# 4.8 Geology and Soils

This section evaluates impacts on geology and soils and paleontological resources from implementation of the proposed 2022 RTP/SCS.

## 4.8.1 Setting

### a. Regional Geology

San Joaquin County includes parts of two of the eleven geomorphic provinces of California: The Great Central Valley and Coast Ranges (California Geological Survey 2002). The Great Central Valley, which covers the majority of San Joaquin County except for the southwestern corner, is an asymmetrical synclinal trough, approximately 50 miles wide and 400 miles long. The region is an unusual lowland in that sediments within the basin are relatively undeformed, while the surrounding rock units are highly deformed. Little geologic variation exists within the Great Central Valley, with surficial deposits consisting primarily of unconsolidated Quaternary sediments. The Great Central Valley is bordered on the east by the west sloping Sierran bedrock surface, which continues westward beneath alluvium and older sediments. The Western border is underlain by east-dipping Cretaceous and Cenozoic strata that form a deeply buried synclinal trough. The San Joaquin Valley comprises the southern portion of the Great Central Valley, whereas the Sacramento Valley is present in the northern portion. Oil fields follow anticlinal uplifts that mark the southwestern border of the San Joaquin Valley and its southernmost basin. The Sacramento Valley plain is interrupted by the Marysville Buttes, an isolated Pliocene volcanic plug approximately 2,000 feet high. There are no active faults located within the SJCOG region but there are potentially active Quaternary faults which transect the southwestern area of the SJCOG region (Figure 4.8-1). Existing geologic, soils, and flooding conditions are briefly summarized below.

### b. Local Geology

San Joaquin County consists of 10 geologic units mapped on the Geologic Map of California (Jennings 2010) including; (1) Quaternary (Pleistocene to Holocene) marine and nonmarine sedimentary rock (Q), (2) Quaternary (Pleistocene) marine and nonmarine sedimentary rocks (Qoa), (3) Tertiary to Quaternary (Pliocene to Pleistocene) nonmarine sedimentary rock (QPc), (4) Tertiary (Miocene) marine sedimentary rocks (M), (5) Tertiary (Miocene) nonmarine sedimentary rock (Mc), (6) Tertiary (Eocene) marine sedimentary rocks (E), (7) Tertiary (Paleocene) marine sedimentary rock (Ep), (8) Upper Cretaceous marine sedimentary and metasedimentary rock (Ku), (9) Cretaceous to Jurassic marine sedimentary and metasedimentary rock (KJf), (10) Cretaceous to Jurassic marine sedimentary and metasedimentary rocks ($KJf_m$).

San Joaquin County is located at the northern end of the San Joaquin Valley, a sedimentary basin filled with an up to six-mile-thick sequence of interbedded clay, silt, sand, and gravel deposits ranging in age from more than 144 million years old to less than 10,000 years. Recent sediments consist of coarse-grained sand and gravel deposits along river courses and fine-grained alluvium consisting of silt and clay deposited in low-lying areas or flood basins. The southwestern corner of San Joaquin County contains part of the Diablo Mountains. The foothills of the Diablo Mountains contain older sedimentary rocks of Pliocene or Pleistocene age (QPc) (Figure 4.8-2). Older rocks are exposed further to the southwest into the main range. Within San Joaquin County, rocks of Neogene (M), Paleogene (E and Ep), Cretaceous (Ku), and Cretaceous-Jurassic (KJf and KJfm) age are exposed. These are primarily sedimentary units, but parts of the Mesozoic (Ku, KJf, and KJfm) units are slightly

metamorphosed (metasedimentary). Mesozoic plutonic (um) and metavolcanic (Mzv) rocks have been reported in nearby areas of the Diablo Mountains but not within San Joaquin County.

The northeastern part of San Joaquin County contains foothills of the Sierra Nevada. Older Quaternary alluvial sediments (Qoa) and Plio-Pleistocene sedimentary rocks (QPc) are found here. The northeastern edge of San Joaquin County contains units mapped as terrestrial Miocene sedimentary rocks (Mc). Exposures of older (Paleogene, Mesozoic, and Paleozoic) sedimentary and plutonic rocks are found deeper within the Sierra Nevada, west of San Joaquin County. Table 4.8-1 summarizes the paleontological sensitivities of each geologic unit.

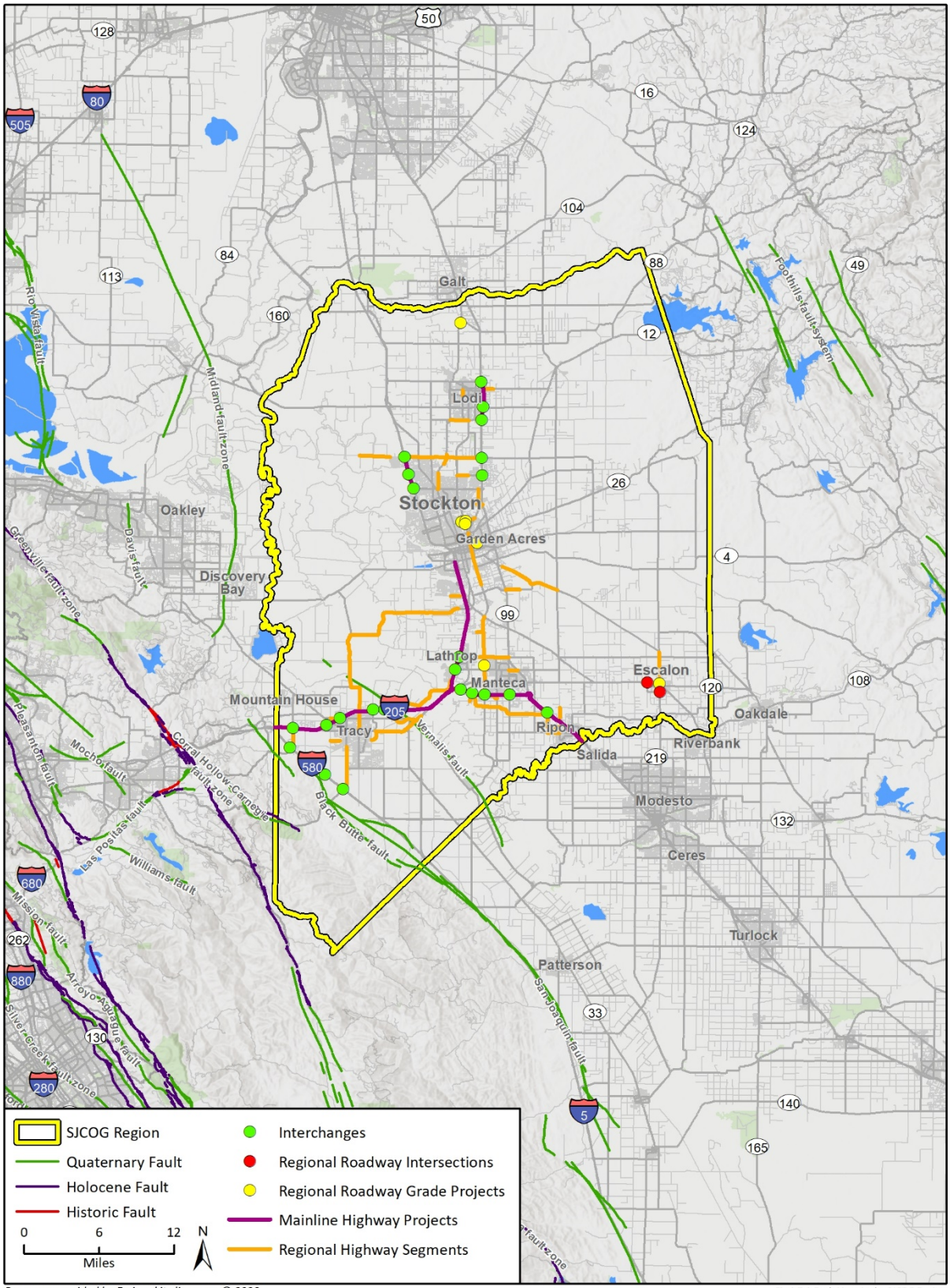
**Table 4.8-1 Paleontological Sensitivity of Geologic Units in the Project Area**

| Geologic Unit | Abbreviation | Paleontological Sensitivity |
|---|---|---|
| Quaternary (Pleistocene-Holocene) marine and nonmarine (continental) sedimentary rocks | Q | Low at surface; increase to high with depth |
| Quaternary (Pleistocene) marine and nonmarine (continental) sedimentary rocks | Qoa | High |
| Quaternary-Pliocene (Pliocene-Pleistocene) nonmarine (continental) sedimentary rocks | QPc | High |
| Miocene marine sedimentary rocks | M | High |
| Miocene nonmarine (continental) sedimentary rocks | Mc | High |
| Eocene marine sedimentary rocks | E | Low |
| Paleocene marine sedimentary rocks | Ep | Low |
| Upper Cretaceous marine sedimentary and metasedimentary rocks | Ku | High |
| Cretaceous-Jurassic marine sedimentary and metasedimentary rocks | KJf and KJfm | High |

## Earthquake Ground-Shaking and Fault Rupture

According to the San Joaquin County 2035 General Plan EIR, there are no active faults located within the SJCOG region (Figure 4.8-1). Instead, there are potentially active Quaternary faults which transect the southwestern area of the SJCOG region, including the Black Butte Fault which lies directly adjacent to Interstate 580 and the Vernalis Fault approximately 3.9 miles east of the City of Tracy. Additionally, the SJCOG region is located between two areas of seismic activity (San Joaquin County 2014). To the west there are active faults associated with the San Andreas Fault System, with the Marsh Creek-Greenville fault located approximately one mile west of the southern tip of the SJCOG region. The Marsh Creek-Greenville fault is capable of producing a maximum moment magnitude earthquake of 6.9 on the Richter Scale, and most recently triggered a magnitude 5.6 earthquake in 1980. Other active faults associated with the San Andreas Fault System include the Concord (25 miles northeast), Calaveras (15 miles southwest), Hayward (18 miles southwest), and the San Andreas (35 mile southwest) faults. To the east of the SJCOG region there is a regional shear zone associated with the Sierra Nevada foothills known as the Foothills Fault System, located approximately 10 miles east and thought capable of producing a maximum moment magnitude earthquake of 6.5 on the Richter scale, but has not been classified as active. It is expected that ground-shaking from a major earthquake could produce a range of ground-shaking intensities that could affect the SJCOG region (San Joaquin County 2014).

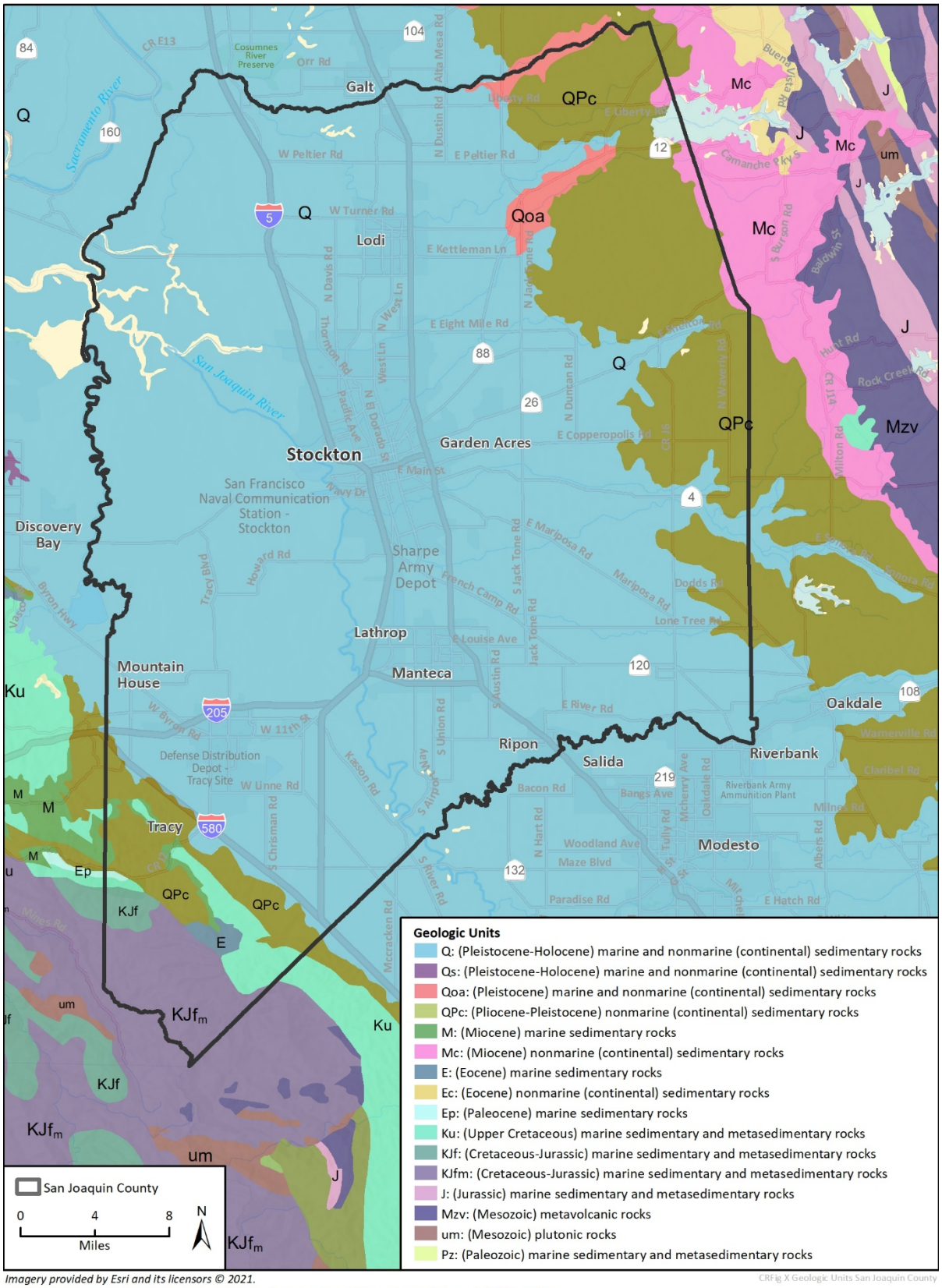
**Figure 4.8-1 Fault Lines in the SJCOG Planning Area**




*Basemap provided by Esri and its licensors © 2022.*
*Fault Line data provided by USGS, 2017.*

Fig 4.7-1 Fault Lines in the SJCOG Region

## Figure 4.8-2 Geologic Units in the SJCOG Region




*Imagery provided by Esri and its licensors © 2021.*
*Additional data provided by Geologic map of California by Jennings, Gutierrez, Bryant, Saucedo & Wills, 2010.*

CRFig X Geologic Units San Joaquin County

## Liquefaction and Lateral Spreading

Liquefaction, or the loss of soil bearing strength during a strong earthquake, is a potential occurrence in several areas with younger soils as well as in areas where the groundwater table is less than 50 feet deep. Specifically, in areas of loose sand and silt that is saturated with water, soils can behave like liquid during earthquakes. In addition to necessary soil conditions, ground acceleration and duration of the earthquake must be of sufficient energy to induce liquefaction. No generalized liquefaction mapping has been completed for the SJCOG region (San Joaquin County 2014), but mapped liquefaction zones exist immediately west of the SJCOG region within the County of Contra Costa and northwest in Solano County (California Geological Survey [CGS] 2022). Thus, any potential liquefaction susceptibility would likely occur within the western portion of the SJCOG region (San Joaquin County 2014). According to the General Plans of Lathrop and Manteca, liquefaction is found within their respective planning areas (City of Lathrop 1991; City of Manteca 2003). The most serious liquefaction threat lies in the Delta, with many levees directly underlain by relatively clean, water saturated sands and peats. Strong ground shaking could cause liquefaction under these levees and lead to localized flooding (San Joaquin County 2014).

## Slope Stability

Landslides and surficial slope failures are most likely to occur in areas of greater than 25 percent slope (hillside areas) and along steep bluffs. Landslides also occur due to specific events, such as loss of vegetation after fires or earthquakes adding loads to barely stable slopes. Steep slopes within the SJCOG region are relatively limited and primarily found in the southwestern portion of San Joaquin County, along with smaller slopes susceptible to instability located throughout the Delta area's levee system (San Joaquin County 2014).

## Expansive Soils

Soils with relatively high clay content are expansive due to the capacity of clay minerals to take in water and swell (expand) to greater volumes. Expansive soils are present throughout the SJCOG region, primarily near its western boundary as well as its central portion, near Stockton, and some eastern portions. Soils within the southwestern end of the SJCOG region have been mapped with high shrink-swell potential (San Joaquin County 2014). As noted in the San Joaquin County General Plan, close to half of the upper five feet of soils throughout the county have a low shrink-swell potential (San Joaquin County 2014).

## Subsidence

Subsidence is a gradual settling or sudden sinking of the Earth's surface due to removal or displacement of subsurface earth materials. Principal causes include aquifer-system compaction associated with groundwater withdrawals; drainage of organic soils; underground mining; or natural compaction or collapse, such as with sinkholes or thawing permafrost (USGS 2022). The loss of peat soils, due to compaction and mining, has caused land within the Delta portion of the SJCOG region to subside. This subsidence has resulted in the Delta being, on average, approximately 15 feet below sea level, with some areas approximately 25 feet below sea level (San Joaquin County 2014).

## c. Paleontological Resources

Paleontological resources, or fossils, are the evidence of once-living organisms preserved in the rock record. They include both the fossilized remains of ancient plants and animals and the traces

thereof (e.g., trackways, imprints, burrows, etc.). Paleontological resources are not found in "soil" but are contained within the geologic deposits or bedrock that underlies the soil layer. Typically, fossils are greater than 5,000 years old (i.e., older than middle Holocene in age) and are typically preserved in sedimentary rocks. Although rare, fossils can also be preserved in volcanic rocks and low-grade metamorphic rocks under certain conditions (Society of Vertebrate Paleontology [SVP] 2010). Fossils occur in a non-continuous and often unpredictable distribution within some sedimentary units, and the potential for fossils to occur within sedimentary units depends on several factors. It is possible to evaluate the potential for geologic units to contain scientifically important paleontological resources, and therefore evaluate the potential for impacts to those resources and provide mitigation for paleontological resources if they are discovered during construction of a project.

Paleontological sensitivity refers to the potential for a geologic unit to produce scientifically significant fossils. Direct impacts to paleontological resources occur when earthwork activities, such as grading or trenching, cut into the geologic deposits within which fossils are buried and physically destroy the fossils. Since fossils are the remains of prehistoric animal and plant life, they are considered to be nonrenewable. Such impacts have the potential to be significant and, under the *CEQA Guidelines*, may require mitigation. Sensitivity is determined by rock type, past history of the geologic unit in producing significant fossils, and fossil localities recorded from that unit. Paleontological sensitivity is derived from the known fossil data collected from the entire geologic unit, not just from a specific survey. Vertebrate fossils are almost always significant because they occur more rarely than invertebrates or plants. Thus, geological units having the potential to contain vertebrate fossils are considered the most sensitive

The SVP outlines in its Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources (2010) guidelines for categorizing paleontological sensitivity of geologic units within a project area. The SVP (2010) describes sedimentary rock units as having a high, low, undetermined, or no potential for containing significant nonrenewable paleontological resources. This criterion is based on rock units within which vertebrates or significant invertebrate fossils have been determined by previous studies to be present or likely to be present.

The geographic distribution, general characteristics, and paleontological sensitivities of each geologic unit in the SJCOG region is discussed below. Figure 4.8-2 summarizes the paleontological sensitivities of each geologic unit.

## Quaternary (Pleistocene-Holocene) marine and nonmarine (continental) sedimentary rocks (Q)

Sediments of Holocene age are generally too young (i.3., <5000 years before present) to preserve paleontologically significant resources (SVP 2010). Although Figure 4.8-2 (based on Jennings et al. 2010) depicts much of the center of San Joaquin County as the undifferentiated Q unit, Wahrhaftig et al. (1993) recognized differentiated Quaternary gravel, sand, and silt alluvial units of Holocene to early Pleistocene age in the County. These deposits are referred to the Modesto, Riverbank, and Turlock Lake formations. The UCMP records 18 Pleistocene fossil localities in San Joaquin County (UCMP 2021). Three of the localities are from the Modesto Formation, but the unit of origin for the other 15 is unreported making it impossible to tell whether the localities originate from units depicted as Q, Qoa, or QPc in Figure 4.8-2. Taxa reported from the localities include horses (*Equus*), camels (*Camelops*), mammoths (*Mammuthus*) and ground sloths (*Megalonyx*) (Jefferson 2010). Overall, the sediments mapped as Quaternary marine and nonmarine (continental) sedimentary rocks (Q) in San Joaquin County have a **low sensitivity at the surface and increases to high with**

**depth.** If more precise maps are used to differentiate among Pleistocene and Holocene sediments, Pleistocene units would have a high paleontological sensitivity. In this case, Holocene units would have a low paleontological sensitivity that increases with depth, because although they are not old enough to bear fossils themselves, the sediments likely grade into Pleistocene sediments below ground.

## Quaternary (Pleistocene) marine and nonmarine (continental) sedimentary rocks (Qoa)

The lithology and paleontological sensitivity of Qoa is identical to the Pleistocene-aged sections of the areas mapped as Q described above except that they are of confirmed Pleistocene age. Therefore, areas mapped as Qoa have a **high paleontological sensitivity.**

## Quaternary-Pliocene (Pliocene-Pleistocene) nonmarine (continental) sedimentary rocks (QPc)

Areas mapped as QPc in southwestern San Joaquin County consist of the Oro Loma Formation per the map Dibblee and Minch (2006). There are no reported vertebrate fossil localities from this unit. Plio-Pleistocene units in northeastern San Joaquin County include the North Merced Gravel and Laguna Formation (Dawson 2009; Gutierrez & Holland 2018). Neither of the units are known to be fossiliferous. Given that areas mapped as QPc include Pleistocene units, these areas may cover the Turlock Lake, Modesto, or Riverbank formations as well. As stated above, these units are known to be fossiliferous. UCMP (2021) reports two Pliocene-aged fossil localities from San Joaquin County both bearing horse (*Equus*) remains. One locality is from an unnamed unit, whereas the other is reportedly from the marine San Joaquin Formation. Given that the areas mapped as QPc include Pleistocene units known to be fossiliferous and Pliocene-aged vertebrate fossils have been found in San Joaquin County, areas mapped as QPc have a **high paleontological sensitivity.**

## Miocene marine sedimentary rocks (M)

The Miocene marine sedimentary unit consist of the Neroly Formation and Briones (or Cierbo) Sandstone preserving marine and marginal marine paleoenvironments (Dibblee & Minch 2006). These units are often referred to collectively as the San Pablo group, but other, often older, sources group the units as the San Pablo Formation. The UCMP reports 35 localities from the Neroly and "San Pablo" formations. Despite the marine or marginal marine nature of the rocks, their fossil content is primarily terrestrial mammals, such as horses (*Nannippus* and *Hipparion*), pronghorn (*Capromeryx*), canids (*Borophagus* [=*Osteoborus*]), elephants (*Gomphotherium*), and rodents (Paleobiology Database [PBDB] 2021; UCMP 2021). Additional fossil localities from the same units occur in Alameda, Contra Costa, and Stanislaus Counties. Given their prolific history of producing vertebrate fossils, the Miocene marine sedimentary units are assigned a **high paleontological sensitivity.**

## Miocene nonmarine (continental) sedimentary rocks (Mc)

The Miocene nonmarine sedimentary unit consist of the Mehrten and Valley Springs formations (Dawson 2009; Gutierrez & Holland 2018). The late Miocene Mehrten Formation is highly fossiliferous. UCMP reports one locality within San Joaquin County, but 42 others are reported from Merced, Stanislaus, and Tuolumne Counties. The localities preserve mammals (horses, cats, elephants, and camels), reptiles (turtles), and fish (PBDB 2021; UCMP 2021). No fossil localities have yet been reported from the Valley Spring Formation. Due to the fossiliferous nature of the Mehrten

Formation within and outside of San Joaquin County, areas mapped as Mc are assigned a **high paleontological sensitivity.**

## Eocene marine sedimentary rocks (E)

The Eocene marine sedimentary unit outcrops within the Diablo Range in southwestern San Joaquin County consist of the Tesla Formation (Dibblee & Minch 2006b). The Tesla Formation has produced invertebrate (mollusk) fossils within San Joaquin County, but no vertebrate material has been reported (PBDB 2021; UCMP 2021). The marine sedimentary rocks have a **low paleontological sensitivity**.

## Paleocene marine sedimentary rocks (Ep)

The mapped Paleocene marine sedimentary units also represent the Tesla Formation. Although Dibblee & Minch (2006a) recognize the entire Tesla Formation as Eocene in age, the location of the outcrops and lack of any Paleocene units in the interpretation of Dibblee & Minch (2006a) show that this is the correct unit. Units designated E in Figure 4.8-2, have a **low paleontological sensitivity.**

## Upper Cretaceous marine sedimentary and metasedimentary rocks (Ku)

The Upper Cretaceous marine sedimentary and metasedimentary units include outcrops of the Moreno and Panoche formations (Dibblee & Minch 2006a, b). The Panoche Formation produces abundant invertebrate (mollusk, arthropod, and echinoderm) throughout the Diablo Range, including San Joaquin County (PBDB 2021; UCMP 2021). However, vertebrate remains are much rarer. Fragmentary bony fish, shark, and marine reptile fossils have been recovered from less than five localities in the Panoche Formation in Contra Costa, Merced, and Stanislaus Counties. The Moreno Formation has produced more than 100 vertebrate fossil localities (PBDB 2021; UCMP 2021). Taxa include marine reptiles (mosasaurs, plesiosaurs, and turtles), bony fish, and sharks, but some of California's few non-avian dinosaur fossils (hadrosaurs) come from the Moreno Formation (Bell & Evans 2010). All vertebrate-bearing localities from the Moreno Formation come from Fresno and Stanislaus Counties, but there are invertebrate (mollusk) fossils reported from San Joaquin and Contra Costa Counties as well, demonstrating that this unit is fossiliferous throughout. Due to the fossil-bearing potential of the Upper Cretaceous marine sedimentary and metasedimentary rocks, particularly the Moreno Formation, has a **high paleontological sensitivity.**

## Cretaceous-Jurassic marine sedimentary and metasedimentary rocks (KJf and KJfm)

Both Cretaceous-Jurassic marine sedimentary and metasedimentary units mapped in Figure 4.8-2 represent the Franciscan Complex differing only in that in areas labeled KJfm consist of fragmented and sheared rather than bedded Franciscan rocks (Jennings et al. 2010). Two marine reptile specimens have been recovered from the Franciscan Complex (PBDB 2021; UCMP 2021). One of the specimens, an ichthyosaur, comes from San Joaquin County (Camp 1941). The other, a plesiosaur, comes from San Luis Obispo County. Invertebrate-bearing localities from the Franciscan Complex are reported throughout the Coast Ranges of central California. The Cretaceous-Jurassic marine sedimentary and metasedimentary rocks have a **high paleontological sensitivity.**

## 4.8.2 Regulatory Setting

### a. Federal Laws, Regulations, and Policies

#### Earthquake Hazards Reduction Act

The Earthquake Hazards Reduction Act was enacted in 1977 to "reduce the risks to life and property from future earthquakes in the United States through the establishment and maintenance of an effective earthquake hazards and reduction program." To accomplish this, the act established the National Earthquake Hazard Reduction Program (NEHRP). NEHRP's mission includes improved understanding and characterization of hazards and vulnerabilities, improvement of building codes and land use practices, risk reduction through post-earthquake investigations and education, development and improvement of design and construction techniques, improvement of mitigation capacity, development of alternative performance objectives to advance functional recovery, and accelerated application of research results. The NEHRP designates the National Institute of Standards and Technology as the lead agency of the program and assigns it several planning, coordinating, and reporting responsibilities. Programs under the NEHRP help inform and guide planning and building code requirements, such as emergency preparedness responsibilities and seismic code standards.

#### Disaster Recovery Reform Act of 2018

The Disaster Recovery Reform Act was signed into law in 2018. The reforms acknowledge the shared responsibility for disaster response and recovery, are intended to reduce the complexity of the Federal Emergency Management Agency (FEMA) and build the nation's capacity for the next catastrophic event. The law, which amends the Robert T. Stafford Disaster Relief and Emergency Assistance Act, contains 56 distinct provisions that require FEMA policy or regulation changes for full implementation. Examples of the provisions include expanding eligible hazard mitigation activities including the replacement of electric utility poles resilient to extreme winds (Section 1204) and earthquake early warning technology (Section 1233).

#### Archaeological and Paleontological Salvage (23 USC 305)

Statute 23 United States Code (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 (Public Law [PL] 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" (Federal Register [FR] 46(19): 9570).

#### Paleontological Preservation Act

The Paleontological Resources Preservation Act (PRPA) was signed into law in 2009. It directs the Department of Agriculture and the Department of the Interior to implement comprehensive paleontological resource management programs on federal lands. The PRPA protects scientifically

significant fossils on federal lands and provides a permitting system where researchers can collect and study scientifically significant fossils which will remain in the public trust. The act also allows for the collection of common plant and invertebrate fossils for personal, non-commercial use on federal lands. The PRPA requires the Secretaries of the Interior and Agriculture to manage and protect paleontological resources on federal land. The PRPA furthers the protection of fossils on federal lands by criminalizing the unauthorized removal of fossils.

## b. State Laws, Regulations, and Policies

### Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act, California's Alquist-Priolo Act (PRC 2621 et seq.), is intended to reduce the risk to life and property from surface fault rupture during earthquakes. The Alquist-Priolo Act prohibits the location of most types of structures intended for human occupancy across the traces of active faults and strictly regulates construction in the corridors along active faults (Earthquake Fault Zones). It also defines criteria for identifying active faults, giving legal weight to terms such as "active," and establishes a process for reviewing building proposals in and adjacent to Earthquake Fault Zones. Under the Alquist-Priolo Act, faults are zoned, and construction along or across them is strictly regulated if they are "sufficiently active" and "well-defined." A fault is considered sufficiently active if one or more of its segments or strands shows evidence of surface displacement during Holocene time (defined as within the last 11,000 years). A fault is considered well-defined if its trace can be clearly identified by a trained geologist at the ground surface or in the shallow subsurface, using standard professional techniques, criteria and judgment.

### Seismic Hazards Mapping Act of 1990

Like the Alquist-Priolo Act, the Seismic Hazards Mapping Act of 1990 (PRC 2690–2699.6) is intended to reduce damage resulting from earthquakes. While the Alquist-Priolo Act addresses surface fault rupture, the Seismic Hazards Mapping Act addresses other earthquake-related hazards, including strong ground-shaking, liquefaction and seismically induced landslides. Its provisions are similar in concept to those of the Alquist-Priolo Act: the State is charged with identifying and mapping areas at risk of strong ground-shaking, liquefaction, landslides and other corollary hazards, and cities and counties are required to regulate development within mapped Seismic Hazard Zones.

### California Building Standards Code

The California Building Code (CBC) appear in the CCR as Title 24, Part 2. Title 24 is administered by the California Building Standards Commission, which, by law, is responsible for coordinating all building standards. The purpose of the CBC is to establish minimum standards to safeguard the public health, safety, and general welfare through structural strength, means of egress facilities, and general stability by regulating and controlling the design, construction, quality of materials, use and occupancy, location, and maintenance of all building and structures within its jurisdiction. The 2019 CBC is based on the 2018 IBC published by the International Code Council. In addition, the CBC contains necessary California amendments, which are based on reference standards obtained from various technical committees and organizations, such as the American Society of Civil Engineers (ASCE), the American Institute of Steel Construction, and the American Concrete Institute. ASCE Minimum Design Standard 7-05 (ASCE 7-05) provides requirements for general structural design and includes means for determining earthquake loads, as well as other loads (e.g., flood, snow, wind), for inclusion into building codes. The provisions of the CBC apply to the construction, alteration,

movement, replacement, and demolition of every building or structure, or any appurtenances connected or attached to such buildings or structures throughout California.

The earthquake design requirements consider the occupancy category of the structure, site class, soil classifications, and various seismic coefficients that are used to determine a Seismic Design Category (SDC) for a project as described in Chapter 16 of the CBC. The SDC is a classification system that combines the occupancy categories with the level of expected ground motions at the site and ranges from SDC A (very small seismic vulnerability) to SDC E (very high seismic vulnerability and near a major fault) and SDC F (hospitals, police stations, emergency control centers in areas near major active faults). Design specifications are then determined according to the SDC in accordance with Chapter 16 of the CBC. Chapter 16, Section 1613 provides earthquake loading specifications for design and construction to resist the effects of earthquake motions in accordance with ASCE 7-05.

Chapter 18 of the CBC covers the requirements of geotechnical investigations (Section 1803); excavation, grading, and fills (Section 1804); load-bearing of soils (1806); foundations (Section 1808); shallow foundations (Section 1809); and deep foundations (Section 1810). Chapter 18 also describes analysis of expansive soils and the determination of the depth to groundwater table. For SDC D, E, and F, Chapter 18 requires analysis of slope instability, liquefaction, and surface rupture attributable to faulting or lateral spreading, plus an evaluation of lateral pressures on basement and retaining walls, liquefaction and soil strength loss, and lateral movement or reduction in foundation soil-bearing capacity. It also addresses mitigation measures to be considered in structural design, which may include ground stabilization, selection of appropriate foundation type and depths, selection of appropriate structural systems to accommodate anticipated displacements, or any combination of these measures. The potential for liquefaction and soil strength loss must be evaluated for site specific peak ground acceleration magnitudes and source characteristics consistent with the design earthquake ground motions.

Specifically, Section 1803.7 of the CBC requires geologic and earthquake engineering reports for all proposed construction. The purpose of the engineering report is to identify geologic and seismic conditions that may require mitigation. The reports, which are prepared by a California certified engineering geologist in consultation with a California-registered geotechnical engineer, assess the nature of the site and potential for earthquake damage based on appropriate investigations of the regional and site geology, project foundation conditions, and potential seismic shaking at the site. These reports must consider the most recent CGS Note 48 (Checklist for the Review of Engineering Geology and Seismology Reports for California Public Schools, Hospitals, and Essential Services Buildings), CGS Special Publication 42: Fault Rupture Hazard Zones in California (for project sites proposed within an Alquist-Priolo Zone), and the most recent version of CGS Special Publication 117: Guidelines for Evaluating and Mitigating Seismic Hazard in California (for project sites proposed within a Seismic Hazard Zone). All conclusions must be fully supported by satisfactory data and analysis.

The geotechnical report required by Section 1803 provides completed evaluations of the foundation conditions of the site and the potential geologic and seismic hazards. It includes site specific evaluations of design criteria related to the nature and extent of foundation materials, groundwater conditions, liquefaction potential, and settlement potential and slope stability, as well as the results of the analysis of problem areas identified in the engineering geologic report. The geotechnical report incorporates estimates of the characteristics of site ground motion provided in the engineering geologic report. The geotechnical report must be prepared by a geotechnical engineer registered in the State of California with the advice of the certified engineering geologist and other technical experts, as necessary. The approved engineering geologic report is submitted with, or as

part of, the geotechnical report. Local jurisdictions in the SJCOG region typically regulate construction activities through a process that requires the preparation of a site specific geotechnical investigation, consistent with Title 24, Part 2, Chapter 18 of the CBC.

## California Construction General Permit Order 2009-0009-DWQ

The California Construction General Permit Order 2009-0009-DWQ (Order) requires projects that would disturb one or more acres of soil, or whose projects disturb less than one acre but are part of a larger common plan of development that in total disturbs one or more acres, to obtain coverage under the Order. As such, applicable projects are required to implement a Storm Water Pollution Prevention Plan (SWPPP) developed by a certified Qualified SWPPP Developer. The SWPPP includes Best Management Practices (BMPs) for erosion and sediment control.

## California Department of Transportation Regulations and Seismic Design Criteria

The California Department of Transportation (Caltrans) has Seismic Design Criteria (SDC) which contain new and currently practiced seismic design and analysis methodologies for the design of new bridges in California. The SDC adopts a performance-based approach specifying minimum levels of structural system performance, component performance, analysis and design practices for ordinary standard bridges. The SDC has been developed with input from the Caltrans Offices of Structure Design, Earthquake Engineering and Design Support and Materials and Foundations. Memo 20-1 outlines the bridge category and classification, seismic performance criteria, seismic design philosophy and approach, seismic demands and capacities on structural components and seismic design practices that collectively comprise Caltrans' seismic design methodology (Caltrans 2010).

## California Assembly Bill 885 (2000)

AB 885 (Chapter 781, Statutes of 2000) required SWRCB to draft and implement regulations for siting, installation, operation, and maintenance of on-site wastewater treatment systems. Proposed regulations were issued in 2009 and adopted in June 2012.

## California Public Resources Code

Section 5097.5 of the Public Resources Code states:

> No person shall knowingly and willfully excavate upon, or remove, destroy, injure or deface any historic or prehistoric ruins, burial grounds, archaeological or vertebrate paleontological site, including fossilized footprints, inscriptions made by human agency, or any other archaeological, paleontological or historical feature, situated on public lands, except with the express permission of the public agency having jurisdiction over such lands. Violation of this section is a misdemeanor.

Here "public lands" means those owned by, or under the jurisdiction of, the state or any city, county, district, authority, or public corporation, or any agency thereof. Consequently, public agencies are required to comply with Public Resources Code Section 5097.5 for their own activities, including construction and maintenance, and for permit actions (e.g., encroachment permits) undertaken by others.

## c. Local Laws, Regulations, and Policies

### San Joaquin County General Plan

The 2035 San Joaquin County General Plan Public Health and Safety Element contains goals and policies related to seismic and geologic hazards. Goal PHS-3 is "To protect life and property from seismic and geologic hazards." The County shall consider the risk to human safety and property from seismic and geologic hazards in designating the location and intensity for new development (PHS3.1). Emergency services, major utility lines and facilities, manufacturing plants using or storing hazardous materials, high occupancy structures, and facilities housing dependent populations are not to be located within one-eighth of a mile of any active fault or on soil that is highly susceptible to liquefaction (PHS-3.2). Emergency service facilities must be capable of withstanding earthquakes and remain operational to provide emergency response (PHS-3.3). New developments in areas determined to have high liquefaction potential must include detailed site-specific liquefaction studies (PHS-3.4). All proposed structures, utilities, or public facilities within County-recognized areas of near-surface subsidence or liquefaction shall be located and constructed in a manner that minimizes or eliminates potential damage (PHS-3.5). The county shall promote regional and local efforts to reduce subsidence in the Delta (PHS-3.6). The county shall encourage the planting of vegetation to decrease loss of soil by erosion (PHS-3.7). The county shall support soil conservation and restoration efforts of the US Soil Conservation Service and the Resource Conservation Districts (PHS-3.8).

### City General Plans and Regulations

#### *City of Escalon General Plan*

The Safety Element of the City of Escalon's General Plan aims to protect the community from seismic and geologic hazards. Geologic Hazards Policies includes ensuring development and infrastructure projects are designed and planned to reduce risk related to seismic and geologic hazards. Specifically, the City of Escalon utilizes implementation strategies which implement California Building Code requirements and require development and infrastructure projects to identify and address potential adverse impacts associated with unstable soils (City of Escalon 2019).

#### *City of Lathrop Comprehensive General Plan*

The City of Lathrop Comprehensive General Plan includes goals and policies for achieving and maintaining safety from seismic events including preventing injury, loss of life, serious damage to critical facilities, and disruption in providing essential public services. Specific policies include, limiting building height to 50 feet, providing soils reports and geologic reports for proposed development, and require all new development to conform to the most recent seismic requirements of the Uniform Building Code (City of Lathrop 1991).

#### *City of Lodi General Plan*

Guiding Policy S-G2 Chapter 8: Safety of the City of Lodi's General Plan aims to prevent the loss of lives, injury, illness, and property damage due to flooding, hazardous materials, seismic and geologic hazards, and fire. Policies S-P18 through S-P22 require soils reports, grading and erosion plans, require geotechnical investigations be prepared for all proposed critical structures, and for buildings identified as seismically unsafe, prohibit change in use to higher occupancy or more intensive use

until an engineering evaluation has been conducted and structural deficiencies corrected consistent with the City of Lodi building codes (City of Lodi 2010).

Policy C-P18 of Chapter 7: Conservation of the City of Lodi's General Plan addresses procedures for the discovery of paleontological resources. It states (City of Lodi 2010):

> In the event that archaeological/paleontological resources are discovered during site excavation, the City shall require that grading and construction work on the project site be suspended until the significance of the features can be determined by a qualified archaeologist/paleontologist. The City will require that a qualified archeologist/ paleontologist make recommendations for measures necessary to protect any site determined to contain or constitute an historical resource, a unique archaeological resource, or a unique paleontological resource or to undertake data recovery, excavation, analysis, and curation of archaeological/paleontologist materials. City staff shall consider such recommendations and implement them where they are feasible in light of project design as previously approved by the City.

### *City of Manteca General Plan 2023*

The Safety Element of the City of Manteca General Plan 2023 require the preparation of geological reports for proposed new development located in an area of potentially significant geologic hazards, require all new development to comply with the Uniform Building Code, California Health and Safety Code Section 19100, and ensures the City identify potentially hazardous buildings and adopt a mitigation program for these buildings (City of Manteca 2003).

### *City of Ripon General Plan*

The City of Ripon General Plan's Community Health and Safety chapter includes goals and policies which aim to prevent the loss of life and property damage due to geological hazards. Policies from the San Joaquin County General Plan Public Health and Safety Element are incorporated into the City of Ripon's General Plan (City of Ripon 2006).

### *City of Stockton General Plan*

The City of Stockton's Safety Element of the Envision Stockton 2040 General Plan Goal SAF-2 focuses on the protection of residents and businesses from natural and human-caused hazards. Actions SAF-2.2B through SAF-2.2D require period updating of emergency management plans, require critical facilities to be located, designed, and constructed to avoid or mitigate seismic and geologic events, and require coordination between the County Office of Emergency Services, other cities, and disaster agencies to coordinate emergency preparedness planning (City of Stockton 2018).

The Land Use Element of the Envision Stockton 2040 General Plan requires the following tasks by an approved archeologist or paleontologist prior to any project approval (City of Stockton 2018):

- Conduct a record search at the Central California Information Center located at California State University Stanislaus, the University of California Museum of Paleontology at Berkeley, and other appropriate historical or archaeological repositories.
- Conduct field surveys where appropriate.
- Prepare technical reports, where appropriate, meeting California Office of Historic Preservation or other appropriate standards.

- Where development cannot avoid an archaeological or paleontological deposit, prepare a treatment plan in accordance with appropriate standards, such as the Secretary of the Interior's Standards for Treatment of Archaeological Sites.

### *City of Tracy General Plan*

The Safety Element of the City of Tracy's General Plan Goal SA-1 aims to reduce risks in the community from earthquakes and other geologic hazards. Specifically, Objectives SA-1.1 and SA-1.2 minimize the impacts of geologic hazards on land development and implement measures related to site preparation and building construction that protect life and property from seismic hazards. Policies that carry out these objectives include requiring underground utilities to be designed to withstand seismic forces, requiring geotechnical reports for projects where potentially serious geologic risks exist, enforcing California Building Code and Tracy Municipal Code standards (City of Tracy 2011).

The Community Character Element of the City of Tracy's General Plan Policies P4 and P5 under Objective CC-3.1 implement a condition of approval for projects that halt operations should a paleontological resource be discovered and require preservation of paleontological resources and implementation of conservation measures should any resources be found unexpectedly (City of Tracy 2011).

## 4.8.3 Impact Analysis

### a. Methodology and Significance Thresholds

Appendix G of the State CEQA Guidelines identifies the following criteria for determining whether development facilitated by the proposed 2022 RTP/SCS would have a significant impact on geology and soils, namely an analysis of whether or not the 2022 RTP/SCS would:

1. Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
    i. 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 of a known fault? Refer to Division of Mines and Geology Special Publication 42?
    ii. Strong seismic ground shaking,
    iii. Seismic-related ground failure, including liquefaction, or
    iv. Landslides;
2. Result in substantial soil erosion or the loss of topsoil;
3. Be located on a geologic unit or soil that is 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;
4. Be located on expansive soil, creating substantial risks to life or property; or
5. 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.
6. Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.

## b. Project Impacts and Mitigation Measures

The following section discusses potential impacts and mitigation measures that may be associated with projects contained within the 2022 RTP/SCS. Section 4.8.3.c summarizes the impacts associated with capital improvement projects proposed in the 2022 RTP/SCS. Due to the programmatic nature of the 2022 RTP/SCS, a precise, project-level analysis of the specific impacts associated with individual transportation and land use projects is not possible at this time. In general, however, implementation of proposed transportation improvements and future projects under the land use scenario envisioned by the 2022 RTP/SCS could result in the impacts as described in the following section.

| | |
|---|---|
| **Threshold 1:** | Directly or indirectly cause potential 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 landslides |

**Impact GEO-1 THE PROPOSED TRANSPORTATION IMPROVEMENTS AND LAND USE PROJECTS ENVISIONED BY THE PROPOSED 2022 RTP/SCS WOULD NOT DIRECTLY OR INDIRECTLY CAUSE POTENTIAL 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 LANDSLIDES. IMPACTS WOULD BE LESS THAN SIGNIFICANT.**

Fault rupture can occur along or immediately adjacent to faults during an earthquake. Fault rupture is characterized by ground cracks and displacement which could endanger life and property. Damage is typically limited to areas close to the moving fault.

Ground shaking effects are also the result of an earthquake, but the impacts can be widespread. Although a function of earthquake intensity, ground shaking effects can be magnified by the underlying soils and geology, which may amplify shaking at great distances. It is difficult to predict the magnitude of ground shaking following an earthquake, as shaking can vary widely within a relatively small area.

As indicated by Figure 4.8-1, transportation projects across the SJCOG region would not be vulnerable to fault rupture as none of the roadway projects for the proposed 2022 RTP/SCS are located within or near an active fault system. Proposed interchange and highway projects would take place along Interstate 580 near the Black Butte Fault, and along Interstate 205 and Interstate 5, near the Black Butte and Vernalis Faults, but these are considered potentially active rather than active. Land use growth envisioned under the proposed 2022 RTP/SCS would emphasize infill development and thus be implemented within the cities of the SJCOG region, none of which intersect earthquake fault zones, as shown in Figure 4.8-1. The city of Tracy is adjacent to the Black Butte and Vernalis Faults and has the potential to be at risk of adverse effects from ground shaking. However, any potential structural damage and the exposure of people to the risk of injury or death from structural failure would be minimized by compliance with California Building Code engineering design and construction measures. Foundations and other structural support features would be designed to resist or absorb damaging forces from strong ground shaking.

Although a function of earthquake intensity, ground-shaking effects can be magnified by the underlying soils and geology, which may amplify shaking at great distances. It is difficult to predict the magnitude of ground-shaking following an earthquake, as shaking can vary widely within a relatively small area. The type of transportation and land use projects proposed under the proposed 2022 RTP/SCS are unlikely to exacerbate seismic activity, fault rupture, or increases in ground shaking due to the nature of the project's effects, including construction, being near or on the

ground surface. Footings and pilings that could extend below the surface would be localized to the project site and require geological testing for specific impacts. The potential to directly, or indirectly, cause adverse impacts due to rupture of a known earthquake fault related to the projected land use pattern and planned transportation improvements from implementation of the proposed 2022 RTP/SCS would be less than significant.

Seismic related ground failure such as liquefaction may result from an earthquake in the SJCOG region. According to the San Joaquin County General Plan EIR, no specific countywide assessments to identify liquefaction hazards have been performed in San Joaquin County. Liquefaction typically occurs in areas underlain with loose saturated cohesion-less soils within the upper 50 feet of subsurface materials. The Counties of Contra Costa and Solano, which have similar Delta conditions as the SJCOG region, indicate the Delta area of the SJCOG region is likely to have areas with moderate to high susceptibility (San Joaquin County 2014). Detailed, site-specific geotechnical engineering investigations would be necessary to evaluate liquefaction potential more accurately in specific project areas and to identify and map the extent of locations in the SJCOG region subject to liquefaction.

Projects near the canal and levee system in the Delta are particularly susceptible to landslides. Much of the system has not been engineered to withstand forces that could be created by future earthquakes. Projects which are the most susceptible include regional highway segments which cross or are adjacent to steeply sloped streambanks within the Delta region, and projects near the Manteca-Lathrop area. Landslide risk also occurs in the southwestern region of the SJCOG region, within the foothills southwest of the City of Tracy; however proposed 2022 RTP/SCS projects do not extend into the foothills area of the SJCOG region. The potential to directly or indirectly cause adverse impacts due to seismic-related liquefaction or landslide from the projected land use development and planned transportation improvements from implementation of the proposed 2022 RTP/SCS would be less than significant.

All projects are required to adhere to design standards described in the CBC and all standard geotechnical investigation, design, grading, and construction practices to avoid or reduce impacts from earthquakes, ground shaking, ground failure, and landslides. These requirements would partially reduce seismic impacts. Moreover, construction within seismic zones as identified by the Alquist-Priolo Act and the Seismic Hazards Mapping Act of 1990 (PRC 2690 -2699.6) is required by the CBC to follow more stringent regulations to withstand fault ruptures and ground shaking effects from seismic activities. The CBC provides standards for various aspects of construction, including but not limited to: excavation, grading and earthwork construction; fills and embankments; expansive soils; foundation investigations; liquefaction potential; and soil strength loss. In accordance with California law and regulation, proponents of specific projects are required to comply with all provisions of the CBC for certain aspects of design and construction.

There are limited instances where the proposed land use pattern and planned transportation investments of the proposed 2022 RTP/SCS may result in growth in or near a known earthquake fault, strong seismic ground shaking, seismic-related ground failure, including liquefaction, or landslides prone areas, substantial geologic-related effects could still occur. The types of transportation and land use projects planned under the proposed 2022 RTP/SCS are unlikely to exacerbate seismic activity, fault rupture, or increases in ground shaking due to the nature of the project's effects, including construction, being near or on the ground surface. Footings and pilings that could extend below the surface would be localized to the project site and require geological testing for specific impacts. The proposed 2022 RTP/SCS would not have the potential to exacerbate risks related to seismic activity. Compliance with the CBC and provisions of the Alquist-Priolo Act,

including the preparation of a site-specific geotechnical investigation, would reduce the potential for seismic damage to occur as a result of implementation of proposed 2022 RTP/SCS projects. Compliance with the CBC and provisions of the Alquist-Priolo Act, including the preparation of a site-specific geotechnical investigation, would minimize the potential for seismic damage to occur as a result of implementation of proposed 2022 RTP/SCS projects. Based on the above analysis, impacts would be less than significant.

## Mitigation Measures

None required.

| **Threshold 2:** | Result in substantial soil erosion or the loss of topsoil |
|---|---|

### Impact GEO-2 THE PROPOSED TRANSPORTATION IMPROVEMENTS AND LAND USE PROJECTS ENVISIONED BY THE PROPOSED 2022 RTP/SCS WOULD NOT RESULT IN SUBSTANTIAL SOIL EROSION OR THE LOSS OF TOPSOIL. IMPACTS WOULD BE LESS THAN SIGNIFICANT.

Erosion and grading have the potential to create unstable slopes and significant loss of topsoil can occur for projects where excavations require off-site soil disposal. The topography of the SJCOG region includes relatively wide expanses of fairly flat areas with soil conditions that exhibit minimal potential for erosion impacts. Varying topography exists within the foothills to the immediate southwest of the City of Tracy, however no proposed projects are southwest of Interstate 580 and South Corral Hollow Road, where the foothill region begins. Buildout under the proposed 2022 RTP/SCS would occur in conformance with Title 9 of the San Joaquin County Code of Ordinances for grading and erosion standards and guidelines. These ordinances would require the appropriate measures to prevent erosion as a result of implementation of transportation and land use projects under the proposed 2022 RTP/SCS, further reducing impacts.

In addition, the Construction General Permit would require a project specific Stormwater Pollution Prevention Plan (SWPP) to be prepared for each project that disturbs an area one acre or larger. The SWPPPs would include project specific best management practices (BMPs) designed to control drainage and erosion. Project BMPs to control erosion may include, but would not be limited to silt fencing, fiber rolls, slope stabilization and sandbags. These BMPs would be required as part of each individual project permit and would minimize impacts related to soil erosion and loss of topsoil as a result of construction or grading.

Adherence to the applicable ordinance codes and other local, State, and regulatory programs, as discussed above, would ensure that project-specific erosion and topsoil loss would be minimized. Because such effects would not be substantial, impacts related to erosion and loss of topsoil would be less than significant.

## Mitigation Measures

No mitigation measures are required.

| | |
|---|---|
| **Threshold 3:** | Be located on a geologic unit or soil that is 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 |
| **Threshold 4:** | Be located on expansive soil, creating substantial direct or indirect risks to life or property |

### Impact GEO-3 IMPLEMENTATION OF TRANSPORTATION IMPROVEMENTS AND FUTURE PROJECTS INCLUDED IN THE LAND USE SCENARIO ENVISIONED IN THE PROPOSED 2022 RTP/SCS COULD BE LOCATED ON POTENTIALLY UNSTABLE SOILS, IN AREAS OF LATERAL SPREADING, SUBSIDENCE, OR HIGH LIQUEFACTION POTENTIAL, OR AREAS OF EXPANSIVE SOIL. IMPACTS WOULD BE LESS THAN SIGNIFICANT.

Implementation of proposed transportation improvements and future projects under the land use scenario envisioned by the proposed 2022 RTP/SCS could be prone to slope instability, liquefaction, and other soil-related hazards.

Ground failure, including liquefaction, lateral spreading, and subsidence, caused by an earthquake could occur in the SJCOG region depending on the underlying conditions including ground water level, relative size of soil particles, and density of subsurface materials within 50 feet of ground surface. Damage from earthquake-induced ground failure associated with liquefaction, lateral spreading, and subsidence could be high in buildings with foundations not properly constructed for such hazards. Ground failure associated with liquefaction would result in damage to transportation projects if not engineered appropriately.

Transportation projects exist near the Manteca-Lathrop area, as well as in the Delta area, where there is potential for landslides and liquefaction. Erosion and ground slumping of soils can also occur along the banks of rivers, such as the San Joaquin River. It is known subsidence occurs across the Delta and has caused a decrease in land elevation. Impacts related to these types of geological hazards are site specific and need to be evaluated on a project-by-project basis (San Joaquin County 2014).

New land use development and transportation projects constructed on expansive soils could be subject to damage or could become unstable when the underlying soil shrinks or swells. Soils with high clay content have the highest potential for shrink-swell. Within the SJCOG region, expansive soils are more common along the western boundary as well as its central portion, near Stockton, and some eastern portions. There are proposed 2022 RTP/SCS projects within areas of expansive soils (San Joaquin County 2014). However, expansive soils found on site can be remediated, as structures and foundations would be engineered to withstand the forces of expansive soil to ensure compliance with the CBC

The preparation of site-specific geotechnical studies prepared in accordance with requirements as set forth by the CBC, the Seismic Hazards Mapping Act, and standard industry practices would reduce impacts related to slope instability, liquefaction, soil expansion, and ground failure. Future projects under the proposed 2022 RTP/SCS would also be required to comply with local general plans and local building code requirements that contain seismic safety policies to resist ground failure through construction techniques, including structural design. Potential structural damage and the exposure of people to the risk of injury or death from structural failure would be minimized by compliance with California Building Code engineering design and construction measures. Foundations and other structural support features would be designed to resist or absorb damaging forces from expansive soils, liquefaction, or landslides. Land use and transportation projects included in the proposed 2022 RTP/SCS would be required to comply with the CBC, and local

building standards including the implementation of geotechnical practices such as ground treatments or replacing existing soils with engineered fill. Transportation projects that would involve the construction or improvements of bridge or overpass design would also be required to comply with Caltrans seismic design criteria which would reduce potential ground failure hazards. The proposed 2022 RTP/SCS would not have the potential to exacerbate risks related to ground failure.

Therefore, impacts related to ground failure hazards, including liquefaction, lateral spreading, subsidence, and expansive soils would be less than significant with compliance with the CBC, local general plans and building standards, and Caltrans design criteria for transportation projects, where applicable.

## Mitigation Measures

No mitigation is required.

| | |
|---|---|
| **Threshold 5:** | 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 |

### Impact GEO-4 THE PROPOSED TRANSPORTATION IMPROVEMENTS AND LAND USE PROJECTS ENVISIONED BY THE PROPOSED 2022 RTP/SCS IN RURAL AREAS MAY HAVE SOILS INCAPABLE OF ADEQUATELY SUPPORTING SEPTIC TANKS OR ALTERNATIVE WASTEWATER DISPOSAL SYSTEMS. IMPACTS WOULD BE LESS THAN SIGNIFICANT.

The proposed 2022 RTP/SCS does not include transportation projects that would require the use of septic tanks or alternative wastewater disposal systems. The expansion and/or improvement of streets, highways, transit facilities, airports and related transportation infrastructure would not include elements that would require wastewater treatment or otherwise necessitate the development of septic systems.

Future land use development projects implementing the proposed 2022 RTP/SCS land use would connect to centralized wastewater infrastructure; and any development projects in rural areas requiring septic tanks or alternative wastewater disposal systems would be required to comply with local regulatory requirements that assure soils would adequately support these systems. Septic and alternative wastewater disposal systems would be required to comply with AB 885 and applicable County or City regulations. Septic systems in the SJCOG region would be required to comply with requirements as set forth by the San Joaquin County Environmental Health Department and San Joaquin County Municipal Code Title 5, Division 3, Chapter 1, Section 5-3004: Septic Tanks. Cities within the SJCOG region would further require compliance with municipal code requirements as set forth by individual jurisdictions. Therefore, impacts related to having soils incapable of adequately supporting the use of septic tanks and alternative wastewater disposal systems would be less than significant.

## Mitigation Measures

No mitigation is required.

| | |
|---|---|
| **Threshold 6:** | Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature |

**Impact GEO-5 IMPLEMENTATION OF THE PROPOSED TRANSPORTATION IMPROVEMENTS AND THE LAND USE SCENARIO ENVISIONED BY 2022 RTP/SCS COULD CAUSE A SUBSTANTIAL ADVERSE CHANGE IN OR DISTURB KNOWN AND UNKNOWN PALEONTOLOGICAL RESOURCES AS DEFINED IN CEQA GUIDELINES SECTION 15064.5. IMPACTS TO PALEONTOLOGICAL RESOURCES WOULD BE SIGNIFICANT AND UNAVOIDABLE.**

Paleontological resources are present throughout the SJCOG region. Therefore, it is possible to encounter known and unknown paleontological resources as a result of implementation of transportation improvement projects pursuant to the proposed 2022 RTP/SCS.

The *State CEQA Guidelines* provide no definition to the term "unique geologic feature." This phrase also has no common definition. However, a geologic unit could be considered unique if it is a stratotype, contributes to scientific research, or is exclusive to the region.

Many of the land use and transportation projects proposed under the proposed 2022 RTP/SCS consist of minor expansions of existing facilities that would not involve construction in previously undisturbed areas. However, depending on the location and extent of the proposed improvement and ground disturbance, paleontological resources or unique geologic features could be impacted. There are mapped areas with a higher occurrence of paleontological features, but it should be noted that any project overlying a geologic unit with high paleontological sensitivity could result in impacts, regardless of location relative to existing development. It is also possible that construction activities associated with some of the proposed roadway or bridge widening or extension projects could adversely impact paleontological resources or unique geologic features by exposing them to potential vandalism or causing displacement from the original context and integrity. Project-specific analysis would be required as individual projects are proposed.

In addition, the proposed 2022 RTP/SCS contains a future land use scenario that emphasizes infill near transit and within existing urbanized areas, but with development still allowed in more suburban and rural areas. It is possible that paleontological resources or unique geologic features could be located on or near future infill sites, or other development sites. Project grading and excavation for land development may disturb these known or undiscovered resources. Impacts to paleontological resources or unique geologic features would therefore be potentially significant. The following mitigation measures would reduce this impact.

## Mitigation Measures

For transportation projects under their jurisdiction, SJCOG shall implement, and transportation project sponsor agencies can and should implement, the following mitigation measures developed for the proposed 2022 RTP/SCS program where applicable for transportation projects that would result in impacts to paleontological resources and where feasible and necessary based on project and site-specific considerations. Cities and the County can and should implement these measures, where relevant to land use projects implementing the proposed 2022 RTP/SCS. Project specific environmental documents may adjust these mitigation measures as necessary to respond to site specific conditions.

### *GEO-5 Paleontological Resources Impact Minimization*

The implementing agency of a proposed 2022 RTP/SCS project involving ground disturbing activities (including grading, trenching, foundation work and other excavations) shall, or can and should, retain a qualified paleontologist, defined as a paleontologist who meets the Society of Vertebrate Paleontology (SVP) standards for Qualified Professional Paleontologist (SVP 2010), to conduct a Paleontological Resources Assessment (PRA). The PRA shall determine the age and paleontological sensitivity of geologic formations underlying the proposed disturbance area, consistent with SVP Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources (SVP 2010) guidelines for categorizing paleontological sensitivity of geologic units within a project area. If underlying formations are found to have a high potential (sensitivity) for paleontological resources and/or could be considered a unique geologic feature, the following measures shall apply:

- **Avoidance.** Avoid routes and project designs that would permanently alter unique paleontological and geological features. If avoidance practices cannot be implemented, the following measures shall apply.
- **Retention of a Qualified Paleontologist.** A Qualified Paleontologist shall be retained to create a Paleontological Resources Monitoring and Mitigation Program (PRMMP) to direct all mitigation measures related to paleontological resources. The Qualified Paleontologist shall meet the qualifications for a Qualified Professional Paleontologist, which is defined by the SVP as an individual, preferably with an M.S. or Ph.D. in paleontology or geology, who is experienced with paleontological procedures and techniques, who is knowledgeable in the geology of California, and who has worked as a paleontological mitigation project supervisor for a least two years (SVP 2010).
- **Paleontological Worker Environmental Awareness Program (WEAP).** Prior to the start of ground disturbance activity, construction personnel shall be informed on the appearance of fossils and the procedures for notifying paleontological staff should fossils be discovered by construction staff.
- **Paleontological Monitoring.** Paleontological monitoring shall be conducted by a qualified paleontological monitor, who is defined as an individual who has experience with collection and salvage of paleontological resources and meets the minimum standards of the SVP (2010) for a Paleontological Resources Monitor. The duration and timing of the monitoring will be determined by the Qualified Paleontologist based on the observation of the geologic setting from initial ground disturbance. If the Qualified Paleontologist determines that full-time monitoring is no longer warranted, based on the specific geologic conditions once the full depth of excavations has been reached, they may recommend that monitoring be reduced to periodic spot-checking or ceased entirely. Monitoring shall be reinstated if any new ground disturbances are required, and reduction or suspension shall be reconsidered by the Qualified Paleontologist at that time. In the event of a fossil discovery by the paleontological monitor or construction personnel, all work in the immediate vicinity of the find shall cease. A Qualified Paleontologist shall evaluate the find before restarting construction activity in the area. If it is determined that the fossil(s) is (are) scientifically significant, the Qualified Paleontologist shall complete the following conditions to mitigate impacts to significant fossil resources:
- **Fossil Salvage**. If fossils are discovered, the implementing agency shall be notified immediately, and the qualified paleontologist (or paleontological monitor) shall recover them. Typically, fossils can be safely salvaged quickly by a single paleontologist and not disrupt construction activity. In some cases, larger fossils (such as complete skeletons or large mammal fossils)

require more extensive excavation and longer salvage periods. In this case, the paleontologist should have the authority to temporarily direct, divert or halt construction activity to ensure that the fossil(s) can be removed in a safe and timely manner.

- **Preparation and Curation of Recovered Fossils**. Once salvaged, fossils shall be identified to the lowest possible taxonomic level, prepared to a curation-ready condition, and curated in a scientific institution with a permanent paleontological collection along with all pertinent field notes, photos, data, and maps.
- **Final Paleontological Mitigation and Monitoring Report**. Upon completion of ground disturbing activity (and curation of fossils, if necessary) the Qualified Paleontologist shall prepare a final mitigation and monitoring report outlining the results of the PRMMP. The report shall include discussion of the location, duration and methods of the monitoring, stratigraphic sections, any recovered fossils, and the scientific significance of those fossils, and where fossils were curated. The report shall be submitted to the sponsor agency. If the monitoring efforts recovered fossils, then a copy of the report shall also be submitted to the designated museum repository.

#### IMPLEMENTING AGENCIES AND TIMING

Implementing agencies for transportation projects are SJCOG and transportation project sponsor agencies. Implementing agencies for land use projects are cities and the County. This mitigation measure shall, or can and should, be applied during permitting and environmental review and implemented during construction where appropriate

### Significance After Mitigation

Implementation of the above mitigation measure would reduce impacts to paleontological resources by requiring a Paleontological Resources Assessment for any projects under the proposed 2022 RTP/SCS that may impact sensitive paleontological resources. While implementation of Mitigation Measure GEO-5 would reduce impacts to the extent feasible, some project-specific impacts may be unavoidable. Therefore, this impact is significant and unavoidable. No additional mitigation measures to reduce this impact to less than significant levels are feasible.

## c. Specific 2022 RTP/SCS Projects that May Result in Impacts

identifies proposed 2022 RTP/SCS projects that may result in geology and soils impacts as discussed above. Given the large number of projects envisioned across the SJCOG region in the proposed 2022 RTP/SCS, the table shows a representative rather than comprehensive list of projects that would generate these impacts. Listed projects are representative of the types of impacts and the types of projects that could be affected in different localities. Additional site-specific analysis will need to be conducted as the individual projects are implemented in order to determine the project-specific magnitude of impact. Mitigation measures discussed above would apply to these specific projects as well as any other proposed 2022 RTP/SCS projects that would result geology and soils-related impacts.

The state of California contains numerous paleontological resources throughout its state boundary. While some geologic units are known to have higher paleontological sensitivities than others, unknown paleontological resources may be encountered at all proposed 2022 RTP/SCS project sites. While additional site-specific paleontological studies could determine the sensitivity of site-specific underlying geologic units, it is impossible to accurately account for the existence of all paleontological resources prior to ground-disturbing activities. Therefore, due to the potential for all

proposed 2022 RTP/SCS projects to encounter paleontological resources, Table 4.8-2 does not specifically identify projects potentially impacted byGeo-5.

### Table 4.8-2 Proposed 2022 RTP/SCS Projects That May Result in Impacts

| Project Jurisdiction and Location | Improvement | Potential Impact |
|---|---|---|
| **City of Lathrop** | | |
| I-5 at Louise Avenue | Reconstruct interchange (PM 16.4-16.8) | GEO-1 |
| I-5 at Lathrop Road | Reconstruct interchange (PM 17.3/17.8) | GEO-1 |
| SR 120 at Yosemite Ave/Guthmiller Road | Reconstruct interchange | GEO-1 |
| Along Northwest side of I-5 from Brookhurst Blvd to Stewart Road | Construct new roadway parallel to I-5, 2 lanes from Brookhurst Blvd to Stewart Road | GEO-1 |
| Along Northwest side of I-5 from Stewart Road to Paradise Road | Construct new roadway parallel to I-5, 4 lanes from Stewart Road to Paradise Road | GEO-1 |
| Along Northwest side of I-5 from Brookhurst Blvd to Stewart Road | Widen from 2 to 4 lanes, from Brookhurst Blvd to Stewart Road | GEO-1 |
| **City of Manteca** | | |
| SR-120 at McKinley Avenue | Construct new interchange | GEO-1 |
| SR-120 at Airport Way | Reconstruct interchange | GEO-1 |
| SR-120 at Main Street | Reconstruct interchange | GEO-1 |
| SR-99 at Raymus Expressway | Construction of new interchange | GEO-1 |
| East of Airport Way to Union Road | Construct new 4 lane roadway (gap closure) | GEO-1 |
| SR-120 to Yosemite Ave. | Widen from 2 to 4 lanes | GEO-1 |
| Lathrop Road to Roth Road | Widen from 2 to 4 lanes | GEO-1 |
| Main Street to SR-99 | Widen from 2 to 4 lanes | GEO-1 |
| McKinley Ave to West of Airport Way | Construct new 4 lane roadway | GEO-1 |
| From East of UPRR to SR-99 | Widen from 2 to 4 lanes | GEO-1 |
| Main Street to SR-99 | Construct new 4-lane expressway | GEO-1 |
| Yosemite Ave. to Lathrop Road | Widen from 2 to 4 lanes | GEO-1 |
| SR-120 to Woodward Ave | Construct new 2 lane expressway | GEO-1 |
| Woodward Ave to McKinley Ave | Construct new 4 lane roadway | GEO-1 |
| Woodward Ave to Main Street | Construct new 2 lane expressway | GEO-1 |
| SR 120 to Lathrop Road | Widen from 4 to 6 lanes | GEO-1 |
| **City of Tracy** | | |
| I-580 at Mountain House Parkway | Reconstruct interchange | GEO-1 |
| I-580 at Coral Hollow Road | Modification of existing interchange | GEO-1 |
| I-580 at Lammers Road | Modification of existing interchange | GEO-1 |
| I-580 at Iron Horse | Modification of existing interchange | GEO-1 |
| I-205 to I-580 | Widen from 2 to 4 lanes, including reconstruction of Delta-Mendota Canal and California Aqueduct bridges | GEO-1 |
| Linne Road to I-580 | Widen 2 to 4 lanes including ROW and construction of two bridges | GEO-1 |

## 4.8.4 Cumulative Impacts

The cumulative impact analysis area for geology and soils consists of the SJCOG region and adjoining counties. Information regarding these adjoining counties can be found in Section 3.0, *Environmental Setting*. Future development in this region that could impact geology and soils is considered in the analysis. This cumulative extent is used to evaluate potential direct and indirect, permanent and temporary impacts to increased exposure to seismic hazards, increased erosion and/or loss of topsoil, the presence of unstable or expansive soils, and the presence of paleontological resource or unique geologic features within the context of the cumulative impact analysis area.

Geology and soils impacts may be related to increased exposure to seismic hazards, increased erosion and/or loss of topsoil, the presence of unstable/expansive soils and alternative waste disposal or septic systems. Individual projects and developments in the cumulative impacts analysis area would be subject to geologic hazards based on site-specific conditions and project design. These effects occur independently of one another and are caused by site specific and project specific characteristics and conditions. In addition, existing regulations, such as the California Building Code, specify mandatory actions that must occur during project development, which would minimize effects from construction and operation of projects related to geology, soils, and seismicity as discussed above. Cumulative impacts related to geology, soils and seismicity would therefore be less than significant.

While projects envisioned under the 2022 RTP/SCS may be subject to seismic hazards, including ground-shaking, landslides, liquefaction, and subsidence, compliance with applicable requirements would reduce impacts. Future development envisioned under the 2022 RTP/SCS would be required to comply with the California Building Code, Seismic Hazards Mapping Act, Alquist Priolo Act, and local building codes, general plan goals and policies. Furthermore, geology and soils impacts are site specific by nature and would not result in cumulative impacts to the surrounding area. The 2022 RTP/SCS would not have a cumulatively considerable contribution to significant cumulative impacts related to geology, soils and seismicity.

Development and construction in the cumulative impacts analysis area would require excavation and ground disturbance. Excavation and ground disturbance could encounter and damage or destroy subsurface paleontological resources, depending on underlying geologic units and soils. While most paleontological resources are typically site specific, with impacts that are project specific, others may have regional significance. For example, fossils may capture a particular type of organism that was endemic to a region and therefore have regional significance. Due to the potential for a fossil of regional significance to be uncovered during excavation and ground disturbing activities of projects in the cumulative impact analysis area, cumulative impacts would be significant.

The 2022 RTP/SCS could cause a substantial adverse change in or disturb known and unknown paleontological resources and would therefore result in a cumulatively considerable contribution to the significant impact. Mitigation measures outlined above, would reduce paleontological resource impacts associated with 2022 RTP/SCS projects. However, as discussed in Impact GEO-5, it cannot be guaranteed that all future project-level impacts can be mitigated to a less than significant level. As such, the 2022 RTP/SCS contribution to cumulative impacts to paleontological resources would be cumulatively considerable.

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