity, including earthquakes, ground shaking, ground failure, and landslides. However, adherence to the laws, regulations, and programs included in Section 4.7.2 would ensure people or structures would not be exposed to substantial adverse effects, and these impacts would therefore be less than significant.

2050

Regional Growth and Land Use Change

From 2036 to 2050, the region is forecasted to increase by 125,725 people (3 percent), 61,433 housing units (4 percent), and 164,843 jobs (8 percent). Approximately 78 percent of the forecasted regional population increase between 2036 and 2050 is in the City of San Diego (37 percent), San Marcos (13 percent), and City of Chula Vista (28 percent).

As discussed in the 2025 and 2035 analyses above, regional growth and land use change resulting in the construction of new and redeveloped buildings would result in significant impacts regarding the exposure of people and structures to seismic activity, including earthquakes, ground shaking, ground failure, and landslides. As stated above, seismic activity can also have indirect effects such as fires. This risk would continue to occur into 2050 as development intensities increase and infrastructure is extended to accommodate forecasted growth. Land use changes by 2050 would result in an increase in regional growth and development, and as shown on Figure 4.7-1, some of this development would occur near an earthquake fault zone. Population and housing in 2050 are located in or near earthquake fault zones. Approximately 78 percent of the forecasted regional population increase between 2036 and 2050 is in the City of San Diego (37 percent), which lies in the Rose Canyon fault zone.

As described in Section 4.7.1, Area 4 landslide susceptibility zones are scattered throughout the region. Additionally, areas prone to liquefaction also occur throughout the region as shown on Figure 4.7-2. Some of these liquefaction and landslide susceptible areas are located in developed areas and areas that are forecasted to develop as a result of regional growth and land use change between 2036 and 2050. Implementation of the proposed Plan would expose people and structures to the adverse effects of landslides and liquefaction.

As discussed in the 2025 and 2035 analyses, existing federal, State, and local laws, regulations, and programs included in Section 4.7.2 would require new structures to adhere to design standards described in the CBC; therefore, regional growth and land use change between 2036 and 2050 would not expose people or structures

to substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, strong seismic ground shaking, seismic-related ground failure including liquefaction, or seismically induced landslides. Therefore, this impact is less than significant.

Transportation Network Improvements and Programs

Major transportation network improvements between 2036 and 2050 include new Managed Lanes and Managed Lane Connectors on SR 52, SR 56, SR 54, SR 125, and SR 905 and on I-5, I-8, I-15, and I-805. Double-tracking at certain locations on the LOSSAN rail corridor would continue during this period. Three major new commuter rail lines will be constructed, including routes between Downtown San Diego and El Cajon (Route 581), National City to the U.S. Border (Route 582 [Extension]), and the CMH to the U.S. Border (Route 583). Improvements also include double-tracking of the SPRINTER, Green Line, and Orange Line. Double-tracking and grade separations on the Blue Line also are included.

Similar to the 2025 and 2035 analyses, some of the improvements would be located in areas containing Alquist-Priolo Earthquake Fault Zones and other earthquake fault lines including the Rose Canyon, Coronado, Sweetwater, and La Nacion fault lines. In these areas, additional people or structures would be at risk of loss, injury, or death from earthquakes and other geologic hazards.

As described in Section 4.7.1, Area 4 landslide susceptibility zones are scattered throughout the region. Additionally, areas prone to liquefaction also occur throughout the region as shown on Figure 4.7-2. Some of these liquefaction and landslide susceptible areas are located in developed areas and areas that are forecasted to develop as a result of transportation network improvements between 2036 and 2050; therefore, implementation of the proposed Plan would expose people and structures to the adverse effects of landslides and liquefaction.

As discussed above, existing federal, State, and local laws, regulations, and programs included in Section 4.7.2 would require each improvement or project to be reviewed by appropriate regulatory agencies prior to construction and would require each improvement or project to adhere to design standards described in the CBC and all standard design, grading, and construction practices to avoid or reduce impacts from geologic hazards. Adherence to these laws and regulations would ensure that the proposed transportation network improvements would not expose people or structures to substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, strong seismic ground shaking, seismic-related ground failure including liquefaction, or seismically induced landslides. Therefore, the impact is less than significant.

2050 Conclusion

Between 2036 and 2050, implementation of the proposed Plan would result in land use changes and the construction of transportation network improvements that would expose a greater number of people and structures to impacts from seismic activity, including earthquakes, ground shaking, ground failure, and landslides. However, adherence to the laws, regulations, and programs included in Section 4.7.2 would ensure people or structures would not be exposed to substantial adverse effects, and these impacts would therefore be less than significant. For this reason, no mitigation is required.

Exacerbation of Climate Change Effects

During the timeframe of the proposed Plan, climate change effects include, but are not limited to, sea-level rise, more frequent and severe precipitation events, higher temperatures, and higher incidence of wildfire. As described in Section 4.7.1, these conditions can increase the likelihood of landslides. Sea-level rise and extreme storms can increase coastal change and cliff retreat, causing further ground instability. Implementation of the proposed Plan, because of adherence to the laws, regulations, and programs included in Section 4.7.2, would not exacerbate climate change effects such as increased landslides and cliff retreat.

GEO-2 LOCATE PROJECTS ON A GEOLOGIC UNIT OR SOIL THAT IS EXPANSIVE OR UNSTABLE, OR THAT WOULD BECOME UNSTABLE AS A RESULT OF THE PROJECT, AND POTENTIALLY RESULT IN ON- OR OFF-SITE LANDSLIDE, LATERAL SPREADING, SUBSIDENCE, LIQUEFACTION OR COLLAPSE, CREATING SUBSTANTIAL DIRECT OR INDIRECT RISKS TO LIFE OR PROPERTY.

ANALYSIS METHODOLOGY

This analysis identifies the location of forecasted regional growth and land use change or planned transportation network improvements in relation to geologic units and soils that are expansive or unstable, or that would become unstable as a result of land development or a transportation network improvement. The analysis describes the risks associated with locating development projects and transportation network improvements on expansive or unstable geologic units or soils, including on- or offsite landslides, lateral spreading, subsidence, liquefaction, or collapse. The analysis next assesses the ability of specific requirements of existing laws and regulations (as described in the regulatory setting) to minimize these risks. (Impact GEO-1 separately addresses unstable soils or geologic units resulting in on- or offsite landslide, lateral spreading, subsidence, liquefaction or collapse because of earthquakes or seismic events.)

IMPACT ANALYSIS

2025

Regional Growth and Land Use Change

From 2016 to 2025, the region is forecasted to increase by 161,338 people (5 percent), 97,661 housing units (8 percent), and 115,328 jobs (7 percent). Approximately 79 percent of the forecasted regional population increase between 2016 and 2025 is in the City of San Diego (58 percent), City of Chula Vista (12 percent), and City of Escondido (9 percent).

Lateral spreading is the movement of sloping ground as a result of liquefaction. Areas become more prone to liquefaction and lateral spreading during a large earthquake event. Conditions favorable for lateral spreading are frequently found along streams and waterfronts or in loosely placed, saturated, sandy fill. Constructed facilities of most types are vulnerable to heavy damage by lateral spreading, including being pulled apart, buckled, or suffering severe structural damage. In addition, liquefaction can also cause slumping of embankments or tilting of retaining walls that may be associated with regional growth and land use changes. Forecasted regional growth and land use change may be located on soils that are prone to lateral spreading and liquefaction.

Subsidence occurs when excessive groundwater pumping causes the consolidation of soils, which can then be unstable or cause ground failure. As regional growth and land use changes occur, a growing population between 2016 and 2025 would demand additional water supply. Additional housing units would draw additional groundwater and as a result could cause land subsidence.

Much of the population growth projected between 2016 and 2025 would occur in or adjacent to areas with existing development. Although these areas may already have been tested for slope failure, even developed areas, particularly those on or near mountains, hills, or the coast, can experience slope failure. New development in areas prone to slope failure would be at a higher risk, particularly development located in coastal communities. Redevelopment of existing areas or new development would likely require grading or earthwork, which may increase the propensity for soils to become unstable and cause slope failure.

Development may occur in areas containing expansive soils, thereby increasing the risk to people and structures from deterioration of infrastructure, structures, and pavements. If the moisture content and/or soil type differs at various locations under the foundation of a structure, localized or nonuniform movement may occur. This movement can cause damage to the foundation and building structural system, evidenced by cracking of the slab or foundation, cracking in the exterior or interior wall coverings (indicating movement of support framing), uneven floors, and/or misaligned doors and windows. Damage caused by expansive soils can be slow and long term, and not attributable to any particular event. Development that occurs near the coast would be more susceptible to damage caused by expansive soils. Any structure developed in the western part of the San Diego region may also be at risk for expansive soils.

Through adherence to existing laws and regulations, development associated with the proposed Plan would be required to adhere to design standards described in the CBC and all standard design, grading, and construction practices to avoid or reduce geologic hazards, including those associated with lateral spreading, subsidence, unstable soils, slope failure, and expansive soils as described in Section 4.7.2.

Although slope failure may not be completely avoidable, site-specific analyses would reduce risks associated with regional growth development. Corrective measures such as structural reinforcement and using engineered fill to replace unstable and expansive soils would be applied to the design of individual future projects. All site designs would be reviewed and approved by the appropriate agencies.

The incorporated cities and County government within the region have, in their general plans, safety elements required for protections against the risks associated with expansive soils, landslides, subsidence, liquefaction, and other seismic and geologic hazards. Project-specific geotechnical investigations consistent with existing regulatory requirements would identify areas of damage and recommend geotechnical measures to ensure long-term stability, ensuring that regional growth and land use changes on geologic units or soils that are expansive or unstable would not become unstable as a result of the project, or result in on- or offsite landslide, lateral spreading, subsidence, liquefaction, or collapse. Adherence to these laws, regulations, local plans, design standards, and practices would ensure impacts would be less than significant. Therefore, this impact is less than significant.

Transportation Network Improvements and Programs

Major transportation network improvements between 2016 and 2025 include new Managed Lanes on I-5 from Manchester Avenue to Vandegrift; new toll lanes on SR 11 to the Otay Mesa POE; Interchange and Arterial Operational improvements at SR 94 and SR 125, and the Otay Mesa POE CVEG; and tolling equipment and Regional Border Management System investments on SR 11. Other major network improvements include double-tracking at certain locations on the LOSSAN rail corridor along with a station addition in the Gaslamp Quarter, San Diego.

Some of these improvements may involve significant grading or earthwork, which increases the likelihood of encountering unstable geologic units and increases the propensity for slope failure. Additionally, some of the transportation improvements would be located in, on, or near hills, coastal areas, canyons, and other places with steep slopes or unstable soils. Specific transportation facilities that would be susceptible to hazards associated with slope failure, or their development are more likely to cause slope failure.

Transportation network improvements in place between 2016 and 2025 that are located in the coastal areas of the region would be subject to lateral spreading and liquefaction, which can cause the slumping of embankments or tilting of retaining walls associated with transportation network improvements. Additionally, liquefaction can cause the failure of highway and railroad embankments built over liquefiable soils. Transportation network improvements in areas prone to lateral spreading and liquefaction would be at risk of damage to pavement, misalignment of railroad tracks, or the failure of bridge piers or abutments.

Improvements could be in areas with soils that have high erosion potential, which may result in greater risk for effects of slope failure, or cause soils to become unstable and cause greater risks to people or structures in proximity to these improvements.

Improvements to the transportation network implemented between 2016 and 2025 may be located in areas with expansive soils, particularly if they are located near the coast. The wetting and drying of soils from water application during construction, landscape irrigation, or from water pipe leaks and storm events can cause significant movement in expansive soils. Transportation network improvements constructed on or adjacent to expansive soils may suffer infrastructure damage, such as weakening or cracking of bridges, concrete platforms, and other facilities.

As discussed previously, existing federal, State, and local laws, regulations, and programs included in Section 4.7.2 would require each improvement or project to be reviewed by appropriate regulatory agencies prior to construction and would require each improvement or project to adhere to design standards described in the CBC and all standard design, grading, and construction practices to avoid or reduce impacts from geologic hazards, including unstable and expansive soils and slope failure. Adherence to Hazard Mitigation Plans, grading and erosion regulations, and seismic standards including geologic investigations required by the Alquist Priolo Earthquake Fault Zoning Act would reduce geologic hazards. Project-specific geotechnical investigations consistent with existing regulatory requirements would identify areas of damage and recommend geotechnical measures to ensure long-term stability, ensuring that transportation network improvements on geologic units or soils that are expansive or unstable would not become unstable as a result of the project, or result in on- or offsite landslide, lateral spreading, subsidence, liquefaction, or collapse. Therefore, this impact is less than significant.

2025 Conclusion

Between 2016 and 2025, implementation of the proposed Plan would result in land use changes and the construction of transportation network improvements that would expose a greater number of structures to risks from unstable and expansive soils, including landslides, lateral spreading, subsidence, liquefaction, or collapse, or cause soils to become unstable. Adherence to the laws, regulations, and programs included in Section 4.7.2 and project-specific investigations following State and local standards and practices would minimize risks to people or property and ensure impacts from these hazards would be less than significant.

2035***Regional Growth and Land Use Change***

From 2026 to 2035, the region is forecasted to increase by 149,500 people (4 percent), 121,650 housing units (9 percent), and 159,728 jobs (9 percent). Approximately 80 percent of the forecasted regional population increase between 2026 and 2035 is in the City of San Diego (71 percent), National City (7 percent), and City of Chula Vista (2 percent).

As discussed in the 2025 analysis, additional growth and development would result in an increase of the number of structures and facilities that may be in areas with unstable soils, areas prone to slope failure, and areas with expansive soils. Impacts would be greater between 2026 and 2035 as more development or redevelopment activities would occur in coastal communities or near areas with canyons and hills. As mentioned above, slope failure may not be completely avoidable, but site-specific analyses would minimize risks associated with regional growth development.

All projects associated with regional growth would be required to adhere to design standards described in the CBC and all standard design, grading, and construction practices to avoid or reduce geologic hazards, including those associated with unstable soils, slope failure, and expansive soils. Regulatory agencies with oversight on development associated with the proposed Plan have developed regulations and engineering design specifications to consider and compensate for site-level geological hazards from unstable soils, slope failure, and expansive soils. Corrective measures such as structural reinforcement and using engineered fill to replace unstable and expansive soils would be applied to the design of individual future projects. All site designs would be reviewed and approved by the appropriate agencies. Additionally, Hazard Mitigation Plans, grading and erosion regulations, and seismic standards including geologic investigations required by the Alquist Priolo Earthquake Fault Zoning Act would reduce geologic hazards. Project-specific geotechnical investigations consistent with existing regulatory requirements that identify areas of damage and recommend geotechnical measures to ensure long-term stability would ensure that regional growth and land use changes on geologic units or soils that are expansive or unstable would not become unstable as a result of the project, or result in on- or offsite landslide, lateral spreading, subsidence, liquefaction, or collapse. This impact is less than significant.

Transportation Network Improvements and Programs

The transportation network improvements that would be implemented between 2026 and 2035 include new Managed Lanes and Managed Lane Connectors on SR 15, SR 52, SR 94, SR 78, SR 163, and SR 125, and on I-5, I-8, I-15, and I-805. Double-tracking of the LOSSAN rail corridor will continue between 2026 and 2035. During

this period, two intermodal transit center Mobility Hub projects will be constructed: the CMH in downtown San Diego and the SYMH at the U.S.-Mexico border.

Similar to the 2025 analysis, transportation network improvements would occur in areas susceptible to slope failure, unstable soils, and expansive soils—particularly improvements located in hilly or coastal areas, such as the managed lanes along the freeways listed above. Specific transportation facilities located in areas prone to slope failure, or where the development of these facilities would be likely to cause slope failure, include services through coastal areas or canyons. These improvements may be at a greater risk for effects of slope failure or cause greater risks to people or structures in proximity to these improvements.

As with regional growth and land use changes, the transportation network improvements in place between 2026 and 2035 that are located in the coastal areas of the region would be subject to lateral spreading and liquefaction, which can cause the slumping of embankments or tilting of retaining walls associated with transportation network improvements. Additionally, liquefaction can cause the failure of highway and railroad embankments built over liquefiable soils. Transportation network improvements in areas prone to lateral spreading and liquefaction would be at risk of damage to pavement, misalignment of railroad tracks, or the failure of bridge piers or abutments. Construction activities associated with transportation network improvements, such as grading and modifying hill slopes, can cause unstable soils. Additionally, the wetting and drying of soils from construction, landscape irrigation, leaking water pipes, and storm events can cause expansion in soils.

As discussed above, existing federal, State, and local laws, regulations, and programs included in Section 4.7.2 would require each improvement or project to be reviewed by appropriate regulatory agencies prior to construction and would require each project or improvement to adhere to design standards described in the CBC and all standard design, grading, and construction practices to avoid or reduce impacts from geologic hazards from unstable slopes, slope failure, and expansive soils. Project-specific geotechnical investigations consistent with existing regulatory requirements would identify areas of damage and recommend geotechnical measures to ensure long-term stability, ensuring that transportation network improvements on geologic units or soils that are expansive or unstable would not become unstable as a result of the project, or result in on- or offsite landslide, lateral spreading, subsidence, liquefaction, or collapse. This impact is less than significant.

2035 Conclusion

Between 2016 and 2035, implementation of the proposed Plan would result in land use changes and the construction of transportation network improvements that would expose a greater number of structures to risks from unstable and expansive soils, landslides, lateral spreading, subsidence, liquefaction, that collapse, or cause soils to subside or become unstable. However, adherence to the laws, regulations, and programs included in Section 4.7.2 and implementation of project-specific investigations in accordance with local and State standards and practices would minimize risks to people or property and ensure impacts would be less than significant.

2050

Regional Growth and Land Use Change

From 2036 to 2050, the region is forecasted to increase by 125,725 people (3 percent), 61,433 housing units (4 percent), and 164,843 jobs (8 percent). Approximately 78 percent of the forecasted regional population

increase between 2036 and 2050 is in the City of San Diego (37 percent), San Marcos (13 percent), and City of Chula Vista (28 percent).

As discussed in the 2025 and 2035 analyses above, additional growth and development would result in an increase of the number of structures and facilities that may be in areas with unstable soils or prone to slope failure and areas with expansive soils. Impacts would be greater between 2036 and 2050 as more development or redevelopment activities would occur in coastal communities or near areas with canyons and hills. As mentioned above, slope failure may not be completely avoidable, but site-specific analyses would minimize risks associated with regional growth development. Also, additional housing units would draw groundwater and could result in land subsidence.

All projects associated with regional growth would be required to adhere to design standards described in the CBC and all standard design, grading, and construction practices to avoid or reduce geologic hazards, including those associated with unstable soils, slope failure, and expansive soils. Regulatory agencies with oversight on development associated with the proposed Plan have developed regulations and engineering design specifications to consider and compensate for site-level geological and seismic conditions.

Corrective measures such as structural reinforcement and using engineered fill to replace unstable and expansive soils would be applied to the design of individual future projects. The incorporated cities and County government within the region have, in their general plans, safety elements required for protections against the risks associated with landslides, subsidence, liquefaction, and other seismic and geologic hazards. Adherence to Hazard Mitigation Plans, grading and erosion regulations, and seismic standards including geologic investigations required by the Alquist Priolo Earthquake Fault Zoning Act would reduce geologic hazards. All site designs would be reviewed and approved by the appropriate agencies.

Project-specific geotechnical investigations consistent with existing regulatory requirements would identify areas of damage and recommend geotechnical measures to ensure long-term stability, ensuring that regional growth and land use changes on geologic units or soils that are expansive or unstable would not become unstable as a result of the project, or result in on- or offsite landslide, lateral spreading, subsidence, liquefaction, or collapse. Adherence to these laws and regulations and project-specific investigations would ensure impacts would be less than significant.

Transportation Network Improvements and Programs

Major transportation network improvements between 2036 and 2050 include new Managed Lanes and Managed Lane Connectors on SR 52, SR 56, SR 54, SR 125, and SR 905 and on I-5, I-8, I-15, and I-805. Double-tracking at certain locations on the LOSSAN rail corridor would continue during this period. Three major new commuter rail lines will be constructed, including routes between Downtown San Diego and El Cajon (Route 581), National City to the U.S. Border (Route 582 [Extension]), and the CMH to the U.S. Border (Route 583). Improvements also include double-tracking of the SPRINTER, Green Line, and Orange Line. Double-tracking and grade separations on the Blue Line also are included.

Similar to the 2025 and 2035 analyses, transportation network improvements would occur in areas susceptible to slope failure and unstable soils, particularly improvements located in hilly or coastal areas, such as double-tracking of the LOSSAN rail corridor and the new commuter lines. These improvements may be at a greater risk for effects of slope failure or cause greater risks to people or structures in proximity to these improvements. Specific transportation facilities prone to risks of slope failure, or the development of which

would be likely to cause slope failure, include those in downtown San Diego, improvements near the coast, and improvements to highways that would involve grading or tunneling through hills or mountains. In addition, transportation network improvements would be in areas with expansive soils, particularly improvements located near the coast.

As discussed above, existing federal, State, and local laws, regulations, and programs included in Section 4.7.2 would require each improvement or project to be reviewed by appropriate regulatory agencies prior to construction and would require each improvement or project to adhere to design standards described in the CBC and all standard design, grading, and construction practices to avoid or reduce impacts from geologic hazards from unstable and expansive soils and slope failure. Project-specific geotechnical investigations consistent with existing regulatory requirements would identify areas of damage and recommend geotechnical measures to ensure long-term stability, ensuring that transportation network improvements on geologic units or soils that are expansive or unstable would not become unstable as a result of the project, or result in on- or offsite landslide, lateral spreading, subsidence, liquefaction, or collapse. This impact is less than significant.

2050 Conclusion

Between 2036 and 2050, implementation of the proposed Plan would result in regional growth development and transportation network improvements that would be constructed on expansive soils or expose a greater number of structures to risks from unstable soils, including landslides, lateral spreading, subsidence, liquefaction, or collapse, or cause soils to become unstable. Adherence to the laws and regulations and programs included in Section 4.7.2 and project-specific investigations consistent with local and State standards and practices would minimize risks to people and property and ensure impacts would be less than significant.

Exacerbation of Climate Change Effects

Implementation of the proposed Plan is not expected to exacerbate the climate change effects on geology and soil resources, for reasons similar to those described for Impact GEO-1.

GEO-3 RESULT IN SUBSTANTIAL SOIL EROSION OR THE LOSS OF TOPSOIL.

ANALYSIS METHODOLOGY

Some projects would require extensive cut and fill grading and could result in manufactured slopes that become unstable over time and increase long-term erosion potential. Unusually high volumes of stormwater runoff can also cause slope failures, particularly in areas where native soils have a moderate to high erosion potential.

In addition to soil erosion from long-term exposure to water, the analysis describes the routine soil erosion and loss of topsoil that may also result from construction activities (movement of soil or changes to drainage). Soil is a dynamic natural body capable of supporting a vegetative cover (University of Michigan 2010). Erosion or loss of topsoil can cause loss of arable land, clogged and polluted waterways, and increased flooding. The rate of erosion is highly dependent on human activity that uncover soil, such as farming, logging, building, overgrazing, off-road vehicles, and fires. Natural rates of soil erosion are lower for soil with a good cover of vegetation than for bare soil (University of Michigan 2010). This analysis discusses erosion and the loss of topsoil qualitatively in regards to regional growth and land use change or transportation network improvements.

The analysis assesses how adherence to State and local regulations and standards for the design and practice of grading, clearing, and filling of land would minimize impacts related to soil erosion and loss of topsoil.

IMPACT ANALYSIS

2025

Regional Growth and Land Use Change

From 2016 to 2025, the region is forecasted to increase by 161,338 people (5 percent), 97,661 housing units (8 percent), and 115,328 jobs (7 percent). Approximately 79 percent of the forecasted regional population increase by 2025 is in the City of San Diego (58 percent), City of Chula Vista (12 percent), and City of Escondido (9 percent).

Development associated with the proposed Plan would cause erosion due to a greater degree of exposed graded or disturbed surfaces, excavation, or stockpiling that would occur with development. This growth would mainly take place in areas of existing urban development, which may increase the susceptibility of soil erosion or loss of topsoil in erosion-prone areas, such as along the coast. New development may disturb soils in previously undisturbed areas. Increased development may also cause higher amounts of water runoff, which can cause or exacerbate erosion problems and slope failure. In addition, the potential for erosion is most common in beachside areas and coastal communities subject to wave action.

Slope instability or erosion problems in the San Diego region are primarily regulated through the CBC and the grading ordinances of local jurisdictions. The CBC requires special foundation engineering and investigation of soils on proposed development sites located in geologic hazard areas. Reports developed from these investigations must demonstrate either that the hazard presented by the project will be eliminated or that there is no danger for the intended use. To minimize slide danger and erosion, a grading permit must be obtained for all major earth-moving projects. All local jurisdictions (County and cities) have grading ordinances designed in part to ensure that development in earthquake or landslide-prone areas does not threaten human life or property. Many of the country's most slide-prone or erosion-prone areas occur along the coastal bluffs, which are regulated under the California Coastal Act and are within the jurisdiction of the California Coastal Commission (CCC). In addition to protecting unique recreational and natural resources, the CCC requires the inclusion of grading, drainage, and erosion control plans with the submittal of a development application. The local geologic background and potential for geologic impacts are important components of local coastal programs under each coastal jurisdiction.

As discussed in Section 4.7.2, the Construction General Permit regulates construction site stormwater management and requires measures that reduce the effects of erosion. Under the Construction General Permit, permit applicants would be required to prepare a SWPPP, which identifies BMPs that must be implemented to reduce construction effects on receiving water quality based on pollutants. The BMPs are directed at implementing both sediment and erosion control measures and other measures to control chemical contaminants.

Adherence to the CBC, coastal zone regulations, construction general permit requirements, and local grading and erosion control ordinances would reduce the potential for substantial soil erosion or loss of topsoil. This impact is less than significant.

Transportation Network Improvements and Programs

Major transportation network improvements between 2016 and 2025 include new Managed Lanes on I-5 from Manchester Avenue to Vandegrift; new toll lanes on SR 11 to the Otay Mesa POE; Interchange and Arterial Operational improvements at SR 94 and SR 125, and the Otay Mesa POECVEG; and tolling equipment and Regional Border Management System investments on SR 11. Other major network improvements include double-tracking at certain locations on the LOSSAN rail corridor along with a station addition in the Gaslamp Quarter, San Diego.

Portions of the transportation improvements included in the proposed Plan would be constructed on or in proximity to steep slopes and would increase the amount of impervious surfaces and the removal of additional vegetative cover. Some transportation or transit projects would require significant earthwork, including cuts into hillsides that can become unstable over time, increasing long-term erosion potential. Road cuts can expose soils to erosion over the life of the project, creating potential landslide and falling rock hazards. Engineered roadways can be undercut over time by stormwater drainage and wind erosion. Some areas would be more susceptible to erosion than others due to the naturally occurring soils with higher erosion potential. Improvements to the transportation network implemented between 2016 and 2025 may cause or worsen soil erosion or loss of topsoil, particularly if those improvements require significant earthwork, such as below-grade transit line extensions or routes. Vibration from new or expanded highways or transit lines may also cause or exacerbate soil erosion along hillsides in canyons or coastal bluffs.

Each improvement or project would be reviewed by appropriate regulatory agencies prior to construction and would adhere to design standards described in the CBC and all standard design, grading, and construction practices to avoid or reduce soil erosion or loss of topsoil. Adherence to these regulations would reduce the potential for substantial soil erosion or loss of topsoil. For this reason, this impact is less than significant.

2025 Conclusion

Between 2016 and 2025, implementation of the proposed Plan would result in land use changes and the construction of transportation network improvements, both of which would cause soil erosion or the loss of topsoil. However, adherence to the CBC design and construction standards and compliance with the Construction General Permit and other local ordinances would ensure that this impact is less than significant.

2035

Regional Growth and Land Use Change

From 2026 to 2035, the region is forecasted to increase by 149,500 people (4 percent), 121,650 housing units (9 percent), and 159,728 jobs (9 percent). Approximately 80 percent of the forecasted regional population increase between 2026 and 2035 is in the City of San Diego (71 percent), National City (7 percent), and City of Chula Vista (2 percent).

Impacts would occur between 2026 and 2035 where regional growth is forecasted to occur in coastal areas or in areas near or in canyons. As stated in the 2025 analysis, the potential for erosion and loss of topsoil increases with human activity and development or redevelopment. Activities such as grading, excavation, stockpiling, boring, and cut-and-fill grading can increase erosion potential and loss of topsoil. Additionally, as described in

the 2025 analysis, an increase in volume or velocity of stormwater can increase erosion potential and loss of topsoil.

Adherence to the CBC, coastal zone regulations, construction general permit requirements, and local grading and erosion control ordinances would reduce the potential for substantial soil erosion or loss of topsoil. For this reason, this impact is less than significant.

Transportation Network Improvements and Programs

The transportation network improvements that would be implemented between 2026 and 2035 include new Managed Lanes and Managed Lane Connectors on SR 15, SR 52, SR 94, SR 78, SR 163, and SR 125, and on I-5, I-8, I-15, and I-805. Double-tracking of the LOSSAN rail corridor will continue between 2026 and 2035. During this period, two intermodal transit center Mobility Hub projects will be constructed: the CMH in downtown San Diego and the SYMH at the U.S.-Mexico border.

Similar to the 2025 analysis, transportation network improvements would cause or worsen soil erosion or loss of topsoil, particularly if those improvements require significant earthwork, such as below-grade transit line extensions or routes. Vibration from new or expanded highways or transit lines may also cause or exacerbate soil erosion along hillsides in canyons or coastal bluffs. Particular projects located in coastal areas and expansion in hilly areas would be susceptible to causing soil erosion impacts.

Each improvement or project would be reviewed by appropriate regulatory agencies prior to construction and would adhere to design standards described in the CBC and all standard design, grading, and construction practices to avoid or reduce soil erosion or loss of topsoil. Adherence to these regulations, the construction general permit, and other local ordinances would reduce the potential for substantial soil erosion or loss of topsoil. For this reason, this impact is less than significant.

2035 Conclusion

Between 2026 and 2035, implementation of the proposed Plan would result in land use changes and the construction of transportation network improvements, both of which would cause soil erosion or the loss of topsoil. Compliance with regulatory requirements and implementation of required design measures would ensure that regional growth and land use changes as well as transportation network improvements and programs associated with the proposed Plan would not cause substantial soil erosion or the loss of topsoil; therefore, this impact is less than significant.

2050

Regional Growth and Land Use Change

From 2036 to 2050, the region is forecasted to increase by 125,725 people (3 percent), 61,433 housing units (4 percent), and 164,843 jobs (8 percent). Approximately 78 percent of the forecasted regional population increase between 2036 and 2050 is in the City of San Diego (37 percent), San Marcos (13 percent), and City of Chula Vista (28 percent).

Impacts may be greater between 2036 and 2050 than in earlier periods because additional growth is forecasted to occur in coastal areas or in areas near or in canyons. As stated in the 2025 and 2035 analyses, the potential for erosion and loss of topsoil increases with human activity and development or redevelopment. Activities

such as grading, excavation, stockpiling, boring, and cut-and-fill grading can increase erosion potential and loss of topsoil. Additionally, as described in the 2025 analysis, an increase in volume or velocity of stormwater can increase erosion potential and loss of topsoil.

Adherence to the CBC, coastal zone regulations, construction general permit requirements, and local grading and erosion control ordinances would reduce the potential for substantial soil erosion or loss of topsoil. For this reason, this impact is less than significant.

Transportation Network Improvements and Programs

Major transportation network improvements include new Managed Lanes and Managed Lane Connectors on SR 52, SR 56, SR 54, SR 125, and SR 905 and on I-5, I-8, I-15, and I-805. Double-tracking at certain locations on the LOSSAN rail corridor would continue during this period. Three major new commuter rail lines will be constructed, including routes between Downtown San Diego and El Cajon (Route 581), National City to the U.S. Border (Route 582 [Extension]), and CMH to the U.S. Border (Route 583). Improvements also include double-tracking of the SPRINTER, Green Line, and Orange Line. Double-tracking and grade separations on the Blue Line also are included.

Similar to the 2025 and 2035 analyses, transportation network improvements would cause or worsen soil erosion or loss of topsoil, particularly if those improvements require significant earthwork, such as below-grade transit line extensions or routes. Vibration from new or expanded highways or transit lines may also cause or exacerbate soil erosion along hillsides in canyons or coastal bluffs. The greatest impacts from construction would likely occur by 2035, although impacts from operation of transportation improvements would be greatest by 2050, as all projects would be implemented by that time.

Each improvement or project would be reviewed by appropriate regulatory agencies prior to construction and would adhere to design standards described in the CBC and all standard design, grading, and construction practices to avoid or reduce soil erosion or loss of topsoil. Adherence to these regulations would reduce the potential for substantial soil erosion or loss of topsoil. For this reason, this impact is less than significant.

2050 Conclusion

Between 2036 and 2050, implementation of the proposed Plan would result in land use changes and the construction of transportation network improvements, both of which would cause soil erosion or the loss of topsoil. Compliance with regulatory requirements and implementation of required design measures would ensure that regional growth and land use changes as well as transportation network improvements and programs associated with the proposed Plan would not cause substantial soil erosion or the loss of topsoil; therefore, this impact is less than significant.

Exacerbation of Climate Change Effects

Although there will be climate change impacts in the San Diego region that could cause soil erosion or the loss of topsoil, as described in Section 4.7.1, implementation of the proposed Plan, because of compliance with regulatory requirements, would not exacerbate climate change effects regarding increasing erosion and topsoil loss.

GEO-4 HAVE SOILS INCAPABLE OF ADEQUATELY SUPPORTING THE USE OF SEPTIC TANKS OR ALTERNATIVE WASTEWATER DISPOSAL SYSTEMS WHERE SEWERS ARE NOT AVAILABLE FOR THE DISPOSAL OF WASTEWATER, POTENTIALLY CAUSING ADVERSE GROUNDWATER IMPACTS.

ANALYSIS METHODOLOGY

The analysis identifies the general locations of forecasted regional growth and land use change under the proposed Plan that would occur in areas without sewer systems and that thus rely on OWTS. It includes a discussion of the relevant regulations, including County policies for permitting septic systems, and their ability to minimize impacts on groundwater quality.

Transportation network improvements and programs would not affect septic systems or OWTS, as facilities associated with transportation network improvements and programs would not use septic systems; therefore, they are not addressed further in the impact analysis.

IMPACT ANALYSIS

2025

Regional Growth and Land Use Change

From 2016 to 2025, the region is forecasted to increase by 161,338 people (5 percent), 97,661 housing units (8 percent), and 115,328 jobs (7 percent). Approximately 79 percent of the forecasted regional population increase between 2016 and 2025 is in the City of San Diego (58 percent), City of Chula Vista (12 percent), and City of Escondido (9 percent).

Regional growth and land use change associated with implementation of the proposed Plan would occur in areas containing expansive soils, or soils incapable of supporting the use of septic tanks or OWTS, thereby causing adverse groundwater impacts. If the moisture content and/or soil type differs at various locations supporting a septic tank or alternative wastewater disposal system, localized or nonuniform movement may occur. This movement can cause damage to the septic tank or alternative wastewater disposal system. Damage caused by expansive soils can be slow and long term, and not attributable to any particular event. The issue of expansive soils, or soils incapable of adequately supporting septic tanks or OWTS, is not as common in the San Diego region as in other parts of the country; however, development that occurs near the coast would be more susceptible to damage caused by expansive soils than eastern areas of the region, where the use of septic systems is more common.

Expansive soils, as described in Section 4.7.1, are not confined to the coastal areas, however. The most common type of septic system found in the San Diego region consists of a septic tank connected to leach lines. Areas with OWTS, rather than sewer connections, include the unincorporated communities of North Mountain, Ramona, Rainbow, San Dieguito, Spring Valley, Sweetwater, Valley Center, Alpine, El Cajon, Bonsall, Fallbrook, Central Mountain, North County Metro, Mountain Empire, Julian, Desert, and Crest/Dehesa. Although not coastal communities, these areas have the potential for expansive soils. The North County Metro area has potential expansive soils mapped in the northern part of the community, while Fallbrook and Spring Valley both have potential expansive soils throughout their boundaries. Valley Center has potential expansive soils throughout the community, and Ramona has a concentration of potential expansive soils in the heart of the community,

surrounding SR 67 (County of San Diego 2011a). Therefore, in certain unincorporated communities with forecasted housing unit and population growth between 2016 and 2025, there would be development on soils incapable of supporting septic tanks or OWTS.

Through adherence to existing laws and regulations, including those adopted by the San Diego RWQCB, regional growth and land use change associated with the proposed Plan would be required to adhere to design standards described in the CBC and all standard design, grading, and construction practices to avoid or reduce adverse groundwater impacts associated with expansive soils, or soils incapable of adequately supporting the use of septic tanks and alternative wastewater disposal systems, as described in Section 4.7.2. Specifically, the CBC requires provisions to classify soils as expansive and measures to address expansive soils. In addition, SWRCB Resolution No. 2012-0032 establishes siting, construction, performance requirements, corrective action requirements, monitoring requirements, and waste discharge requirements, which would ensure that septic tanks or OWTS would not affect groundwater or surface water to a degree that makes it unfit for drinking water or other uses.

Corrective measures would be applied to the design of individual future projects. All site designs would be reviewed and approved by the appropriate agencies and consistent with regulatory requirements would ensure that new septic tanks or alternative wastewater disposal systems associated with regional growth and land use change would not result in adverse groundwater impacts due to incapable soils. This impact is less than significant.

2025 Conclusion

Regional growth and land use change associated with the proposed Plan would occur on expansive or unstable soils incapable of supporting the use of septic tanks or alternative wastewater disposal systems; however, adherence to the laws and regulations included in Section 4.7.2 and described above would minimize the potential for adverse impacts on groundwater. Therefore, this impact is less than significant.

2035

Regional Growth and Land Use Change

From 2026 to 2035, the region is forecasted to increase by 149,500 people (4 percent), 121,650 housing units (9 percent), and 159,728 jobs (9 percent). Approximately 80 percent of the forecasted regional population increase between 2026 and 2035 is in the City of San Diego (71 percent), National City (7 percent), and City of Chula Vista (2 percent).

As discussed above, the issue of expansive soils, or soils incapable of adequately supporting septic tanks or OWTS, is not as common in the San Diego region as in other parts of the country; however, development that occurs near the coast would be more susceptible to damage caused by expansive soils than eastern areas of the region, where the use of septic systems is more common. Expansive soils, as described in Section 4.7.1, are not confined to the coastal areas, however. As discussed in the 2025 analysis, areas with OWTS include unincorporated parts of the County. Some of these communities have projected population and housing unit increases and have potential expansive soils and are therefore incapable of supporting septic tanks or OWTS.

Additionally, areas with high groundwater levels can also cause unstable soils and may not be able to support the use of septic tanks or alternative wastewater disposal systems, potentially causing adverse groundwater

impacts. Because high groundwater levels occur mainly in the western part of the region, where reliance on these systems is not common and where land use is not anticipated to change substantially between 2026 and 2035, regional growth and land use change associated with the proposed Plan in this area would not have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater, potentially causing adverse groundwater impacts.

As mentioned above, all projects associated with regional growth and land use change under the proposed Plan would be required to adhere to design standards described in the CBC and all standard design, grading, and construction practices to avoid or reduce adverse groundwater impacts from expansive soils or soils incapable of supporting the use of septic tanks or OWTS. Regulatory agencies with oversight on regional growth and land use change associated with the proposed Plan have developed regulations and engineering design specifications to reduce risks from expansive soils or soils incapable of supporting the use of septic tanks or OWTS. Corrective measures would be applied to the design of individual future projects. All site designs would be reviewed and approved by the appropriate agencies, and consistency with regulatory requirements would ensure that new septic tanks or alternative waste-water disposal systems associated with regional growth and land use change would not result in adverse groundwater impacts due to incapable soils. This impact is less than significant.

2035 Conclusion

Implementation of regional growth and land use change associated with the proposed Plan would occur on expansive or unstable soils incapable of supporting the use of septic tanks or alternative wastewater disposal systems; however, adherence to the laws and regulations included in Section 4.7.2 and described above would minimize the potential for adverse impacts on groundwater. Therefore, this impact is less than significant.

2050

Regional Growth and Land Use Change

From 2036 to 2050, the region is forecasted to increase by 125,725 people (3 percent), 61,433 housing units (4 percent), and 164,843 jobs (8 percent). Approximately 78 percent of the forecasted regional population increase between 2036 and 2050 is in the City of San Diego (37 percent), San Marcos (13 percent), and City of Chula Vista (28 percent).

The issue of expansive soils, or soils incapable of adequately supporting septic tanks or OWTS, is not as common in the San Diego region as in other parts of the country; however, development that occurs near the coast would be more susceptible to damage caused by expansive soils than eastern areas of the region, where the use of septic systems is more common. Expansive soils, as described in Section 4.7.1, are not confined to the coastal areas, however. Areas with OWTS, rather than sewer connections, include the unincorporated communities of the County described in the 2025 and 2035 analyses. In certain parts of these unincorporated communities with forecasted regional population and housing unit growth between 2036 and 2050, there would be development on soils incapable of supporting septic tanks or OWTS.

Additionally, areas with high groundwater levels can also cause unstable soils and may not be able to support the use of septic tanks or alternative wastewater disposal systems. Because high groundwater levels occur mainly in the western part of the region, where reliance on these systems is not common and where land use is not forecast to change substantially between 2036 and 2050, regional growth and land use change associated

with the proposed Plan in this area would not be likely on soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater, potentially causing adverse groundwater impacts.

As mentioned above, all projects associated with regional growth and land use change under the proposed Plan would be required to adhere to design standards described in the CBC and all standard design, grading, and construction practices to avoid or reduce adverse impacts on groundwater from expansive soils or soils incapable of supporting the use of septic tanks or OWTS. Regulatory agencies with oversight on regional growth and land use change associated with the proposed Plan have developed regulations and engineering design specifications to reduce risks from expansive soils. Corrective measures would be applied to the design of individual future projects. All site designs would be reviewed and approved by the appropriate agencies, and consistency with regulatory requirements would ensure that new septic tanks or alternative wastewater disposal systems associated with regional growth and land use change would not result in adverse groundwater impacts due to incapable soils. This impact is less than significant.

2050 Conclusion

Between 2036 and 2050, regional growth and land use change associated with the proposed Plan would occur on expansive or unstable soils incapable of supporting the use of septic tanks or alternative wastewater disposal systems; however, adherence to the laws and regulations included in Section 4.7.2 and described above would minimize the potential for adverse impacts on groundwater. Therefore, this impact is less than significant.

Exacerbation of Climate Change Effects

The proposed Plan is not expected to exacerbate climate change effects regarding soils that are unsuitable for septic tank use.

PALEO-1 DIRECTLY OR INDIRECTLY DESTROY A UNIQUE PALEONTOLOGICAL RESOURCE OR SITE OR UNIQUE GEOLOGIC FEATURE.

ANALYSIS METHODOLOGY

This section analyzes the potential for ground-disturbing construction activities associated with the implementation of the proposed Plan to uncover unique paleontological resources and unique geologic features. Paleontological resources (i.e., fossil remains) are known to occur within the coastal plain, the desert, and alluvial deposits and other mountain formations. Construction activities associated with both forecasted regional growth and land use change or planned transportation network improvements (deep excavation, trenching, tunneling, blasting, chiseling rock formations, altered hydrologic flow, vibration, or erosion) in previously undisturbed areas would have the highest likelihood for encountering paleontological resources and unique geologic features. This analysis compares areas identified for regional growth and land use change or transportation network improvements with areas mapped as having paleontological sensitivity and the locations of unique geologic features to assess the potential impacts on these resources.

IMPACT ANALYSIS

2025

Regional Growth and Land Use Change

As described in Section 4.7.1 and Table 4.7-1, geologic formations with moderate to high paleontological resource potential are present throughout the San Diego region, but particularly within the Coastal Plain Region, which is forecasted to have the highest proportion of regional population and housing unit increases from 2016 to 2025. Approximately 79 percent of the forecasted regional population increase during this period is in the City of San Diego (58 percent), City of Chula Vista (12 percent), and City of Escondido (9 percent). Those same three jurisdictions accommodate approximately 78 percent of new housing units in the region between 2016 and 2025. Excavation and grading activities associated with new development and redevelopment in areas with moderate to high paleontological resource potential, including the cities of San Diego, Chula Vista, and Escondido and unincorporated communities like Otay and North County Metro, may encounter paleontological resources. Ground-disturbing activities in high or moderate sensitivity fossil-bearing geologic formations such as these have the potential to encounter paleontological resources that may be present below the ground surface.

The majority of unique geologic features described in Table 4.7-2 are located in the eastern portions of the region in areas that are not forecasted to change significantly between 2016 and 2025. Additionally, many of the unique geologic features are located in canyons, riverbanks, or other areas where construction would be infeasible or difficult. The policies and ordinances of local jurisdictions typically restrict construction on steep slopes to preserve hillsides and reduce hazards. Therefore, the majority of identified unique geologic features would not be directly impacted from regional development associated with the proposed Plan land use pattern.

However, some of identified unique geologic features listed in Table 4.7-2 are located in areas that would experience increased regional growth and land use change under the proposed Plan. Communities such as Mission Valley contain unique geologic features and are forecast to increase in population and housing unit densities between 2016 and 2025. These geologic features may experience direct impacts from construction associated with increased development, including impacts caused by changes to hydrology and water runoff. Features sensitive to the effects of erosion, such as valley walls, may be impacted by runoff or vibration from construction activities.

Any future development projects implementing the proposed Plan would be required to adhere to the regulations and policies discussed in Section 4.7.2 or listed in Table 4.7-4. These regulations and policies require protection of paleontological resources, with measures such as paleontological monitoring during grading projects and reducing of erosion and runoff in areas where unique paleontological resources and unique geologic features are located, and in some cases limiting development in those areas. These requirements would help reduce impacts on unique paleontological resources and unique geologic resources through avoidance and implementation of BMPs. However, it cannot be guaranteed that these measures would reduce significant impacts for all future development projects. Therefore, impacts on unique paleontological resources and unique geologic features are considered significant.

Transportation Network Improvements and Programs

Implementation of the proposed Plan would result in transportation network improvements and programs being constructed within geologic formations of moderate to high paleontological resource potential and areas containing unique geologic features during the 2016 to 2025 timeframe, such as improvements to the Otay Mesa POE southbound truck route. Ground disturbance associated with roadway improvements, bridge replacements, new rail tracks, track reconfigurations, grade separations; and construction of facilities such as commuter rail maintenance facilities can directly impact unique paleontological resources in areas with high or moderate paleontological resource sensitivity, and can directly and permanently alter unique geologic features, particularly in canyons, coast lines, and mountain passes. Construction and operation of these transportation network improvements would also produce vibration and contribute to the effects of erosion, which would impact unique paleontological resources and unique geologic features.

Upon implementation of the individual transportation network improvements and programs included as part of the proposed Plan, both unique paleontological resources and unique geologic features would be encountered. As discussed above, existing federal, State, and local laws, regulations, and programs included in Section 4.7.2 and Table 4.7-4 would help reduce impacts on unique paleontological resources and unique geologic features, but there is no assurance these measures would reduce significant impacts for all future projects. Therefore, impacts on unique paleontological resources and unique geologic features are considered significant.

2025 Conclusion

Implementation of the proposed Plan would result in regional growth and land use change as well as transportation network improvements and programs that would directly or indirectly destroy a unique paleontological resource or site or unique geologic feature. Therefore, this impact (PALEO-1) in the year 2025 is significant.

2035

Regional Growth and Land Use Change

As discussed in the 2025 analysis above, geologic formations with moderate to high paleontological resource potential are present throughout the San Diego region, particularly within the Coastal Plain Region, which is forecasted to have the highest proportion of regional population and housing unit increases from 2026 to 2035. Approximately 80 percent of the forecasted regional population increase between 2026 and 2035 is in the City of San Diego (71 percent), National City (7 percent), and City of Chula Vista (2 percent). Similarly, these three jurisdictions accommodate approximately 76 percent of new housing units. Excavation and grading activities associated with new development and redevelopment of the areas included in the proposed Plan, including the cities of San Diego, National City, and Chula Vista and unincorporated communities like Lakeside, North County Metro, and Otay, may result in impacts on unique paleontological resources and unique geologic features. Ground-disturbing activities in high or moderate sensitivity fossil-bearing geologic formations such as those listed in Tables 4.7-1 have the potential to damage or destroy unique paleontological resources that may be present below the ground surface. The types of activities that would result in significant impacts on unique paleontological resources and unique geologic features (i.e., excavation and grading) in 2025 would continue to occur into 2035 as development intensities would increase to accommodate the forecasted growth. In addition, with more construction planned to occur within previously unearched areas, or increase the

likelihood of impacts from erosion or changes to hydrology, there is an increased potential to physically destroy or alter unique paleontological resources and unique geologic features. As discussed in the 2025 analysis, existing federal, State, and local laws, regulations, and programs included in Section 4.7.2 and Table 4.7-4 would help reduce impacts on unique paleontological resources and unique geologic features, but there is no guarantee that they would be reduce significant impacts for all future projects. Therefore, impacts on unique paleontological resources and unique geologic features are considered significant.

Transportation Network Improvements and Programs

Ground disturbances associated with the construction of transportation network improvements and programs would occur within geologic formations of moderate to high paleontological resource potential and areas containing unique geologic features during the 2026 to 2035 timeframe, including projects such as the Central Mobility Hub, the San Ysidro Mobility Hub, and the Del Mar Tunnel. It is possible that more unique paleontological resources or unique geologic features would also be destroyed or altered by runoff or erosion. As discussed in the 2025 analysis, existing federal, State, and local laws, regulations, and programs included in Section 4.7.2 and Table 4.7-4 would help reduce impacts on unique paleontological resources and unique geologic features, but there is no guarantee that they would reduce significant impacts for all future projects. Therefore, impacts on unique paleontological resources and unique geologic features are considered significant.

2035 Conclusion

Implementation of the proposed Plan would result in regional growth and land use change as well as transportation network improvements and programs that would directly or indirectly destroy a unique paleontological resource or site or unique geologic feature. Therefore, this impact (PALEO-1) in the year 2035 is significant.

2050

Regional Growth and Land Use Change

As discussed in the 2025 and 2035 analyses above, geologic formations with moderate to high paleontological resource potential are present throughout the San Diego region, particularly within the Coastal Plain Region, which is forecasted to have the highest proportion of regional population and housing unit increases from 2036 to 2050. Approximately 78 percent of the forecasted regional population increase between 2036 and 2050 is in the City of San Diego (37 percent), San Marcos (13 percent), and City of Chula Vista (28 percent). Similarly, these three jurisdictions accommodate approximately 89 percent of new housing units. Excavation and grading activities associated with new development and redevelopment of the areas included in the proposed Plan, including the cities of San Diego, San Marcos, and Chula Vista, may result in impacts on unique paleontological resources and unique geologic features. Ground-disturbing activities in high or moderate sensitivity fossil-bearing geologic formations such as those listed in Tables 4.7-1 have the potential to damage or destroy unique paleontological resources that may be present below the ground surface. The types of activities that would result in significant impacts on unique paleontological resources and unique geologic features (i.e., excavation and grading) in 2025 and 2035 would continue to occur into 2050 as development would continue in order to accommodate the forecasted growth. In addition, with more construction planned within previously unearthed areas, or with an increase in the likelihood of impacts from erosion or changes to hydrology, there is an increased potential to physically destroy or alter unique paleontological resources and unique geologic

features. As discussed in the 2025 and 2035 analyses, existing federal, State, and local laws, regulations, and programs included in Section 4.7.2 and Table 4.7-4 would help reduce impacts on unique paleontological resources and unique geologic features, but there is no guarantee that they would reduce significant impacts for all future projects. Therefore, impacts on unique paleontological resources and unique geologic features are considered significant.

Transportation Network Improvements and Programs

The transportation network improvements that would be implemented between 2036 and 2050 include the Complete Corridors (individual and freight vehicles), transit leap (a complete network of high-speed, high-capacity, and high-frequency transit services), mobility hubs, and flexible fleets (shared, on demand transportation services).

Ground disturbances associated with the construction of transportation network improvements and programs would occur within geologic formations of moderate to high paleontological resource potential and areas containing unique geologic features during the 2036 to 2050 timeframe, including projects such as the Sorrento Mesa tunnel and the new commuter rail line between Downtown San Diego and El Cajon (Route 581). It is possible that more unique paleontological resources or unique geologic features would also be destroyed or altered by runoff or erosion. As discussed in the 2025 and 2035 analyses, existing federal, State, and local laws, regulations, and programs included in Section 4.7.2 and Table 4.7-4 would help reduce impacts on unique paleontological resources and unique geologic features, but there is no guarantee that they would reduce significant impacts for all future projects. Therefore, impacts on unique paleontological resources and unique geologic features are considered significant.

2050 Conclusion

Implementation of the proposed Plan would result in regional growth and land use change as well as transportation network improvements and programs that would directly or indirectly destroy a unique paleontological resource or site or unique geologic feature. Therefore, this impact (PALEO-1) in the year 2050 is significant.

Exacerbation of Climate Change Effects

Implementation of the proposed Plan may result in exacerbation of climate change effects on paleontological resources, as described in Section 4.7.1. The development from regional growth and land use changes as well as transportation network improvements and programs would exacerbate the consequences of likely increased landslides in the region. Landslides increase groundwater percolation, which can negatively impact fossil remains, as described in Section 4.7.1.

MITIGATION MEASURES

PALEO-1 DIRECTLY OR INDIRECTLY DESTROY A UNIQUE PALEONTOLOGICAL RESOURCES OR SITE OR UNIQUE GEOLOGIC FEATURE.

2025, 2035, and 2050

PALEO-1a Identify the Potential for Unique Paleontological Resources or Unique Geologic Features for Development Projects or Transportation Network Improvements. During planning, design, and project-

level CEQA review of transportation network improvements or development projects, SANDAG shall, and other transportation project sponsors, the County of San Diego, cities, and other local jurisdictions can and should, assess the potential for disturbing unique paleontological resources (e.g., fossils and fossiliferous deposits consisting of identifiable vertebrate fossils, large or small, uncommon invertebrate, plant, and trace fossils) or affecting unique geologic features (i.e., a geologic feature that is the best example of its kind locally or regionally, illustrates a geologic principle, provides a key piece of geologic information, is the “type locality” of a fossil or formation, or has high aesthetic appeal) in the project area. For project sites with a high probability of these resources being present, SANDAG shall, and other transportation project sponsors, the County of San Diego, cities, and other local jurisdictions can and should, retain a qualified paleontologist to conduct a field survey and recommend subsequent steps to be taken during project construction to reduce or avoid impacts on these resources—as described in mitigation measure PALEO-1b—in a report documenting the field survey, and with as-needed support from a registered geologist for unique geologic features not related to fossil localities or fossiliferous deposits.

PALEO-1b Avoid or Reduce Impacts on Unique Paleontological Resources or Unique Geologic Features for Development Projects or Transportation Network Improvements. If it is determined during planning, design, and project-level CEQA review that transportation network improvements or development projects would be located within an area that likely contains unique paleontological resources or unique geologic features (based on results of the work done in mitigation measure PALEO-1a), SANDAG shall, and other transportation project sponsors, the County of San Diego, cities, and other local jurisdictions can and should, avoid or reduce impacts on these resources when feasible. If impacts cannot be avoided, SANDAG shall, and other transportation project sponsors, the County of San Diego, cities, and other local jurisdictions can and should, retain a qualified paleontologist prior to construction to:

- Prepare a paleontological monitoring and mitigation plan, which will outline where monitoring should occur and procedures for discoveries, consistent with applicable regulations and guidelines. Such regulatory standards include the Antiquities Act of 1906, PRPA, and Public Resources Code requirements; regional and local policies of San Diego County and the cities of Carlsbad, Chula Vista, Coronado, Del Mar, Encinitas, Escondido, La Mesa, Lemon Grove, National City, Oceanside, San Diego, San Marcos, Santee, Solana Beach, and Vista; and guidelines of other transportation project sponsors such as the California Department of Transportation’s *Standard Environmental Reference, Environmental Handbook: Volume 1: Guidance for Compliance, Chapter 8: Paleontology* (Caltrans 2014).
- Establish procedures for monitoring and the possible preconstruction salvage of exposed unique resources if fossil-bearing rocks or unique geologic features have the potential to be affected.
- Provide preconstruction coordination with contractors.
- Be on site to observe during grading operations and oversee original cutting in previously undisturbed areas of sensitive geologic formations, temporarily halt or redirect construction activities as appropriate to allow recovery of newly discovered fossil remains, recover scientifically valuable specimens or ensure avoidance of the unique paleontological resource or unique geologic feature, and oversee fossil salvage operations and reporting.

SIGNIFICANCE AFTER MITIGATION

2025, 2035, and 2050

Implementation of regional growth and land use change as well as transportation network improvements and programs of the proposed Plan would result in significant impacts on a unique paleontological resource or unique geologic feature in 2025, 2035, and 2050. Implementation of mitigation measures PALEO-1a and PALEO-1b would protect these unique resources through the presence of a certified paleontologist and compliance with existing regulations; however, it cannot be guaranteed that these measures will reduce impacts to a less-than-significant level for all projects. Therefore, this impact (PALEO-1) is significant and unavoidable.