3 Affected Environment, Environmental Consequences, and Mitigation Measures

3.9 Geology, Soils, Seismicity, and Paleontological Resources

3.9.1 Introduction

Section 3.9, Geology, Soils, Seismicity, and Paleontological Resources, of this *Merced to Fresno Section: Central Valley Wye Draft Supplemental Environmental Impact Report (EIR)/Environmental Impact Statement (EIS)* (Draft Supplemental EIR/EIS) updates the *Merced to Fresno Section California High-Speed Train Final Project EIR/EIS* (Merced to Fresno Final EIR/EIS) (California High-Speed Rail Authority [Authority] and Federal Railroad Administration [FRA] 2012) with new and revised information relevant to geologic and paleontological resources, analyzes the potential impacts of the No Project Alternative and the Central Valley Wye alternatives, and describes impact avoidance and minimization features (IAMF) that would avoid, minimize, or reduce these impacts. Where applicable, mitigation measures are proposed to further reduce, compensate for, or offset impacts of the Central Valley Wye alternatives. Section 3.9 also defines the geologic and paleontological resources within the region and describes the affected environment in the resource study areas (RSA).

The analysis herein has similarities to and differences from the analysis conducted for the Merced to Fresno Final EIR/EIS. Both analyses used the same methods to examine potential impacts on geologic resources, including an evaluation of seismic and nonseismic geologic hazards, soil conditions, and mineral and energy resources. For paleontological resources, both analyses considered the documented paleontological sensitivity[1] of surface-exposed and underlying geologic units to determine the potential for impacts. The geology and paleontological resources analyses presented here use data sources similar to those used in the Merced to Fresno Final EIR/EIS, including national and state databases to identify soil units and geologic hazards, and the published geologic and paleontological literature and museum and university collections databases to evaluate paleontological sensitivity. Where information has changed or new information has become available since the Merced to Fresno Final EIR/EIS was prepared in 2012, the analysis in this Draft Supplemental EIR/EIS uses the updated versions of these sources or datasets. Relevant portions of the Merced to Fresno Final EIR/EIS that remain unchanged are summarized and referenced in this section but are not repeated in their entirety. The analyses differ in the following ways:

- The Merced to Fresno Final EIR/EIS examined geology, soils, and seismicity separately from paleontological resources, which was grouped with cultural resources.
- Subsequent to the preparation of the Merced to Fresno Final EIR/EIS, the Authority adopted updated guidelines for paleontological resources; the paleontological resources analysis presented in this Draft Supplemental EIR/EIS follows the current methodology.

The *Merced to Fresno Section: Central Valley Wye Geology, Soils, and Seismicity Technical Report* (Geology, Soils, and Seismicity Technical Report) (Authority and FRA 2016a) provides additional technical details on geologic resources and geologic hazards. The *Merced to Fresno Section: Central Valley Wye Paleontological Resources Technical Report* (Paleontological Resources Technical Report) (Authority and FRA 2016b) provides additional technical details on paleontological resources. The Geology, Soils, and Seismicity Technical Report and the Paleontological Resources Technical Report are available on the Authority's website: http://hsr.ca.gov/Programs/Environmental_Planning/supplemental_merced_fresno.html,

[1] *Paleontological sensitivity* is defined in Section 3.9.4.2, Paleontological Resources.

respectively.[2] Additional information relevant to the analysis of geologic and paleontological resources is provided in the following appendix of this Draft Supplemental EIR/EIS:

- Appendix 2-C, Applicable Design Standards, provides the list of applicable design standards relevant to geology, soils, and seismicity.

Geologic resources, including soils, geologic hazards, and seismic hazards in the San Joaquin Valley are important factors in the design, construction, and operation of infrastructure projects. The geologic setting of the Central Valley Wye alternatives in the Great Valley Geomorphic and Physiographic Province is also an important area for paleontological resources. Key geologic units in the area include the Turlock Lake, Modesto, and Riverbank Formations, which have all produced significant paleontological finds. Three other resource sections in this Draft Supplemental EIR/EIS provide additional information related to geologic resources:

- **Section 3.8, Hydrology and Water Resources**—Impacts of the Central Valley Wye alternatives on surface water hydrology, water quality, groundwater, floodplains, and soil erosion.
- **Section 3.10, Hazardous Materials and Wastes**—Impacts of the Central Valley Wye alternatives on hazardous materials and waste sites.
- **Section 3.11, Safety and Security**—Impacts of the Central Valley Wye alternatives on the earthquake safety of the high-speed rail (HSR) system.

The following topics are not included in this Draft Supplemental EIR/EIS because they do not present a risk or would not result in a change from baseline conditions:

- Seiche and tsunami hazards are not included this Draft Supplemental EIR/EIS because the Central Valley Wye alternatives are not located close to a lake, bay, or ocean that might create these risks.
- Volcanic hazards are not included this Draft Supplemental EIR/EIS because the nearest volcanic source is more than 85 miles from the Central Valley Wye alternatives. Primary volcanic sources are located east of the Central Valley Wye alternatives in the Long Valley Caldera (USGS 2016), and to the north and south of this volcanically active region. Although ash fall from volcanic activity could occur near the Central Valley Wye alternatives, there is less than a 1 percent probability of a volcanic eruption from the closest source to the Central Valley Wye alternatives during any given year. If a volcanic event were to occur, the predominant direction of ash fall would be to the east of the Central Valley Wye alternatives. Because of the low likelihood of volcanic activity and the predominant west-east wind direction, this event is considered highly unlikely to occur and was dismissed from further consideration.
- Regarding electrical interconnections and network upgrades (EINU), because only existing transmission and power lines would be reconductored and the reconfiguration of the Site 7—Wilson, Wilson Substation would occur within the fence line of the existing substation, implementation would not result in exposure to new or additional risks associated with geologic hazards, primary seismic hazards, secondary seismic hazards, areas of difficult excavations or resource hazards. Therefore, for these topics, the analysis only evaluates potential impacts associated with new/expanded components (i.e., Site 6—El Nido, El Nido

[2] The Geology, Soils and Seismicity and Paleontological Resources Technical Reports were finalized in 2016; however, the content of this Draft Supplemental EIR/EIS has continued to evolve to incorporate the most current data and other sources of information relevant to the environmental analyses, some of which were not available at the time that the technical reports were prepared. As a result, some of the information presented in the Draft Supplemental EIR/EIS is more current than the information presented in the technical reports. To provide clarity on any information and data differences between the Draft Supplemental EIR/EIS and the technical reports and the location of the most current information, a Central Valley Wye Technical Report Memorandum of Updates has been produced and included in Appendix 3.1-D, Central Valley Wye Technical Report Memorandum of Updates.

Substation, Site 7—Wilson, 230 kV Tie-Line, and Site 7—Le Grand Junction/Sandy Mush Road, Dutchman Switching Station and 115 kV Tie-Line).

- Construction of the Central Valley Wye alternatives would require substantial quantities of borrow material for use as track ballast and subgrade materials in approach fills for elevated structures and for aggregate in concrete construction. The Central Valley Wye alternatives would require, depending on the alternative, approximately 1.4 million to 1.7 million tons of aggregate and 16.9 million to 21.5 million cubic yards of fill (assuming no fill is provided from excavation). Borrow requirements for the Central Valley Wye alternatives were evaluated, and five permitted and operating aggregate quarries were identified in two mineral production-consumption regions adjacent to the Central Valley with capacity for ballast (refer to the *Merced to Fresno Section: Central Valley Wye Air Quality and Global Climate Change Technical Report,* Appendix D [Authority and FRA 2016c] regarding the methods to estimate borrow material and list of quarries). The California Geological Survey (CGS) concluded that there were 115 million tons of aggregate permitted for mining within the North San Francisco Bay Production-Consumption Region in 2013, representing less than 5 percent of the total available aggregate resource (Miller and Busch 2013). CGS surveys also concluded that there were 404 million tons of aggregate permitted for mining in the South San Francisco Bay Production-Consumption Region in 2012 (Clinkenbeard 2012). Further, CGS estimated that current aggregate permitted resources identified within the 31 statewide study areas in 2012 represented only about 5 percent of the total available resource (Clinkenbeard 2012). Based on this estimate, there would be sufficient aggregate and fill available in the two production-consumption regions to provide material for the Central Valley Wye alternatives without harmfully depleting available sources; therefore, borrow sites are not evaluated in the analysis of geology, soils, and seismicity.

Definition of Resources

The following are definitions for geology, soils, seismicity, and paleontological resources analyzed in this Draft Supplemental EIR/EIS. These definitions are the same as those used in the Merced to Fresno Final EIR/EIS (Authority and FRA 2012).

Geologic Resources

- **Soil Hazards**—Soil hazards present in the San Joaquin Valley include expansive soils, erodible soils, and corrosive soils. Expansive soils are susceptible to expansion and contraction resulting from changes in moisture and provide an unstable support for foundations or other structures. Erodible soils are susceptible to wind and water erosion. Corrosive soils have chemical properties that weaken concrete or uncoated steel and thereby reduce the design life of the structure.
- **Geologic Hazards**—Geologic hazards such as landslides, slumps, and land subsidence pose potential threats to the proposed Central Valley Wye alternatives.
- **Primary Seismic Hazards**—Primary seismic hazards include ground surface fault ruptures and ground shaking. Surface fault ruptures are the result of stresses relieved during an earthquake event and often cause damage to structures astride the fault zone. A fault zone is a group of earthquake-induced fractures in soil or rock where there has been documented seismic displacement on two sides of the fault relative to one another. Ground shaking is the level of ground movement caused by a seismic event.
- **Secondary Seismic Hazards**—Secondary seismic hazards include liquefaction, seismically induced settlements, lateral spreads or slumps, and flooding resulting from seismically induced dam failure. Liquefaction is a type of ground failure in which soils lose their strength as a result of buildup in pore water pressure during and immediately following ground shaking.
- **Areas of Difficult Excavation**—Difficult excavation is defined as excavation methods that require more than standard earth-moving equipment or special controls to enable work to proceed.

- **Mineral Resources**—Mineral resources include resources used for building (i.e., aggregate); industrial minerals such as lime, pumice, and gypsum; and fossil fuels and geothermal resources.

Paleontological Resources

- **Paleontological Resources**—Paleontological resources are the preserved remains or traces of animals and plants. They include body fossils (the remains of the organism itself) and trace fossils (which record the presence and movement of past organisms in their environment). Fossils are typically found in sedimentary and certain types of volcanic rock units, and they provide information about the evolution of life on earth over the past approximately 4 billion years. Paleontological resources are important to science and education because they document the presence and evolutionary history of particular groups of organisms, reconstruct the environments in which these organisms lived, provide information on the age of the rocks in which they are found, and shed light on environmental change over time.

3.9.2 Laws, Regulations, and Orders

3.9.2.1 Geology, Soils, and Seismicity

This section identifies laws, regulations, and orders that are relevant to the analysis of geology, soils, and seismicity in this Draft Supplemental EIR/EIS. Also provided are summaries of new, additional, or updated laws, regulations, and orders that have occurred since publication of the Merced to Fresno Final EIR/EIS.

Federal

Procedures for Considering Environmental Impacts (64 Fed. Reg. 28545)

These FRA procedures state that an EIS should consider possible effects on energy and mineral resources.

State

The following state laws, regulations, orders, and plans are the same as those described in Section 3.9.2, Laws, Regulations, and Orders, of the Merced to Fresno Final EIR/EIS (Authority and FRA 2012; pages 3.9-2 through 3.9-3):

- Alquist-Priolo Earthquake Fault Zoning Act (Cal. Public Res. Code § 2621 et seq.)
- Seismic Hazards Mapping Act (Cal. Public Res. Code §§ 2690 to 2699.6)
- Surface Mining and Reclamation Act (Cal. Public Res. Code § 2710 et seq.)
- California Building Standards Code (Cal. Code Regs., title 24)

One additional state regulation follows.

Oil and Gas Conservation (Cal. Public Res. Code §§ 3000–3473)

The Division of Oil, Gas, and Geothermal Resources (DOGGR) within the California Department of Conservation oversees the drilling, operation, maintenance, and plugging and abandonment of oil, natural gas, and geothermal wells. The DOGGR's regulatory program emphasizes the wise development of oil, natural gas, and geothermal resources in the state through sound engineering practices that protect the environment, prevent pollution, and protect public safety. Since 2012, the DOGGR has adopted additional regulations related to tracking new oil wells and the use of hydraulic fracturing in oil and natural gas production.

Regional and Local

The following county and local plans and policies are the same as those described in Section 3.9.2 of the Merced to Fresno Final EIR/EIS (Authority and FRA 2012: pages 3.9-4 through 3.9-6):

- *Madera County General Plan*, Policy Document (1995)
- *Fresno County General Plan* (2000)
- *City of Chowchilla 2040 General Plan* (2011)

Dewatering Activities: Permit varies by Regional Water Quality Control Board

Dewatering activity permits were described in Section 3.8.2.3 of the Merced to Fresno Final EIR/EIS (Authority and FRA 2012: page 3.8-4) but have since been updated.

Care is required for the removal of nuisance water from a construction site, known as dewatering. The Central Valley Regional Water Quality Control Board's (RWQCB) Order No. R5-2013-0074 (NPDES No. CAG95001), Waste Discharge Requirements General Order for Dewatering and Other Low-Threat Discharges to Surface Waters (General Dewatering Permit), updates the regulation of discharges to surface water from dewatering activities. The State Water Resources Control Board's (SWRCB) Order No. 2003-0003-DWQ, General Waste Discharge Requirements for Discharges to Land with a Low Threat to Water Quality (Low-Threat Discharge Permit), as updated by Resolution No. R5-2013-0145, Approving Waiver of Reports of Waste Discharge and Waste Discharge Requirements for Specific Types of Discharge within the Central Valley Region, continues to cover discharges to land from dewatering activities.

General Plan Policies and Ordinances

Table 3.9-1 lists new, updated, or additional county and city general plan goals, policies, and ordinances relevant to the Central Valley Wye alternatives.

Table 3.9-1 Local Plans and Policies

Policy Title	Summary
Merced County	
2030 Merced County General Plan (2013)	Merced County adopted the *2030 Merced County General Plan* on December 10, 2013, updating the previous version of the general plan that was included in Section 3.9.2.3 of the Merced to Fresno Final EIR/EIS (page 3.9-4). The general plan includes the following goals and policies: ▪ Health and Safety Element Goal HS-1: Minimize the loss of life, injury, and property damage of County residents due to seismic and geologic hazards. ▪ Policy HS-1.1: Require that all new habitable structures be located and designed in compliance with the Alquist-Priolo Special Studies Zone Act and related State earthquake legislation. ▪ Policies HS-1.6, HS-1.7, HS-1.8, and HS-1.9 related to construction on unstable soils address unstable soils, slope instability, and landslides. ▪ Natural Resources Element Goal NR-3: Facilitate orderly development and extraction of mineral resources while preserving open space, natural resources, and soil resources and avoiding or mitigating significant adverse impacts. ▪ Policy NR-3.1: Protect soil resources from erosion, contamination, and other effects that substantially reduce their value or lead to the creation of hazards. ▪ Policy NR-3.2 addresses soil erosion and soil stability.
Merced County Code	The Merced County Code is current through Ordinance No. 1939, passed February 2016, and the June 2016 code supplement. ▪ 16.16.010 International Building Code: The International Building Code, 2012 Edition, the Standards referenced in Chapter 35 and all Appendix Chapters, as adopted by the International Code Council, and California State Amendments to the code, are hereby adopted by reference and, except as herein otherwise provided, are applicable to and shall cover all construction within the unincorporated area of the county of Merced. ▪ 18.41 Performance Standards: The Merced County Code, Chapter 18.41, establishes performance standards to make sure there is compatibility between land uses by setting limits. It includes provisions for clearing, grading, earth moving, and other site preparation activities during construction.

Policy Title	Summary
Madera County	
Madera County Code	The Madera County Code is codified through Ordinance No. 677, passed June 2, 2015, and Ordinance No. 532B, passed March 1, 2016. ▪ 14.08.010 - California Building Code - Amendments Generally: Adopted as amended. ▪ 14.50 Grading and Erosion Control: The Madera County Code, Chapter 14.50, establishes standards for grading and erosion control in Madera County; sets forth rules and regulations to control excavations and related activities to prevent erosion, sedimentation, and other environmental damage and to promote the public health, safety, and general welfare of the community; and establishes the administrative procedure for issuance of permits.
Stanislaus County	
Stanislaus County General Plan (2016)	The *Stanislaus County General Plan* was adopted on August 23, 2016 and provides the following goals and policies from the Safety Element that are relevant to geological, seismic, and soil resources: ▪ Goal Two: Minimize the effects of hazardous conditions that might cause loss of life and property. ▪ Policy Fourteen: The County will continue to enforce state-mandated structural Health and Safety Codes, including but not limited to the Uniform Building Code, the Uniform Housing Code, the Uniform Fire Code, the Uniform Plumbing Code, the National Electric Code, and Title 24.
City of Chowchilla	
City of Chowchilla Code	The City of Chowchilla Code is codified through Ordinance No. 471-14, passed December 9, 2014. ▪ Chapter 15.06.010 California Building Code – Adopted. The 2013 California Building Code is based on the 2012 International Building Code as published by the International Code Council (ICC) as adopted and amended by the California Building Standards Commission in the 2013 California Building Standards Code of the 2013 California Code of Regulations title 24, together with all appendices.

Source: *Merced County, 2013; Stanislaus County, 2016*
Merced to Fresno Final EIR/EIS = Merced to Fresno Section *California High-Speed Train* Final Project Environmental Impact Report/Environmental Impact Statement

3.9.2.2 Paleontological Resources

This section identifies laws, regulations, and orders that are relevant to the analysis of paleontological resources in this Draft Supplemental EIR/EIS, with a focus on new, additional, or updated laws, regulations, and orders that have been enacted since publication of the Merced to Fresno Final EIR/EIS.

Federal

The American Antiquities Act (16 United States Code [U.S.C.]§§ 431–433) is the same as described in Section 3.17.2.1 of the Merced to Fresno Final EIR/EIS (Authority and FRA 2012: page 3.17-3). One additional federal law follows.

Paleontological Resources Preservation Act (16 U.S.C. § 470aaa)

The Paleontological Resources Preservation Act was enacted in 2009 as part of the Omnibus Public Land Management Act. It requires the Secretaries of the Interior and Agriculture to manage and protect paleontological resources on federal land using scientific principles and expertise. The Paleontological Resources Preservation Act includes specific provisions addressing management of these resources by the Bureau of Land Management, the National Park Service, the U.S. Bureau of Reclamation, the U.S. Fish and Wildlife Service, and the U.S. Forest Service of the Department of Agriculture. The Paleontological Resources Preservation Act affirms the authority for many of the policies the federal land managing agencies already have in place for the management of paleontological resources, such as requiring permits for large-scale collection of paleontological resources, curation of paleontological resources, and confidentiality of locality data.

State

The California Environmental Quality Act (CEQA) Public Resources Code Section 21083.2 and CEQA Guidelines (Cal. Code Regs., title 14, § 15064.5) are the same as described in Section 3.17.2.2 of the Merced to Fresno Final EIR/EIS (Authority and FRA 2012: pages 3.17-4 through 3.17-5). Additional state regulations follow.

California Code of Regulations

The California Code of Regulations prohibits destruction, disturbance, mutilation, and removal of geological materials and paleontological features on state park lands, although rockhounding is permitted (Cal. Code Regs., title 14, div. 3, §4307(a)). *Rockhounding* is defined in title 14, section 4301, as recreational gathering of naturally occurring "stones and minerals" found on the undisturbed ground surface and panning for gold in natural stream gravels. Fossil collection is not specifically addressed in section 4301.

California Public Resources Code

The California Public Resources Code protects paleontological resources in specific contexts. In particular, California Public Resources Code section 5097.5 prohibits "knowing and willful" excavation, removal, destruction, injury, and defacement of any paleontological feature on public lands without express authorization from the agency with jurisdiction. Violation of this prohibition is a misdemeanor and is subject to fine and/or imprisonment (Cal. Public Res. Code, §5097.5(c)); persons convicted of such a violation may also be required to provide restitution (Cal. Public Res. Code § 5097.5(d)(1)). Additionally, California Public Resources Code section 30244 requires "reasonable mitigation measures" to address impacts on paleontological resources as identified by the State Historic Preservation Officer.

Regional and Local

The *Madera County General Plan, Policy Document* (1995) and *Fresno County General Plan* (2000) are the same as described in Section 3.17.2.3 of the Merced to Fresno Final EIR/EIS (Authority and FRA 2012: page 3.17-6 and page 3.17-7).

General Plan Policies and Ordinances

Table 3.9-2 lists new or revised county plans, policies, and objectives for paleontological resources relevant to the Central Valley Wye alternatives.

Table 3.9-2 Local Plans and Policies

Policy Title	Summary
Merced County	
2030 Merced County General Plan (2013), Recreation and Cultural Resources (RCR) Element	Merced County adopted the *2030 Merced County General Plan* on December 10, 2013, updating the previous version of the general plan that was referenced in Section 3.17.2.3 of the Merced to Fresno Final EIR/EIS (pages 3.17-6 to 3.17-7). The general plan includes the following goals and policies pertinent to paleontological resources: ▪ Goal RCR-2 stresses protection of the cultural, archaeological, and historic resources of the County "in order to maintain its unique character" ▪ Goal RCR-2, Policy RCR-2.9 (Historical and Cultural Resources Investigation, Assessment, and Mitigation Guidelines), calls for the "establish[ment] and adopt[ion] of mandatory guidelines for use during the environmental review processes for private and public projects to identify and protect historical, cultural, archaeological, and paleontological resources, and unique geological features." ▪ Policy RCR-2.9-2 is supported by Implementation Program RCR-B (Historic and Cultural Resources Investigation, Assessment and Mitigation Guidelines), planned for accomplishment during the 2016−2020 timeframe:

Policy Title	Summary
	▪ Prepare and formally adopt guidelines and standards for the preparation of assessments of historical, cultural, archaeological, and paleontological resources, and unique geological features prepared pursuant to Policy RCR2.9. At a minimum, the guidelines shall include resource survey guidelines covering personnel qualifications, research and field techniques, investigation and documentation, data collection and recordation, and resource preservation, avoidance, minimization, and mitigation strategies. The guidelines shall specify broad categories of acceptable mitigation consistent with Public Resources Code section 21083.2 and State CEQA Guidelines section 15126.4[b], as they may be amended for any identified adverse effects to historic and cultural resources, paleontological resources, or unique geological feature.

Source: Merced County, 2013

Merced to Fresno Final EIR/EIS = Merced to Fresno Section *California High-Speed Train* Final Project Environmental Impact Report/Environmental Impact Statement

3.9.3 Compatibility with Plans and Laws

As indicated in Section 3.1.3.3, Compatibility with Plans and Laws, CEQA and National Environmental Policy Act (NEPA) regulations[3] require a discussion of inconsistencies or conflicts between a proposed undertaking and federal, state, regional, or local plans and laws. As such, this Draft Supplemental EIR/EIS describes the inconsistency of the Central Valley Wye alternatives with federal, state, regional, and local plans and laws to provide planning context.

3.9.3.1 Geology, Soils, and Seismicity

There are a number of federal and state laws and implementing regulations, listed in Section 3.9.2.1, Geology, Soils, and Seismicity, under subsections Federal and State, that govern compliance with construction and operations standards relating to geology, soils, and seismicity for construction projects and transportation facilities. A summary of the federal and state requirements considered in this analysis follows:

- FRA guidelines for consideration of possible effects on energy and mineral resources
- State laws that govern construction in areas of known seismic activity
- State laws that address construction in or near areas of energy and mineral extraction activity
- State guidelines governing construction with respect to geologic and soils hazards

The Authority, as the lead state agency proposing to construct and operate the HSR system, is required to comply with all federal and state laws and regulations and to secure all applicable federal and state permits prior to initiating construction on the selected alternative. Similarly, FRA, as federal lead agency, is required to comply with all federal laws and regulations. Therefore, there would be no inconsistencies between the Central Valley Wye alternatives and these federal and state laws and regulations.

The Authority is a state agency and therefore is not required to comply with local land use and zoning regulations; however, it has endeavored to design and construct the HSR project so that it is compatible with land use and zoning regulations. For example, the Central Valley Wye alternatives would incorporate an IAMF that requires the contractor to evaluate and take into account soil vulnerabilities, as local ordinances also require. The Authority would also adopt a monitoring program to track any potential subsidence during operations. A total of five plans and 57 policies, goals, objectives, implementation actions, implementation programs, and implementation measures were reviewed. The Central Valley Wye alternatives are consistent with all plans, codes, policies, and goals for geology, soils, and seismicity because construction

[3] NEPA regulations refer to the regulations issued by the Council on Environmental Quality located at 40 CFR Part 1500.

practices, infrastructure design, and operations will be consistent with established building standards relevant to geotechnical issues.

3.9.3.2 Paleontological Resources

Federal and State Laws and Regulations

There are a number of federal and state laws and implementing regulations listed in Section 3.9.2.2, Paleontological Resources, that protect paleontological resources. A summary of these federal and state requirements considered follows:

- Federal regulations address paleontological resources on federally owned or controlled lands.
  - The American Antiquities Act (16 U.S.C. §§ 431–433) prohibits unauthorized collection, damage, and destruction of "any … object of antiquity" located on lands owned or controlled by the federal government. The Antiquities Act does not recognize paleontological resources explicitly, but a number of federal agencies interpret *objects of antiquity* as including paleontological materials.
  - The Omnibus Public Land Management Act (Public Law [PL] 111-11 H.R. 146) institutes a federal statutory definition of paleontological resources, requires science-based management of such resources, sets up guidelines for collection on federal lands (including permit requirements for large-scale and commercial collecting), and establishes criminal penalties for unauthorized removal and damage of resources, and for transport, exchange, and sale of illegally obtained resources.
- The California Public Resources Code prohibits unauthorized excavation, removal, and damage to paleontological features on public (state, county, city, special district, public authority, and public corporation) lands (§ 5097.5) and requires mitigation for impacts on paleontological resources "as identified by the State Historic Preservation Officer" (§ 30244).
- The California Code of Regulations prohibits disturbance, destruction, and removal of paleontological features on state park lands (14 Cal. Code Regs. 4307(a)).

Although federal and state regulations establish protection for paleontological resources, they do not provide specifics regarding what resources merit protection, and what level of protection is adequate. This gap has been filled in two ways: through processes and protocols developed by the professional community—in particular the Society of Vertebrate Paleontology (SVP)—and through guidelines developed by federal, state, and local lead agencies, including the Authority and FRA (Authority and FRA 2016b). Many lead agency guidelines have been influenced by the SVP's "Assessment and Mitigation of Adverse Impacts to Nonrenewable Paleontologic Resources: Standard Guidelines" (Standard Guidelines) (SVP Conformable Impact Mitigation Guidelines Committee 1995) and "Conditions of Receivership for Paleontologic Salvage Collections" (Conditions of Receivership) (SVP Conformable Impact Mitigation Guidelines Committee 1996), and more recently by the SVP's updated *Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources* (SVP Impact Mitigation Guidelines Revision Committee 2010). Together, these publications have come to be accepted as the discipline standard for paleontological resources impact analysis and mitigation. The SVP Standard Guidelines, Conditions of Receivership, and Standard Procedures are discussed in more detail in the Paleontological Resources Technical Report (Authority and FRA 2016b).

The Authority, as the lead state agency proposing to construct and operate the HSR system, is required to comply with all federal and state laws and regulations and to secure all applicable federal and state permits prior to initiating construction on the selected alternative. Similarly, FRA, as federal lead agency, is required to comply with all federal laws and regulations. Therefore, there would be no inconsistencies between the Central Valley Wye alternatives and these federal and state laws and regulations.

None of the Central Valley Wye alternatives would involve federally owned or controlled lands or state park lands. Technically, therefore, none of the federal protections summarized in the preceding text would apply to the Central Valley Wye alternatives. California Code of Regulations protection for paleontological resources on state park lands (14 Cal. Code Regs. 4307(a)) also would not apply, because no such lands are involved. However, the IAMFs for paleontological resources, described in Section 3.9.4.2, Paleontological Resources, Impact Avoidance and Minimization Features, nonetheless would require specific actions to protect scientifically important paleontological resources and avoid the loss of scientific information, consistent with prevailing SVP guidance (the SVP Standard Guidelines, Conditions of Receivership, and Standard Procedures) and the overall objectives of federal laws protecting paleontological resources. Moreover, with the IAMFs in place, any collection of paleontological resources during construction of the Central Valley Wye alternatives would occur with the authorization and oversight of the Authority and would be conducted by qualified paleontological staff in a manner consistent with the prevailing discipline standard for paleontological resources recovery and curation. Consequently, the Central Valley Wye alternatives are considered consistent with the objectives of federal and state regulations that require science-based management of paleontological resources and prohibit unauthorized disturbance, destruction, and removal of such resources.

The Central Valley Wye alternatives would be constructed in a right-of-way owned by a state agency—the Authority. As a result, the California Public Resources Code prohibition on unauthorized excavation, removal, and damage to paleontological features on public lands (section 5097.5) would apply. The requirement to mitigate paleontological impacts “as identified by the State Historic Preservation Officer” (section 30244) could also apply. As discussed in the preceding paragraph, however, any excavation or removal of paleontological resources required for construction of the Central Valley Wye alternatives would take place with the authorization and oversight of the Authority—which is the “agency [with] jurisdiction” per section 5097.5(a)—and would be implemented by qualified staff in a manner consistent with prevailing discipline practices as laid out by the SVP (1996, 2010) and the California Department of Transportation (Caltrans) (2014a). The IAMF stipulations for appropriate collection and curation of paleontological resources encountered during construction would also satisfy the mitigation requirement per Public Resources Code section 30244, since paleontological salvage would be conducted consistent with prevailing discipline practices (e.g., SVP 1996 and 2010, Caltrans 2014a). Thus, the Central Valley Wye alternatives would be consistent with California Public Resources Code sections 5097.5 and 30244.

Local Plans and Policies

The Authority is a state agency and therefore is not required to comply with local land use and zoning regulations; however, it has endeavored to design and construct the HSR project so that it is compatible with land use and zoning regulations, including goals and policies protecting paleontological resources. Local plans, including six policies and three implementation programs relevant to paleontological resources, were reviewed. The Central Valley Wye alternatives are considered consistent with the objectives of all of the local plans, policies, and implementation programs reviewed because all of the alternatives would adhere to the prevailing discipline standard for paleontological resources protection. As a foundation for appropriate treatment of paleontological resources, the Authority has adopted statewide methods for the analysis and mitigation of paleontological resources impacts (Authority 2016b). These methodology guidelines were developed for consistency with SVP guidance (Standard Guidelines, Conditions of Receivership, and Standard Procedures) as well as the methods currently used by Caltrans (2014a), and as such they reflect the current prevailing discipline standard for paleontological resources protection.

The Authority’s standard paleontological resources methodology guidelines (Authority 2014) guided the development and content of the paleontological resources IAMFs incorporated into the Central Valley Wye alternatives. For instance, ground disturbance in paleontologically sensitive units would be subject to monitoring by qualified paleontological staff members who have the authority to divert work such that resources can be protected and recovered in the event of a find. Finds would be transferred to an appropriate and qualified repository institution (museum or university) where they will remain available for scientific study (GEO-IAMF#9). With these requirements and the other IAMFs for paleontological resources in place, the overall goals of avoiding needless destruction of paleontological resources, and protecting the scientific information and heritage value they transmit, will be met. As a result, although the Authority is not subject to local jurisdiction plan and policy requirements, the Central Valley Wye alternatives are nonetheless considered consistent with the objectives of local plans, goals, policies, and implementation programs that protect paleontological resources.

3.9.4 Methods for Evaluating Impacts

The evaluation of impacts on geology, soils, seismicity, and paleontological resources is a requirement of the NEPA and CEQA. The following sections summarize the RSAs and the methods used to analyze impacts on geology, soils, and seismicity, and paleontological resources.

3.9.4.1 Geology, Soils, and Seismicity

Definition of Resource Study Areas

The RSAs for impacts on geology, soils, and seismicity comprise the project footprint for each of the Central Valley Wye alternatives and adjoining areas specific to each resource (geologic resources; resource hazards; and seismicity, faulting, and dam failure) where impacts could occur. As defined in Section 3.1, Introduction, RSAs are the geographic boundaries in which the environmental investigations specific to each resource topic were conducted. RSA boundaries vary for (1) geology, soils, and seismicity; (2) resource hazards; and (3) seismicity, faulting, and dam failure inundation. Table 3.9-3 describes these three RSAs, and includes a general definition and boundary definition for each RSA.[4]

Table 3.9-3 Definition of Resource Study Areas for Geology, Soils, and Seismicity

Resource	General Definition	Boundary Definition
Geology, Soils, and Seismicity RSA		
Construction and Operations	Geologic conditions other than those covered under the resource hazards and seismicity, faulting, and dam failure inundation RSAs.	The RSA for geology, soils, and seismicity is defined as 150 feet on either side of the project footprints of the Central Valley Wye alternatives and the temporary and permanent footprints associated with EINU components.
Resource Hazards RSA		
Construction and Operations	Resource hazards, such as soil failures (e.g., adequacy of load-bearing soils), settlement, corrosivity, shrink-swell, erosion, earthquake-induced liquefaction risks, subsidence, and subsurface gas hazards, mineral resource extraction and oil and gas wells.	The resource hazards RSA is 0.5 mile on either side of the project footprints of the Central Valley Wye alternatives and the temporary and permanent footprints associated with EINU components.

[4] The RSA for EINU components is limited to the project footprints given the minor and limited extent of potential impacts. Impacts for geology, soils, seismicity, and resources hazards for EINU components are limited because construction activities are generally associated with existing facilities and would include minor and localized ground disturbance; consequently, activities do not have the potential to disturb areas outside of the project footprints of construction and permanent structures.

Resource	General Definition	Boundary Definition
Seismicity, Faulting, and Dam Failure Inundation RSA		
Construction and Operations	Earthquake faults and dams.	The seismicity, faulting, and dam failure inundation RSA encompasses the San Joaquin Valley within a 65-mile radius of the Central Valley Wye alternatives.

Source: Authority and FRA, 2018
RSA = resource study area

Impact Avoidance and Minimization Features

As noted in Section 2.2.3.7, Impact Avoidance and Minimization Features, the Central Valley Wye alternatives would incorporate standardized IAMFs to avoid and minimize impacts. The Authority would implement IAMFs during design and construction, and, as such, the analysis of impacts of the Central Valley Wye alternatives in this section factors in all applicable IAMFs. Appendix 2-B, California High-Speed Rail: Impact Avoidance and Minimization Features, provides a detailed description of IAMFs that are included as part of the Central Valley Wye alternatives design. IAMFs applicable to geology, soils, and seismicity include:

- GEO-IAMF#1, Geologic Resources
- GEO-IAMF#2, Slope Monitoring
- GEO-IAMF#3, Evaluate and Design for Large Seismic Ground Shaking
- GEO-IAMF#4, Suspension of Operations During an Earthquake
- GEO-IAMF#5, Subsidence Monitoring
- GEO-IAMF#6, Geology and Soils
- BIO-IAMF#20, Dewatering and Water Diversion
- HYD-IAMF#3, Prepare and Implement a Construction Stormwater Pollution Prevention Plan
- SS-IAMF#2, Safety and Security Management Plan
- SS-IAMF#4, Oil and Gas Wells

Methods for NEPA and CEQA Impact Analysis

This section describes the sources and methods the Authority and FRA used to analyze potential impacts from implementing the Central Valley Wye alternatives on geology, soils, and seismicity. These methods apply to both NEPA and CEQA unless otherwise indicated. Refer to Section 3.1.3.4, Methods for Evaluating Impacts, for a description of the general framework for evaluating impacts under NEPA and CEQA. As described in Section 3.8.1, Introduction, and in the following discussions, the Authority and FRA have applied the same methods and many of the same data sources from the Merced to Fresno Final EIR/EIS to this Draft Supplemental EIR/EIS. Refer to the Geology, Soils, and Seismicity Technical Report (Authority and FRA 2016a) for more information regarding the methods and data sources used in this analysis. Laws, regulations, and orders (see Section 3.9.2) that regulate geology, soils, and seismicity were also considered in the evaluation of impacts on geology, soils, and seismicity; resource hazards; faulting; and dam failure inundation.

The analysis focuses on the direct impacts of the Central Valley Wye alternatives related to geology, soils, and seismicity. Impacts that may occur in relation to other resource areas that may be inferred as indirect geology, soils, and seismicity impacts in other documents (e.g., surface water quality related to erosion) are discussed in the relevant resource sections of this Draft Supplemental EIR/EIS.

Geologic and Geotechnical Site Conditions

The *Merced to Fresno Section: Central Valley Wye Geotechnical Summary Report* (Authority and FRA 2015) and the Geology, Soils, and Seismicity Technical Report summarize the geologic setting for the Central Valley Wye alternatives and describe site conditions. They also provide preliminary evaluations and recommendations for addressing geologic hazards, natural chemical hazards and corrosion potential, and foundation support methods. The geotechnical information presented in the reports and used in this Draft Supplemental EIR/EIS analysis included representative boring logs along the four Central Valley Wye alternatives, as well as preliminary engineering interpretations. Much of the information on borings was obtained at stream and river crossings. The *Merced to Fresno Section: Central Valley Wye Geotechnical Summary Report* also summarized the results of geotechnical explorations conducted by Caltrans and others along the alternatives or in the vicinity. Existing geological and geotechnical information was sufficient to analyze the potential impacts of the Central Valley Wye alternatives. For example, existing data sources provide suitable information to identify the locations where the Central Valley Wye alternatives would cross corrosive soils, and therefore, where appropriate, design standards and methods, such as those identified in the Caltrans Design Standards, American Society for Testing and Materials, and California Building Code would need to be applied to overcome soil risks caused by corrosivity. Further site-specific geotechnical investigations for the Central Valley Wye alternatives would be conducted for the preliminary and final engineering design. This information would be used for detailed design of specific structures and foundations.

Geology, Soils, and Seismicity Analysis

Soils

Analysts overlaid geographic information system (GIS) layers for the Central Valley Wye alternatives on the GIS layers for Natural Resources Conservation Service (NRCS) soil surveys (NRCS 2006, 2007, 2008, 2010, 2016) to identify the potential impacts on expansive, erodible, or corrosive soils. NRCS soil survey data was also used to determine potential impacts from the Central Valley Wye alternatives on soils associated with alluvial, floodplain, and basin areas.

Geologic Hazards

Analysts evaluated construction and operations activities on nonseismic geologic hazards such as landslides, slumps, and land subsidence by reviewing available U.S. Geological Survey (USGS) and CGS landslide inventories and data available from the U.S. Bureau of Reclamation and the California Department of Water Resources (Sneed et al. 2013; Faunt 2009; Galloway and Riley 1999; Ireland et al. 1984; Ireland 1986; Lofgren 1969). Analysts compared these inventories with the GIS layers for the Central Valley Wye alternatives to evaluate the potential for landslides, slumps, and subsidence resulting from construction and operations activities.

Primary Seismic Hazards

Analysts evaluated primary seismic hazards by overlaying GIS layers for the Central Valley Wye alternatives on the GIS layers for active faults (USGS 2015). Only active and potentially active faults within 65 miles of the Central Valley Wye alternatives were considered. Direct primary seismic impacts evaluated included surface fault ruptures, permanent offsets at the ground surface, and ground shaking.

Secondary Seismic Hazards

Analysts evaluated secondary seismic hazards from strong ground shaking, including liquefaction, seismically induced slides or slumps, and flooding resulting from seismically induced dam failure. The same methods were used as described for primary seismic hazards (USGS 2015), but analysts also utilized NRCS soil survey data (NRCS 2006, 2007, 2008, 2010, 2016), and USGS groundwater data to identify areas of liquefiable soils, alluvial deposits, and areas of shallow depth to groundwater underlying the seismicity, faulting, and dam failure inundation RSA (DWR 2000). Areas with potential for seismically induced dam failures that could result in flooding were evaluated by reviewing dam inundation maps and risk assessments prepared by Merced, Madera, Stanislaus, and Fresno Counties and the Cities of Chowchilla and Merced, and peer-reviewed reports (City of Merced 2015; Esmaili et al. 2012; Madera County 2011; City of Chowchilla 2010; USBR 2014; Merced County 2000; Stanislaus County 2016).

Areas of Difficult Excavation

Analysts performed a qualitative analysis for impacts related to areas of difficult excavation. A combination of soil conditions and shallow groundwater locations could result in difficult excavation conditions. Areas of difficult excavation may vary from mapping because of past land use. Site-specific subsurface geotechnical investigations and geotechnical design evaluations would be conducted during the design of the Central Valley Wye alternatives to determine specific locations where difficult excavations may occur and to plan for this during construction.

Resource Hazards

Analysts evaluated potential impacts on mineral and energy resources by reviewing local planning documents and by comparing the GIS layers for the Central Valley Wye alternatives with the online mapping system of the DOGGR (DOC 2015). Active mining operations and oil and natural gas wells within the resource hazards RSA were quantified for each of the Central Valley Wye alternatives.

Determining Significance under CEQA

CEQA requires that an EIR identify the significant environmental impacts of a project (CEQA Guidelines § 15126). One of the primary differences between NEPA and CEQA is that CEQA requires a significance determination for each impact using a threshold-based analysis (see Section 3.1.3.4). By contrast, under NEPA, significance is used to determine whether an EIS will be required; NEPA requires that an EIS is prepared when the proposed federal action (project) as a whole has the potential to “significantly affect the quality of the human environment.” Accordingly, Section 3.9.9, CEQA Significance Conclusions, summarizes the significance of the environmental impacts on geology, soils, and seismicity for each Central Valley Wye alternative. The Authority uses the following thresholds to determine if a significant impact on geology, soils, and seismicity would occur as a result of the Central Valley Wye alternatives. A significant impact is one that would:

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving the following:
  - 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
  - Strong seismic ground shaking
  - Seismically related ground failure, including but not limited to, liquefaction
  - Seiche or tsunami hazard
  - Dam failure inundation hazard
  - Landslides, including seismically induced landslides
- Result in substantial soil erosion or the loss of topsoil
- Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, with the potential to result in an on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse
- Be constructed on expansive soil, as defined in Table 18-1-B of the current Uniform Building Code or current California Building Standards Code section 1803.5.3, Expansive Soil, creating substantial risks to life or property
- Be constructed on corrosive soils, creating substantial risks to life or property
- Result in the loss of availability of a known mineral, petroleum, or natural gas resource of local, regional, or statewide value
- Result in the loss of availability of a locally important mineral resource recovery site
- Be in an area of subsurface gas hazard, creating substantial risks to life or property

3.9.4.2 Paleontological Resources

Definition of Resource Study Areas

The RSA for paleontological resources is based on the project footprint for each of the Central Valley Wye alternatives plus a surrounding 150-foot-wide buffer. As defined in Section 3.1, RSAs are the geographic boundaries within which the environmental investigations specific to each resource topic were conducted. Because fossil resources could be buried below ground surface, the RSA for paleontological resources extends into the subsurface beneath the Central Valley Wye alternatives, and thus represents a three-dimensional volume.

Table 3.9-4 provides a general definition and boundary definition for the Central Valley Wye alternatives paleontological resources RSA. Work for EINU components would be associated with existing facilities, with only minor and very localized ground disturbance required. Because EINU-related activities are not expected to create disturbance outside the immediate construction work area and/or existing permanent structures, the boundary used to develop the RSA for EINU is limited to the project footprints.

Table 3.9-4 Definition of Resource Study Area for Paleontological Resources

Resource	General Definition	Boundary Definition
Paleontological Resources RSA		
Construction and Operations	Impacts on paleontological resources occur as a direct outcome of Central Valley Wye alternatives-related ground disturbance, such as excavation, grading, and foundation drilling. Because fossil remains may be buried below the surface, they represent a three-dimensional resource; impact analysis is therefore concerned with the three-dimensional extent of ground disturbance. The *paleontological sensitivity* (potential to produce significant fossil finds) of geologic units affected by ground disturbance is evaluated based on their past track record of producing such finds, regardless of where those finds were located (SVP 1995, 2010). Accordingly, for paleontological resources, the RSA encompasses all of the geologic units affected by ground disturbance throughout the entirety of their (three-dimensional) extent.	Affected geologic units throughout their geographic extent; includes units exposed at the surface within the project footprints of the Central Valley Wye alternatives and a surrounding 150-foot-wide buffer, and units within the temporary and permanent footprints associated with EINU components, as well as those present in the subsurface below this area, to the depth potentially encountered by construction or operations.

Source: Authority and FRA, 2018
RSA = resource study area

Impact Avoidance and Minimization Features

As noted in Section 2.2.3.7 and discussed in Section 3.9.4.1, Geology, Soils, and Seismicity, the Central Valley Wye alternatives would incorporate standardized IAMFs to avoid and minimize impacts. The Authority would incorporate IAMFs during design and construction and as such, the analysis of effects of the Central Valley Wye alternatives in this section factors in all applicable IAMFs. Appendix 2-B provides a detailed description of IAMFs that are included as part of the Central Valley Wye alternatives design. The following IAMFs are applicable to paleontological resources.

- GEO-IAMF#7, Engage a Qualified Paleontological Resources Specialist
- GEO-IAMF#8, Perform Final Design Review and Triggers Evaluation
- GEO-IAMF#9, Prepare and Implement Paleontological Resources Monitoring and Mitigation Plan (PRMMP)

- GEO-IAMF#10, Provide Worker Environmental Awareness Program (WEAP) Training for Paleontological Resources
- GEO-IAMF#11, Halt Construction, Evaluate, and Treat if Paleontological Resources Are Found

Like the geology, seismicity, and soils IAMFs, the paleontological resources IAMFs differ from mitigation measures in that they are part of the Central Valley Wye alternatives and would be implemented by the Authority as a binding commitment as part of approval of the selected Central Valley Wye alternative.

Because of their length and complexity, the Central Valley Wye alternatives are expected to be designed and constructed in segments, with separate construction documents (plans and specifications) developed for each segment. Each segment is referred to as a *construction package* (CP). The paleontological resources IAMFs have been developed with the need for multiple CPs in mind, with impact avoidance actions linked to stages in the design and construction process for individual CPs. For instance, for each CP, the qualified paleontological resources specialist (GEO-IAMF#7) must be engaged prior to the 90 percent design milestone, such that the design review and triggers evaluation (GEO-IAMF#8) and development of the PRMMP for that CP (GEO-IAMF#9) can occur promptly after the 90 percent design milestone. The IAMFs were also developed to permit some flexibility—in particular, for greater efficiency, PRMMPs may be combined such that they cover more than one CP, as long as the level of detail and specificity is maintained for each CP covered.

Methods for NEPA and CEQA Impact Analysis

This section describes the sources and methods the Authority and FRA used to analyze potential impacts from implementing the Central Valley Wye alternatives on paleontological resources. These methods apply to both NEPA and CEQA unless otherwise indicated. Refer to Section 3.1.3.4, Methods for Evaluating Impacts, for a description of the general framework for evaluating impacts under NEPA and CEQA. As described in Section 3.9.1, Introduction, and in the following discussions, the Authority and FRA used an updated methodology, adopted subsequent to the preparation of the Merced to Fresno Final EIR/EIS, to analyze impacts on paleontological resources in this Draft Supplemental EIR/EIS. The Paleontological Resources Technical Report (Authority and FRA 2016b) prepared for this Draft Supplemental EIR/EIS describes in detail the methods used to evaluate the Central Valley Wye alternatives' potential for impacts on paleontological resources.

The primary concern related to impacts on paleontological resources is the potential for loss of scientific information, and particularly new information. This means it is important to distinguish resources that are scientifically important—that is, *significant*—from those with less potential to provide information. *Significant paleontological resources* are those that provide taxonomic, taphonomic, phylogenetic, stratigraphic, ecological, or climatic information. Significant fossils may include body fossils (the remains of the organism itself) as well as traces, tracks, and trackways (which record the presence and movement of past organisms in their environment). In California, vertebrate fossils of all types and sizes are considered significant because of their comparative rarity and their informational potential. Invertebrate fossils, plant fossils, and microfossils may also be scientifically important and therefore significant. This definition reflects the prevailing discipline standard for paleontological resources, as described in guidance from the SVP Conformable Impact Mitigation Guidelines Committee (SVP 1995) and SVP Impact Mitigation Guidelines Revision Committee (SVP 2010)), and is consistent with the approach used by Caltrans (2014a).

The state's *CEQA Guidelines* (Appendix G) reference impacts on unique paleontological resources. No specific definition of *unique paleontological resources* is provided in the CEQA statute or *Guidelines*. However, all paleontological resources that would meet reasonable working definitions for *unique* also satisfy the criteria to qualify as significant resources because of their potential to provide scientific information.

The paleontological resources impact analysis involved the following steps:

- Inventory potentially affected resources.
  - Identify the geologic units within the RSA, based on existing geological mapping. (See Section 3.9.4.2 for the current definition of the paleontological resources RSA.)
  - Evaluate the potential of the identified geologic units to contain significant fossils (their *paleontological potential* or *paleontological sensitivity*, defined in full under Paleontological Resource Inventory), based on review of geological and paleontological literature and museum and university collections.
- Identify and assess the nature and extent of impacts on paleontologically sensitive units—those with the potential to produce significant paleontological finds—as a result of constructing and operating the Central Valley Wye alternatives, taking into consideration all ground-disturbing activities.
- Evaluate impact significance.

The following sections present additional information on each step in the process.

Paleontological Resource Inventory

The resource inventory and evaluation process involved the following activities:

- Compile geologic mapping of the vicinity of the Central Valley Wye alternatives in ArcGIS
- Identify geologic units within the RSA by overlaying the RSA boundary and anticipated maximum depth of disturbance on the compiled geologic map
- Compile information on lithology and fossil content of affected units
- Evaluate paleontological sensitivity based on fossil content

To maximize detail, resource evaluation focused on available 1:24,000-scale mapping; larger scale maps provided additional context. The Paleontological Resources Technical Report (Authority and FRA 2016b) provides a detailed geologic map set for the Central Valley Wye alternatives and complete reference information for the maps used.

Numerous sources provided information on the fossil content of the affected units, including the published geologic and paleontological literature, university and museum databases—including those of the University of California Museum of Paleontology (UCMP) in Berkeley, Sierra College Natural History Museum, and Natural History Museum of Los Angeles County—and relevant theses and dissertations, as discussed in more detail in the Paleontological Resources Technical Report (Authority and FRA 2016b) and referenced in Section 3.9.5.2, Paleontological Resources.

A geologic unit's *paleontological potential* or *paleontological sensitivity* is defined as the likelihood that it will yield significant fossil finds, based on the record of past documented finds in that unit. Geologic units that have produced significant fossil materials in the past are considered to have the potential to produce additional significant finds and are evaluated as having high paleontological potential/high paleontological sensitivity. Geologic units that do not have a record of producing significant fossil materials are considered less likely to produce such materials in the future and are evaluated as having low paleontological potential/low paleontological sensitivity. Geologic units that form in settings that do not support life (such as plutonic/intrusive igneous rocks), and those that are unlikely to retain recognizable fossil materials, such as most lava flows and moderate- to high-grade metamorphic rocks, are generally evaluated as having no paleontological potential/sensitivity.

Paleontological sensitivity was evaluated based on the documented fossil content of the affected units. Field surveys were not conducted for this evaluation, because the sensitivity of the units involved is well documented in the literature and museum collections.[5]

Table 3.9-5 presents the paleontological potential/paleontological sensitivity categories used in this analysis.

Table 3.9-5 Paleontological Potential/Sensitivity Categories Used in This Analysis

Paleontological Sensitivity Rating	Description
High potential (high sensitivity)	Includes rock units that, based on previous studies, are known or likely to contain significant vertebrate, invertebrate, or plant fossils, including but not limited to sedimentary formations that contain significant nonrenewable paleontological resources anywhere within their geographical extent, and sedimentary rock units temporally or lithologically suitable for the preservation of fossils. May include some volcanic and low-grade metamorphic rock units. Fossiliferous deposits with very limited geographic extent or an uncommon origin (e.g., tar pits and caves) are given special consideration. *High sensitivity* reflects the potential to contain (1) abundant vertebrate fossils; or (2) a few significant vertebrate, invertebrate, or plant fossils that may provide new and significant taxonomic, phylogenetic, ecologic, and stratigraphic data. It also encompasses areas that may contain datable organic remains older than recent, including packrat or woodrat (*Neotoma* sp.) middens and areas that may contain unique new vertebrate deposits, traces, and trackways.
Low potential (low sensitivity)	Includes sedimentary rock units that (1) are potentially fossiliferous but have not yielded significant fossils in the past; (2) have not yielded fossils but have the potential to do so; or (3) contain common or widespread invertebrate fossils whose taxonomy, phylogeny, and ecology are well understood. Sedimentary rocks expected to contain vertebrate fossils are not placed in this category because vertebrate fossils are typically rare and occur in more localized deposits.
No potential (not sensitive)	Includes rock units considered to have no potential to contain significant paleontological resources, such as rocks of intrusive igneous origin, most volcanic rocks, and moderate- to high-grade metamorphic rocks.

Source: Authority 2014

Paleontological Resources Impact Analysis

The primary mechanism for impacts on paleontological resources is ground disturbance, which can result in damage or destruction of fossil resources contained within substrate materials.[6]

Analysis therefore evaluated the risk to paleontological resources based on the anticipated three-dimensional extent of ground disturbance and the paleontological sensitivity of the geologic units

[5] Note that because of the “sensitive anywhere, sensitive everywhere” rule (that is, the accepted practice that a geologic unit with a track record of producing significant paleontological finds is considered paleontologically sensitive throughout its geographic extent), reconnaissance-level field surveys are insufficient to "clear" paleontologically sensitive units. That is, even if no fossils are found during a field survey, the unit must still be considered sensitive, and the potential for future finds must be addressed, in this case through the incorporation of the Authority’s standard IAMFs for paleontological resources.

[6] This is a direct impact mechanism; a project only has the potential to result in indirect impacts on paleontological resources when it leads to additional projects that may in turn have direct impacts. For instance, over the longer term, the Central Valley Wye alternatives may contribute to a long-term alteration of development patterns in the San Joaquin Valley and could thus enable or foster future projects that would entail ground disturbance with the potential to result in the destruction of significant paleontological resources. This is addressed separately in Section 3.19, Cumulative Impacts.

involved. Analysis considered all ground-disturbing activities including site preparation, excavation, grading, tunneling/trenchless construction, and foundation drilling.

Analysis also took into consideration the general proportionality between the extent of ground disturbance and the extent of the potential loss of information. Because detailed information on depth of disturbance associated with the Central Valley Wye alternatives is not available at this preliminary planning stage, volumes of disturbance for the various alternatives could not be calculated. As a proxy, the extent of surface ground disturbance in areas situated on paleontologically sensitive units was projected for each of the Central Valley Wye alternatives and was used as a generalized basis of comparison among the alternatives. The extent of disturbance within paleontologically sensitive geologic units was not used as a criterion in assessing the significance of potential impacts (discussed further in the next section). This is because even a very small extent of ground disturbance can result in the loss of important information—potentially constituting a significant impact under CEQA and an impact under NEPA—if scientifically important fossils are involved. This approach is both conservative and consistent with the prevailing discipline practice, as reflected in the SVP Standard Procedures (SVP Impact Mitigation Guidelines Revision Committee 2010).

Determining Significance under CEQA

CEQA requires that an EIR identify the significant environmental impacts of a project (CEQA Guidelines § 15126). One of the primary differences between NEPA and CEQA is that CEQA requires a significance determination for each impact using a threshold-based analysis (see 3.1.3.4 for further information). By contrast, under NEPA, significance is used to determine whether an EIS will be required; NEPA requires that an EIS be prepared when the proposed federal action (project) as a whole has the potential to “significantly affect the quality of the human environment.” Accordingly, Section 3.9.9, CEQA Significance Conclusions, summarizes the significance of the environmental impacts on paleontological resources for each Central Valley Wye alternative. The Authority uses the following thresholds to determine if a significant impact on paleontological resources would occur as a result of the Central Valley Wye alternatives. A significant impact is one that would:

- Directly or indirectly destroy a unique paleontological resource or site.

3.9.5 Affected Environment

This section describes the affected environment for geology, soils, seismicity, and paleontological resources underlying the Central Valley Wye alternatives and in the surrounding San Joaquin Valley, including physiography and regional geologic setting, geologic units, site soils, geologic hazards, primary seismic hazards, secondary seismic hazards, areas of difficult excavation, mineral and energy resources, Holocene alluvial materials, and geologic formations and their fossil content. This section also discusses changes to geology, soils, seismicity, and paleontological resources in the San Joaquin Valley since publication of the Merced to Fresno Final EIR/EIS. This information provides the context for the environmental analysis and evaluation of impacts.

3.9.5.1 Geology, Soils, and Seismicity

Physiography and Regional Geologic Setting

The Central Valley Wye alternatives are located in the Central Valley of California, which is in the Great Valley Geomorphic and Physiographic Province (CGS 2002). The Central Valley is a large, nearly flat valley bound by the Klamath and Trinity mountains to the north, the southern Cascade Range and Sierra Nevada to the east, the San Emigdio and Tehachapi Mountains to the south, and the Coast Ranges and San Francisco Bay to the west. The Central Valley consists of the Sacramento Valley in the north and the San Joaquin Valley in the south.

The Central Valley Wye alternatives are located in the northern part of the San Joaquin Valley. The topography in this part of the Central Valley is generally flat. In the region, there are approximately 260 feet of relief within an area approximately 28.5 miles in an east-west direction and 75 miles in a north-south direction. The west end of the geology, soils, and seismicity RSA (between Carlucci Road and Turner Island Road) is at an elevation of 104 feet (WGS84 Datum). The northern extent (at the intersection of Le Grand Road and SR 99) is at an elevation of 193 feet, and the southern extent (at the intersection of Avenue 18 1/2 and El Vado Drive) is at 280 feet. A general downward gradient occurs in the direction of the Central Valley axis, determined principally by the gentle slope of the vast alluvial fans extending from the Sierra Nevada in the east, and the Diablo Range in the west, to the center of the San Joaquin Valley (Authority and FRA 2015; Google Earth Pro 2016).

Geologic Units

Geologic formations near the Central Valley Wye alternatives include the Turlock Lake, Modesto, Dos Palos Alluvium, Riverbank, Laguna, and Mehrten formations. Bedrock is about 6 miles below ground surface (bgs). These formations can be categorized lithologically into post-Laguna alluvial deposits representing a series of alluvial fills deposited on the valley floor, and older, pre-Laguna Tertiary units comprising predominantly nonmarine clastic deposits lain atop metamorphic and granitic basement rocks. The Modesto, Riverbank, and Turlock Lake formations are similar in four respects:

- The parent material of the sand and silt fraction
- A tendency toward coarser material at the top of each geologic layer
- Deposition as sequential overlapping alluvial terrace and fan systems
- The origin of much of the sediment

The Mehrten Formation is one in a sequence of well-defined, pre-Laguna, Tertiary stratigraphic units. These units are older, cemented sedimentary units, each with well-defined source material and composition. The Mehrten Formation is andesitic, with a higher proportion of calcium plagioclase, amphibole, and pyroxene than the overlying Laguna Formation (Marchand and Allwardt 1981).

The Laguna Formation is unique in that it is lithologically related to both the Mehrten Formation, and the younger post-Laguna alluvial deposits, and forms a sequential stratigraphic link between them. It is composed of arkosic minerals (quartz, sodium and potassium feldspar, biotite, and minor amounts of mafic minerals), like the younger alluvial deposits above it. However, the base of the Laguna Formation contains reworked andesitic material from the Mehrten Formation, overlying it in an unconformable contact (Marchand and Allwardt 1981).

Surficial geology underlying the Central Valley Wye alternatives consists primarily of alluvial deposits of clay, silt, sand, and gravel with varying grain sizes and content. The soil type and consistency of these deposits vary by location. Figure 3.9-1 depicts surficial geology near the Central Valley Wye alternatives, and Table 3.9-6 provides a description of the mapped surficial geology for each geologic formation and geologic unit type.[7]

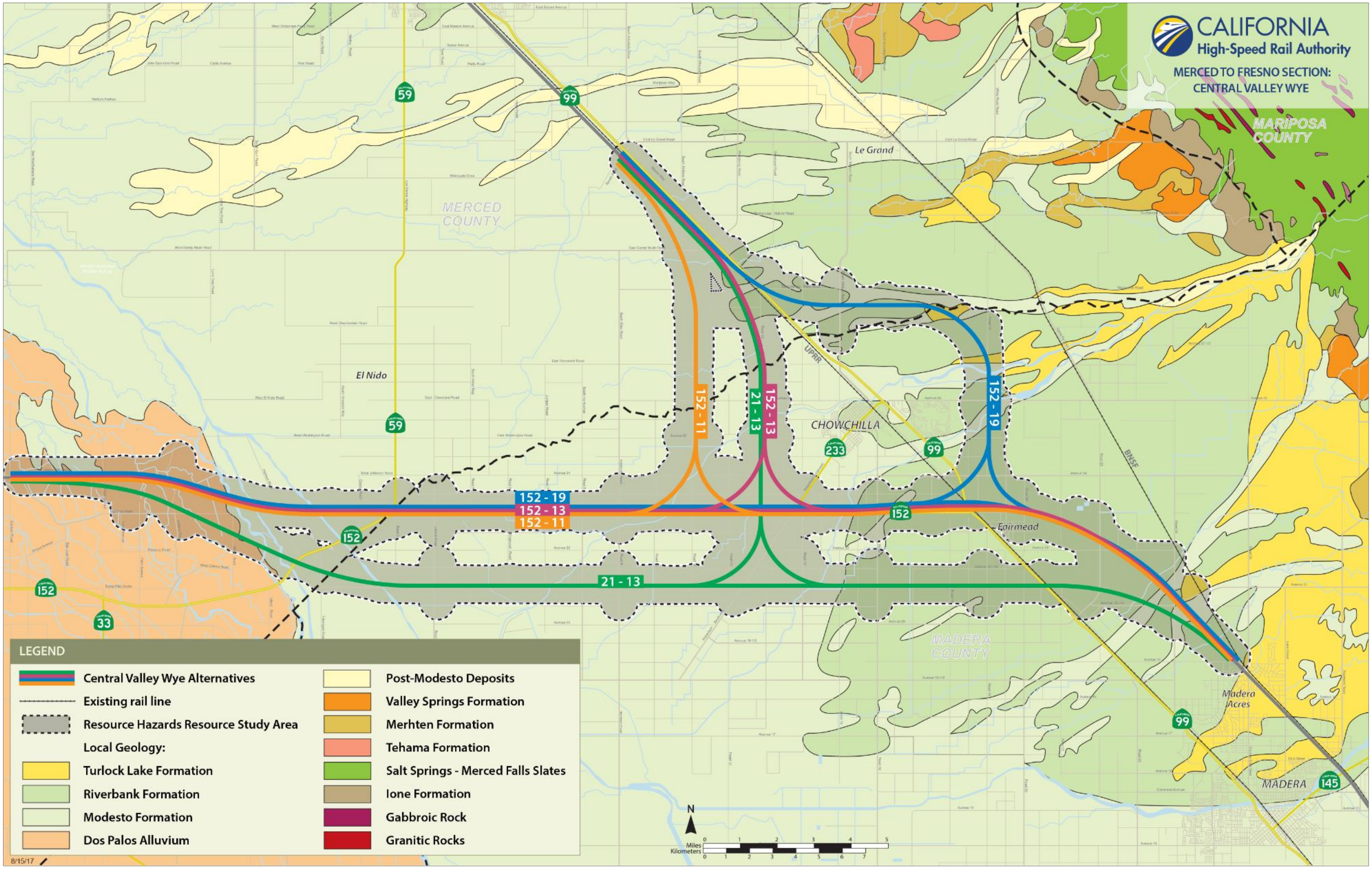
[7] The RSA for EINU components is limited to the temporary and permanent project footprints given the minor and limited extent of potential impacts. Impacts for geology, soils, seismicity, resources hazards, and paleontological resources for EINU components are limited because construction activities are generally associated with existing facilities and would include minor and localized ground disturbance; consequently, activities do not have the potential to disturb areas outside of the footprints of construction and permanent structures. Because the context for the EINU components can adequately be described in text, several graphics in this section only depict the Central Valley Wye alternatives.

Table 3.9-6 Summary of Mapped Surficial Geologic Units near the Central Valley Wye Alternatives

Geologic Formation	Geologic Unit Type	Description
Dos Palos Alluvium	Holocene to Late Pleistocene	Alluvial deposits of gravel, sand, silt, and clay covering the flood basin of the lower San Joaquin River
Modesto Formation	Late Pleistocene Alluvial Fan Deposits	Fan, axial basin, and west-flowing river channel deposits
Riverbank Formation	Middle Pleistocene	Sediments derived from weathering and erosion of the Sierra Nevada Granite
Turlock Lake Formation	Early Pleistocene Alluvial Deposits	Alluvial deposits in Chowchilla area vary from 164 to 755 feet, thickening toward the west
Mehrten Formation	Upper Miocene to Pliocene	Stratigraphic sequence formed of andesitic detritus from erosion of lava flows originally formed in the Sierra Nevada
Laguna Formation[1]	Pliocene to Pleistocene	Alluvial deposit of non-andesitic detrital gravel, sand, silt, and clay sediments formed from erosion of the Sierra Nevada

Source: Authority and FRA, 2015: page 2-2; Piper et al., 1939; Jennings and Strand, 1958
[1] The Laguna Formation is specific to the Site 7—Le Grand Junction/Sandy Mush Road, Warnerville–Wilson 230 kV Transmission Line.

As noted in Section 3.9.4, Methods for Evaluating Impacts, most of the available geologic and stratigraphic information is from geotechnical investigations conducted by Caltrans at river and stream crossings where bridges have already been constructed. Geotechnical investigations for these locations indicate that soils generally consist of layers of clay, silt, and sand of varying grain-size distributions, consistencies, and thicknesses. Most soils within the resource hazards RSA are competent stiff silts and clays or dense sands. *Competent* soils are soils that resist settlement and would not continue to compress when bearing the weight of typical components of the Central Valley Wye alternatives. However, some fine-grained soils range from soft to medium-stiff in consistency and some cohesionless soils occur, ranging from loose to medium-dense. Generally, these less-competent materials are encountered in the upper 10 to 20 feet. Between 20 and 30 feet, soils are typically more competent, stiff-to-hard silts and clay, and dense sands. Dense sands and hard silts generally occur at depths of 30–60 feet bgs. Gravels occur in some soil layers.



Source: Wagner et al., 1991

DRAFT – AUGUST 15, 2017

Figure 3.9-1 Local Geological Map

Depth to groundwater ranges from 40 to 260 feet bgs and varies considerably (by about 20 feet or more) each season, depending on rainfall conditions. In general, groundwater is typically shallower to the north and deepest between Chowchilla and Madera Acres and near the Merced/Stanislaus County line. Table 3.9-7 provides a summary of groundwater depths at different locations near the Central Valley Wye alternatives (see Section 5.3, Groundwater, in the Hydrology and Water Resources Technical Report (Authority and FRA 2016d) for more detail on the groundwater basins).

Table 3.9-7 Depth to Groundwater near the Central Valley Wye Alternatives

Groundwater Subbasin	City	Approximate Depth to Groundwater (feet bgs)
Chowchilla	Chowchilla	180–190
Delta-Mendota	Mendota	50
Merced	Merced	40–80
Madera	Madera	150–260
Modesto	Waterford/Oakdale	90
Turlock	Stanislaus - Merced County Line	200+
Westside	Los Banos - Dos Palos	90-120

Source: DWR, 2012; SJRECWA 2012
bgs = below ground surface

Soils

NRCS soil surveys describe soil associations within the resource hazards RSA (NRCS 2010). This soils information is based on conditions within the upper 4–5 feet of the ground surface. Figure 3.9-2 shows the soil associations in the resource hazards RSA. Table 3.9-8 provides a summary of the physiographic features, soil associations, counties of occurrence, and soil hazards. The soil hazards[8] present in the resource hazards RSA are (NRCS 2016):

- **Expansive soils**—Clay soils that are susceptible to expansion and contraction swell with an increase in water content and shrink with a decrease. Expansive soils provide an unstable subgrade support for foundations or other structures, and exert uplift or lateral pressures on foundations or walls in contact with them. Soils defined as expansive by NRCS correspond closely to expansive soils as defined under current California Building Standards Code Section 1803.5.3 Expansive Soil. NRCS recognizes a gradation of expansiveness from low to high, whereas California Building Standards Code recognizes only two categories—expansive or not expansive.
- **Erodible soils**—Soils that are susceptible to wind erosion, water erosion, or both.
- **Corrosive soils**—Soils that have electrochemical or chemical properties that corrode or weaken concrete or uncoated steel. Factors for corrosivity to concrete are sulfate and sodium content, texture, moisture content, and soil acidity. Factors for corrosivity to uncoated steel are moisture content, particle-size distribution, soil acidity, and electrical conductivity of the soil.

[8] Hydrocompaction hazard is present in the extreme western edge of the San Joaquin Valley but not along the Central Valley Wye alternatives. Soils that are vulnerable to hydrocompaction are deposited as loose, porous, dry particles that are cemented along particle edges by water-soluble minerals. The soils hold their structure and can carry weight but lose the ability to carry weight when wet. The nearest area of soils susceptible to hydrocompaction is mapped 18 miles to the south of the Central Valley Wye alternatives (Authority and FRA 2016a).

More detailed information on-site soils can be found in the Geology, Soils, and Seismicity Technical Report (Authority and FRA 2016a).

The soils within the resource hazards RSA generally occur within one of the four landform groups (Authority and FRA 2016a):

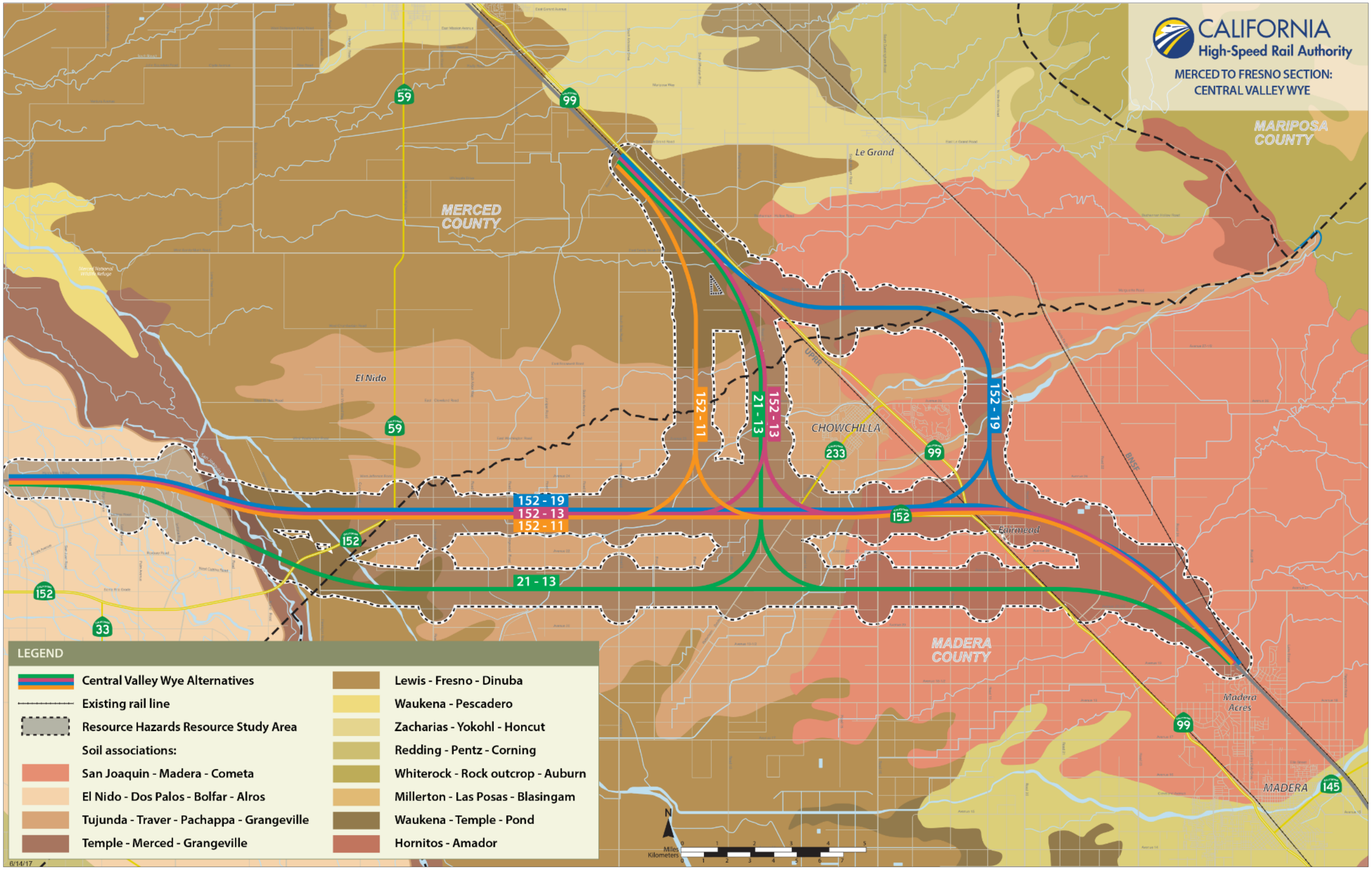
- **Recent Alluvial Fans and Floodplains**—These soils are found in Merced and Madera Counties. *Alluvial fans* are fan-shaped deposits of water-transported material (alluvium). They typically form at the base of topographic features where there is a marked break in slope.
- **Older, Low Alluvial Terraces**—These soils are found in Merced and Madera Counties. They are often found in rolling topography, and can include a strongly cemented or indurated hardpan in the subsoil.
- **Basin Areas (including saline-alkali basins)**—These soils are found primarily in Merced County. The topography of these areas is nearly level or gently undulating. They have more clay content than fans and terraces, and nearly all have accumulations of salt and alkali because of poor drainage.
- **High Terraces**—These soils are found primarily in Merced County. They tend to occur in undulating landscape and have textures ranging from fine sand to gravel. Some of the high terrace soils are underlain by an iron silica hardpan or claypan. Despite the coarser texture, these soils have a moderate to high potential for shrink-well,[9] are highly corrosive to uncoated steel, and are moderately corrosive to concrete.[10] The potential for water erosion is moderate,[11] and the potential for wind erosion is from low to high,[12] depending on surface textures.

[9] Soils are recognized as having moderate shrink-swell vulnerability if they have a value of 3 to 6 percent linear extensibility percent and a high shrink-swell vulnerability with a value of 6 to 9 linear extensibility percent (Natural Resources Conservation Service n.d.a).

[10] The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. The steel or concrete in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel or concrete in installations that are entirely within one kind of soil or within one soil layer (Natural Resources Conservation Service n.d.b).

[11] Soil susceptibility to water erosion is measured by multiple factors, including the susceptibility of a soil to sheet and rill erosion by water (erosion factor K). Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water. Erosion factor Kw (whole soil) indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments (Natural Resources Conservation Service n.d.b).

[12] Wind erosion is rated in terms of wind erodibility group. A wind erodibility group consists of soils that have similar properties affecting their susceptibility to wind erosion in cultivated areas. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible (Natural Resources Conservation Service n.d.b).



Source: NRCS, 2016

DRAFT – AUGUST 15, 2017

Figure 3.9-2 Soil Associations

Table 3.9-8 Soil Types in the Resource Hazards RSA

Soil Association	SR 152 (North) to Road 13 (acres)	SR 152 (North) to Road 19 (acres)	Avenue 21 to Road 13 (acres)	SR 152 (North) to Road 11 (acres)	Counties of Occurrence	Landform Groups	Potential Soil Hazards Characterization
Temple-Merced-Grangeville	641	641	792	641	Merced	Recent alluvial fans and floodplains	▪ Low to moderate expansion potential[2] ▪ Moderately to highly corrosive to uncoated steel[3] ▪ Slightly corrosive to concrete[4] ▪ Moderate potential for water erosion[5] ▪ High potential for wind erosion[6]
Hilmar-Delhi-Atwater[1]	0	49	0	0			
Woo-Stanislaus[1]	6	6	6	6			
Lewis-Fresno-Dinuba	8,003	6,110	8,647	6,517	Stanislaus, Merced, and Madera		
Tujunga-Traver-Pachappa-Grangeville	15,604	14,913	13,985	15,565			
Tujunga-Merritt-Grangeville-Columbia[1]	0	9	0	0			
Dosamigos-Deldota-Chateau[1]	70	70	70	70	Merced and Fresno		
Ciervo-Cerini[1]	27	27	27	27			
Panoche-Ciervo-Cerini[1]	22	22	22	22			
Zacharias-Yokohl-Honcut[1]	37	42	37	37	Stanislaus, Merced, and Madera	Older, low alluvial terraces	▪ High expansion potential[2] ▪ Highly corrosive to uncoated steel[3] ▪ Moderately corrosive to concrete[4] ▪ Moderate potential for water erosion[5] ▪ High potential for wind erosion[6]
San Joaquin- Madera-Cometa	10,519	16,956	9,964	10,062			
Finrod-Cogna-Archerdale[1]	0	4	0	0	Stanislaus		
Tokay-Greenfield[1]	0	6	0	0			

Soil Association	SR 152 (North) to Road 13 (acres)	SR 152 (North) to Road 19 (acres)	Avenue 21 to Road 13 (acres)	SR 152 (North) to Road 11 (acres)	Counties of Occurrence	Landform Groups	Potential Soil Hazards Characterization
El Nido-Dos Palos-Bolfar-Alros	4,979	4,977	6,584	4,930	Merced	Basin areas (including saline-alkali basins)	▪ Moderate expansion potential[2] ▪ Highly corrosive to uncoated steel[3] ▪ Moderately corrosive to concrete[4] ▪ High potential for water erosion[5] ▪ Moderate to high potential for wind erosion[6]
Peters-Pentz[1]	0	5	0	0	Merced and Stanislaus	High terraces	▪ Moderate expansion potential[2] ▪ Highly corrosive to uncoated steel[3] ▪ Moderately corrosive to concrete[4] ▪ High potential for water erosion[5] ▪ Moderate to high potential for wind erosion[6]
Redding-Pentz-Corning[1]	0	17	0	0			
Whitney-Rocklin-Montpellier[1]	0	220	0	0			

Source: NRCS, 2016

[1] These soil associations are located only within the temporary and permanent footprints of the EINU components.

[2] Soils with expansion potential expand when wet and contract when dry. This expansion and contraction can damage foundations and structures that are built in or on expansive soils. Soils are recognized as having moderate shrink-swell vulnerability if they have a value of 3 to 6 percent linear extensibility percent and a high shrink-swell vulnerability with a value of 6 to 9 linear extensibility percent (Natural Resources Conservation Service n.d.(a))

[3] Soils that are corrosive to uncoated steel interact with uncoated steel chemically to weaken steel that is exposed to the soil. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel in installations that are entirely within one kind of soil or within one soil layer (Natural Resources Conservation Service n.d.(b)).

[4] Soils that are corrosive to uncoated concrete interact with uncoated concrete chemically to weaken concrete that is exposed to the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. The concrete in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the concrete in installations that are entirely within one kind of soil or within one soil layer (Natural Resources Conservation Service n.d.(b)).

[5] Soil susceptibility to water erosion is measured by multiple factors, including the susceptibility of a soil to sheet and rill erosion by water (erosion factor K). Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water. Erosion factor Kw (whole soil) indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments (Natural Resources Conservation Service n.d.(b)).

[6] Wind erosion is rated in terms of wind erodibility group, which consists of soils that have similar properties affecting their susceptibility to wind erosion in cultivated areas. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible (Natural Resources Conservation Service n.d.(b))

Geologic Hazards

The review of the affected environment considered two types of nonseismic geologic hazards within the resource hazards RSA. These geologic hazards pose potential threats to the health and safety of citizens:

- **Landslides and Slumps**—Topography within the resource hazards RSA is generally flat, with principal relief occurring where stream channels have been incised into the landscape. Analysts did not identify any large, deep-seated landslide areas during review of available USGS and CGS landslide inventories. The only steep slopes that may be encountered in this area are either built features such as channels or embankments, or the banks of incised streams or rivers. Localized, surficial failures of these slopes can occur from changes in groundwater, erosion, stream meander, changes in slope steepness from construction activities, or new earth loads being placed at the top of the slope. The potential for the slumps and slides increases with slope steepness and height. Design features such as retaining structures and slope modification by grading are expected to be sufficient to prevent landslides (Authority and FRA 2016a).
- **Land Subsidence**—Ground subsidence is the settling or sinking of the land surface caused by groundwater extraction from alluvial geologic formations. Subsidence can happen over large areas when it results from regional groundwater extraction or over small areas when it results from localized dewatering.

  Regional land subsidence is a phenomenon that occurs throughout the Central Valley, depending on the geologic and soil conditions, and variable factors such as rainfall, aquifer draw, and recharge rates. The effect of subsidence is measureable with topographic surveys. In the Central Valley, subsidence bowls typically occur across the landscape and cover areas of several hundred square miles. The USGS has documented subsidence across the San Joaquin Valley, including the area of the Central Valley Wye alternatives (Sneed et al. 2013). The Central Valley Wye alternatives would cross the Los Banos-Kettleman Hills bowl subsidence feature.

  The Authority has surveyed operators of other linear facilities, such as roads, railroad tracks, and water conveyance facilities, to determine what their experience has been with regional land subsidence. Questions included, for example, whether they observed localized subsidence affecting their operations and whether they were incurring higher maintenance costs in the Central Valley compared to other areas where they operate. Caltrans and commercial railroads did not report increased maintenance costs. Operators of water canals address subsidence by regrading canals or installing pumps to augment gravity flow.

  The San Joaquin Valley has a long history of regional land subsidence in response to water and mineral (oil and gas resources) extraction. The San Joaquin Valley had experienced subsidence of approximately 30 feet near Mendota, approximately 20 miles south of the resource hazards RSA, by 1981. The rate of subsidence in the San Joaquin Valley slowed between the 1970s and the early 2000s because lower-cost surface water made available by the Delta-Mendota Canal, the Friant-Kern Canal, and the California Aqueduct allowed groundwater levels to recover. However, active subsidence in the resource hazards RSA was recorded between 2003 and 2014 (USBR and DWR 2014; Sneed et al. 2013; Faunt 2009). The U.S. Bureau of Reclamation measured a maximum rate of subsidence at the Eastside Bypass of 0.9 foot over an 18-month period between 2011 and 2014, just north of State Route (SR) 152; and the California Department of Water Resources measured 2.5 to 3 feet of subsidence on the Eastside Bypass levees from 2008 to 2012. Federal, state, and local agencies and other interested parties have formed a Subsidence Coordination Group as part of the San Joaquin River Restoration Program to study and evaluate the groundwater overdraft issue, to determine possible mitigations and solutions to eliminate future subsidence (Morberg 2017).

  Localized land subsidence is a related phenomenon that can occur as a result of construction-related dewatering because of changes in pore water pressure (Ding 2017).

Removal of water (i.e., dewatering) reduces pore water pressure, which increases effective stress in the soil structure. Increased effective stress can lead to localized land subsidence, depending on the characteristics of the soil.

Primary Seismic Hazards

The primary seismic hazards assessed within the seismicity, faulting, and dam failure inundation RSA are surface fault ruptures transecting the alignments and ground shaking. Both active and inactive faulting are prevalent throughout California. As discussed in the following sections, only active and potentially active faults are considered. Figure 3.9-3 shows active and potentially active regional faults. A seismic event along any of these faults, depending on type and exposure, could result in permanent offsets at the ground surface along the fault line and, depending on proximity to the event epicenter, varying degrees of ground shaking.

An *active fault* is defined as a ground rupture within a fault zone that has occurred within approximately the last 11,000 years. This includes historic surface ruptures (approximately the last 200 years), as well as older Holocene displacements. A *potentially active fault* is defined as a ground rupture that occurred between 11,000 and 1.6 million years ago. Additional detail about active and potentially active faults in the seismicity, faulting, and dam failure inundation RSA is provided in the *Merced to Fresno Section: Central Valley Wye Geotechnical Summary Report* (Authority and FRA 2015). Active faults, distance from the Central Valley Wye alternatives, and their characteristic magnitude (maximum expected magnitude on a segment) are listed in Table 3.9-9.

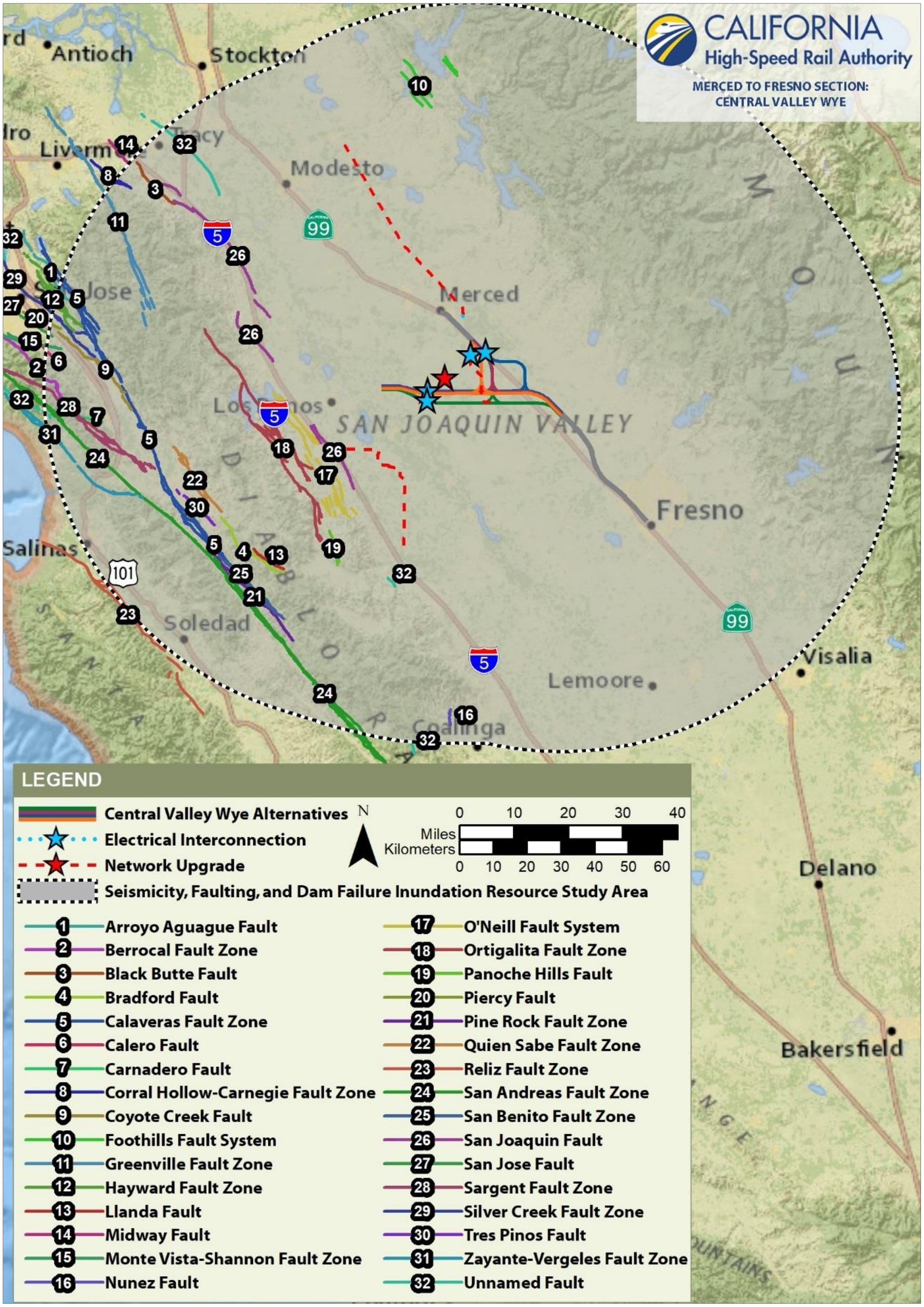
Definition

A *fault zone* is a group of earthquake-induced fractures in soil or rock where there has been documented seismic displacement of the two sides relative to one another. A fault zone ranges from a few feet to several miles wide.

Table 3.9-9 Active Faults within 65 Miles of the Central Valley Wye Alternatives

Fault	Distance[1] and Direction Miles (km)—Direction	Maximum Magnitude (Moment)
Great Valley	29 (47)—west	N/A
Ortigalita	37 (60)—west	7.1
Quien Sabe	53 (85)—southwest	6.6
Calaveras	57 (92)—southwest	7.0
San Andreas	59 (95)—southwest	7.9
Sargent	62 (100)—west	6.8
Greenville	62 (100)—northwest	7.2

Source: Authority and FRA, 2015
[1] Distances measured from approximate geographic center of all four Central Valley Wye alternatives.
km = kilometers



Source: USGS, 2010

DRAFT – AUGUST 22, 2017

Figure 3.9-3 Regional Faults

The review of information published by the USGS and CGS determined the following primary seismic hazards within the seismicity, faulting, and dam failure inundation RSA (Authority and FRA 2016a):

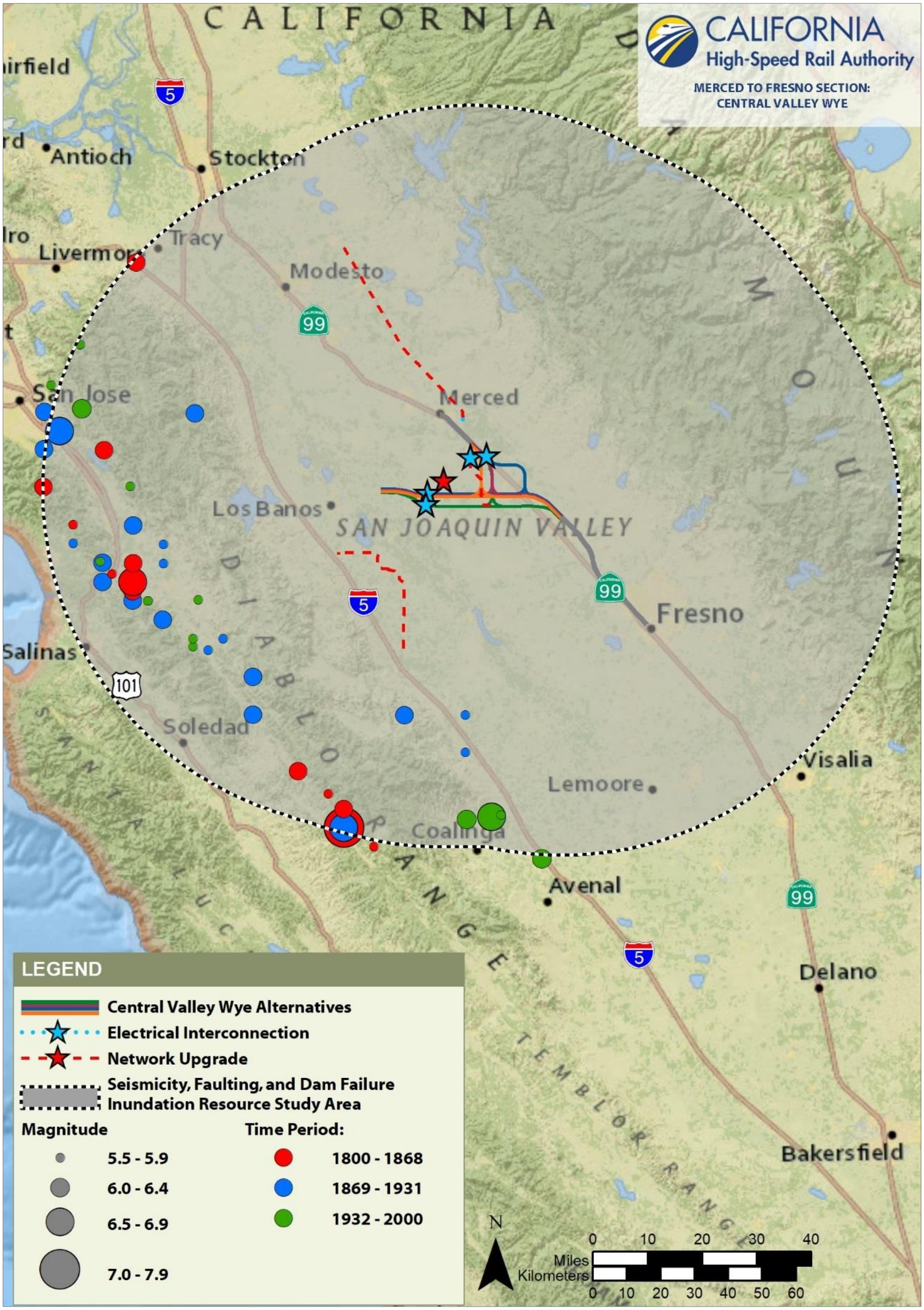
- **Surface Fault Rupture**—Surface fault ruptures are the result of stresses relieved during an earthquake event and often cause damage to structures astride the rupture zone. The potential hazard posed by surface rupture from fault offset is considered very low in the seismicity, faulting, and dam failure inundation RSA because no known active or potentially active faults cross the alignments. Regional faults that exhibit geologically recent activity and are considered capable of causing strong ground shaking in the seismicity RSA are listed in Table 3.9-9.
- **Ground Shaking**—During an earthquake, the Central Valley Wye alternatives would be susceptible to ground shaking, which is anticipated to be moderate; peak ground accelerations at the ground surface could range from 0.33g to 0.45g, where *g* is the acceleration of gravity. This level of ground shaking is based on a seismic event with a 2 percent probability of being exceeded within a 50-year interval, with an associated return period of approximately 2,500 years. Information about ground motions (USGS 2009) suggests that the primary cause of shaking likely would be a nearby shallow earthquake (magnitude 5.2 at 4.5 miles), but that large, distant (greater than 30 miles) events with a magnitude greater than 6.6 also generally contribute to the ground-motion hazard. Regional historical earthquakes and their magnitudes are shown on Figure 3.9-4.

Secondary Seismic Hazards

A number of secondary seismic hazards could occur in the seismicity, faulting, and dam failure inundation RSA if there were strong ground shaking. Strong ground shaking could result from either a nearby or a distant earthquake, depending on the earthquake’s magnitude and its distance from the Central Valley Wye alternatives. These secondary hazards include liquefaction, seismically induced settlement, lateral spreading, slides or slumps, and flooding resulting from seismically induced dam failure. The first two of these hazards could occur primarily where liquefiable soils exist within the resource hazards RSA. Seismically induced flooding could occur in the event any of the several dams located in the seismicity, faulting, and dam failure inundation RSA fail, releasing impounded water that could inundate the area.

A potential for liquefaction exists in the resource hazards RSA (see Table 3.9-3) where there are loose, cohesionless soils close to the ground surface, and where these soils are saturated (i.e., below static groundwater level), such as where groundwater is within 50 feet of the ground surface. This occurs in some western portions of the RSA, the city of Chowchilla, and areas where the Central Valley Wye alternatives cross stream or river channels. The combination of groundwater conditions and soil types under an estimated peak ground acceleration of 0.35g is sufficient to warrant further detailed subsurface geotechnical investigations and geotechnical design evaluations in these areas.

The two primary consequences of liquefaction are loss of soil strength during and after ground shaking, and ensuing ground settlement. The severity of this effect depends on the relative density, grain-size characteristics, thickness of the liquefied stratum, and magnitude of the causative seismic event. Where liquefaction occurs at natural waterbody crossings (e.g. stream and river crossings, as opposed to concrete-lined waterways or agricultural irrigation canals or ditches), the potential also exists for liquefaction-induced lateral spreading, or flow, of the soil. These liquefaction-related ground displacements could occur on ground that has slope angles of 5 degrees or more. Natural waterbody crossings are the most susceptible locations for liquefaction-induced lateral spreading or flow failures. Consistent with standard industry practice, further detailed subsurface geotechnical investigations and geotechnical design evaluations would be conducted during the later stages of engineering design to confirm any site-specific risks and to minimize these risks in the final design of structures. These studies would be conducted during final design following the environmental review process.



Source: USGS, 2010

DRAFT – AUGUST 22, 2017

Distances measured from approximate center of Central Valley Wye alternatives.

Figure 3.9-4 Regional Earthquakes 1800–2000

In the past, the hazard posed by liquefaction has been considered relatively minor in the Central Valley; however, localized deposits within the resource hazards RSA may be liquefiable, particularly in high groundwater areas that are underlain by poorly compacted granular fills or geologically young, loose, alluvial stream deposits. The RSA is in the Delta-Mendota Groundwater basin, where groundwater generally is located 50 feet or more bgs. Exceptions occur in Chowchilla and in localized areas near river and stream crossings, where groundwater is less than 50 feet bgs. At these locations, the potential for liquefaction exists if the saturated near-surface soils are loose, cohesionless soils. Available geotechnical exploration data indicate that such soils occur on a localized basis; soil testing prior to construction would be required.

The inertial impacts of ground shaking can also be sufficient to cause slopes to fail, even where liquefaction does not occur. In this case, inertial forces in combination with gravity loads exceed the strength of the soil; that is, destabilizing forces exceed the soil's resistance. When this occurs, slope movements can result and, depending on magnitude of movement, failure can ensue. This hazard is most acute where slopes are steep (i.e., greater than 2H:1V [horizontal to vertical]) and where soil strength is low (e.g., factor of safety under static loading is less than about 1.5). All of the natural waterbody crossings in the seismicity, faulting, and dam failure inundation RSA are candidate locations for these inertial impacts failures.

The last type of secondary hazard involves water inundation resulting from the failure of dams located in the seismicity, faulting, and dam failure inundation RSA. Seismically induced flood hazards in the seismicity, faulting, and dam failure inundation RSA include the potential for inundation or erosion from floodwaters associated with the breach of a dam. A review of dam inundation maps and risk assessments prepared by Merced, Madera, Stanislaus, and Fresno Counties and the Cities of Chowchilla and Merced show that each of the Central Valley Wye alternatives cross the inundation areas of several large dams: Buchanan Dam on the Chowchilla River, Hidden Dam on the Fresno River, Friant Dam on the San Joaquin River, Pine Flat Dam on the Kings River, Don Pedro Dam on the Tuolumne River and the New Melones Dam on the Stanislaus River.

Areas of Difficult Excavation

Difficult excavation is defined as excavation methods requiring more than standard earth-moving equipment or special controls to enable the work to proceed. Areas of difficult excavation are most common in bedrock formations, and possibly cemented or hardpan strata not amenable to excavation with a ripper-equipped dozer. Bedrock is generally far below the ground surface in the resource hazards RSA. Cemented zones and hardpan layers also occur near the Central Valley Wye alternatives and can be rock-like in consistency. Cemented zones and hardpan form because of the soil-weathering process and are found in the subsoil in most of the surficial site soils previously described. Areas of difficult excavation within the resource hazards RSA (including drilled piers or piles) are not expected to be pervasive because of the predominantly uncemented Quaternary sediments in the San Joaquin Valley, although some localized areas may occur. In areas that have been used for agricultural purposes, the hardpan has often been removed or tilled to improve the drainage characteristics of the soil. Past land use, as well as infrastructure development in the resource hazards RSA and vicinity, should limit the locations where hardpan and cemented zones pose a potential problem for excavations.

Shallow groundwater can make construction excavations difficult and increase risk of excavation failure. Groundwater is shallow in much of the San Joaquin Valley, seasonally near 10 feet below ground surface (DWR 2014). It is possible that the combination of soil conditions and shallow groundwater in some locations could result in difficult excavation conditions if sufficient consideration is not given to specific conditions when excavating for construction of below-grade sections of the track. Whenever excavations extend below groundwater levels, a need exists to prevent excess hydrostatic pressures. These conditions are most critical where loose, cohesionless deposits have to be excavated in areas of high groundwater. Although these conditions are unlikely to be widespread, localized areas where groundwater is near the surface and loose soil conditions exist cannot be ruled out, especially near natural waterbody crossings. Site-specific subsurface geotechnical investigations and geotechnical design evaluations would be conducted during the design of the Central Valley Wye alternatives to determine specific locations where difficult excavations may occur and to plan for this during construction.

Resource Hazards

Active mining operations in the San Joaquin Valley region are for building materials or aggregate (near-surface sand and gravel) and industrial minerals such as lime, pumice, and gypsum. A variety of MRZ-2 aggregate resource areas are present across the San Joaquin Valley, the spatial distribution of which is dependent on the underlying alluvial sediments.

There are two areas classified as MRZ-2 (MRZ-2a SG-2—Central Merced River Area and MRZ-2b SG-C6—Tuolumne River Aggregate Resource Area) within the RSA of the Site 7—Le Grand Junction/Sandy Mush Road, Warnerville—Wilson 230 kV Transmission Line associated with SR 152 (North) to Road 19 Wye Alternative (Clinkenbeard 1999; Stanislaus County 2016). The Central Merced River Area is a part of the channel and floodplain deposits of the Merced River, which drains the Sierra Nevada to the east. Sediments are comprised of largely quartz and feldspathic minerals, which are typically very hard and durable, making them amenable to construction applications. The Tuolumne River Aggregate Resource Area is part of the channel of the Tuolumne River, which also drains the Sierra Nevada to the east. Aggregate resources are largely comprised of siliceous undifferentiated metasedimentary and metamorphic rocks, quartzite, vein quartz, slate, greenstone, and granitic rocks. Several mining companies have operated in these areas in the past, producing a variety of aggregate products, including concrete aggregate; however, there are no current aggregate mining operations within the resource hazards RSA.

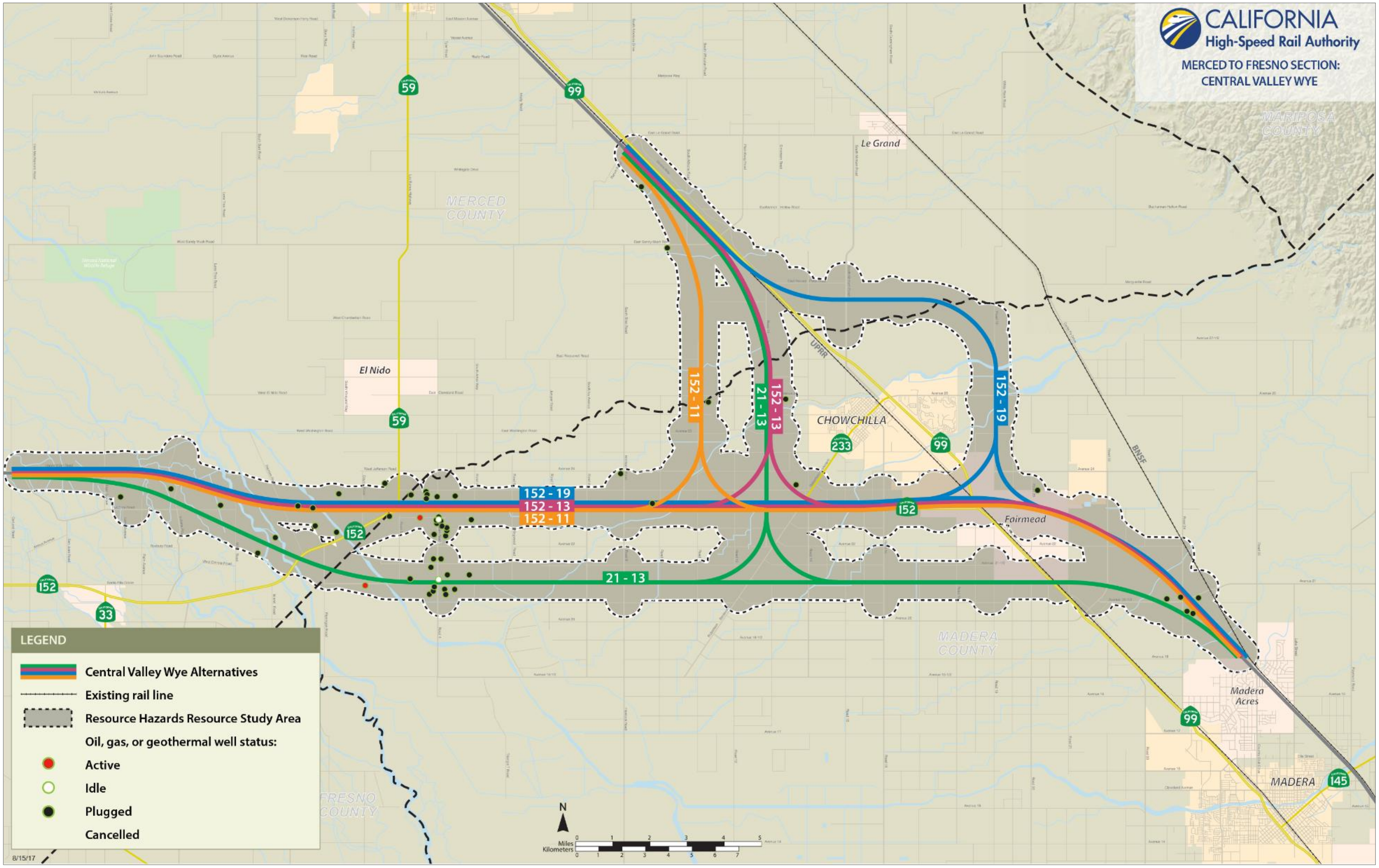
Energy resources in the resource hazards RSA include oil and natural gas wells. The Chowchilla Gas Field is located near where SR 152 crosses the Merced-Madera County line. Most of the wells within the Chowchilla Gas Field are dry or plugged; operators abandoned these wells between 1930 and 1986. Table 3.9-10 shows the number of wells within the resource hazards RSA and within the project footprints. Figure 3.9-5 shows the location of wells within the resources hazards RSA and within the project footprints.[13]

[13] The RSA for EINU components is limited to the project footprints given the minor and limited extent of potential impacts. Impacts for geology, soils, seismicity, resources hazards, and paleontological resources for EINU components are limited because construction activities are generally associated with existing facilities and would include minor and localized ground disturbance; consequently, activities do not have the potential to disturb areas outside of the footprints of construction and permanent structures. Because the context for the EINU components can adequately be described in-text, several graphics in this section only depict the Central Valley Wye alternatives.

Table 3.9-10 Gas and Oil Wells in the Resource Hazards Resource Study Area

Alternative	Active Dry Gas	Cancelled Dry Gas	Idle Dry Gas	Plugged and Abandoned Dry Gas	Plugged and Abandoned Oil and Gas	Plugged and Abandoned Dry Gas/Oil and Gas	Total
SR 152 (North) to Road 13 Wye							
0.5 mile buffer	1	1	--	6	28	1	37
Project footprint	--	--	1	1	5	--	7
Total	**1**	**1**	**1**	**7**	**33**	**1**	**44**
SR 152 (North) to Road 19 Wye							
0.5 mile buffer	1	1	--	6	29	1	38
Project footprint	--	--	1	1	5	--	7
Total	**1**	**1**	**1**	**7**	**34**	**1**	**45**
Avenue 21 to Road 13 Wye							
0.5 mile buffer	1	3	--	3	23	--	30
Project footprint	--	--	1	1	2	--	4
Total	**1**	**3**	**1**	**4**	**25**		**34**
SR 152 (North) to Road 11 Wye							
0.5 mile buffer	1	1	--	6	28	1	37
Project footprint	--	--	1	1	5	--	7
Total	**1**	**1**	**1**	**7**	**33**	**1**	**44**

Source: DOC, 2015



Source: DOC, 2014

DRAFT – AUGUST 15, 2017

Figure 3.9-5 Oil, Gas, and Geothermal Wells in the Resource Hazards Resource Study Area

3.9.5.2 Paleontological Resources

Figure 3.9-6 is a generalized regional map showing where paleontologically sensitive materials are exposed at the surface in the paleontological resources RSA for the Central Valley Wye alternatives. The Paleontological Resources Technical Report (Authority and FRA 2016b) for the Central Valley Wye alternatives presents a complete set of geologic maps for all four Central Valley Wye alternatives, developed using 1:24,000-scale USGS geologic mapping. The detailed maps in the Paleontological Resources Technical Report (Authority and FRA 2016b) provided the basis for the regional map in Figure 3.9-6.

Table 3.9-11 identifies the geologic units expected to be involved in construction of the Central Valley Wye alternatives, based on the geologic map set included in the Paleontological Resources Technical Report. The table lists surface-exposed units as well as units known and potentially present in the shallow subsurface within the anticipated volume of disturbance. It also identifies the Central Valley Wye alternatives that would involve surface exposures of each geologic unit; additional underlying units are presumed to be present in the subsurface and would potentially be affected.

Text that follows Table 3.9-11 briefly describes each geologic unit within the paleontological resources RSA, focusing on documented fossil content; more detailed information is presented in the Paleontological Resources Technical Report (Authority and FRA 2016b).

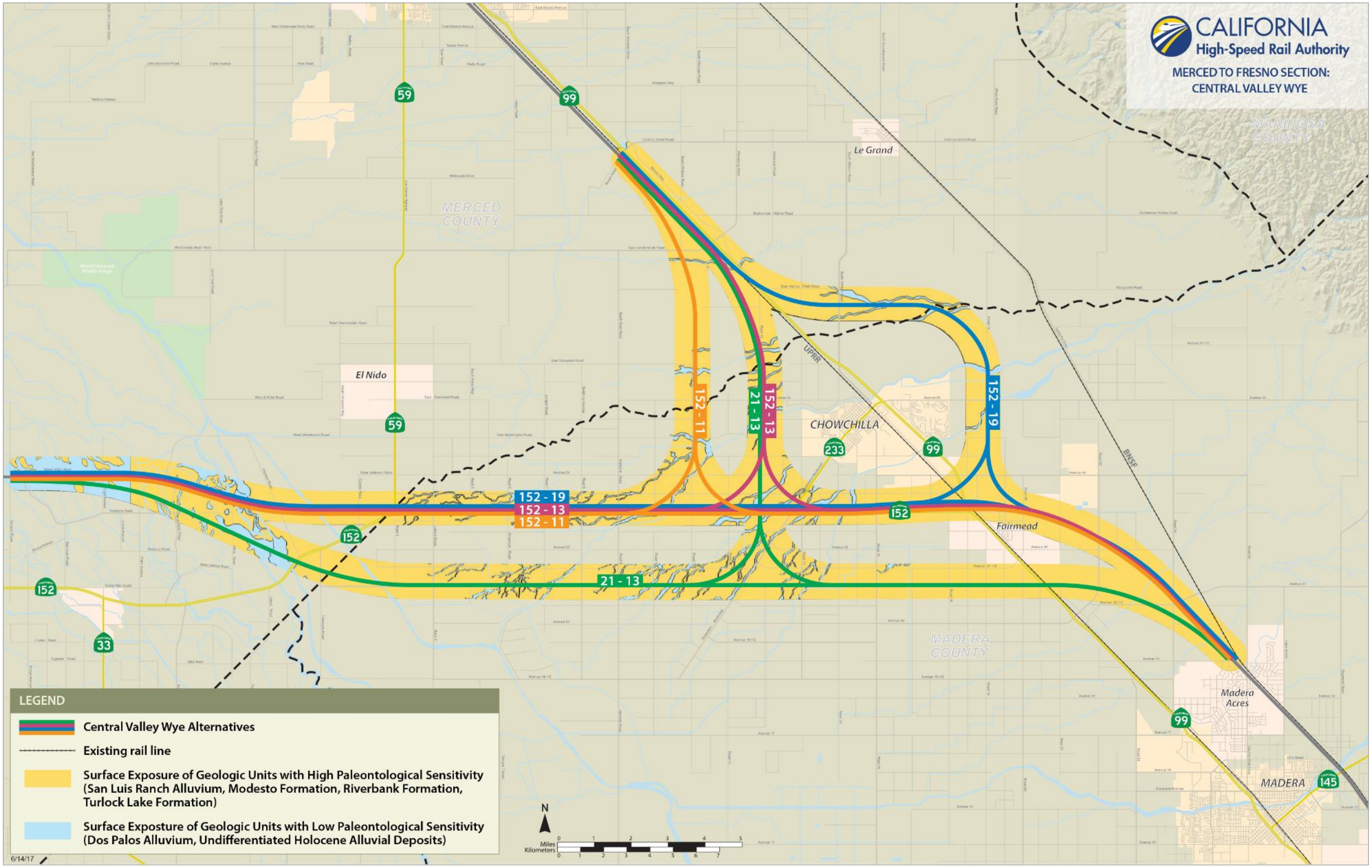
Table 3.9-11 Affected Geologic Units – Central Valley Wye Alternatives

Geologic Unit	Paleontological Sensitivity	Comments	Surface Exposure Within RSA
Holocene alluvial materials (undifferentiated floodplain and terrace deposits)	Low	No records indicating potential to yield significant fossils	All Central Valley Wye alternatives
Dos Palos alluvium[1]	Low	No records indicating potential to yield significant fossils	All Central Valley Wye alternatives
San Luis Ranch Alluvium, alluvium of San Luis Ranch	High	These units have yielded vertebrate fossils	Not surface-exposed within Central Valley Wye alternative project footprints; potentially present in subsurface at western ends of all Central Valley Wye alternatives
Undifferentiated Modesto Formation and Holocene alluvial and colluvial materials	High	This unit is mapped in areas where Holocene alluvium and Modesto Formation cannot be reliably distinguished in the field or cannot be accurately delineated at the scale of the source maps. Because the Modesto Formation has yielded vertebrate fossils from a number of localities and is considered highly sensitive, this unit is also considered highly sensitive	All Central Valley Wye alternatives
Modesto Formation	High	This unit has yielded vertebrate fossils from a number of localities	All Central Valley Wye alternatives

Geologic Unit	Paleontological Sensitivity	Comments	Surface Exposure Within RSA
Riverbank Formation	High	This unit has yielded numerous and diverse vertebrate fossils from a number of localities, notably the Arco Arena site and Teichert Gravel Pit in Sacramento County and the famous Fairmead Landfill in Madera County	All Central Valley Wye alternatives
Turlock Lake Formation	High	The Turlock Lake Formation has yielded numerous and diverse vertebrate fossils from localities that include the famous Fairmead Landfill site in Madera County	All Central Valley Wye alternatives
North Merced Gravel	Low	The North Merced Gravel is not known to be fossiliferous	Potentially present in subsurface
Laguna Formation	High	The Laguna Formation has produced vertebrate remains	Potentially present in subsurface
Mehrten Formation	High	The Mehrten Formation has produced abundant plant and vertebrate remains from a number of localities	Potentially present in subsurface

Source: Authority and FRA, 2016b; UCMP, 2016

[1] The Dos Palos alluvium has not been through the formal U.S. Geological Survey definition process; alluvium is therefore in lowercase. San Luis Ranch Alluvium in contrast has been through the formal process as indicated by the use of uppercase.



Source: Marchand, 1976; Lettis, 1982

DRAFT – JUNE 15, 2017

Figure 3.9-6 Paleontological Sensitivity of Surface-Exposed Geologic Units

Holocene Alluvial Materials

The Holocene alluvial units of the western San Joaquin Valley consist of unconsolidated materials deposited in riverine, lacustrine, and associated terrestrial environments (Marchand 1976). Alluvial fan and terrace deposits are also present along the Diablo Range and Sierran range fronts (e.g., Lettis 1982; Norris and Webb 1990).

Past work reflects several approaches to Holocene stratigraphy along the valley margins and in the San Joaquin Valley itself. In general, where map coverage was available, this analysis and that in the supporting Paleontological Resources Technical Report (Authority and FRA 2016b) follow the breakdown of Marchand (1976), who recognizes three units based on geomorphology and occurrence. Within the paleontological resources RSA, portions of all of the Central Valley Wye alternatives are situated on surface exposures of Marchand's hal unit, comprising sand, silt, and gravel deposited in floodplain and low-level terrace settings. Aeolian (dune) sand and lacustrine, marsh, and swamp deposits are also present in the vicinity but have not been mapped along the alignments (Marchand 1976). In the Delta Ranch 7.5-minute quadrangle, which is outside the area of Marchand's 1976 mapping, analysis relied on the usage of Lettis (1982) and the 1:250,000 compilation map of Wagner et al. (1991), which employ a different nomenclature. More specifically, both Lettis (1982) and Wagner et al. (1991) show this portion of the RSA as situated on exposures of the Dos Palos Alluvium of Holocene age and the Modesto Formation. The Dos Palos Alluvium is regionally underlain by the San Luis Ranch Alluvium of Late Pleistocene−Early Holocene age (Lettis 1982; Wagner et al. 1991).

The UCMP database contains no listings from either the undifferentiated/unnamed Holocene of Merced and Madera Counties or from the Dos Palos Alluvium (UCMP 2011, 2015), and these units are not known to contain significant fossil materials. They are accordingly considered to have low paleontological sensitivity and are not discussed further.

The UCMP database also lacks listings attributed to the San Luis Ranch Alluvium (UCMP 2011). However, this unit is known to be vertebrate-bearing (Wentworth et al. 1999).

Modesto Formation

The Modesto Formation is of Pleistocene to earliest Holocene age and, as such, is at least partially coeval with the alluvium of San Luis Ranch (Lettis 1982; Wentworth et al. 1999)/San Luis Ranch Alluvium (Wagner et al. 1991) along the western edge of the San Joaquin Valley. Regionally, the Modesto Formation has been divided into a lower member of Early and Middle Wisconsinan age (at least 25,000 years old and most likely older, as discussed by Marchand and Allwardt [1978]) and an upper member of Late Wisconsinan age (14,000–9,000 years) (Marchand 1976; Marchand and Allwardt 1978). Marchand (1976) further subdivides both the lower and upper members based on geomorphic setting and sedimentologic/grain-size characteristics. Both the lower and upper members are exposed at the surface along the Central Valley Wye alternatives in the paleontological resources RSA. Exposures of the lower member near the Central Valley Wye alternatives include the m1 and m1b units of Marchand (1976), which respectively comprise sand, silt, and gravel of upper fan areas, channels, and terraces; and sand, silt, and clay of interdistributary areas. The m1e unit of Marchand (1976), consisting of moderately sorted sands recording deposition in an aeolian (sand dune) environment, is also locally exposed. Exposures of the Modesto Formation upper member include Marchand's m2 and m2b units, which reflect a similar differentiation between coarser channel/proximal-fan deposits and overall slightly finer grained interchannel deposits, as well as Marchand's m2e unit, comprising well-sorted dune sands (Marchand 1976). In the Chowchilla and Plainsburg 7.5-minute quadrangles, the SR 152 (North) to Road 11 Wye Alternative (only) also crosses areas where surface-exposed sand, silt, and gravel have been mapped as "undifferentiated Modesto and Holocene" alluvial and colluvial materials (mh unit of Marchand 1976), meaning that the two units could not be reliably distinguished in the field in these areas, that exposures are too small to delineate on 1:24,000-scale maps, or both.

The UCMP database contains a number of records for fossil finds in the Modesto Formation, including remains of the giant ground sloth (*Megalonyx jeffersoni*), mammoth (*Mammuthus columbi* and *Mammuthus* sp.), bison (*Bison latifrons* and *Bison* sp.), and an extinct camel (*Camelops* sp.) (UCMP 2011). Pedestrian surveys conducted for the Fresno to Bakersfield Section of the HSR system also reported finds including clamshells and bone fragments from the Modesto Formation (several fossil finds and stratigraphically equivalent units) (Authority and FRA 2011). The UCMP holdings do not document plant materials from the Modesto Formation (UCMP 2011). However, this unit is known to contain plant fossils, and PaleoResource Consultants (see Authority and FRA 2011) reported roots, root casts, and pieces of wood from the Modesto Formation along the Fresno to Bakersfield Section alignment.

Riverbank Formation

The Riverbank Formation of Pleistocene age underlies the Modesto Formation regionally (Marchand 1976, Marchand and Allwardt 1978). It is divided into three members, all composed primarily of sediment derived from the eroding Sierra Nevada range or recycled from older Sierran-derived alluvial deposits (Marchand 1976, Marchand and Allwardt 1978).

The Riverbank Formation contains a diverse vertebrate fauna from a number of localities (UCMP 2011) and is particularly well known for the important fossil deposit unearthed in 1989 during construction at the Arco Arena site in Sacramento. Vertebrate materials recovered from the Arco Arena deposit include remains of unidentified clams, unidentified birds, bison (*Bison antiquus*), camel (*Camelops hesternus*), Harlan's ground sloth (*Paramylodon harlani*), coyote (*Canis* cf. *latrans*), horse (*Equus* sp.), mammoth (*Mammuthus* sp.), a squirrel similar to modern *Sciurus* sp., an unidentified antelope (*Antilocapridae*) or deer (*Cervidae*) and a probable elephant (*Proboscideae*) (Hilton et al. 2000; Sierra College Natural History Museum 2012). The deposit also yielded plant fossils, including a holly-leaf cherry (*Prunus* cf. P. *ilicifolia*) seed and an unidentified leaf (Hilton et al. 2000). As one of a small number of sites in northern California to produce materials from a significant number of taxa, this find sheds important light on Pleistocene paleoecology in the Sacramento Valley (Hilton et al. 2000).

Other localities have also yielded significant fossil materials from the Riverbank Formation. Rich fossil deposits at Fairmead Landfill in Madera County (located less than 1 mile north of the Avenue 21 to Road 13 Wye Alternative and approximately 1 mile south of the closest portions of the SR 152 (North) to Road 13 Wye Alternative, SR 152 (North) to Road 19 Wye Alternative, and SR 152 (North) to Road 11 Wye Alternative) have produced a diverse assemblage from the Riverbank Formation, including pond turtle (*Clemmys marmorata*), desert tortoise (*Xerobates agassizii*), and unidentified bird(s), as well as camel (*Camelops* sp.), Armbruster's wolf (*Canis armbrusteri*), coyote (*C*. *latrans*), a small pronghorn-like antelocaprid (*Capromeryx* sp.), kangaroo rat (*Dipodomys* sp.), horse (*Equus* sp.), giant ground sloth (*Glossotherium* [*Paramylodon*] *harlani*), the camelid *Hemiauchenia* sp., scimitar-toothed cat (*Homotherium serum*), jackrabbit (*Lepus* sp.), mammoth (*Mammuthus columbi*), Jefferson's ground sloth (*Megalonyx jeffersoni*), a cheetah-like cat (*Miracinonyx trumani*), Shasta ground sloth (*Northrotheriops shastensis*), shrew (*Notiosorex* sp.), deer (*Odocoileus* sp.), saber-toothed cat (*Smilodon fatalis*, *Smilodon* sp.), the ancestral pronghorn *Tetrameryx irvingtonensis*, pocket gopher (*Thomomys* sp.), and fox (*Vulpes* sp.) (UCMP 2011).

At Chicken Ranch Slough in Sacramento County, the Riverbank Formation contains mammoth (*M*. *columbi*) and horse (*Equus* sp.) remains (UCMP 2011). Also in Sacramento County, the Teichert Gravel Pit site has produced remains of the mole *Scapanus latimanus* (Hutchison 1987; UCMP 2011), Sacramento blackfish (*Orthodon* sp.), garter snake (*Thamnophis* sp.), bison (*Bison* sp.), camel (*C*. *hesternus*), coyote (*Canis latrans*), dire wolf (*C*. *dirus*), horse (*Equus* sp.), ground sloth (*Glossotherium* [*Paramylodon*] *harlani*), mammoth (*M*. *columbi, Mammuthus* sp.), packrat (*Neotoma* sp.), and pocket gopher (*Thomomys* sp.) (UCMP 2011). In addition, recent monitoring during Caltrans roadway improvements along SR 180 in the Fresno area recovered numerous *Mammuthus* sp. remains, including tusks, a partial femur, partial molars, rib fragments, and pelvic fragments, from the Riverbank Formation (Harmsen et al. 2008; Dundas et al. 2009).

Turlock Lake Formation

The Turlock Lake Formation of Pleistocene age underlies the Riverbank Formation. Similar to the strata above it, it consists of dominantly arkosic alluvium deposited on a westward-prograding fan system documenting progressive erosion of the Sierran massif (Marchand and Allwardt 1978). The Turlock Lake Formation has been informally divided into two dominantly siliciclastic units separated by the approximately 600,000-year-old Friant ash/Friant pumice (Marchand 1976; Marchand and Allwardt 1978).

The Turlock Lake Formation and related units are abundantly fossiliferous. Strata at the Fairmead Landfill site in Madera County, tentatively equated to the upper member of the Turlock Lake Formation, have yielded remains of turtle (*Clemmys marmorata*), ground sloth (*Glossotherium* [*Paramylodon*] *harlani*, *Nothrotheriops shastensis*, *Megalonyx wheatleyi*), canids (*Canis armbrusteri*, *Canis* cf. *C. latrans*), saber-toothed cat (*Smilodon* cf. *S. fatalis*, *Homotherium* sp.), mammoth (*Mammuthus columbi*), horse (*Equus* sp.), camelids (*Camelops* sp., *Hemiauchenia* sp.), deer (*Odocoileus* sp.), pronghorns (*Capromeryx* sp., *Tetrameryx irvingtonensis*), and several small mammals (*Thomomys* sp., cf. *Dipodomys* sp., *Lepus* sp.) (Dundas et al. 1996; Dundas et al. 2010). The Fairmead locality has also produced bird fossils representing at least four taxa, including a small goose (cf. *Branta* sp.), a pygmy goose (cf. *Anabernicula* sp.), and a diving duck (cf. *Aythya* sp.), as well as a burrowing owl (*Athene* sp.) (Ngo et al. 2010). Totaling thousands of specimens in all, the Fairmead Landfill deposits are considered to represent an "important complement" (Bell et al. 2004) to the type Irvingtonian Fauna originally described from Alameda County, west of the Coast Ranges. They have also become highly visible to the nonspecialist community through media coverage and the outreach efforts of the Fossil Discovery Center of Madera County.

North Merced Gravel

The North Merced Gravel underlies the Turlock Lake Formation. It is probably of Late Pliocene age (Marchand and Allwardt 1981) but may be as young as early Pleistocene in some places (Marchand 1976). It consists of a thin (typically less than about 6 feet thick) veneer of locally derived, predominantly metamorphic and quartz vein gravel recording alluvial deposition on a regionally extensive pediment surface that truncates older bedrock strata, including the Laguna Formation (Marchand and Allwardt 1981). The UCMP database contains no records for the North Merced Gravel and it is not known to be fossiliferous (UCMP 2016)

Laguna Formation

The Laguna Formation, regionally separated from the younger Turlock Lake Formation by the North Merced Gravel (Marchand and Allwardt 1981), is of Late Pliocene age (Marchand 1976. It records alluvial deposition (Marchand and Allwardt 1981) and comprises at least two upward-coarsening members consisting primarily of Sierran-derived arkosic sand and silt with minor gravel; reworked andesitic material is present near the base of the unit. The upper member is capped by the China Hat Gravel, a cobble conglomerate with a granitic/arkosic matrix and interbeds of granitic sand and minor silt (Marchand 1976, Marchand and Allwardt 1978)

The UCMP database contains no listings for the Laguna Formation (UCMP 2016). However, a single horse tooth (species not identified) recovered from the Laguna Formation in a well near Galt (Piper et al. 1939) indicates that is has the potential to yield vertebrate remains.

Mehrten Formation

The Mehrten Formation underlies the Laguna Formation and is of Miocene to (probably Late) Pliocene age. It consists of andesitic sandstone, siltstone, and conglomerate believed to be derived from Sierran volcanic mudflow sources to the northeast and records deposition in a primarily fluvial environment (Marchand 1976, Marchand and Allwardt 1981).

The Mehrten Formation has produced numerous and diverse fossil finds from at least 54 documented localities (UCMP 2016). Specimens in the UCMP collection include microfossils such as foraminifera (*Cyclammina pacifica*, *Dentalina dusenbergae*, *Gaudryina* sp., *Globanomalina lillisi*, *Lenticulina* sp., *Melonis* sp., and *Trochammina* sp., as well as ostracodes

(*Buntonia* sp. and *Pseudonosaria ovata*) (UCMP 2016). The Mehrten Formation has also produced abundant plant fossils, including the holotype of the manzanita *Arctostaphylos oakdalensis* along with remains of sedge (*Cyperus* sp.), rush (*Juncus* sp.), several shrubs—indigo bush (hypotypes and homeoptypes of *Amorpha condoni*), bayberry (*Mahonia marginata*), coffeeberry and related species (hypotypes of *Rhamnus precalifornica* and *R*. *moragensis*), gooseberry (a cotype of *Ribes mehrtensis*), *Ceanothus*, *Celtis, and Toxicodendron*—and a number of trees, including madrone (*Arbutus matthesii*), pine (*Pinus sturgis*), aspens and cottonwoods (*Populus alexandri*, *P. garberii*, *P. pliotremuloides*, *P. parcedentata*), laurel (hypotype and homeotypes of *Persea coalingensis*), sycamore (*Platanus paucidentata*), oaks and live oaks (plesiotypes and homeotypes of *Quercus wislizenoides* as well as remains of *Q. dispersa*, *Q. douglasioides*, *Q. pliopalmeri*, *Q. prelobata*, *Q. pseudolyrata*, *Q. remingtonii* plus at least one unidentified *Quercus* species), locust (a plesiotype of *Robinia californica*), willows (*Salix edenensis*, *S. hesperia*, *S. garberii*, *S. laevigatoides*, *S. wildcatensis*), redwood (*Sequoia* sp.), bay (*Umbellularia salicifolia)*, and an extinct tree related to the modern soapberry (plesiotypes of *Sapindus oklahomensis*) (UCMP 2016). Among the vertebrates represented in the Mehrten Formation are a salmonid fish (*Smilodonichthys rastrosus*), blackfish (*Orthodon* sp.), salamanders (*Aneides lugubris*, *Batrachoseps* sp.), pond turtle (*Clemmys* [*Actinemys*] *marmorata*, *Clemmys* sp.), tortoises (*Geochelone orthopygia*, *Geochelone* sp., *Gopherus* sp., *Hesperotestudo* sp.), hare (*Hypolagus* sp.), the extinct rodent *Cupidinimus*, beaver (*Castor* sp., *Dipoides williamsi*), raccoon (*Procyon* sp.), numerous horses (*Dinohippus coalingensis*, *Hipparion mohavense*, *Hipparion* sp., *Nannippus tehonensis*, *Nannippus* sp., *Neohipparion molle, Neohipparion* sp., *Pliohippus coalengensis, P. interpolatus, P. tantalus, Pliohippus* sp.), camelids (*Paracamelus* sp., *Pliauchenia* sp.), rhinoceroses (*Aphelops* sp., *Teleoceras* sp.), antelocaprids (*Merycodus* sp., *Sphenophalos* sp., *Tetrameryx* sp.), giant ground sloths (*Megalonyx mathisi, Pliometanastes protistus*), fox (*Vulpes* sp.), proboscids (*Mammut americanum*, *Platybelodon* sp.), canids (*Borophagus parvus, Osteoborus* sp.), and saber-toothed cat (*Machairodus coloradensis*) (UCMP 2016).

3.9.6 Environmental Consequences

3.9.6.1 Overview

This section evaluates how the No Project Alternative and the Central Valley Wye alternatives could affect geology, soils, seismicity, and paleontological resources. The impacts of the Central Valley Wye alternatives are described and organized in Section 3.9.6.2, Geology, Soils, and Seismicity and Section 3.9.6.3, Paleontological Resources as follows:

Geology, Soils, and Seismicity

Construction Impacts

- Impact GEO#1: Soil Erosion
- Impact GEO#2: Moderate to High Shrink-Swell Potential
- Impact GEO#3: Moderately to Highly Corrosive Soils
- Impact GEO#4: Unstable Soils Resulting in On-Site or Off-Site Slumps and Small Slope Failures
- Impact GEO#5: Soil Settlement at Structures or along Trackway
- Impact GEO#6: Slope Failure
- Impact GEO#7: Seismic-Induced Ground Shaking and Secondary Seismic Hazards
- Impact GEO#8: Difficult Excavations due to Hardpan and Shallow Groundwater
- Impact GEO#9: Loss of Availability of Mineral or Energy Resources and Increase in Safety Risk due to Disruption of Subsurface Oil and Gas Resources

Operations Impacts

- Impact GEO#10: Seismic-Induced Ground Shaking and Secondary Seismic Hazards

Paleontological Resources

Construction Impacts

- Impact PAL#1: Common Impacts on Paleontological Resources due to Construction

Operations Impacts

- Impact PAL#2: Common Impacts on Paleontological Resources due to Operations

3.9.6.2 Geology, Soils, and Seismicity

No Project Alternative

The population in the San Joaquin Valley is expected to grow through 2040 (see Section 2.2.2.2, Planned Land Use). Development in the San Joaquin Valley to accommodate the population increase would continue under the No Project Alternative and result in associated direct and indirect impacts on geologic resources. Such planned projects anticipated to be constructed by 2040 include residential, commercial, industrial, recreational, transportation, and agricultural projects. These planned improvements include both those in plans and those that have been funded.

Current ongoing risks to infrastructure and development include localized deposits of soils that have low bearing capacity, exhibit excessive settlement under load, or involve geologic hazards from steep slopes near rivers and streams, primary seismic hazards from earthquake ground shaking, and secondary hazards from earthquake-induced liquefaction and slope failures. Historical trends in development has increased impermeable surfaces and resulted in erosion and the loss of valuable topsoil in areas of the San Joaquin Valley. In addition, the San Joaquin Valley has a long history of land subsidence in response to water and mineral (oil and gas resources) extraction. The rate of subsidence in the San Joaquin Valley slowed between the 1970s and allowed groundwater levels to recover. However, active subsidence in the resource hazards RSA was recorded between 2003 and 2014 (DWR and USBR 2014; Sneed et al. 2013; Faunt 2009).

Future development projects in Merced and Madera Counties include dairy farm expansions, implementation of airport development and land use plans, and implementation of general and specific plans throughout both counties. Planned projects under the No Project Alternative would also include transportation projects, such as the expansion of SR 99, and residential, commercial, and industrial developments. A full list of anticipated future development projects is provided in Appendix 3.19-A, Cumulative Plans and Non-Transportation Projects List, and Appendix 3.19-B, Cumulative Transportation Projects List. The residential and commercial growth expected in and around the City of Chowchilla, as described in the Introduction and Land Use sections of the *City of Chowchilla 2040 General Plan* (City of Chowchilla 2011; pages I-1 through L-69), is anticipated to result in ground disturbance, an increase in impermeable surfaces, and the potential for construction in areas with potential resource hazards. Impacts associated with soil and geologic hazards could occur if ground disturbance occurs on or near unstable soils or slopes, if construction dewatering activities result in ground settlement, and if structures and people are put at a greater risk from seismic activity caused by residential or commercial growth. Additionally, development activity in the region could affect mineral and energy resources if the development results in a mineral or energy resource becoming unavailable for extraction.

Under the No Project Alternative, recent development trends are anticipated to continue, leading to ongoing impacts on geological and soil resources. Existing undeveloped and agricultural land would be converted for residential, commercial, and industrial development, as well as for transportation infrastructure, to accommodate future growth. These developments could result in increased erosion, the loss of valuable topsoil, increase in impervious surface, and could affect the risks associated with geology and soils, such as slope failure and soil settlement. Continued operation of existing highways, airports, and railways would not change impacts on geology, soils, and seismicity resources because operations are subject to regulations designed to reduce impacts on geologic resources.

Infrastructure and development projects would not affect seismicity. However, the increasing population could result in development in less suitable areas, where the risk of geologic and seismic hazards such as ground shaking, slope instability near rivers, or liquefaction in areas of liquefiable soils is higher than in existing developed areas. Ultimately, this would result in more risk to the public of injury and loss of life and a greater chance of property damage. In addition, the increasing population could lead to the reuse of older buildings to accommodate the growth, which in turn could present a risk during a seismic event if such buildings are not upgraded to current standards. Planned projects under the No Project Alternative would require individual environmental review, such as permits, regulatory requirements, and design standards. Future projects would need to comply with Title 24 California Building Code requirements with adherence to geotechnical and stability regulations and would be designed to avoid or minimize impacts.

Central Valley Wye Alternatives

Construction and operations of the Central Valley Wye alternatives could result in temporary and permanent impacts on geology, soils, and seismicity. Impacts could include increased erosion or loss of topsoil, increased exposure of people or property to risks associated with unstable, expansive, or corrosive soils, increased exposure of people or property to risks associated with oil and gas wells, and increased exposure of people or property to seismic risk.

Construction Impacts

Construction of the Central Valley Wye alternatives would involve, for example, demolition of existing structures, clearing and grubbing; handling, storing, hauling, excavating, and placing fill; possible pile driving; and construction of aerial structures, bridges, road modifications, utility upgrades and relocations, HSR electrical systems, and railbeds. Construction activities are further described in Chapter 2, Alternatives.

Soils Hazards

Impact GEO#1: Soil Erosion

Construction of any of the Central Valley Wye alternatives would require excavation and grading activities. Such ground disturbance removes the vegetative or other cover that otherwise intercepts and slows water as it reaches the ground, which slows potential water erosion and reduces wind speed along the soil surface. Without protective vegetative or other cover, soils can be subject to scouring high-speed winds and moving water. Some soils are more easily eroded than others.

Soils in the resource hazards RSA that have a high potential for wind or water erosion are identified in Table 3.9-8. The potential for soil erosion from water is most pronounced in the EL Nido-Dos-Palos-Blofar-Alros soil association. Table 3.9-12 shows the area of soils subject to erosion for each Central Valley Wye alternative. The SR 152 (North) to Road 19 Wye Alternative would affect a greater area of soils with high susceptibility to water erosion in the project footprint within the resource hazards RSA than the other alternatives (1,115 acres), followed in order by area of ground disturbance by SR 152 (North) to Road 11 Wye Alternative (976 acres), SR 152 (North) to Road 13 Wye Alternative (896 acres), and Avenue 21 to Road 13 Wye Alternative (773 acres).

Table 3.9-12 Area of Impact by Alternative, Soils with High Susceptibility to Erosion (acres)

Resource Category	Central Valley Wye Alternatives			
	SR 152 (North) to Road 13 Wye	SR 152 (North) to Road 19 Wye	Avenue 21 to Road 13 Wye	SR 152 (North) to Road 11 Wye
Soils subject to erosion (acres)	896	1,115	773	976

Source: NRCS, 2016
[1] Acreage reflects area of high susceptibility to water erosion.

The Central Valley Wye alternatives' IAMFs would minimize water and wind erosion through adoption of construction best management practices (BMPs), including use of stabilizers, mulches, revegetation, and covering areas with biodegradable geotextiles, which would be documented in a construction management plan (CMP) (GEO-IAMF#1).

The Central Valley Wye alternatives' IAMFs would also require conformance to guidelines specified by relevant transportation and building agencies and codes in order to build the HSR system in accordance with the best available practices, which would include conducting site-specific subsurface geotechnical investigations and design evaluations (GEO-IAMF#6). These guidelines minimize water and wind erosion through adoption of standard construction practices to reduce the potential for erosion. Standard practices include those listed in the *Caltrans Storm Water Quality Handbook Project Planning and Design Guide* (Caltrans 2017), the Caltrans *Construction Site Best Management Practices Field Manual and Troubleshooting Guide* (Caltrans 2003a) and the *Caltrans Construction Site Best Management Practices Manual* (Caltrans 2003b), and could include soil stabilization, watering for dust control, perimeter silt fences, and sediment basins. In addition, these guidelines provide guidance on the characterization of soils; provide detailed guidance on the characterization of geotechnical conditions at sites (Federal Highway Administration circulars and reference manuals); provide principles, data, specifications, plans, and economics pertaining to the engineering, design, and construction of railways (American Railway Engineering and Maintenance-of-Way Association Manual); provide construction requirements relating to structural safety (California Building Code); provide minimum design and construction standards for all aspects of transportation system design, ranging from geotechnical explorations to construction practices (Caltrans design standards); provide guidance and BMPs for dewatering options and management, erosion control and soil stabilization, and non-stormwater management at construction sites (Caltrans construction manuals); and standards and guidelines for all types of material testing, including soil compaction testing (American Society for Testing and Materials). Because these practices require Authority contractors to take soil properties into account, these practices would reduce the potential for impacts associated with wind and water erosion during construction.

If in-water construction occurs where open or flowing water is present, the Authority would incorporate a dewatering plan (BIO-IAMF#20). Dewatering in open water increases the potential for erosion. Erosion can result because dewatering changes flows, resulting in new flow directions or velocities, which can disturb stream bottoms. However, the dewatering plan under BIO-IAMF#20 would include measures to reduce the potential for work to disrupt water flows (see description in Appendix 2-B).

Erosion could also occur because of temporary dewatering during construction but is unlikely. Construction of any of the four Central Valley Wye alternatives in areas of high groundwater, such as those in the Delta-Mendota and Merced Subbasins, could require dewatering for bridge column construction or the construction of below-grade underpasses. The SR 152 (North) to Road 19 Wye Alternative would have a tunnel segment crossing under SR 99 that would be up to 60 feet deep, including subgrade. The HSR aerial structure foundations would sit on drilled shaft piles that could be 60 feet deep, depending on geotechnical conditions, and the roadway underpasses could be as deep as 40 feet, including subgrade. If dewatering was necessary during construction, the amount of dewatering would likely be relatively small and conducted in widely spaced locations, even where waterbodies are crossed more than once. Most of the water depths in the resource hazards RSA are more than 50 feet (Table 3.9-7), so construction is not expected to encounter groundwater or require dewatering for the at-grade or below-grade sections of the track.

If temporary dewatering should occur during construction, it would be conducted in compliance with the SWRCB Construction General Permit (HYD-IAMF#3), which would minimize the potential for contaminants to be discharged into groundwater, and minimize short-term increases in sediment transport caused by construction. Dewatering activities would also comply with the Central Valley RWQCB's General Dewatering Permit, Order No. 5-00-175 (NPDES No. CAG995001), Waste Discharge Requirements General Order for Dewatering and Other Low-Threat Discharges to Surface Waters. For a discussion of settlement impacts related to dewatering, see Impact GEO#5. See also Section 3.8 for further discussion of dewatering. In addition, the construction contractor would dispose of any dewatered groundwater generated by construction in compliance with the SWRCB Construction General Permit (HYD-IAMF#3), the Central Valley RWQCB's Regional Dewatering Permit, and the Caltrans *Field Guide to Construction Site Dewatering* (Caltrans 2014b) to protect groundwater quality. The Central Valley Wye alternatives would comply with both Caltrans and the Authority's MS4 requirements.

Therefore, the risk associated with erosion would be greatest for the SR 152 (North) to Road 19 Wye Alternative, followed by the three other alternatives in order by area of ground disturbance: SR 152 (North) to Road 11 Wye Alternative, SR 152 (North) to Road 13 Wye Alternative, and Avenue 21 to Road 13 Wye Alternative. For all alternatives, implementation of best available practices as specified by relevant transportation and building agencies and codes (GEO-IAMF#6), incorporation of a dewatering plan (BIO-IAMF#20), and compliance with the SWRCB Construction General Permit (HYD-IAMF#3) would avoid the risks presented by susceptibility to erosion.

CEQA Conclusion

The impact under CEQA would be less than significant because measures to avoid substantial soil erosion or loss of topsoil would be implemented during construction of the Central Valley Wye alternatives. These include incorporation of standard construction practices and BMPs that account for soil properties, as well as developing a dewatering plan. The standard construction practices and BMPs would minimize impacts by providing a barrier between exposed soils and erosive forces (revegetation) or lessening the degree of erosive forces. Therefore, CEQA does not require any mitigation.

Impact GEO#2: Moderate to High Shrink-Swell Potential

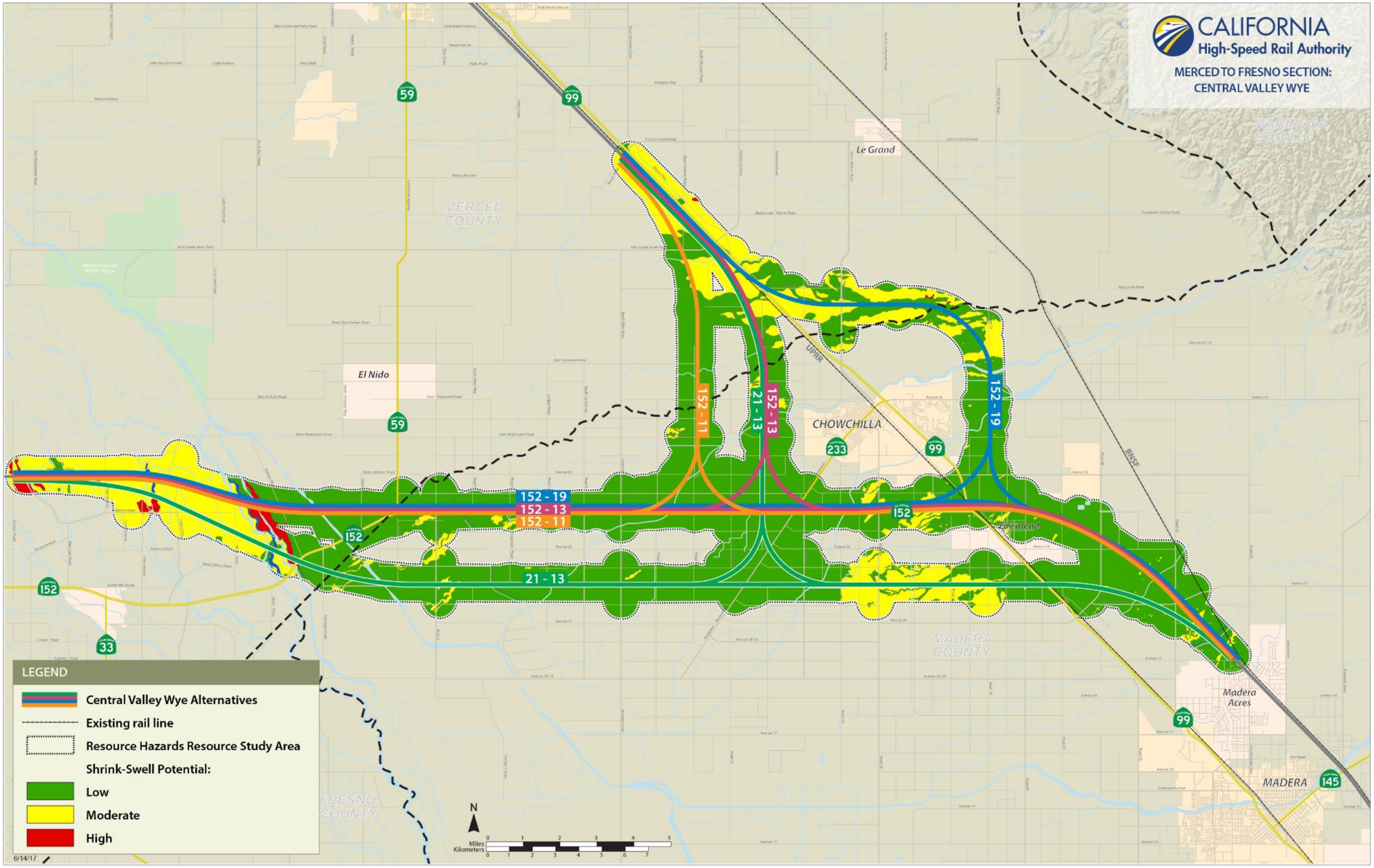
Expansive soils respond to changes in soil moisture content by expanding when wet and contracting when dry. The more water they absorb, the more they increase in volume and, conversely, the more they decrease in volume when they dry out. Through this change in volume, expansive soils exert uplift or lateral pressures on foundations or walls in contact with them when they expand and contract, thus providing unstable support for foundations and other structures. Standard construction practices would minimize the risk to HSR infrastructure and of injury and loss of life to construction personnel and passengers from expansive soils.

Soils located in the uppermost 5 feet of the soil profiles in the eastern extent of the resource hazards RSA along all Central Valley Wye alternatives toward Madera, Merced, and Stanislaus Counties generally have moderate to high expansion potential (expansive soils). Figure 3.9-7 maps soils with moderate and high expansion potential in Merced and Madera Counties within the resource hazards RSA. Table 3.9-13 shows the area of soils subject to moderate or high expansion potential for each alternative. While the Central Valley Wye alternatives generally traverse areas of low expansion potential, all of the alternatives traverse soils with moderate expansion potential as well as small pockets of soils with high expansion potential. The Avenue 21 to Road 13 Wye Alternative would affect the most acres of expansive soils in the project footprint (1,013 acres), followed in order by area of ground disturbance by the SR 152 (North) to Road 19 Wye Alternative (938 acres), SR 152 (North) to Road 13 Wye Alternative (735 acres), and SR 152 (North) to Road 11 Wye Alternative (580 acres).

Table 3.9-13 Area of Impact by Alternative, Soils with Moderate and High Expansion Potential (acres)

Resource Category	Central Valley Wye Alternatives			
	SR 152 (North) to Road 13 Wye	SR 152 (North) to Road 19 Wye	Avenue 21 to Road 13 Wye	SR 152 (North) to Road 11 Wye
Soils with moderate to high expansion potential (acres)	735	938	1,013	580

Source: NRCS, 2016



Source: NRCS SSURGO, 2007, 2008, 2010

DRAFT – JUNE 15, 2017

Figure 3.9-7 Expansive Soils in the Resource Hazards Resource Study Area

During construction of the Central Valley Wye alternatives, impacts of soils with moderate to high shrink-swell potential would be avoided through adherence to standard construction practices, which address the risks associated with expansive soils. In locations where expansion potential is high or moderate, soil additives may be mixed with existing soil to reduce the expansion potential, or upper portions of soils that exhibit high expansion potential may be removed and replaced with soils that do not exhibit these characteristics (GEO-IAMF#1). Additionally, GEO-IAMF#6 would require the design and construction of the Central Valley Wye alternatives to conform to specific guidelines and standards specified by relevant transportation and building agencies and codes in order to build the HSR system in accordance with the best available practices, which would include conducting site-specific subsurface geotechnical investigations and design evaluations. These guidelines require Authority contractors to account for soil properties during the design and construction of the Central Valley Wye alternatives. By following guidelines for addressing expansive soils during construction, the Central Valley Wye alternatives would avoid the risk of construction on soils with moderate to high shrink-swell potential.

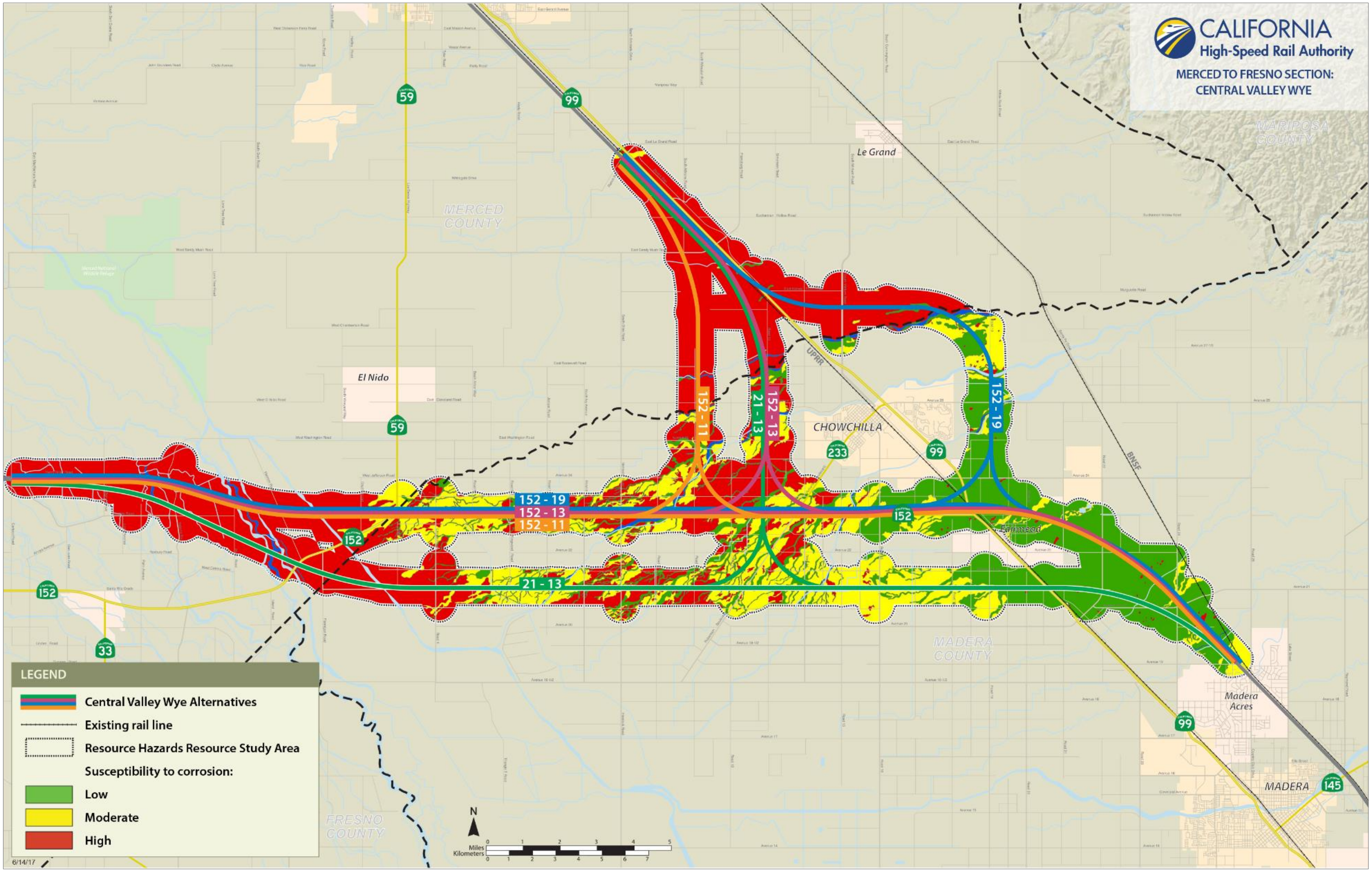
The risk associated with expansive soils would be greatest for the Avenue 21 to Road 13 Wye Alternative, followed in order by area of ground disturbance by the SR 152 (North) to Road 19 Wye Alternative, SR 152 (North) to Road 13 Wye Alternative, and SR 152 (North) to Road 11 Wye Alternative. However, for all alternatives, conformance to specific guidelines and standards as specified by relevant transportation and building agencies and codes (GEO-IAMF#6) and directly treating soil to reduce risks associated with expansive soils (GEO-IAMF#1) would avoid the risks presented by expansive soil conditions. Because these practices consider geotechnical properties when addressing the risks associated with constructing in areas of expansive soils, they would avoid the impact of construction in these areas for all alternatives.

CEQA Conclusion

The impact under CEQA would be less than significant because the design and construction practices of the Central Valley Wye alternatives would avoid increased exposure of people to loss of life or HSR property to damage from the risks presented by expansive soils as defined by California Building Standards Code section 1803.5.3. The Central Valley Wye alternatives would incorporate requirements to treat or replace expansive soils, and to implement best available practices as specified by relevant transportation and building agencies and codes, and document this implementation. Therefore, CEQA does not require any mitigation.

Impact GEO#3: Moderately to Highly Corrosive Soils

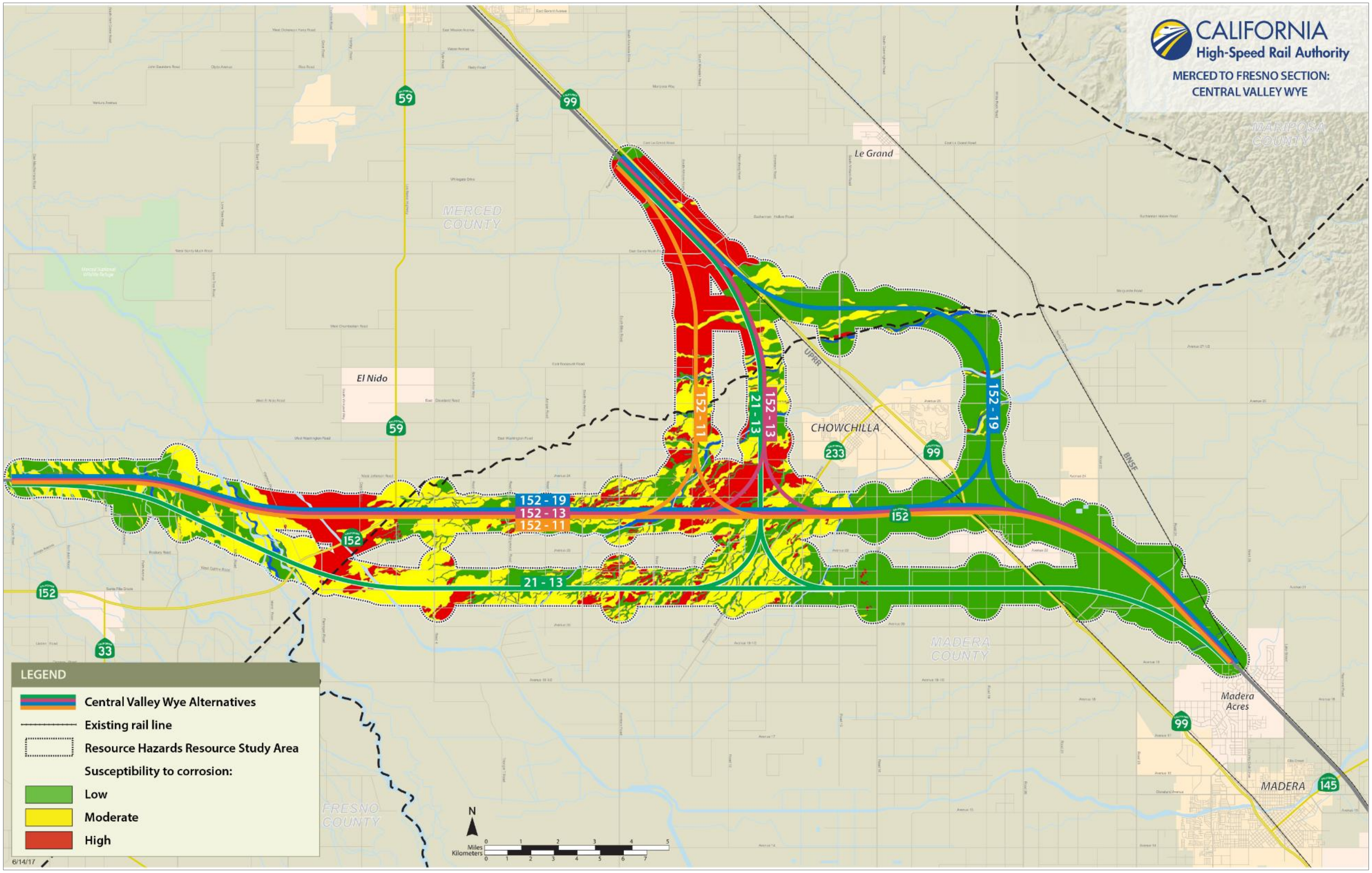
Corrosive soils have electrochemical or chemical properties that can corrode or weaken concrete or uncoated steel, which are principal components of the HSR track system. Corrosion, if not accounted for in the design of the Central Valley Wye alternatives, can weaken structures built on corrosive soils, potentially causing structural failure. The factors determining corrosive potential are presence of air (less air means higher potential for corrosion), presence of water (more water means higher potential for corrosion), presence of salts (more dissolved salt content means higher conductivity and thus higher potential for corrosion), soil resistivity (lower resistivity means higher potential for corrosion), soil acidity (higher acidity is more corrosive for steel and lower acidity is more corrosive for aluminum), and presence of sulfate ions that feed bacteria (higher presence of sulfate ions means higher corrosivity for concrete). All Central Valley Wye alternatives would include design measures to protect the integrity of the HSR track system and minimize the risk of injury and loss of life to passengers and damage to property of the HSR system that could result from corrosive soils. Soils along all Central Valley Wye alternatives in the resource hazards RSA have moderate to high corrosivity to uncoated steel and concrete in some locations (Figure 3.9-8 and Figure 3.9-9). The retained-fill and at-grade segments of all alternatives would be most vulnerable to corrosive soils. The retained cut would generally have sufficient earth between the corrosive soil and the track to protect it from corrosion, and the elevated structures supported on deep foundations would use concrete that is resistant to concrete corrosion. Moderately to highly corrosive soils are also located in the new permanent footprints associated with the Site 7—Wilson, 230 kV Tie-Line, Site 6—El Nido, El Nido Substation, and the Site 7—Le Grand Junction/Sandy Mush Road, Dutchman Switching Station and 115 kV Tie-Line. Table 3.9-14 shows the area of soils subject to moderate or high corrosivity potential for each alternative.



Source: NRCS SSURGO, 2007, 2008, 2010, 2016

DRAFT – JUNE 15, 2017

Figure 3.9-8 Susceptibility of Uncoated Steel to Corrosion when in Contact with the Soil



Source: NRCS SSURGO, 2007, 2008, 2010, 2016

DRAFT– JUNE 15, 2017

Figure 3.9-9 Susceptibility of Concrete to Corrosion when in Contact with the Soil

Table 3.9-14 Area of Impact by Alternative, Corrosive Soils (acres)

Resource Category	Central Valley Wye Alternatives			
	SR 152 (North) to Road 13 Wye	SR 152 (North) to Road 19 Wye	Avenue 21 to Road 13 Wye	SR 152 (North) to Road 11 Wye
Soils moderately to highly corrosive to steel	2,176	2,173	2,005	2,016
Soils moderately to highly corrosive to concrete	1,524	1,268	1,394	1,384

Source: NRCS, 2016

Although the Central Valley Wye alternatives would have a similar area of impact, the SR 152 (North) to Road 13 Wye Alternative, would affect the most acres of soil that is moderately to highly corrosive to steel in the project footprint (2,176 acres), followed in order by area of ground disturbance by SR 152 (North) to Road 19 Wye Alternative (2,173 acres), SR 152 (North) to Road 11 Wye Alternative (2,016 acres), and Avenue 21 to Road 13 Wye Alternative (2,005 acres).

Although the Central Valley Wye alternatives would have a similar area of impact, the SR 152 (North) to Road 13 Wye Alternative would affect the most acres of soil that is moderately to highly corrosive to concrete in the project footprint (1,524 acres), followed in order by area of ground disturbance by the Avenue 21 to Road 13 Wye Alternative (1,394 acres), SR 152 (North) to Road 11 Wye Alternative (1,384 acres), and SR 152 (North) to Road 19 Wye Alternative (1,268 acres).

The Central Valley Wye alternatives would minimize potential impacts from corrosive soils through conforming to guidelines specified by relevant transportation and building agencies and codes, which would include conducting site-specific subsurface geotechnical investigations and design evaluations (GEO-IAMF#6). These guidelines require Authority contractors to account for soil properties during Central Valley Wye alternatives design and construction and thus address risk factors associated with corrosive soils. By implementing standard engineering and design features, such as replacing the upper portions of soils that exhibit high corrosivity characteristics with soils that do not exhibit these characteristics, or by using coated or corrosion-resistant steel or concrete materials, the risk from corrosive soils would be reduced.

The risk associated with soils susceptible to corrosion to steel would be greatest for the SR 152 (North) to Road 13 Wye Alternative, followed in order by area of ground disturbance by SR 152 (North) to Road 19 Wye Alternative, SR 152 (North) to Road 11 Wye Alternative, and Avenue 21 to Road 13 Wye Alternative. The risk associated with soils susceptible to corrosion to concrete would be greatest for the SR 152 (North) to Road 13 Wye Alternative, followed in order by area of ground disturbance by the Avenue 21 to Road 13 Wye Alternative, SR 152 (North) to Road 11 Wye Alternative, and SR 152 (North) to Road 19 Wye Alternative. However, for all alternatives, conformance to specific guidelines and standards as specified by relevant transportation and building agencies and codes (GEO-IAMF#6) would avoid the risks presented by corrosive soil conditions. Because these practices consider geotechnical properties when addressing the risks associated with constructing in areas of corrosive soils, they would avoid the impact of construction in these areas for all alternatives.

CEQA Conclusion

The impact under CEQA would be less than significant because the design and construction practices of the Central Valley Wye alternatives would include effective measures to avoid increased risk of injury and loss of life to passengers or damage to property from the risks presented by corrosive soils. During construction, best practices would be followed, such as treating or replacing corrosive soils or using coated or corrosion-resistant steel or concrete, and documenting this implementation. Therefore, CEQA does not require any mitigation.

Geologic Hazards

Impact GEO#4: Unstable Soils Resulting in On-Site or Off-Site Slumps and Small Slope Failures

Unstable soils consist of loose or soft deposits of sands, silts, and clays that are not adequate to support planned structure loads. These soils exhibit low shear strength. The shear resistance of a soil is related to friction and the interlocking of soil particles, as well as possible cementation of soil particles. When unstable soils are loaded, they can fail through bearing failures (collapse) or slope instabilities, presenting a risk of injury and loss of life to construction personnel and passengers and damage to HSR property. Failure can result in temporary impacts during construction or permanent impacts after the Central Valley Wye alternatives are constructed.

Although competent soils dominate the land beneath the Central Valley Wye alternatives near the ground surface in the resource hazards RSA, unstable soils occur on a localized basis. Groundwater withdrawal can increase the potential for these soils to fail. Implementation of Site 6—El Nido, Nido Substation, Site 7—Wilson, 230 kV Tie-Line, Site 7—Le Grand Junction/Sandy Mush Road, Dutchman Switching Station and 115 kV Tie-Line would result in new permanent structures with new loading forces. However, landslides and slumps are not considered a hazard because these components are proposed in areas with relatively flat terrain and avoid areas of channel incision.

Unstable soils occur in soils surrounding natural waterbodies for all Central Valley Wye alternatives. Although the Central Valley Wye alternatives would have a similar impact, the Avenue 21 to Road 13 Wye Alternative would have the most natural waterbody crossings (39 crossings), followed in order by the SR 152 (North) to Road 19 Wye Alternative (32 natural waterbody crossings), the SR 152 (North) to Road 13 Wye Alternative (31 natural waterbody crossings), and the SR 152 (North) to Road 11 Wye Alternative (30 natural waterbody crossings). See Table 5-5 in the Hydrology and Water Resources Technical Report (Authority and FRA 2016d) for additional information on which natural waterbodies are crossed by each alternative and the number of crossings of each waterbody.

During construction, the design of the Central Valley Wye alternatives would minimize impacts related to unstable soils through engineered ground improvements, such as regrading or groundwater controls to stabilize soft or loose soils wherever they occur. The design-build contractor would prepare a CMP that would address how geologic constraints would be avoided or minimized during construction, including improving the stability of deep unstable soils through replacement of unstable soils with competent soils, strengthening replacement materials with geosynthetics, and placement of stone columns or vertical drains (GEO-IAMF#1). The features of the Central Valley Wye alternatives would minimize impacts of ground settlement caused by unstable soils through use of alternate foundation designs to offset the potential for settlement that would otherwise result from removal of supportive groundwater (GEO-IAMF#1). Additionally, the Authority would conform to guidelines specified by relevant transportation and building agencies and codes that require Authority contractors to account for soil properties during Central Valley Wye alternatives design and construction, which would include conducting site-specific subsurface geotechnical investigations and design evaluations, and thus address risk factors associated with bearing capacity and slope stability (GEO-IAMF#6).

Permanent impacts from unstable soils would be minimized or preempted with design measures such as use of alternate foundation designs to offset the potential for settlement caused by groundwater withdrawal, which would be documented in a CMP (GEO-IAMF#1). Typically, elevated structures supported on deep foundations are specifically designed to handle soft, near-surface soils, and retained cuts can accommodate soft-soil conditions. Where soft-soil conditions are combined with the potential for small slumps and slope failures, the severity of the risk is correspondingly greater. In these locations, the potential impact of loss in bearing or additional soil loads associated with the slump or slope failure would also be considered.

Where a potential for long-term instability exists from gravity or seismic loading, the Authority would incorporate slope monitoring by a registered engineering geologist into the operations and maintenance procedures at sites identified in the CMP (GEO-IAMF#2). Monitoring would provide information to identify and repair any ground movement before it can damage track integrity. Additionally, GEO-IAMF#5 would require HSR trains to be equipped with autonomous equipment for daily track surveys, once tracks are operational, as part of a stringent track monitoring program. The track monitoring program would provide early warning of reduced track integrity in case of ground settlement.

Although the risk of soil failure would be greater if a large seismic event were to occur, the likelihood of a large earthquake during construction is considered low because of the comparatively short duration of these temporary activities relative to the infrequency of large earthquakes (only one earthquake with a magnitude greater than 6.6 has occurred near the Central Valley Wye alternatives since 1800). The intensity of the impact would depend on the size of the earthquake and the specific state of construction at the moment of the earthquake. Any structure supported in or on the ground would comply with Caltrans seismic design criteria (GEO-IAMF#3). The design features would reduce seismic risk to the greatest extent possible.

The risk of soil failure would be greatest for the Avenue 21 to Road 13 Wye Alternative because it would have the most natural waterbody crossings, followed in order by the SR 152 (North) to Road 19 Wye Alternative, the SR 152 (North) to Road 13 Wye Alternative, and the SR 152 (North) to Road 11 Wye Alternative. However, for all alternatives, stabilizing the soil (GEO-IAMF#1), monitoring slopes (GEO-IAMF#2), monitoring subsidence (GEO-IAMF#5), and conforming to specific guidelines and standards as specified by relevant transportation and building agencies and codes (GEO-IAMF#6) would avoid the risks presented by unstable soils. Because these practices consider geotechnical properties when addressing the risks associated with constructing in areas of unstable soils, unstable slopes, and ground subsidence, they would avoid the impact of construction in these areas for all alternatives.

CEQA Conclusion

The impact under CEQA would be less than significant because the design features of the Central Valley Wye alternatives would include effective measures that would avoid risk of unstable soils from settlement and slope failure. These include measures to replace or strengthen unstable soils, installing vertical drains, offsetting potential for settlement caused by groundwater withdrawal, minimizing risk of slope failure related to seismic activity, using alternate foundations to offset the potential for settlement because of groundwater withdrawal, monitoring slope movement in order to identify and repair any ground movement before it can damage track integrity, and monitoring subsidence, in order to warn of reduced track integrity in case of ground settlement. In addition, design and construction practices would incorporate best available practices as specified by relevant transportation and building agencies and codes. Because these practices consider soil properties when addressing the risks of unstable soils, they would minimize the impact of unstable soils. Therefore, CEQA does not require any mitigation.

Impact GEO#5: Soil Settlement at Structures or along Trackway

Soft soil can be compressible and unstable, which can have direct impacts during construction. The extent of compressible soil can be broad or relatively localized and is typically associated with young alluvial deposits with high clay content or residual soil over bedrock. The greatest effects from soft soils are on embankment and trench construction. Embankment construction could cause compression of underlying soft-soil layers because new fill adds more load (weight) on the ground resulting in permanent ground settlement. Soft soil can also compress under new loads imposed by structures and construction equipment. Settlement resulting from the compression of soft soils is a time-dependent process that is influenced by the properties of the soil and imposed load. Ground settlement could cause damage to engineered structures including train tracks, bridges, and staging areas. This process is most problematic at locations where soft deposits, such as silty or clay soils, exist that have not previously been consolidated by loads of the same levels that new construction would impose. Construction of the HSR in areas prone to soil settlement could result in an increased risk of injury and loss of life to passengers and damage to HSR property, although appropriate design and construction practices that take into account soil settlement can avoid these risks.

Soils along all Central Valley Wye alternatives in the resource hazards RSA are generally competent (medium-dense, stiff, or better), although localized deposits of soft or loose soils could occur at various locations, particularly at natural water crossings where soft or loose soils are more prevalent, resulting in increased risk of settlement. Although the Central Valley Wye alternatives would have a similar impact, the Avenue 21 to Road 13 Wye Alternative would have the most natural waterbody crossings (39 natural waterbody crossings), followed in order by the SR 152 (North) to Road 19 Wye Alternative (32 natural waterbody crossings), the SR 152 (North) to Road 13 Wye Alternative (31 natural waterbody crossings), and the SR 152 (North) to Road 11 Wye Alternative (30 natural waterbody crossings). See Table 5-5 in the Hydrology and Water Resources Technical Report (Authority and FRA 2016d) for additional information on which natural waterbodies are crossed by each alternative and the number of crossings of each waterbody.

Regional ground subsidence in the RSA could have direct and long-term effects during construction. Although ground subsidence typically is considered a slow phenomenon, rapid subsidence rates in the San Joaquin Valley could affect portions of all alternatives, even within the relatively short construction period and could continue to contribute to subsidence and compound the risks of injury to passengers and damage to HSR property. Subsidence can result in differential settlement, such that foundations are subject to stresses that can result in shifting, tilting, and compromises in structural integrity. Regional ground subsidence in the San Joaquin Valley is likely to continue as groundwater extraction continues in the region where historic and ongoing subsidence has been recorded. The potential for effects from regional subsidence is the same under all alternatives because design features are the same for all alternatives.

The design of the Central Valley Wye alternatives would incorporate techniques that would minimize the impacts of settlement and subsidence wherever they occur, such as by engineering ground improvements to stabilize compressible soils. The design-build contractors would prepare a CMP that would address how geologic constraints, including the risk of settlement and subsidence, would be avoided or minimized during construction (GEO-IAMF#1). In order to minimize impacts of ground settlement caused by construction on silty or clay soils, the Authority would either reduce settlement by controlling the amount of groundwater withdrawal from the Central Valley Wye alternatives or engineer the HSR infrastructure to accommodate settlement by using alternate foundation designs to offset the potential for settlement (GEO-IAMF#1). The Authority would also stabilize soils that are subject to potential settlement, for example, replacement of unstable soils with competent soils and placement of stone columns or vertical drains (GEO-IAMF#1). These methods would improve deep unsuitable soils in order to protect against potential settlement. Further, the Authority would conform to guidelines specified by relevant transportation and building agencies and codes (GEO-IAMF#6), requiring Authority contractors to account for soil and geotechnical properties during design and construction, which would include conducting site-specific subsurface geotechnical investigations and design evaluations, and thus address risk factors associated with bearing capacity and slope stability. Construction near existing structures or buried utilities located close to the project footprint can result in settlement in areas of unstable soils. This type of impact would result from either new structures or earth fills (including retained fills) placed in areas underlain by settlement-prone (loose or soft) soils or from dewatering excavations for below-grade sections of track where shallow groundwater occurs and soils are loose or soft. In order to monitor any earth movement, the Authority would conduct topographic surveys for the final design to establish top-of-rail elevations and as a benchmark to determine whether any subsidence has occurred (GEO-IAMF#1).

The Authority would conform to guidelines specified by relevant transportation and building agencies and codes, such as the Field Guide to Construction Dewatering (Caltrans 2001) (GEO-IAMF#6), requiring Authority contractors to account for soil and geotechnical properties design and construction and thus address risk factors associated with bearing capacity and slope stability. This document describes BMPs that can be used to reduce the risk from this type of hazard. Further, the design-build contractors would develop a CMP that would address how geologic constraints would be avoided or minimized during construction, including monitoring for subsidence by conducting topographic surveys for preparation of final design and comparing the results of their surveys with results from surveys for the initial track design (GEO-IAMF#1). The results would be used to determine top-of-rail elevations for final design as well as determine areas where overbuilding is needed (i.e., in floodplains) to counteract anticipated results of future subsidence.

The risks associated with settlement caused by loading and settlement because of regional subsidence would be the same for all Central Valley Wye alternatives. For all alternatives, stabilizing the soil, controlling for subsidence cause by groundwater over-pumping, and developing a CMP that would address avoidance of geologic hazards such as subsidence (GEO-IAMF#1); and conformance to specific guidelines and standards as specified by relevant transportation and building agencies and codes (GEO-IAMF#6) would avoid the risks presented by soil settlement. Because these practices consider geotechnical properties when addressing the risks associated with constructing in areas of unstable soil and ongoing ambient subsidence, they would avoid the impact of construction in these areas for all alternatives.

Localized ground subsidence from construction-related dewatering could have direct and short-term effects during construction. Aerial structures would require deep foundations, which may require dewatering during construction. Aerial structure deep foundations would typically include piers that would be excavated by using rotary drilling rigs, using either bentonite slurry or temporary casings to stabilize pile shaft excavation, therefore eliminating the need to dewater to the pier depth. Construction in areas prone to soil settlement can result in an increased risk of injury to construction personnel and passengers, and damage to HSR property. Localized ground subsidence can result in differential settlement, such that foundations are subject to stresses that can result in shifting, tilting, and compromises in structural integrity. Construction of any of the Central Valley Wye alternatives in areas of high groundwater, such as those in the Delta-Mendota and Merced Subbasins, could also require dewatering for the construction of bridge columns or below-grade underpasses.

Groundwater levels in the Central Valley Wye alternatives project footprints are generally deeper than anticipated excavation depths. Typical track, substation, and switching station construction would remain on the surface and could go 1–2 feet below the surface for clearing and grading. Auguring, varying from depths of approximately 6–24 feet, would be required for installation of structures associated with network upgrades and tie-lines. The SR 152 (North) to Road 19 Wye Alternative is the only Central Valley Wye alternative with a tunnel section. The tunnel section under SR 99 would be up to 60 feet deep, including subgrade. The HSR aerial structure foundations would sit on drilled shaft piles that would be 60 feet deep, depending on geotechnical conditions, and the roadway underpasses could be as deep as 40 feet, including subgrade. While the water depths in the groundwater RSA are greater than 50 feet (Table 3.8-6), it is possible that construction of these piles or of the tunnel floor would encounter groundwater and may require dewatering. The risk of soil settlement due to dewatering is greatest for the SR 152 (North) to Road 19 Wye Alternative because it would require dewatering. The other three alternatives, because drilling would be shallower, would require less extensive dewatering, and the risk of soil settlement as a result of localized subsidence would be correspondingly less and the same for all three alternatives.

As discussed under Impact GEO#1, because of the design of the alternatives, dewatering activities would likely be required only during construction of the SR 152 (North) to Road 19 Wye Alternative tunnel section. For construction of all Central Valley Wye alternatives, in order to monitor any earth movement, the Authority would conduct topographic surveys for the final design to establish top-of-rail elevations and as a benchmark to determine whether any subsidence has occurred (GEO-IAMF#1). The Authority would require the construction contractor to implement a dewatering plan (BIO-IAMF#20), and monitor and control the amount of groundwater withdrawal during construction. If groundwater withdrawals are required and levels are changing, then the contractor would be required to re-inject water to protect groundwater levels and supply and to maintain groundwater quality and ground surface conditions (GEO-IAMF#1). Further, the Authority would conform to guidelines specified by relevant transportation and building agencies and codes (GEO-IAMF#6), requiring Authority contractors to account for geotechnical properties during design and construction and thus address the risk of soil settlement associated with dewatering. For a discussion of erosion impacts related to dewatering, see Impact GEO#1. For a discussion of potential impacts to water quality and groundwater volume related to dewatering, see Impact HYD#3, Temporary Surface Water Quality Impacts, and Impact HYD#5, Temporary Groundwater Quality and Volume Impacts, in Section 3.8.6.3, Central Valley Wye Alternatives.

CEQA Conclusion

The impact under CEQA would be less than significant because the design and construction practices of the Central Valley Wye alternatives would incorporate effective measures to avoid any increase in exposure of people to loss of life or structures to damage associated with unstable soils because of subsidence and soil settlement. These design characteristics include measures to reduce settlement by using engineered ground improvements to stabilize compressible soils, offsetting the impacts of settlement as a result of groundwater withdrawal with alternate foundations, replacing unstable soils with competent soils, placing vertical drains or stone columns, and conforming to guidelines specified by relevant transportation and building agencies and codes. In addition, the Authority would monitor for subsidence to counteract anticipated results of future subsidence. These approaches would counter the impacts of unstable soils that are prone to ground settlement. Therefore, CEQA does not require any mitigation.

Impact GEO#6: Slope Failure

Slopes along some rivers and streams can fail from additional earth loads imposed by construction at the top of the slope, undercutting by stream erosion at the toe of the slope, or additional seismic forces during a seismic event. Loads imposed by construction at the top of the slope could cause slope failure by overcoming the shear strength of the soil. Undercutting the toe of a slope could cause slope failure through undermining the structural support for the slope. Seismic forces could cause slope failure by destabilizing the cohesion between particles, allowing gravity to play a greater role in the position of the slope materials, allowing them to move downhill. Risk of slope failure is greatest where the soil is unconsolidated and saturated, such as at natural waterbody crossings. The consequences of slope failure can be either loss of bearing support or increased load on structures that are in the path of the slope failure, which can lead risk of risk injury and loss of life to construction personnel and passengers or HSR property damage. Loss in bearing support affects at-grade and retained-fill segments more than retained cuts and elevated structures supported on deep foundations.

All four Central Valley Wye alternatives would be constructed on near-flat topography; however, slopes at some natural waterbody crossings in the resource hazards RSA could be subject to slope failure as a result of construction activities. Although the impacts on natural waterbodies from construction of each of the Central Valley Wye alternatives would be similar, the Avenue 21 to Road 13 Wye Alternative would have the most natural waterbody crossings (39 natural waterbody crossings), followed in order by the SR 152 (North) to Road 19 Wye Alternative (32 natural waterbody crossings), the SR 152 (North) to Road 13 Wye Alternative (31 natural waterbody crossings), and the SR 152 (North) to Road 11 Wye Alternative (30 natural waterbody crossings). See Table 5-5 in the Hydrology and Water Resources Technical Report (Authority and FRA 2016d) for additional information on which natural waterbodies are crossed by each alternative and the number of crossings of each waterbody.

The design of the Central Valley Wye alternatives minimizes instabilities that stream erosion could introduce. The design-build contractor would prepare a CMP that would address how geologic constraints, including slope failure, would be avoided or minimized during construction. This would include the use of design features such as stabilizers, mulches, revegetation, and covering areas with biodegradable geotextiles (GEO-IAMF#1). These methods would be implemented in coordination with other erosion, sediment, stormwater, and fugitive dust control measures. Use of stabilizers, mulches, revegetation, and other measures, as appropriate, would slow water velocity and minimize sediment transport. The Central Valley Wye alternatives' IAMFs would incorporate slope monitoring by a registered engineering geologist into the operations and maintenance procedures at sites identified in the CMP where a potential for long-term instability exists from gravity or seismic loading, in order to prevent risk of injury and loss of life to construction personnel and passengers and damage to HSR property and HSR structural integrity by long-term slope changes (GEO-IAMF#2). Monitoring would provide information to identify and repair any ground movement before it can damage track integrity. Further, the Authority would require that the most recently updated Caltrans seismic design criteria be used in the design of any HSR structures supported in or on the ground (GEO-IAMF#3). These IAMFs reduce to the greatest practical extent any potential movements, shear forces, and displacements that could result from inertial response of the structure and that could lead to damage of the structure.

Further, the Authority would conform to guidelines specified by relevant transportation and building agencies and codes, which would include conducting site-specific subsurface geotechnical investigations and design evaluations (GEO-IAMF#6), requiring Authority contractors to account for soil and geotechnical properties during design and construction and thus address risk factors associated with bearing capacity and slope stability.

The risk of slope failure would be greatest for Avenue 21 to Road 13 Wye Alternative based on number of natural waterbody crossings, followed in order by the SR 152 (North) to Road 19 Wye Alternative and SR 152 (North) to Road 11 Wye Alternative, and the SR 152 (North) to Road 13 Wye Alternative. However, for all alternatives, stabilizing the soil (GEO-IAMF#1), monitoring slopes (GEO-IAMF#2), incorporating the most recently updated Caltrans seismic design criteria in the design of any HSR structures supported in or on the ground (GEO-IAMF#3), and conforming to specific guidelines and standards as specified by relevant transportation and building agencies and codes (GEO-IAMF#6) would avoid the risks of slope failure. Because these practices consider geotechnical properties when addressing the risks associated with constructing in areas of unstable slopes, they would avoid the impact of construction in these areas for all alternatives.

CEQA Conclusion

The impact under CEQA would be less than significant because design and construction practices of the Central Valley Wye alternatives would incorporate effective measures that would reduce risk of slope failure from unstable soils. These IAMFs would include measures to minimize stream erosion that could lead to slope instability, monitor for slope stability in order to prevent long-term slope changes, implement Caltrans seismic design criteria, and conform to guidelines specified by relevant transportation and building agencies and codes. Therefore, CEQA does not require any mitigation.

Primary and Secondary Seismic Hazards

Impact GEO#7: Seismic-Induced Ground Shaking and Secondary Seismic Hazards

Seismic events, such as surface fault ruptures, seismically induced ground shaking, and risks from secondary seismic hazards (i.e., liquefaction, seismically induced slope failures, and seismically induced dam failure), could affect construction and operation and increase the risk of injury and loss of life to construction personnel and passengers and damage to HSR property. These phenomena can affect structural integrity by undermining the substrate on which structures are built or shaking the structures. The Central Valley Wye alternatives would be constructed in the seismicity, faulting, and dam failure inundation RSA, which is subject to seismic events.

Surface Fault Rupture

Surface fault rupture refers to the extension of a fault to the ground surface by which the ground breaks, resulting in an abrupt relative ground displacement—for example, vertical or horizontal offset. Surface fault ruptures are the result of stresses relieved during an earthquake event, and they often cause damage to structures astride the rupture zone. Surface fault rupture causes damage through relative displacement of the opposite sides of the fault. Portions of foundations built astride the fault move in opposite directions during an earthquake that exhibits surface fault rupture, shearing and breaking the foundation.

None of the Central Valley Wye alternatives would lie within a current Alquist-Priolo Earthquake Fault Zone or cross any mapped fault exhibiting offset of geologically recent deposits. The risk of surface fault rupture for all the Central Valley Wye alternatives is low and therefore the potential risk is the same among the alternatives.

Seismically Induced Ground Shaking

Construction activities, particularly those involving excavations, retaining walls, earth stabilization, and erection of structures, could be affected by strong ground shaking. In the event of a nearby seismic event, seismically induced ground motion could result in significant loads to structures supported on the ground during construction, and present a risk to workers and temporary and permanent structures. Strong seismic ground shaking from a seismic event could also damage new electrical infrastructure. However, all electrical facilities would be unmanned and would not cause risk involving injury or loss of life resulting from seismic-induced ground shaking. Because of the relatively short construction period, a large earthquake during the construction period is considered unlikely, and actual risks to personnel and construction equipment during construction from ground shaking during construction are considered low.

In case of earthquake during the construction period, the potential for damage from seismically induced ground motion would vary with structure type and location (at-grade, aerial, or tunnel), and the nature and location of the earthquake. Aerial structures would be most vulnerable to ground shaking. Although the alternatives would be similar in the length of aerial structure, the SR 152 (North) to Road 11 Wye Alternative would have the longest portion of aerial track (4.5 miles), followed in order by length of aerial track by the Avenue 21 to Road 13 Wye Alternative (4 miles), SR 152 (North) to Road 19 Wye Alternative (3.5 miles) and the SR 152 (North) to Road 13 Wye Alternative (3 miles).

The Authority would require contractors to use the most recently updated Caltrans seismic design criteria in the design of any HSR structures supported in or on the ground (GEO-IAMF#3). These IAMFs would reduce to the greatest practical extent any potential movements, shear forces, and displacements that could result from inertial response of the structure and that could lead to damage of the structure, thereby avoiding the potential impacts on HSR infrastructure from seismic events. The HSR design would address seismically induced ground shaking by specifying minimum seismic loading requirements for any elevated structures, specifically evaluating the response of the track system, and confirming that the soil provides sufficient support to the track. Detailed seismic response evaluations would be conducted, and measures such as enhanced structural detailing, more system redundancy, or special ground-motion isolation systems would be implemented, as appropriate, to reduce the potential for failures from inertial forces resulting from the ground motions. These measures would implement professional standards using site-specific geotechnical data to reduce risk of ground movement at HSR structures because of seismic activity.

In addition, the Authority would conform to guidelines specified by relevant transportation and building agencies and codes, which would include conducting site-specific subsurface geotechnical investigations and design evaluations (GEO-IAMF#6), requiring Authority contractors to account for geotechnical properties during design and construction of the Central Valley Wye alternatives, and thus address risk factors associated with seismically induced ground shaking.

Secondary Seismic Hazards

Secondary seismic hazards include liquefaction, seismically induced slope failures, and seismically induced dam failure. Liquefaction occurs when sediments temporarily lose shear strength and collapse. This condition is caused by cyclic changes in pressure during earthquake shaking that generate high pore water pressures[14] within the sediments. The soils most susceptible to liquefaction are loose, cohesionless, granular soils below the water table and within about 50 feet of the ground surface.

Liquefaction susceptibility is high at various locations within all subsections within alluvial soils. Liquefaction can have direct and short-term effects during construction. Liquefaction could be triggered by earthquakes, which are intermittent events. Liquefaction can cause ground settlement that may result in differential movement of temporary structures or large construction

[14] *Pore water pressure* is the pressure of groundwater held within soils or rock, in gaps between particles.

equipment. Differential movement could lead to permanent damage to these structures or equipment, which could cause an increased risk of injury to construction workers.

Liquefaction can result in loss of foundation support and settlement of overlying structures, ground subsidence, and lateral ground surface movement, discussed below, because of lateral spreading and differential settlement of affected deposits.

The impact of these secondary seismic hazards could vary along the alignments, depending on the type of structure and type of impact. Retained fills and at-grade structures could be more affected from loss of bearing support. Elevated structures located on deep foundations are capable of withstanding near-surface liquefaction, and retained-cut structures can be designed for increased loads from liquefied soil. Structures located on or in the path of moving ground associated with slope instability or flow can be designed for earth loads of the moving soil. Although the risk of soil failure would be greater if a large seismic event were to occur, the likelihood of a large earthquake during construction is considered low because of the comparatively short duration of these temporary activities relative to the infrequency of large earthquakes.

Lateral spreading could be triggered by earthquake-induced liquefaction, which are intermittent events, and could have direct and short-term effects on improvements related to the Central Valley Wye alternatives. Lateral spreading can cause ground movement that may result in differential movement of structures or equipment where liquefiable soil is located near a slope such as a creek bank or canal. Differential movement could lead to permanent damage to these structures and equipment, which could lead to an increased risk of injury or death. Because of the relatively short construction duration, a large earthquake during construction would be unlikely. The effects of lateral spreading are more likely to affect post-construction improvements.

Seismically induced landslides can have direct and short-term impacts during construction. Seismically induced landslides are triggered by earthquakes, which are intermittent events. Landslides can result in differential lateral and vertical movements of temporary or permanent structures or construction equipment situated on or in the path of a landslide. Because of the relatively short construction duration, a large earthquake during the construction period is considered unlikely, and actual risks from seismically induced landslide hazards during construction are considered low.

Risk of liquefaction, lateral spreading, and seismically induced landsliding is greatest in areas where the soil is unconsolidated and saturated (Harden 1998). Because boring data do not exist for the entire HSR area, it is not possible to state with certainty where soil meets these conditions. Much of the HSR area other than the natural waterbody crossings is of Pleistocene age (Wagner et al. 1991); therefore, it is likely that these areas are consolidated and not highly subject to liquefaction. At these natural waterbody crossings, sediments are young, unconsolidated, and saturated, and therefore potentially subject to liquefaction (Knudsen et al. 2009). Therefore, the Central Valley Wye alternatives with the most natural waterbody crossings would be at greatest risk from liquefaction.

The Avenue 21 to Road 13 Wye Alternative would have the most natural waterbody crossings (39 crossings), followed in order by the SR 152 (North) to Road 19 Wye Alternative (32 natural waterbody crossings), the SR 152 (North) to Road 13 Wye Alternative (31 natural waterbody crossings), and the SR 152 (North) to Road 11 Wye Alternative (30 natural waterbody crossings). See Table 5-5 in the Hydrology and Water Resources Technical Report (Authority and FRA 2016d) for additional information on which natural waterbodies are crossed by each alternative and the number of crossings of each waterbody.

The Central Valley Wye alternatives' IAMFs would minimize the risk from secondary seismic hazards of liquefaction and slope failure. The Authority would document how the most recently updated Caltrans seismic design criteria were used in the design of any HSR structures supported in or on the ground (GEO-IAMF#3). Specifications would include that site-specific geotechnical investigations would be carried out as the design work progresses to determine whether the type and density of the soil could result in conditions that would be susceptible to liquefaction and are in need of stabilization. Detailed slope-stability evaluations would also be conducted, and engineering measures such as ground improvement, use of retaining walls, or regrading of slopes would be implemented, as appropriate, to reduce the potential for seismically induced slope failures; localized instabilities that may occur would be handled as a maintenance issue. These measures would implement professional standards using site-specific geotechnical data to reduce risk of ground movement at HSR structures because of seismic activity.

In addition, the Authority would conform to guidelines specified by relevant transportation and building agencies and codes, which would include conducting site-specific subsurface geotechnical investigations and design evaluations (GEO-IAMF#6) requiring Authority contractors to account for geotechnical properties during design and construction of the Central Valley Wye alternatives and thus address risk factors associated with seismically induced ground shaking. Following these guidelines would reduce the intensity of the impact because structures would be designed to withstand seismic activity.

Secondary seismic impacts also include dam failure. The risk of seismically induced flood hazards affecting the Central Valley Wye alternatives comes from the potential for dam failure during a seismic event. Dams fail because of seismic activity through several mechanisms: surface fault rupture can potentially in turn rupture a structure built across a fault, seismic ground shaking can cause a structure's integrity to fail, and both liquefaction and slope failure can undermine foundations. Seismically induced flooding can have direct and short-term impacts on the Central Valley Wye alternatives. Earthquakes are episodic, so the impacts of seismically induced flooding would be intermittent. Flooding could cause permanent property damage or an increased risk of injury or death. Rapidly moving waters could affect electrical systems, flood excavations, and undermine foundations; and increase risk of injury and loss of life to construction personnel and passengers and of damage to HSR property. The dams that could potentially affect all four Central Valley Wye alternatives are Buchanan Dam, Hidden Dam, Friant Dam, and Pine Flat Dam. The Site 7—Le Grand Junction/Sandy Mush Road, Warnerville–Wilson 230 kV Transmission Line associated with the SR 152 (North) to Road 19 Wye Alternative would pass through the inundation zones of the Don Pedro Dam near the city of Waterford and the New Melones Dam near the city of Oakdale; however, activities would be limited to replacement or modification of existing structures and there would be no change from baseline conditions. Therefore, any potential failure of dams would affect all the Central Valley Wye alternatives equally. The following are the potential inundation impacts:

- Failure of Buchanan Dam, located approximately 14 miles northeast of Chowchilla, would flood an area of 104 square miles that includes the city of Chowchilla and a portion of eastern Merced County. Floodwaters would likely inundate the easternmost portions of all Central Valley Wye alternatives in Merced County.
- Failure of Hidden Dam, located approximately 18 miles east of the city of Chowchilla, would send floodwaters traveling southwest, flooding the community of Madera Acres, the city of Madera, and a surrounding area of 132 square miles entirely within Madera County. Floodwaters would likely inundate the southeastern-most portions of all Central Valley Wye alternatives in Madera County.
- Failure of the Friant Dam, located approximately 18 miles east of the city of Madera, would flood an area of 736 square miles in Fresno, Merced, and Madera Counties. Floodwaters would likely inundate the westernmost portions of all Central Valley Wye alternatives in Merced County.
- Failure of Pine Flat Dam, located approximately 40 miles southeast of the city of Madera, would cause the greatest total area of flooding. This dam would flood an area of 1,818 square miles, extending from the dam location in Fresno County south to the Central Valley in Kings County, and as far north as Stockton in San Joaquin County. The failure of Pine Flat Dam would likely inundate the westernmost portions of all Central Valley Wye alternatives in Merced County.

However, potential seismic hazard at these dams is low because none of the dams crosses a known earthquake fault (USGS 2015). A seismic hazard analysis was done for Friant Dam (USBR and DWR 2003) and Pine Flat Dam (Esmaili et al. 2012). Both dams were reported as unlikely to fail in case of ground shaking caused by earthquake. While risk of seismically induced dam failure exists on one or more of the dams, these analyses indicate it would be an unlikely event. Moreover, because of the relatively short construction duration, a large earthquake during construction would be unlikely. It is more likely that seismically induced flooding would affect post-construction improvements. Any potential likely risk is the same for all Central Valley Wye alternatives. The potential impacts from seismically induced dam failure associated with operations are discussed in Impact GEO#10.

As stated previously, the risk of dam failure during operations would affect all Central Valley Wye alternatives equally. The anticipated risk is low.

CEQA Conclusion

The impact under CEQA would be less than significant because the Central Valley Wye alternatives would incorporate effective measures to minimize exposing people or structures to an increased potential for loss of life, injuries, or destruction from seismic activity and related hazards. The Central Valley Wye alternatives would include design and construction practices to minimize risk from primary and secondary seismic hazards, including providing minimum seismic loading requirements, system redundancy, ground-motion isolation systems as appropriate, and conforming to guidelines specified by relevant transportation and building agencies and codes. Therefore, CEQA does not require any mitigation.

Areas of Difficult Excavation

Impact GEO#8: Difficult Excavations due to Hardpan and Shallow Groundwater

For these discussions, difficult excavation is defined as excavation methods requiring more than standard earth-moving equipment or special controls to enable the work to proceed. Areas of difficult excavation are most common in rock formations and cemented or hardpan strata not amenable to excavation with a ripper-equipped dozer, or areas of shallow groundwater.

Rock is located far below the ground surface along the Central Valley Wye alternatives; therefore, the potential for encountering rock is not likely. However, cemented zones and hardpan can occur within the Central Valley Wye geology, soils, and seismicity RSA, and the cemented zones and hardpan can be rock-like in consistency. Cemented zones and hardpan form as a result of the soil-weathering process and can develop in most of the surficial site soils previously described. These cemented zones and hardpan may pose local excavation issues for conventional machinery, depending on the thickness and degree of cementation of the hardpan or cemented layer. In areas that have been used for agricultural purposes, the hardpan has often been removed or tilled to improve the drainage characteristics of the soil. Past land use, as well as infrastructure development in the study area, should limit the locations where hardpan and cemented zones pose a potential problem for excavations.

Construction in areas where the upper layers of soil contain cemented zones and hardpan that can be difficult to excavate with conventional machinery could increase the risk of injury or loss of life to construction personnel or damage to HSR property or equipment damage during construction excavations. The primary risk associated with construction in hardpan is that excavation or drilling could lead to sudden rupture of a cemented soil layer that covers a void under the hardpan, with the associated risk of collapse into the void. These impacts would primarily affect construction personnel on construction-related property. Excavations in these types of soils are relatively familiar in this region, and contractors are familiar with methods to handle excavations in hardpan. Further, areas of difficult excavation along the alternatives (including drilled piers or piles) are not expected to be pervasive because of the predominantly uncemented Quaternary sediments in the San Joaquin Valley, although some localized areas may occur. All four Central Valley Wye alternatives would include areas in the resource hazards RSA where the upper layers of soil contain cemented layers and hardpan. Areas of difficult excavation would not be problematic for the EINU components because electrical interconnection facilities are proposed in areas of active agricultural use, and network upgrades and modifications to existing facilities are proposed in areas subject to prior disturbance.

It is possible that shallow groundwater locations would result in difficult excavation conditions if sufficient consideration is not given to specific conditions when excavating below-grade sections of the track. In open excavations in cohesionless soil, shallow groundwater can reduce the strength of the soil and cause instabilities of the excavation side-slopes or heave of the excavation base, leading to loss of ground support or total collapse. Shallow groundwater also increases the hydrostatic pressures on braced excavations, which would need to be accounted for during design and may require specialized equipment and procedures. Dewatering may be required for excavations that need to remain dry below the groundwater table such as construction of aerial structure foundations and trenches. If dewatering is needed, it could lead to localized ground subsidence (see also Land Subsidence in Section 3.9.5.1, Geology, Soils, and Seismicity). If a dewatering system fails during construction, excavations could flood and damage equipment or cause harm to people. The depth of groundwater varies with time because of changes in geology, weather, and human activities. Therefore, the impacts of shallow groundwater during construction could be intermittent.

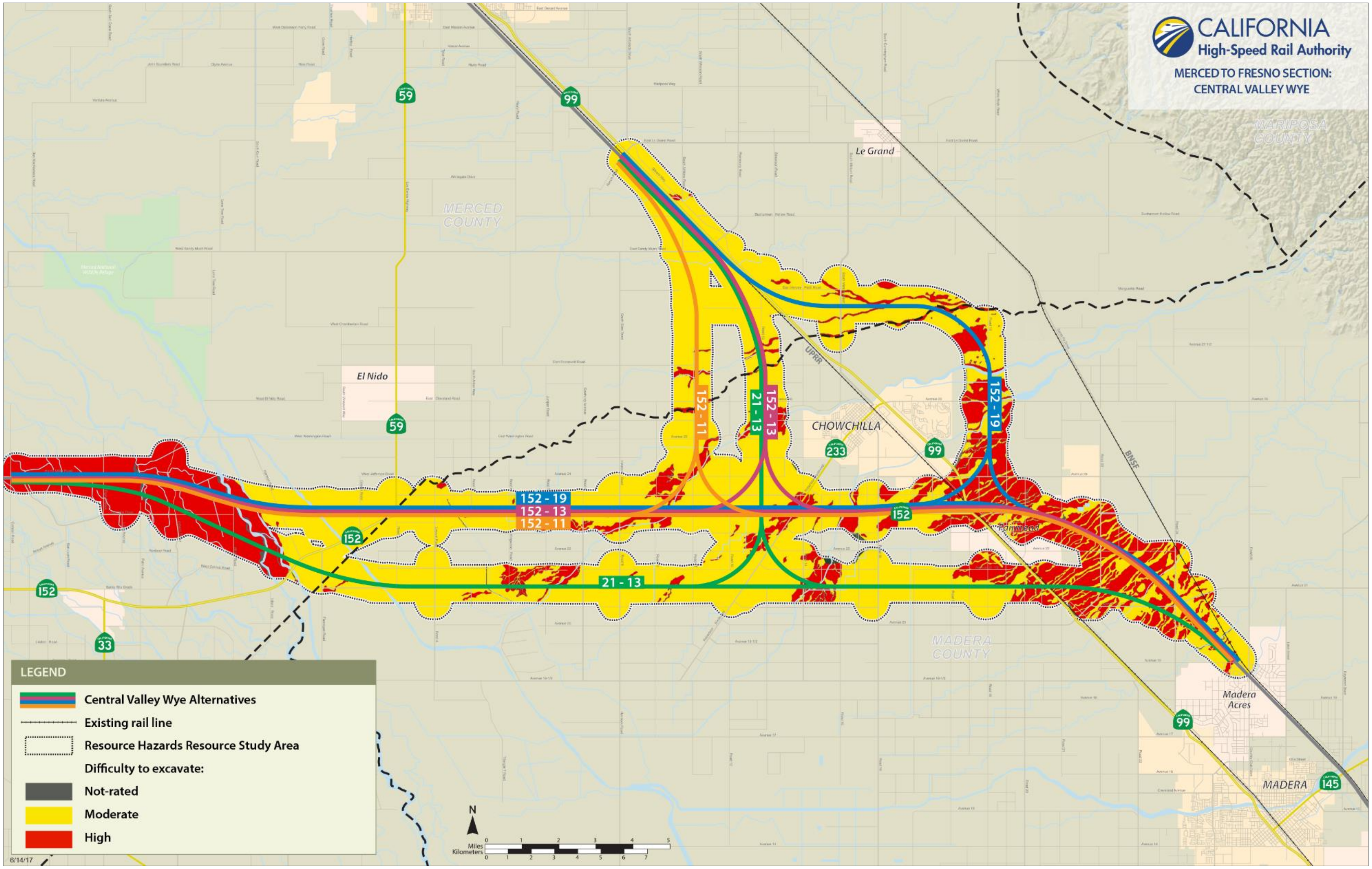
Although these conditions are unlikely to be widely encountered, localized areas where groundwater is near the surface and loose soil conditions exist cannot be ruled out, especially near natural waterbody crossings. These types of design issues are routinely handled during construction using temporary dewatering with deep groundwater wells and well points that lower the water level; installing sheet pile wall systems to stabilize the soil; or using techniques such as jet grouting and cement deep soil mixing techniques that add cement to the soil, thereby providing a cement-soil mix that resists hydrostatic forces. Alternatively, excavations can be avoided by using deep foundations that can be driven or drilled into the loose, water-saturated soil.

All of the Central Valley Wye alternatives would traverse soils in the resource hazards RSA that exhibit a moderate difficulty to excavate, except west of Mariposa Slough and along SR 152 east of Road 13, where the level of difficulty to excavate soils is high. The SR 152 (North) to Road 19 Wye Alternative would involve a short section of tunnel with soils moderately difficulty to excavate. The Authority would conduct site-specific subsurface geotechnical investigations and geotechnical design evaluations during the design of the Central Valley Wye alternatives to determine specific locations where difficult excavations may occur and plan for this during construction. The Authority would conform to guidelines specified by relevant transportation and building agencies and codes, which would include conducting site-specific subsurface geotechnical investigations and design evaluations (GEO-IAMF#6) and require its contractors to account for geotechnical properties during design and construction. In doing so, the Authority would be able to avoid risk factors associated with difficult excavation conditions such as hardpan and shallow groundwater. Methods in the Caltrans *Construction Site Best Management Practices Field Manual and Troubleshooting Guide* (Caltrans 2003a) and the *Caltrans Construction Site Best Management Practices Manual* (Caltrans 2003b), such as predrilling rock bits for drilled piers/piles or the use of backhoe-mounted hydraulic impact hammers for shallow excavations, would be used.

Figure 3.9-10 depicts the areas that are moderately or highly difficult to excavate, which takes into account both hardpan soils and shallow groundwater. Table 3.9-15[15] show the acres of difficult excavation caused by hardpan and shallow groundwater by alternative. Although the impacts of each of the Central Valley Wye alternatives would similar to each other, the SR 152 (North) to Road 19 Wye Alternative would be subject to a greater amount of acres of difficult excavation conditions in the project footprint than the other alternatives (1,106 acres), followed in

[15] NRCS SSURGO soils database considers both hardpan and shallow groundwater together as conditions for difficult excavation, so both conditions are considered together in this Figure 3.9-10 and Table 3.9-15.

order by the SR 152 (North) to Road 11 Wye Alternative (835 acres), SR 152 (North) to Road 13 Wye Alternative (819 acres), and Avenue 21 to Road 13 Wye Alternative (753 acres).



Source: NRCS SSURGO, 2007, 2008, 2010, 2016

DRAFT– JUNE 14, 2017

Figure 3.9-10 Areas of Difficult Excavation

Table 3.9-15 Areas of Moderate or Highly Difficult Excavation by Alternative (acres)

Resource Category	Central Valley Wye Alternatives			
	SR 152 (North) to Road 13 Wye	SR 152 (North) to Road 19 Wye	Avenue 21 to Road 13 Wye	SR 152 (North) to Road 11 Wye
Areas of Difficult Excavation (acres)	819	1,106	753	835

Source: NRCS, 2016
Note: NRCS soil survey geographic database (SSURGO) considers both hardpan and shallow groundwater together as conditions for difficult excavation, so both conditions are considered together in this geographic calculation.

Locations where retained-cut alignment segments are planned in all four Central Valley Wye alternatives would be most affected by hardpan and shallow groundwater conditions. Both the retained-fill and at-grade design types would usually involve a limited need to excavate the hardpan or work below the groundwater level, and deep foundations for elevated structures are conventionally constructed into rock and below the groundwater. As mentioned previously, the SR 152 (North) to Road 19 Wye Alternative involves a short section of tunnel with moderately difficulty-to-excavate soils. It would affect 14.8 acres of difficult-to-excavate soil in the resource hazards RSA. The risk associated with difficult excavation conditions would therefore be greater for the SR 152 (North) to Road 19 Wye Alternative, followed by SR 152 (North) to Road 11 Wye Alternative, SR 152 (North) to Road 13 Wye Alternative, and Avenue 21 to Road 13 Wye Alternative. However, for all alternatives, implementation of best available practices as specified by relevant transportation and building agencies and codes would avoid the risks presented by difficult excavation conditions. Because these practices consider geotechnical properties when addressing the risks associated with constructing in areas of hardpan and shallow groundwater conditions, they would avoid the impact of construction in these areas for all alternatives.

CEQA Conclusion

The impact under CEQA would be less than significant because the design and construction practices of the Central Valley Wye alternatives would include effective measures to avoid increased exposure of people to loss of life or structures to damage from the risks of construction in areas of unstable soils caused by hardpan and shallow groundwater. The Central Valley Wye alternatives' IAMFs would minimize risk of construction in areas of hardpan and shallow groundwater by using standard construction techniques and conforming to guidelines specified by relevant transportation and building agencies and codes. Therefore, CEQA does not require any mitigation.

Resource Hazards

Impact GEO#9: Loss of Availability of Mineral or Energy Resources and Increase in Safety Risk due to Disruption of Subsurface Oil and Gas Resources

This discussion describes loss of mineral and energy resources and risk of injury and loss of life to construction personnel from working near a gas field because of potential oil or gas pipeline explosion and to passengers from use of the HSR constructed near an oil and gas field. For a discussion of hazards associated with release of petroleum products and other chemicals from oil and gas wells and associated infrastructure, see Impact HMW#6, Temporary Effects Associated with Risks during Construction on or near Landfills and Oil and Gas Wells, in Section 3.10. The Central Valley Wye alternatives would not cross any areas of known geothermal resources. Accordingly, the Authority does not anticipate encountering any existing geothermal wells or impeding future geothermal well development on any of the four alignments. Construction near gas and oil fields carries with it two types of impacts: loss of availability of mineral and energy resources and increase in risk of injury and loss of life to construction personnel and passengers and damage to HSR property. These two impacts are somewhat related. The loss of availability could occur because construction in such an area requires that oil and gas wells be capped and taken out of service and that appurtenant facilities such as pipelines be taken out of service for practical reasons—to make room for the construction—as well as for safety reasons. While it is possible to replace an active oil well entrance with another entrance to the same well from a different location, it is possible that the changed entrance could affect productivity. Data collected from exploration activities are used to optimize the entrance to the target zone when drilling and developing a well. Therefore, capping an existing well and redrilling into the target zone from a nearby location may not result in the same level of production from the new well. The production rate from a new well cannot be estimated before it is installed. Consequently, replacing wells may result in a reduction in the rate of production at the new well. The increase in risk of injury and loss of life to construction personnel and passengers could occur because of the increased proximity of the HSR to volatile materials.

All four Central Valley Wye alternatives pass through the Chowchilla Gas Field, located near where SR 152 crosses the Merced-Madera County line. Most of the oil and natural gas wells within the Chowchilla Gas Field are dry or plugged, abandoned by well operators between 1930 and 1986. Because of construction of the Central Valley Wye alternatives, active oil and gas wells would be capped and relocated to nearby locations using directional drilling techniques, if feasible. Appurtenant facilities such as pipelines would also potentially need to be relocated if they fall within the project footprints of the Central Valley Wye alternatives. Production lost during well relocation is expected to be small on a regional basis, because of the small number of potentially affected wells. Figure 3.9-5 and Table 3.9-16 show the number of wells by alternative.

Table 3.9-16 Number of Oil and Gas Wells by Alternative

Resource Category	Central Valley Wye Alternatives			
	SR 152 (North) to Road 13 Wye	SR 152 (North) to Road 19 Wye	Avenue 21 to Road 13 Wye	SR 152 (North) to Road 11 Wye
Subsurface Oil and Gas Wells	44 wells (1 active)	45 wells (1 active)	34 wells (1 active)	44 wells (1 active)

Source: DOC, 2015

Analysts mapped locations of all oil and gas wells (both active and abandoned) from data obtained from the DOGGR database (DOC 2015). As shown in Table 3.9-16, the database identified 44 wells within the SR 152 (North) to Road 13 Wye Alternative's resource hazards RSA. Although the alternatives are similar, the resource hazards RSA for the SR 152 (North) to Road 19 Wye Alternative has the most wells (45), followed by the SR 152 (North) to Road 13 Wye Alternative and SR 152 (North) to Road 11 Wye Alternative (44 wells each), and the Avenue 21 to Road 13 Wye Alternative (34 wells). However, most of the oil and natural gas wells are dry, plugged, or abandoned, and as a result, impacts on available oil and gas resources are anticipated to be minimal. Only two active wells are identified in the resource hazards RSA; one in the RSA of the three SR 152 alternatives and one in the RSA of Avenue 21 to Road 13 Wye Alternative. All active wells would be relocated, and impacts associated with the relocation would be minimized.

The Central Valley Wye alternatives' IAMFs would minimize the impacts related to relocation of active oil and gas wells to the greatest extent possible. Further, the Authority would compensate well owners for relocation and drilling of new wells, relocation of ancillary pipelines and underground conveyance, and for any loss in production. In addition, the Authority would conform to guidelines specified by relevant transportation and building agencies and codes, which would include conducting site-specific subsurface geotechnical investigations and design evaluations (GEO-IAMF#6), requiring Authority contractors to account for geotechnical properties during Central Valley Wye alternatives design and construction, thus allowing for safe relocation of well entrances to oil and gas resources in order to minimize loss of productivity. Although the Central Valley Wye alternatives may affect a small number of individual wells, no damage to the geologic horizons containing the oil or natural gas is anticipated. Construction in the Chowchilla Gas Field could increase risk of injury and loss of life for construction personnel and passengers, in case of oil or gas pipeline rupture associated with construction. The Central Valley Wye alternatives' IAMFs would minimize the risks associated with open wells that would increase risk of injury and loss of life to construction workers and passengers to the Central Valley Wye alternatives through the following actions that would improve safety.

- The Authority would identify and inspect wells within 200 feet of the HSR, and the well operator would cap, abandon, or relocate them with compensation from the Authority (SS-IAMF#4).
- The Authority would also use safe and explosion-proof equipment, implement regular testing for gases, and develop a safety and security management plan (SS-IAMF#2).
- The Authority would conform to guidelines specified by relevant transportation and building agencies and codes (GEO-IAMF#6) requiring Authority contractors to account for geotechnical properties during design and construction of the Central Valley Wye alternatives and thus addressing potential increased risk associated with construction near oil and gas fields.

Because of the number of wells near the Central Valley Wye alternatives, the risk associated with construction near oil and gas fields would be greatest for the SR 152 (North) to Road 19 Wye Alternative, followed by followed by the SR 152 (North) to Road 13 Wye Alternative/SR 152 (North) to Road 11 Wye Alternative and the Avenue 21 to Road 13 Wye Alternative. As mentioned previously, although the total number of wells would vary among alternatives, the number of active wells would be the same for all Central Valley Wye alternatives: one. For all alternatives, requiring identification and inspection of all wells within 200 feet of the HSR (SS-IAMF#4); using safe and explosion-proof equipment and developing a safety and security management plan (SS-IAMF#2) implementing best available practices as specified by relevant transportation and building agencies and codes, would avoid the risks presented by construction near active oil and gas wells (GEO-IAMF#6). Because these practices consider geotechnical properties when addressing the risks associated with constructing in areas of oil and gas reserves, as well as safety practices to follow when excavating and operating near such reserves, they would avoid the impact of construction in these areas for all alternatives.

A temporary access road associated with the reconductoring of the existing Site 7—Le Grand Junction/Sandy Mush Road, Warnerville–Wilson 230 kV Transmission Line to support the SR 152 (North) to Road 19 Wye Alternative would cross the Central Merced River Area (MRZ-2a); however, the area is not actively mined. The temporary use of the road would not affect the future availability of mineral resources. In addition, the Site 7—Le Grand Junction/Sandy Mush Road, Warnerville–Wilson 230 kV Transmission Line currently spans the Tuolumne River Aggregate Resource Area (MRZ-2b). This area is also not actively mined, and reconductoring of the existing transmission line would have no impact on the future availability of mineral resources. Accordingly, no loss of availability of minerals of local or statewide significance or hazards associated with encountering such surface or subsurface deposits of such minerals is anticipated.

CEQA Conclusion

The impact under CEQA would be less than significant because construction of the Central Valley Wye alternatives would not reduce the availability of oil and gas resources for extraction and construction and design measures would minimize risk of injury and loss of life to construction personnel and passengers or damage to HSR property from construction in the Chowchilla Gas Field. Active oil and gas wells would be capped and relocated to increase the distance between the well and the HSR and reduce risk of injury to construction personnel and passengers. The Authority would compensate well owners to offset any loss of productivity that might result from well relocation. The Authority would use safe and explosion-proof equipment, implement regular testing for gases, and develop a safety and security management plan to minimize risk of explosion from open wells. Further, the Central Valley Wye alternatives' IAMFs would minimize risk of construction in areas of active gas and oil wells through conforming to guidelines specified by relevant transportation and building agencies and codes. Therefore, CEQA does not require any mitigation.

Operations Impacts

Seismic events could produce hazards to the operations of the HSR system. Potential hazards include seismic-induced ground shaking and dam failures.

Primary and Secondary Seismic Hazards

Impact GEO#10: Seismic-Induced Ground Shaking and Secondary Seismic Hazards

Seismic events, including surface fault rupture, seismically induced ground shaking, and secondary seismic hazards (e.g., liquefaction, seismically induced slope failures, and seismically induced dam failure) in the seismicity, faulting, and dam failure inundation RSA could produce hazards to operations for any rail operations, increasing the risk of injury and loss of life to passengers and damage to HSR property. These phenomena can affect structural integrity by undermining the substrate on which structures are built or shaking the structures.

Surface Fault Rupture

Surface fault rupture refers to the extension of a fault to the ground surface by which the ground breaks, resulting in an abrupt relative ground displacement—for example, vertical or horizontal offset. Surface fault ruptures are the result of stresses relieved during an earthquake event, and often cause damage to structures astride the rupture zone. Surface fault rupture causes damage through relative displacement of the opposite sides of the fault. Portions of foundations built astride the fault move in opposite directions during an earthquake that exhibits surface fault rupture, shearing and breaking the foundation.

None of the Central Valley Wye alternatives would lie within a current Alquist-Priolo Earthquake Fault Zone or cross any mapped fault exhibiting offset of geologically recent deposits. The risk of surface fault rupture for all four Central Valley Wye alternatives is low, and therefore potential risk is the same among the alternatives.

Seismically Induced Ground Shaking

Strong seismic ground shaking could affect rail operations, increasing the risk of injury and loss of life to passengers and damage to HSR property. Seismic ground motion could have direct, short-term impacts during operations. Earthquakes are episodic, so the impacts of seismic ground motion on operations would be intermittent. Seismic ground shaking can cause structures to topple and could result in damage to tracks, potentially causing derailment. As with Impact GEO#7, elevated segments would create greater susceptibility to the impacts of ground shaking than at-grade segments. Although the alternatives would be similar in the length of aerial structure, the SR 152 (North) to Road 11 Wye Alternative would have the longest portion of aerial track (4.5 miles), followed by the Avenue 21 to Road 13 Wye Alternative (4 miles), SR 152 (North) to Road 19 Wye Alternative (3.5 miles) and the SR 152 (North) to Road 13 Wye Alternative (3 miles).

A key consideration is the response of the operating HSR to a seismic event that shakes the track. The Authority would require contractors to use the most recently updated Caltrans seismic design criteria in the design of any HSR structures supported in or on the ground (GEO-IAMF#3). These IAMFs would reduce to the greatest practical extent any potential movements, shear forces, and displacements that could result from inertial response of the structure and that could lead to damage of the structure, thereby reducing the potential impacts on operations of the Central Valley Wye alternatives from seismic events. Furthermore, the Authority would conform to guidelines specified by relevant transportation and building agencies and codes, which would include conducting site-specific subsurface geotechnical investigations and design evaluations (GEO-IAMF#6), requiring Authority contractors to account for geotechnical properties during design and construction of the Central Valley Wye alternatives and thus address risk factors associated with seismically induced ground shaking.

Prior to final design, additional seismic studies would be conducted to establish the most up-to-date estimation of levels of ground motion, and updated Caltrans seismic design criteria would be used in the design of any structures supported in or on the ground. Movement of the railbed would be transferred into the train. The train cars, the spring system for the train cars, and the track design would be appropriately configured to resist the resulting inertial response of the train while it is traveling at a high speed. Available information for other HSRs in seismically active areas, such as Japan and Taiwan (see Section 3.11), suggests that the California HSR system would be able to satisfy life-safety requirements for the expected earthquake magnitude.

In order to reduce risk of injury and loss of life to passengers and damage to HSR property and HSR operational integrity in case of an earthquake during HSR operations, the Authority would install an Early Earthquake Detection System that would be used in combination with the automatic train control system to stop HSR trains temporarily during or after a potentially damaging earthquake (GEO-IAMF#4). This network of instruments would provide ground-motion data that would be used with the HSR instrumentation and controls system to shut down HSR operations temporarily in the event of an earthquake. Shutting down operations temporarily during or after a potentially damaging earthquake would minimize the risk of a moving train encountering structures that have been compromised by seismic activity.

As mentioned previously, the SR 152 (North) to Road 11 Wye Alternative would have the longest portion of aerial track, exposing it to the greatest risk from ground shaking. It is followed by the Avenue 21 to Road 13 Wye Alternative, SR 152 (North) to Road 19 Wye Alternative, and the SR 152 (North) to Road 13 Wye Alternative. However, for all alternatives, implementation of best available practices, as specified by relevant transportation and building agencies and codes, would avoid the risks presented by difficult excavation conditions. Because these practices consider geotechnical properties when addressing the risks associated with operation in seismically active areas, they would avoid the impact of operation in these areas for all alternatives.

Secondary Seismic Hazards

Secondary seismic hazards include liquefaction, seismically induced slope failures, and seismically induced dam failure. Potential impacts to HSR structures from secondary seismic hazards during operations are essentially the same as those during construction, as discussed in Impacts GEO#7. The impact of these secondary seismic hazards could vary along the alignments, depending on the type of structure and type of impact. Retained fills and at-grade structures could be more affected from loss of bearing support. Elevated structures located on deep foundations are capable of withstanding near-surface liquefaction, and retained-cut structures can be designed for increased loads from liquefied soil. Structures located on or in the path of moving ground associated with slope instability or flow can be designed for earth loads of the moving soil.

As described under Impact GEO#7, risk of liquefaction, lateral spreading, and seismically induced landslide is greatest in areas where the soil is unconsolidated and saturated (Harden 1998). Because boring data do not exist for the RSA, it is not possible to state with certainty where soil meets these conditions. Much of the HSR area other than natural waterbody crossings is of Pleistocene age (Wagner et al. 1991); therefore, it is likely that these areas are consolidated and not highly subject to liquefaction. At natural waterbody crossings, sediments are young, unconsolidated, and saturated, and therefore potentially subject to liquefaction (Knudsen et al. 2009). Therefore, the alternatives with the most natural waterbody crossings would be at greatest risk from liquefaction.

Although similar, the Avenue 21 to Road 13 Wye Alternative would have the most natural waterbody crossings (39 crossings), followed by the SR 152 (North) to Road 19 Wye Alternative (32 natural waterbody crossings), the SR 152 (North) to Road 13 Wye Alternative (31 natural waterbody crossings), and the SR 152 (North) to Road 11 Wye Alternative (30 natural waterbody crossings). See Table 5-5 in the Hydrology and Water Resources Technical Report (Authority and FRA 2016d) for additional information on which natural waterbodies are crossed by each alternative and the number of crossings of each waterbody.

Consistent with standard industry practice, further detailed subsurface geotechnical investigations and geotechnical design evaluations would be conducted during the later stages of engineering design to confirm any site-specific risks and to minimize these risks in the final design of structures. These studies would be conducted during final design following the environmental review process. The Authority would require contractors to use the most recently updated Caltrans seismic design criteria in the design of any HSR structures supported in or on the ground (GEO-IAMF#3) to minimize the risk from secondary seismic hazards. Specifications would include that site-specific geotechnical investigations would be carried out as the design work progresses to determine whether the type and density of the soil could result in conditions that would be susceptible to liquefaction and in need of stabilization. Detailed slope-stability evaluations would also be conducted, and engineering measures such as ground improvement, use of retaining walls, or regrading of slopes would be implemented, as appropriate, to reduce the potential for seismically induced slope failures; localized instabilities that may occur would be handled as a maintenance issue. These measures would implement professional standards using site-specific geotechnical data to reduce risk of ground movement at HSR structures because of seismic activity. Additionally, the Authority would conform to guidelines specified by relevant transportation and building agencies and codes, which would include conducting site-specific subsurface geotechnical investigations and design evaluations (GEO-IAMF#6), requiring Authority contractors to account for geotechnical properties during design and construction of the Central Valley Wye alternatives and thus address risk factors associated with seismically induced ground shaking.

The Avenue 21 to Road 13 Wye Alternative would have the most natural waterbody crossings, exposing this alternative to the greatest risk of seismically induced slope failure and liquefaction. This alternative is followed by the SR 152 (North) to Road 19 Wye Alternative/SR 152 (North) to Road 13 Wye Alternative and the SR 152 (North) to Road 11 Wye Alternative. However, for all alternatives, implementation of best available practices as specified by relevant transportation and building agencies and codes would avoid the risks presented by difficult excavation conditions. Because these practices consider geotechnical properties when addressing the risks associated with operation in seismically active areas, they would avoid the impact of operation in these areas for all alternatives.

Secondary seismic impacts also include dam failure. Dams fail because of seismic activity through several mechanisms: surface fault rupture can potentially rupture a structure built across a fault, seismic ground shaking can cause a structure’s integrity to fail, and both liquefaction and slope failure can undermine foundations. During operations, damage from seismically induced dam failure could occur as a result of a large earthquake, as could occur during construction, discussed under Impact GEO#7. During operations, if a moving train encounters track that has been damaged or inundated then there would be an increasing risk of personal injury, loss of life, and property damage. Flooding could cause permanent property damage or an increased risk of injury or death. Rapidly moving waters could potentially erode embankments and bridge foundations, or submerge parts of the alignment. Flood waters could also inundate train stations or other supporting structures. Flooded tracks and damaged structures pose hazards to a moving train and its occupants. Earthquakes are episodic, so the impacts of seismically induced flooding on operations would be intermittent. As described in Impact GEO#7, the potential dam failures that could result in inundation of the downstream flat-lying areas and potentially affect all four Central Valley Wye alternatives are Buchanan Dam, Hidden Dam, Friant Dam, and Pine Flat Dam. Specific dam failure expectations are described under Impact GEO#7. While any potential failure of these dams would affect all the Central Valley Wye alternatives the same, they would not affect EINU components. Potential seismic hazard at these dams is low because none of the dams crosses a known earthquake fault, and seismic hazard analyses conducted for two of the dams (Friant and Pine Flat Dams) found dam failure from earthquakes is unlikely (USGS 2015; USBR 2014; Esmaili et al. 2012).

Nonetheless, in the event of an earthquake, HSR operational procedures would minimize potential hazards from dam failure for all Central Valley Wye alternatives. In order to protect HSR operational integrity and reduce risk of injury and loss of life to passengers in case of earthquake during HSR operations, the Authority would install a control system to shut down HSR operations temporarily during or after a potentially damaging earthquake to reduce risks (GEO-IAMF#4). A network of instruments would be installed to provide ground-motion data that would be used with the HSR instrumentation and controls system to shut down HSR operations temporarily. Shutting down operations temporarily during or after a potentially damaging earthquake would minimize the risk of injury and loss of life to passengers or damage to HSR property from inundation in the unlikely event of a seismically induced dam failure. Procedures would be in place to identify possible water routes from a dam breach and move trains that are in operation out of the anticipated water route.

The risk of dam failure during operations would affect all Central Valley Wye alternatives the same. However, for all alternatives, implementation of best available practices as specified by relevant transportation and building agencies and codes, would avoid the risks presented by potential dam failure, specifically shutting down HSR operations temporarily in case of earthquake. Because these practices consider geotechnical properties when addressing the risks associated with operations in seismically active areas, they would avoid the impact of operation in these areas for all alternatives.

CEQA Conclusion

The impact under CEQA would be less than significant because the design of the Central Valley Wye alternatives would include effective measures to minimize exposing people or structures to an increased potential for loss of life, injuries, or destruction from seismic activity and related hazards. The Central Valley Wye alternatives' IAMFs would minimize risks associated with seismic activity by, providing minimum seismic loading requirements, system redundancy, and ground-motion isolation systems as appropriate; installing a ground-motion detection network to shut down HSR operations in case of earthquake; and conforming to guidelines specified by relevant transportation and building agencies and codes. Therefore, CEQA does not require any mitigation.

3.9.6.3 Paleontological Resources

No Project Alternative

The population in the San Joaquin Valley is expected to grow through 2040 (see Section 2.2.2.2). Development in the San Joaquin Valley to accommodate the population increase would continue under the No Project Alternative. Such planned projects anticipated to be constructed by 2040 include residential, commercial, industrial, recreational, and transportation projects, which could affect paleontological resources.

Paleontologically sensitive geologic units are widespread throughout the San Joaquin Valley (e.g., Marchand 1976; Marchand and Allwardt 1978; Lettis 1982; Wagner et al. 1991). Anywhere in the region, construction activity that involves ground disturbance in geologic units with high paleontological sensitivity could result in the destruction of significant paleontological resources.

Future development projects anticipated in Merced and Madera Counties include dairy farm expansions, implementation of airport development and land use plans, and implementation of general and specific plans throughout both counties. Planned projects under the No Project Alternative would also include transportation projects, such as the expansion of SR 99, as well as residential, commercial, and industrial developments. A full list of anticipated future development projects is provided in Appendix 3.19-A and Appendix 3.19-B. The residential and commercial growth expected in and around the city of Chowchilla, as described in the Introduction and Land Use sections of the *City of Chowchilla 2040 General Plan* (pages I-1 through L-69) (City of Chowchilla 2011), would also have the potential to affect paleontological resources where development occurs in areas with high paleontological sensitivity.

More specifically, where future projects involve paleontologically sensitive units, ground disturbance could result in the destruction of significant paleontological resources and associated loss of scientific information. To the extent that ongoing infrastructure and other operations would involve ground disturbance, such operations would also have the potential to result in the destruction of significant paleontological resources and the loss of scientific information. However, future projects under the No Project Alternative would require separate environmental review; potential impacts on paleontological resources would be analyzed and addressed on a program or project basis through future environmental reviews as individual undertakings are processed by other lead agencies.

Central Valley Wye Alternatives

Although the paleontological record near the Central Valley Wye alternatives is rich and diverse, no unique paleontological resources have been identified in the vicinity; as a result, none of the Central Valley Wye alternatives is expected to affect unique paleontological resources. However, construction of the Central Valley Wye alternatives would involve ground disturbance in paleontologically sensitive geologic units and thus could result in impacts on other (non-unique) significant paleontological resources.[16] Impacts, if any, would be permanent, since damage would occur to resources that would be nonrecoverable. Operation of the Central Valley Wye alternatives is not expected to require ground disturbance in previously undisturbed strata and therefore would not affect significant paleontological resources.

Construction Impacts

Impact PAL#1: Common Impacts on Paleontological Resources due to Construction

SR 152 (North) to Road 13 Wye Alternative and SR 152 (North) to Road 11 Wye Alternative

There are no substantive differences between the SR 152 (North) to Road 13 Wye Alternative and SR 152 (North) to Road 11 Wye Alternative with regard to paleontological resources. This is because the geologic setting for both alternatives is similar and the same geologic units would be involved in construction of the two alternatives.

The potential for impacts on paleontological resources relates to the paleontological sensitivity of the geologic units involved in construction-related ground disturbance—that is, the likelihood, based on past fossil finds, that these units would produce additional finds of significant paleontological resources.

The SR 152 (North) to Road 13 and SR 152 (North) to Road 11 Wye Alternatives, including the Site 6—El Nido, El Nido Substation and the Site 7—Wilson, Wilson Substation and 230 kV Tie-Line, would be located on the floor of the San Joaquin Valley, which is underlain by several geologic units that have yielded abundant, diverse, and scientifically important fossil finds, including but not limited to numerous vertebrate remains. Despite the richness of the fossil resources documented in the area around the Central Valley Wye alternatives, no unique paleontological resources or sites have been identified within the paleontological resources RSA for the SR 152 (North) to Road 13 Wye Alternative or the SR 152 (North) to Road 11 Wye Alternative. Therefore, destruction of unique resources is not anticipated under either of these alternatives.

The Dos Palos Alluvium and other, unnamed, Holocene alluvial units as well as the North Merced Gravel, present at depth in the surface, are identified as having low paleontological sensitivity. Ground disturbance involving these units is not expected to result in the destruction of scientifically important (significant) fossil resources. Because these units have not been documented as containing significant paleontological resources, an increased extent of disturbance involving these units is not expected to produce a substantive increase in the potential to destroy scientifically important fossil resources.

Where geologic units with high paleontological sensitivity are present, construction-related ground disturbance has the potential to destroy other significant (scientifically important but non-unique) paleontological resources. Impacts are possible in two situations, as follows.

---

[16] *Significant paleontological resources* are fossil resources that provide various types of scientific information. They may include body fossils as well as traces, tracks, and trackways. Vertebrate fossils of all types and sizes are considered significant because of their rarity and their informational potential. Invertebrate fossils, plant fossils, and microfossils may also be scientifically important and therefore significant. *Paleontological potential* or *paleontological sensitivity* describes a geologic unit's potential to produce finds of significant paleontological resources; see Table 3.9-5 for additional information.

- Where strata with high paleontological sensitivity are exposed at the ground surface in areas subject to ground-disturbing activities.
- Where highly sensitive units are not surface-exposed, but ground disturbance would extend deep enough to involve underlying highly sensitive materials

The SR 152 (North) to Road 13 Wye Alternative is expected to result in 2,725 acres of surface ground disturbance in areas situated on units with high paleontological sensitivity. The SR 152 (North) to Road 11 Wye Alternative is expected to result in 2,563 acres of surface ground disturbance in areas situated on units with high paleontological sensitivity. For both alternatives, additional disturbance in the subsurface is anticipated but cannot be quantified at this preliminary stage of design.

The Modesto Formation, Riverbank Formation, Turlock Lake Formation, and San Luis Ranch Alluvium are identified as having high paleontological sensitivity, as are the Laguna and Mehrten Formations in the deeper subsurface (see Table 3.9-5 and Figure 3.9-1). Exposures identified as undifferentiated Holocene and Modesto Formation alluvial and colluvial deposits by Marchand (1976) are also considered highly sensitive. Ground disturbance involving any of these units has the potential to destroy significant (scientifically important) fossil resources. The potential for impacts would increase with increasing extent and depth of disturbance, but even activity that is limited in areal extent and/or depth could destroy scientifically important fossil resources. As a result, all construction activities involving ground disturbance in these paleontologically sensitive units are considered to have the potential for impacts. However, the Central Valley Wye alternatives would incorporate IAMFs (GEO-IAMF#7 through GEO-IAMF#11) to avoid destruction of scientifically important fossil resources in areas of high paleontological sensitivity, as summarized in the following paragraphs.

- As discussed in Section 3.9.4.2, the Central Valley Wye alternatives would be designed and constructed in segments, with separate construction documents (plans and specifications) developed for each segment. As design for each CP is approaching the final stages such that the location, extent, and depth of ground disturbance are well constrained, the contractor would be required through the inclusion of GEO-IAMF#7 and GEO-IAMF#8 to retain a qualified paleontological resources specialist (PRS) to review the design, identify the specific locations where paleontologically sensitive units would be involve. GEO-IAMF#9 requires the PRS to develop a thorough and detailed PRMMP) for the CP.
- PRMMPs would be required to meet the content and detail standards established in the SVP Standard Procedures (SVP Impact Mitigation Guidelines Revision Committee 2010) and Conditions of Receivership (SVP Conformable Impact Mitigation Guidelines Committee 1996), and would be consistent with relevant guidance from Chapter 8 (Paleontology) of the current Caltrans Standard Environmental Reference (Caltrans 2014a). As such, the PRMMP for each CP would provide for at least the following actions:
  - Implementation by qualified staff, including a supervising paleontologist who meets or exceeds the principal paleontologist qualifications laid out in Chapter 8 of the current Caltrans Standard Environmental Reference, and paleontological monitor(s) meeting or exceeding Caltrans Paleontological Monitor qualifications.
  - Preconstruction survey in areas where the CP would result in surface disturbance of geologic units identified as highly sensitive for paleontological resources. Significant finds, if any, would be salvaged or protected in place, based on the judgment of the supervising paleontologist.
  - Paleontological monitoring for all ground-disturbing activities known to involve, or potentially involving, paleontologically sensitive units, and for activities involving other geologic units where the PRS considers it warranted. If the PRS considers it warranted, monitoring or examination of recovered materials may also be conducted for drilling operations. Monitoring activities and results would be documented via “construction dailies” or a similar reporting method.

   - Paleontological resources worker environmental awareness program (WEAP) training for all management, supervisory, and construction staff involved with ground-disturbing activities. WEAP training would include information on coordination between construction staff and paleontological staff, construction and paleontological staff roles and responsibilities in implementing the PRMMP, the possibility of encountering fossils during construction, the types of fossils that may be seen and how to recognize them, and proper procedures in the event fossils are encountered.
   - Provisions for a "stop work, evaluate, and treat appropriately" response in the event of a known or potential paleontological discovery. Treatment of finds would be directed by the supervising paleontologist.
   - Sampling and recovery procedures for both macro- and microfossils, consistent with SVP Standard Procedures (SVP Impact Mitigation Guidelines Revision Committee 2010) and the SVP Conditions of Receivership (SVP Conformable Impact Mitigation Guidelines Committee 1996).
   - A repository agreement providing for appropriate curation of recovered materials, consistent with the SVP Conditions of Receivership (SVP Conformable Impact Mitigation Guidelines Committee 1996).
   - Procedures for the preparation, identification, and analysis of fossil specimens and data recovered, consistent with the SVP Conditions of Receivership (SVP Conformable Impact Mitigation Guidelines Committee 1996) and any specific requirements of the designated repository institution(s).
   - Final report preparation procedures consistent with Caltrans Standard Environmental Reference Chapter 8 requirements for the Paleontological Monitoring Report and Paleontological Stewardship Summary (Caltrans 2014a).

  Each PRMMP would also lay out preconstruction and construction-period coordination procedures and communications protocols between paleontological and construction staff.

- Although ground disturbance in paleontologically sensitive geologic units potentially could destroy significant paleontological resources, measures incorporated during construction assist in avoiding destruction. Specifically, GEO-IAMF#11 provides measures to recover significant fossil finds and avoid the loss of scientific information, consistent with the prevailing discipline standard for paleontological resources as reflected in guidance from the SVP (SVP Impact Mitigation Guidelines Revision Committee 2010, SVP Conformable Impact Mitigation Guidelines Committee 1996) and Caltrans (2014a). Consequently, construction of either the SR 152 (North) to Road 13 Wye Alternative or the SR 152 (North) to Road 11 Wye Alternative would not result in substantial loss of scientific data, and could benefit scientific research by providing for recovery, curation, and study of fossil materials that would otherwise remain buried.

Specific to Site 6—El Nido, El Nido Substation and the Site 7—Wilson, Wilson Substation and 230 kV Tie-Line, destruction of unique paleontological resources is not anticipated in areas of potential excavation as these footprints have been previously disturbed, either by activities associated with previous construction of the existing electrical infrastructure or by ongoing agricultural operations.

CEQA Conclusion

The impact under CEQA would be less than significant because no unique paleontological resources have been identified within the area potentially affected by construction of the SR 152 (North) to Road 13 Wye Alternative or the SR 152 (North) to Road 11 Wye Alternative and therefore no destruction of unique paleontological resources is anticipated. Additionally, GEO-IAMF#11 provides for the recovery of significant fossil finds to avoid the loss of scientific information. Therefore, CEQA does not require any mitigation.

SR 152 (North) to Road 19 Wye Alternative

The SR 152 (North) to Road 19 Wye Alternative is geologically and paleontologically very similar to the SR 152 (North) to Road 13 Wye Alternative and the SR 152 (North) to Road 11 Wye Alternative. No unique paleontological resources have been identified in association with the SR 152 (North) to Road 19 Wye Alternative, but all of the same paleontologically sensitive geologic units discussed for the other two alternatives are also expected to be involved in construction of with the SR 152 (North) to Road 19 Wye Alternative.

The Laguna and Mehrten Formations are present at greater depth in the subsurface within the RSA of the Site 7—Le Grand Junction/Sandy Mush Road, Warnerville–Wilson 230 kV Transmission Line; however, the potential for destruction of unique paleontological resources is low because the footprint has been previously disturbed by activities associated with construction of the existing electrical infrastructure and by ongoing agricultural operations.

In other locations, ground disturbance involving any of the paleontologically sensitive units—Modesto Formation, Riverbank Formation, Turlock Lake Formation, San Luis Ranch Alluvium, undifferentiated Holocene and Modesto Formation alluvial and colluvial deposits of Marchand (1976), Mehrten Formation, and Laguna Formation—would have the potential to destroy fossil resources. The SR 152 (North) to Road 19 Wye Alternative is expected to result in 3,110 acres of surface ground disturbance in areas situated on paleontologically sensitive geologic units; additional subsurface disturbance is anticipated but cannot be quantified at this preliminary design stage. However, like the other alternatives, the SR 152 (North) to Road 19 Wye Alternative would incorporate the same extensive IAMFs for paleontological resources protection, recovery, and curation.

CEQA Conclusion

The impact under CEQA would be less than significant because no unique paleontological resources have been identified within the area potentially affected by construction of the SR 152 (North) to Road 19 Wye Alternative and therefore no destruction of unique paleontological resources is anticipated. Additionally, GEO-IAMF#11 provides for the recovery of significant fossil finds to avoid the loss of scientific information. Therefore, CEQA does not require any mitigation.

Avenue 21 to Road 13 Wye Alternative

The Avenue 21 to Road 13 Wye Alternative is geologically and paleontologically similar to the SR 152 (North) to Road 13 Wye Alternative, the SR 152 (North) to Road 19 Wye Alternative, and the SR 152 (North) to Road 11 Wye Alternative. All of the same geologic units discussed for those alternatives would also be involved in the Avenue 21 to Road 13 Wye Alternative. The Avenue 21 to Road 13 Wye Alternative is expected to result in 2,328 acres of surface ground disturbance in areas situated on paleontologically sensitive geologic units; additional subsurface disturbance is anticipated but cannot be quantified at this preliminary design stage.

Unlike the other three Central Valley Wye alternatives, the Avenue 21 to Road 13 Wye Alternative would pass close to the well-known Fairmead Landfill site, where strata assigned to the Riverbank and Turlock Lake Formations have yielded a particularly rich and diverse vertebrate fauna. However, because of the “sensitive anywhere, sensitive everywhere” approach that governs paleontological resources sensitivity evaluation, as discussed in the Paleontological Resources Technical Report (Authority and FRA 2016b), the Riverbank and Turlock Lake Formations are considered highly sensitive wherever they occur, in part because of the Fairmead Landfill finds. That is, the finds at Fairmead Landfill elevate the level of caution with which these units should be treated throughout their extent, rather than the landfill site representing a uniquely sensitive locality. Additionally, although there are differences in routing and in the locations and footprints of some ancillary facilities, the overall construction process for the Avenue 21 to Road 13 Wye Alternative would be similar to that under the other three alternatives. As a result, construction of the Avenue 21 to Road 13 Wye Alternative would have a similar potential to destroy significant paleontological resources. However, like the other three Central Valley Wye alternatives, Avenue 21 to Road 13 Wye Alternative would incorporate the same extensive IAMFs for paleontological resources protection, recovery, and curation thereby avoiding destruction of unique fossil resources.

CEQA Conclusion

The impact under CEQA would be less than significant because no unique paleontological resources have been identified within the area potentially affected by construction of the Avenue 21 to Road 13 Wye Alternative and therefore no destruction of unique paleontological resources is anticipated. Additionally, GEO-IAMF#11 provides for the recovery of significant fossil finds to avoid the loss of scientific information. Therefore, CEQA does not require any mitigation.

Operations Impacts

Impact PAL#2: Common Impacts on Paleontological Resources due to Operations

For all of the Central Valley Wye alternatives and associated electrical infrastructure, routine operations and maintenance are not expected to disturb previously undisturbed substrate materials. Resources within the project footprints would be identified, evaluated, and appropriately treated through implementation of the construction-period IAMFs incorporated in all of the Central Valley Wye alternatives, and no ground disturbance outside the area disturbed for construction is anticipated for operations and maintenance. The potential to encounter additional significant resources during operations is therefore considered extremely low, and no destruction of significant paleontological resources is anticipated because of operating and maintaining any of the Central Valley Wye alternatives.

CEQA Conclusion

There would be no impact under CEQA**.** No unique paleontological resources have been identified near the Central Valley Wye alternatives, and with no disturbance of previously undisturbed substrate materials, no destruction of other significant paleontological resources is anticipated as a result of operating and maintaining the Central Valley Wye alternatives.

CEQA does not require the identification of any additional mitigation.

3.9.7 Mitigation Measures

All construction and operations impacts would be minimized or avoided. No mitigation measures are required.

3.9.8 Impacts Summary for NEPA Comparison of Alternatives

This section summarizes the impacts of the Central Valley Wye alternatives and compares them to the anticipated impacts of the No Project Alternative. Table 3.9-17 provides a comparison of the potential impacts of the Central Valley Wye alternatives related to geology, soils, and seismicity and on paleontological resources, summarizing the more detailed information provided in Section 3.9.6, Environmental Consequences.

Under the No Project Alternative, development pressures resulting from an increasing population in Merced and Madera Counties would continue to lead to associated impacts related to geology, soils, seismicity, and paleontological resources. The No Project Alternative is anticipated to result in a continuation of recent development trends that have led to conditions affecting geology, soils, and seismicity, such as soil subsidence and risk of erosion; and primary and secondary seismic hazards such as ground shaking hazard and increased liquefaction hazard near waterbodies. The No Project Alternative could result in damage to significant paleontological resources and the loss of associated scientific information. However, future projects under the No Project Alternative would require separate environmental review; potential impacts on paleontological resources would be analyzed and addressed on a program or project basis through future environmental reviews as individual undertakings are processed by other lead agencies.

The Merced to Fresno Final EIR/EIS concluded that development of the HSR system would result in potential impacts related to geology, soils, seismic risk, and paleontological resources but also concluded that the design would minimize impacts during construction related to soil resources, soil and slope stability, difficult excavation, mineral resources, seismic risk, and paleontological resources.

Table 3.9-17 Comparison of Central Valley Wye Alternative Impacts

Resource Category	Central Valley Wye Alternatives			
	SR 152 (North) to Road 13 Wye	SR 152 (North) to Road 19 Wye	Avenue 21 to Road 13 Wye	SR 152 (North) to Road 11 Wye
Construction				
Soils				
Impact GEO#1: Soil Erosion				
Impacts on soils subject to erosion	896 acres	1,115 acres	773 acres	976 acres
Groundwater dewatering	The need for dewatering for bridge column and below-grade underpass construction is the same for all alternatives. However, no anticipated erosion impacts related to dewatering are anticipated.			
Impact GEO#2: Moderate to High Shrink-Swell Potential				
Impacts on soils with moderate to high shrink-swell potential	735 acres	938 acres	1,013 acres	580 acres
Impact GEO#3: Moderately to Highly Corrosive Soils				
Impacts on soils with high corrosivity to steel	2,176 acres	2,173 acres	2,005 acres	2,016 acres
Impacts on soils with high corrosivity to concrete	1,524 acres	1,268 acres	1,394 acres	1,384 acres
Impact GEO#4: Unstable Soils Resulting in On-Site or Off-Site Slumps and Small Slope Failures	31 natural waterbody crossings	32 natural waterbody crossings	39 natural waterbody crossings	30 natural waterbody crossings
Impact GEO#5: Soil Settlement at Structures or Along Trackway				
Settlement due to compressible soils	31 natural waterbody crossings	32 natural waterbody crossings	39 natural waterbody crossings	30 natural waterbody crossings
Regional subsidence	Ambient regional subsidence is the same for all alternatives; no impacts related to subsidence are anticipated.			
Localized subsidence/groundwater dewatering	No anticipated subsidence related to dewatering	Impacts related to tunnel construction	No anticipated subsidence related to dewatering	No anticipated subsidence related to dewatering
Impact GEO#6: Slope Failure	31 natural waterbody crossings	32 natural waterbody crossings	39 natural waterbody crossings	30 natural waterbody crossings
Impact GEO#7: Seismic-Induced Ground Shaking and Secondary Seismic Hazards				
Surface fault rupture	No surface fault rupture risk			

Resource Category	Central Valley Wye Alternatives			
	SR 152 (North) to Road 13 Wye	SR 152 (North) to Road 19 Wye	Avenue 21 to Road 13 Wye	SR 152 (North) to Road 11 Wye
Ground shaking	3 miles aerial track 0.5 mile tunnel	3.5 miles aerial track 3 miles tunnel	4 miles aerial track 0.5 mile tunnel	4.5 miles aerial track 0 mile tunnel
Liquefaction and seismically induced slope failure	31 natural waterbody crossings	32 natural waterbody crossings	39 natural waterbody crossings	30 natural waterbody crossings
Dam failure	Although inundation is unlikely, all four alternatives have the same slight risk of inundation in the southeast			
Areas of Difficult Excavation				
Impact GEO#8: Difficult Excavations due to Hardpan and Shallow Groundwater[1]	819 acres	1,106 acres Impacts related to tunnel	753 acres	835 acres
Mineral and Energy Resources				
Impact GEO#9: Loss of Availability of Mineral or Energy Resources and Increase in Safety Risk due to Disruption of Subsurface Oil and Gas Resources	44 wells (1 active)	45 wells (1 active)	34 wells (1 active)	44 wells (1 active)
Operation				
Impact GEO#10: Seismic-Induced Ground Shaking and Secondary Seismic Hazards				
Surface fault rupture	No surface fault rupture risk			
Ground shaking	3 miles aerial track 0.5 mile tunnel	3.5 miles aerial track 3 miles tunnel	4 miles aerial track 0.5 mile tunnel	4.5 miles aerial track 0 miles tunnel
Liquefaction and seismically induced slope failure	31 natural waterbody crossings	32 natural waterbody crossings	39 natural waterbody crossings	30 natural waterbody crossings
Dam failure	Although inundation is unlikely, all four alternatives have the same slight risk of inundation in the southeast			
Construction				
Paleontological Resources				
Impact PAL#1: Common Impacts on Paleontological Resources due to Construction	No destruction of unique paleontological resources is anticipated under any of the four alternatives.			

Resource Category	Central Valley Wye Alternatives			
	SR 152 (North) to Road 13 Wye	SR 152 (North) to Road 19 Wye	Avenue 21 to Road 13 Wye	SR 152 (North) to Road 11 Wye
Operation				
Paleontological Resources				
Impact PAL#2: Common Impacts on Paleontological Resources due to Operations	No impact			

Source: NRCS, 2016; DOC, 2015
[1]The impacts are comparable in context and intensity.
HSR = high-speed rail

Implementing the Central Valley Wye alternatives would result in the same impacts as described in the Merced to Fresno Final EIR/EIS related to geology, soils, seismic risk, and paleontological resources from construction and operations activities. The Central Valley Wye alternatives would incorporate IAMFs that would reduce impacts related to geology, soils, and seismic risk. These IAMFs would include features for groundwater withdrawal, managing unstable soils, subsidence monitoring, erosion control, treatment of soils with shrink-swell potential, slope monitoring, impact minimization associated with seismic ground shaking, suspension of operations during earthquake, and adherence to specified professional standards. The Central Valley Wye alternatives would also incorporate IAMFs to avoid destruction of paleontological resources and avoid the loss of information associated with the destruction of significant paleontological resources. These IAMFs would provide for paleontological monitoring by qualified staff, WEAP training for construction staff involved in ground-disturbing activities, a “stop work, evaluate, and treat” procedure in the event of fossil finds, and recovery and curation of significant finds, consistent with prevailing discipline standards (SVP 1996, 2010; Caltrans 2014a). Overall, the four Central Valley Wye alternatives are not anticipated to result in impacts related to geology, soils, seismic risk, or destruction of significant paleontological resources such that mitigation would be required.

The Central Valley Wye alternatives could result in impacts related to geologic resources, soils, and seismicity, but the potential is low, and the Central Valley Wye alternatives would not result in any new impacts beyond those disclosed in the Merced to Fresno Final EIR/EIS. The potential for impacts related to geologic resources, soil and seismicity is low because the Central Valley Wye alternatives would implement guidance set by professional standards in the design, construction, and operations phases to reduce risk of impacts related to geologic resources, soils, and seismicity.

3.9.8.1 Geology, Soils, and Seismicity

Construction of any of the Central Valley Wye alternatives could cause erosion because associated excavation and grading activities would result in removal of vegetative cover that could expose unprotected soils to erosive forces of wind and water. The SR 152 (North) to Road 19 Wye Alternative would affect the largest area of soils in the project footprint with high susceptibility to water erosion than the other alternatives (1,115 acres), followed in order by area of ground disturbance by SR 152 (North) to Road 11 Wye Alternative (976 acres), SR 152 (North) to Road 13 Wye Alternative (896 acres), and Avenue 21 to Road 13 Wye Alternative (773 acres). However, IAMFs would minimize construction impacts related to erosion through adoption of BMPs. Erosion could also result from groundwater dewatering because dewatering changes flows, resulting in new flow directions or velocities, which can disturb stream bottoms. Because the SR 152 (North) to Road 19 Wye Alternative would involve a tunnel at depths that could encounter groundwater, this alternative could require dewatering with its associated risk of erosion. In contrast, the other alternatives would involve shallower drilling and would have no risk of erosion associated with dewatering. These relative risks are reflected in Table 3.9-17. However, IAMFs would minimize erosion impacts related to dewatering through implementation of BMPs, implementation of a dewatering plan, and compliance with the SWRCB Construction General Permit.

Construction of any of the alternatives on expansive soils could increase risk of injury and loss of life to construction personnel and passengers and damage to HSR property. Expansive soils respond to changes in soil moisture content by expanding when wet and contracting when dry. Through this change in volume, expansive soils exert uplift or lateral pressures on foundations or walls in contact with them when they expand and contract, thus providing unstable support for foundations and other structures. The Avenue 21 to Road 13 Wye Alternative would affect the most acres of expansive soils in the project footprint (1,013 acres), followed in order by area of ground disturbance by the SR 152 (North) to Road 19 Wye Alternative (938 acres), SR 152 (North) to Road 13 Wye Alternative (735 acres), and SR 152 (North) to Road 11 Wye Alternative (580 acres). These relative risks are reflected in Table 3.9-17. However, standard construction practices addressed in IAMFs would minimize the impact of expansive soils on risk to personal injury and damage to HSR property.

Construction of any of the alternatives on corrosive soils could increase risk of injury and loss of life to construction personnel and passengers and damage to HSR property. Corrosive soils have electrochemical or chemical properties that can corrode or weaken concrete or uncoated steel, which are principal components of the HSR track system. The SR 152 (North) to Road 13 Wye Alternative, would affect the most acres of soil that is moderately to highly corrosive to steel in the project footprint (2,176 acres), followed in order by area of ground disturbance by SR 152 (North) to Road 19 Wye Alternative (2,173 acres), SR 152 (North) to Road 11 Wye Alternative (2,016 acres), and Avenue 21 to Road 13 Wye Alternative (2,005 acres). In addition, the SR 152 (North) to Road 13 Wye Alternative would affect the most acres of soil that is moderately to highly corrosive to concrete in the project footprint (1,524 acres), followed in order by area of ground disturbance by the Avenue 21 to Road 13 Wye Alternative (1,394 acres), SR 152 (North) to Road 11 Wye Alternative (1,384 acres), and SR 152 (North) to Road 19 Wye Alternative (1,268 acres). These relative risks are reflected in Table 3.9-17. However, IAMFs would minimize impacts related to corrosive soils by requiring Authority contractors to account for soil properties during Central Valley Wye alternatives design and construction.

Soft and unstable soils and soil subsidence in the resource hazards RSA could result in multiple impacts: on-site or off-site slumps and slope failure, including seismically induced slope failure, and soil settlement. Loose or soft deposits of sands, silts, and clays that are not adequate to support planned structure loads occur in the resource hazards RSA on a localized basis, generally at natural waterbody crossings. When unstable soils are loaded, they can fail through bearing failures (collapse) or slope instabilities, presenting a risk of injury and loss of life to construction personnel and passengers and damage to HSR property. Unstable soils occur in the resource hazards RSA primarily near natural waterbody crossings, so the risk would be greatest at locations where the Central Valley Wye alternatives would cross natural waterbodies. The Avenue 21 to Road 13 Wye Alternative would have the most waterbody crossings (39 natural waterbody crossings), followed in order by the SR 152 (North) to Road 19 Wye Alternative (32 natural waterbody crossings), the SR 152 (North) to Road 13 Wye Alternative (31 natural waterbody crossings), and the SR 152 (North) to Road 11 Wye Alternative (30 natural waterbody crossings). These relative risks are reflected in Table 3.9-17. However, IAMFs would minimize impacts related to unstable soils by use of alternative foundation designs and requiring Authority contractors to account for soil properties during Central Valley Wye alternatives design and construction in a CMP. Where a potential for long-term instability exists from gravity or seismic loading, the Authority would incorporate slope monitoring by a registered engineering geologist into the operations and maintenance procedures at sites identified in the CMP. To minimize risk of seismically induced slope failure, the Authority would require that the most recently updated Caltrans seismic design criteria be used in the design of any HSR structures supported in or on the ground.

Soil settlement can result from construction on silty or clay soils if imposed loads cause compression of the underlying materials over a period. Soils along all four alternatives in the resource hazards RSA are generally competent (medium-dense, stiff, or better), although localized deposits of soft or loose soils could occur at various locations, particularly at natural waterbody crossings where soft or loose soils are more prevalent, resulting in increased risk of settlement. The risk would be greatest for the Avenue 21 to Road 13 Wye Alternative, which would have the most waterbody natural crossings (39 crossings), followed in order by the SR 152 (North) to Road 19 Wye Alternative (31 natural waterbody crossings), SR 152 (North) to Road 13 Wye Alternative (31 natural waterbody crossings), and the SR 152 (North) to Road 13 Wye Alternative (30 natural waterbody crossings). These relative risks are reflected in Table 3.9-17.

Regional subsidence is a gradual or sudden sinking of the earth's surface because of underground material movement, most frequently as a result of extraction of underground resources such as water, natural gas, or mineral resources. Subsidence can result in differential settlement, such that foundations are subject to stresses that can result in shifting, tilting, and compromises in structural integrity. The risks associated with regional subsidence would be the same for all Central Valley Wye alternatives. These risks are reflected in Table 3.9-17.

Settlement because of groundwater dewatering is the same process as regional dewatering, but on a smaller geographic scale. Localized ground subsidence from construction-related dewatering could have direct and short-term effects during construction of the Central Valley Wye alternatives. The risks associated with groundwater dewatering differ among the alternatives. They are greatest for the SR 152 (North) to Road 19 Wye Alternative because groundwater dewatering would be required for the tunnel section of the alternative; the other three alternatives would involve shallower dewatering and would therefore involve less risk of subsidence. These relative risks are reflected in Table 3.9-17. However, IAMFs would minimize risks associated with subsidence, including subsidence related to groundwater dewatering. For any required dewatering, a dewatering plan would be required, and if needed, the contractor would re-inject water based on site-specific conditions. For any subsidence, a CMP would address how geologic constraints would be avoided or minimized during construction, including monitoring for subsidence, and requiring Authority contractors to account for soil properties during Central Valley Wye alternatives design and construction.

Seismic ground shaking and secondary seismic effects such as liquefaction and dam failure could affect the Central Valley Wye alternatives. Seismic ground shaking can cause structures being erected to topple, and slopes graded for below-ground construction to fail. Liquefaction can result in loss of foundation support and settlement of overlying structures, ground subsidence, and lateral ground surface movement because of lateral spreading and differential settlement of affected deposits. Dam failure could result in inundation of the downstream flat-lying areas of the Central Valley Wye alternatives. The resulting inundation could affect electrical systems, undermine foundations, and increase risk of injury and loss of life to construction personnel and passengers and of damage to HSR property. Impacts for ground shaking would be the same for all alternatives. Soils subject to liquefaction and seismically induced slope failure occur in the resource hazards RSA primarily near natural waterbody crossings, so the risk would be greatest at locations where the Central Valley Wye alternatives would cross waterbodies. The Avenue 21 to Road 13 Wye Alternative would have the most natural waterbody crossings (39 crossings), followed in order by the SR 152 (North) to Road 19 Wye Alternative (31 natural waterbody crossings), SR 152 (North) to Road 13 Wye Alternative (31 natural waterbody crossings), and the SR 152 (North) to Road 13 Wye Alternative (30 natural waterbody crossings). These relative risks are reflected in Table 3.9-17. Impacts of dam failure would be the same for all alternatives, as reflected in Table 3.9-17. However, IAMFs would minimize any potential impact. Consistent with standard industry practice, further detailed subsurface geotechnical investigations and geotechnical design evaluations would be conducted during the later stages of engineering design to confirm any site-specific risks and to minimize these risks in the final design of structures. These studies would be conducted during final design following the environmental review process. For construction impacts, the Authority would require contractors to use the most recently updated Caltrans seismic design criteria in the design of any HSR structures supported in or on the ground and would require Authority contractors to account for geotechnical properties during design and construction of the Central Valley Wye alternatives, and thus address risk factors associated with seismically induced ground shaking. Further, because of the relatively short construction duration, with respect to geologic time, a large earthquake during the construction period is considered unlikely, and actual risks from ground shaking and secondary effects during construction are considered low. For operations impacts, the Authority would install and Early Earthquake Detection System to stop HSR trains temporarily during or after a potentially damaging earthquake to reduce risks.

Construction of any of the alternatives on hardpan or in areas of shallow groundwater could increase risk of injury and loss of life to construction personnel and damage to HSR property. The primary risk associated with construction in hardpan is that excavation or drilling could lead to sudden rupture of a cemented soil layer that covers a void under the hardpan, with the associated risk of collapse into the void. The primary risks related to construction in areas of shallow groundwater are localized ground subsidence and possible flooding if a dewatering system fails.

Impacts would be greatest for SR 152 (North) to Road 19 Wye Alternative (1,106 acres) because of the tunnel, followed in order by the SR 152 (North) to Road 11 Wye Alternative (835 acres), SR 152 (North) to Road 13 Wye Alternative (819 acres), and Avenue 21 to Road 13 Wye Alternative (753 acres). These relative risks are reflected in Table 3.9-17. However, excavations in these types of soils are relatively familiar in this region, and contractors are familiar with methods to handle excavations in hardpan. Further, IAMFs would require contractors to account for geotechnical properties during design and construction. In doing so, the Authority would avoid risk factors associated with difficult excavation conditions.

Construction of any of the alternatives could cause loss of availability of mineral and energy resources and increase in risk of injury to and loss of life of construction personnel and passengers and damage to HSR property. The loss of availability could occur because construction in such an area requires that oil and gas wells be capped and taken out of service and that appurtenant facilities such as pipelines be taken out of service for practical reasons—to make room for the construction—as well as for safety reasons. The increase in risk of injury and loss of life to construction personnel and passengers could occur because of the increased proximity of the HSR to volatile materials. The resource hazards RSA for the SR 152 (North) to Road 19 Wye Alternative has the most wells (45), followed by the SR 152 (North) to Road 13 Wye Alternative and SR 152 (North) to Road 11 Wye Alternative (44 wells each), and the Avenue 21 to Road 13 Wye Alternative (34 wells). These relative risks are reflected in Table 3.9-17. However, IAMFs would require relocation of any active wells and ancillary pipelines and underground conveyance, and would require Authority contractors to account for geotechnical properties during Central Valley Wye alternatives design and construction, thus allowing for safe relocation of well entrances to oil and gas resources in order to minimize loss of productivity.

3.9.8.2 Paleontological Resources

Ground disturbance during construction of all of the Central Valley Wye alternatives would involve geologic units that have produced abundant and diverse fossil resources, including vertebrate remains, and are thus considered highly sensitive for paleontological resources (i.e., likely to produce additional significant finds in the future). Work in these units—which include the Modesto, Riverbank, Turlock Lake, Laguna, and Mehrten Formations and areas mapped as underlain by undifferentiated Modesto Formation and Holocene deposits—would thus have the potential to result in destruction of significant (scientifically important) fossil resources. Because similarly sensitive geologic units would be affected by all four Central Valley Wye alternatives, the potential for impacts on paleontological resources is generally similar for all Central Valley Wye alternatives. The potential for destruction of significant resources would increase with increasing extent of disturbance in highly sensitive geologic units, however. The three-dimensional extent of disturbance cannot be calculated in detail at this preliminary planning stage, since information on the depth of disturbance by alternative is not yet available. To enable a preliminary comparison among the alternatives, Table 3.9-18 shows acreages of surface disturbance within geologic units identified as highly sensitive for paleontological resources.

Table 3.9-18 Comparison of Surface Disturbance within Paleontologically Sensitive Geologic Units

Surface Disturbance in Geologic Units with High Paleontological Sensitivity (Acres)[1]			
SR 152 (North) to Road 13 Wye	SR 152 (North) to Road 19 Wye	Avenue 21 to Road 13 Wye	SR 152 (North) to Road 11 Wye
2,784	3,584	2,387	2,622

Source: Authority and FRA 2016b; Jennings et al. 1958; Wagner et al. 1991
[1] Does not include EINU footprints as destruction of unique paleontological resources is not anticipated as areas of potential excavation have been previously disturbed, either by activities associated with construction of the existing electrical infrastructure or by ongoing agricultural operations.

Based on the acreages shown in Table 3.9-18, the SR 152 (North) to Road 19 Wye Alternative would have the greatest potential to result in the destruction of significant paleontological resources, followed in order by the SR 152 (North) to Road 13 Wye Alternative, the SR 152 (North) to Road 11 Wye Alternative, and the Avenue 21 to Road 13 Wye Alternative. To address the potential for loss of information, all of the Central Valley Wye alternatives incorporate the same robust construction-period IAMF package for paleontological resources:

- GEO-IAMF#7, Engage a Qualified Paleontological Resources Specialist
- GEO-IAMF#8, Perform Final Design Review and Triggers Evaluation
- GEO-IAMF#9, Prepare and Implement Paleontological Resources Monitoring and Mitigation Plan (PRMMP)
- GEO-IAMF#10, Provide Worker Environmental Awareness Program (WEAP) Training for Paleontological Resources
- GEO-IAMF#11, Halt Construction, Evaluate, and Treat if Paleontological Resources Are Found

The paleontological resources IAMFs have been developed for consistency with the prevailing discipline standard as reflected in the SVP Standard Procedures (SVP Impact Mitigation Guidelines Revision Committee 2010), the SVP Conditions of Receivership (SVP Conformable Impact Mitigation Guidelines Committee 1996) and the Caltrans SER, Chapter 8, Paleontological Resources (Caltrans 2014). With the paleontological resources IAMFs in place, all of the Central Valley Wye alternatives would be equally equipped to avoid the loss of scientific information that is the principal concern related to the destruction of significant paleontological resources.

An additional difference between the Central Valley Wye alternatives is that, unlike the other alternatives, the Avenue 21 to Road 13 Wye Alternative would pass close to the well-known Fairmead Landfill site, where a rich and diverse vertebrate fauna has been recovered from strata of the Riverbank and Turlock Lake Formations. However, because of the “sensitive anywhere, sensitive everywhere” rule, the finds at Fairmead Landfill increase the sensitivity of these units throughout their extent, rather than the landfill site representing a uniquely sensitive locality. All of the Central Valley Wye alternatives would involve the Riverbank and Turlock Lake Formations. The proximity of the Avenue 21 to Road 13 Alternative to Fairmead Landfill is not considered to increase the paleontological risks associated with this alternative, and all of the Central Valley Wye alternatives would incorporate the same IAMFs to avoid the destruction of unique paleontological resources during construction.

In view of these considerations, the potential for the destruction of significant paleontological resources, and associated loss of scientific information, does not provide a meaningful discriminator among the alternatives.

3.9.9 CEQA Significance Conclusions

Table 3.9-19 provides a summary of the CEQA determination of significance for all construction and operations impacts discussed in Section 3.9.6.2, and Section 3.9.6.3. The CEQA level of significance before and after mitigation for each impact in this table is the same for all Central Valley Wye alternatives.

Table 3.9-19 CEQA Significance Conclusions for Geology, Soils, Seismicity, and Paleontological Resources for the Central Valley Wye Alternatives

Impact	CEQA Level of Significance before Mitigation	Mitigation Measures	CEQA Level of Significance after Mitigation
Geological Resources			
Construction Impacts			
Soils Hazards			
Impact GEO#1: Soil Erosion	Less than significant for all alternatives	No mitigation measures are required	Not applicable
Impact GEO#2: Moderate to High Shrink-Swell Potential	Less than significant for all alternatives	No mitigation measures are required	Not applicable
Impact GEO#3: Moderately to Highly Corrosive Soils	Less than significant for all alternatives	No mitigation measures are required	Not applicable
Geologic Hazards			
Impact GEO#4: Unstable Soils Resulting in On-Site or Off-Site Slumps and Small Slope Failures	Less than significant for all alternatives	No mitigation measures are required	Not applicable
Impact GEO#5: Soil Settlement at Structures or along Trackway	Less than significant for all alternatives	No mitigation measures are required	Not applicable
Impact GEO#6: Slope Failure	Less than significant for all alternatives	No mitigation measures are required	Not applicable
Primary and Secondary Seismic Hazards			
Impact GEO#7: Seismic-Induced Ground Shaking and Secondary Seismic Hazards	Less than significant for all alternatives	No mitigation measures are required	Not applicable
Areas of Difficult Excavation			
Impact GEO#8: Difficult Excavations due to Hardpan and Shallow Groundwater	Less than significant for all alternatives	No mitigation measures are required	Not applicable

Impact	CEQA Level of Significance before Mitigation	Mitigation Measures	CEQA Level of Significance after Mitigation
Resource Hazards			
Impact GEO#9: Loss of Availability of Mineral or Energy Resources and Increase in Safety Risk due to Disruption of Subsurface Oil and Gas Resources	Less than significant for all alternatives	No mitigation measures are required	Not applicable
Operations Impacts			
Primary and Secondary Seismic Hazards			
Impact GEO#10: Seismic-Induced Ground Shaking and Secondary Seismic Hazards	Less than significant for all alternatives	No mitigation measures are required	Not applicable
Paleontological Resources			
Construction Impacts			
Impact PAL#1: Common Impacts on Paleontological Resources due to Construction	Less than significant for all alternatives	No mitigation measures are required	Not applicable
Operations Impacts			
Impact PAL#2: Common Impacts on Paleontological Resources due to Operations	No impact for all alternatives	No mitigation measures are required	Not applicable

Source: Authority and FRA, 2018