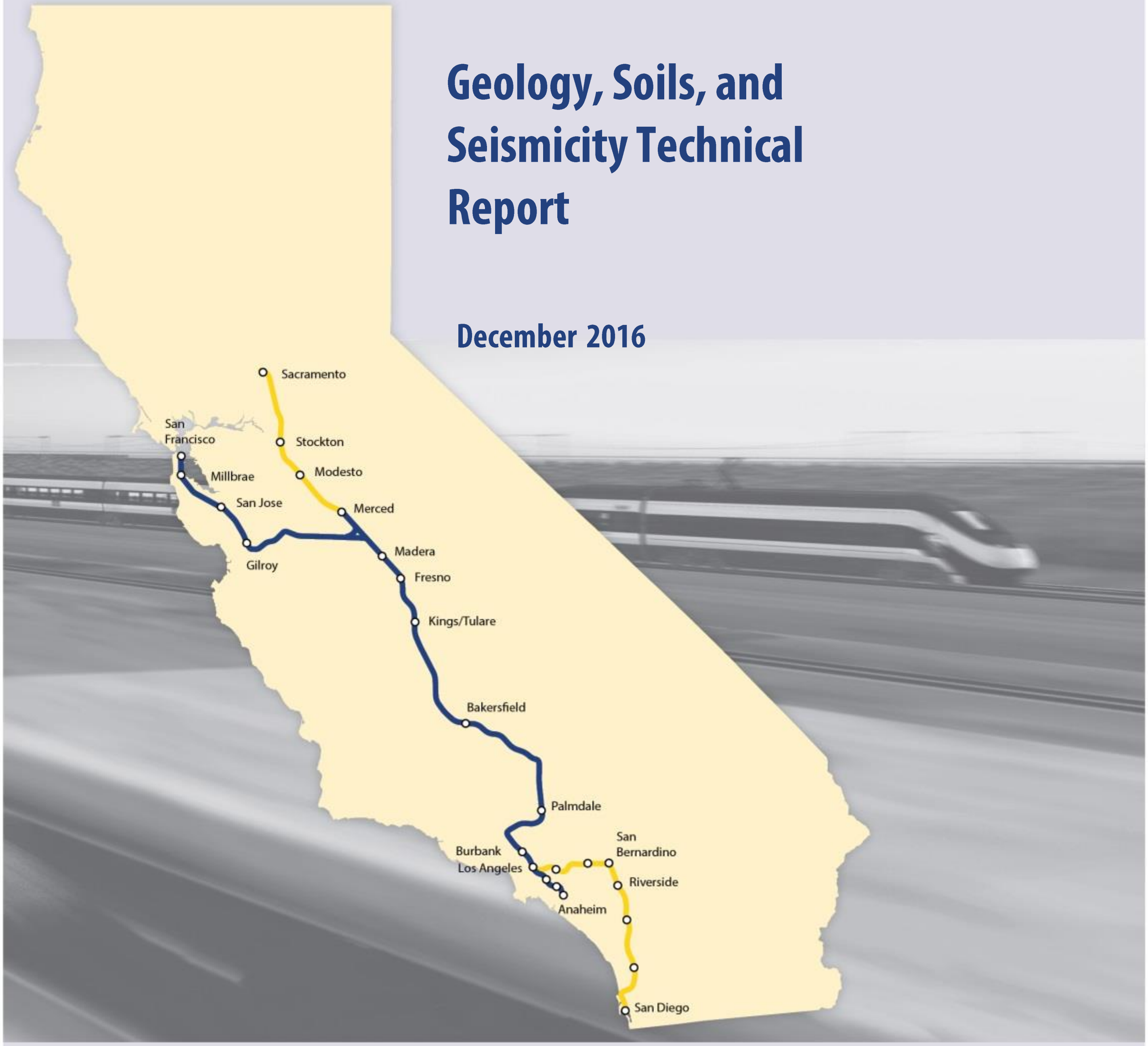
California High-Speed Rail Authority

Merced to Fresno Section: Central Valley Wye

Geology, Soils, and Seismicity Technical Report

December 2016



CALIFORNIA High-Speed Rail Authority

U.S. Department of Transportation Federal Railroad Administration

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ACRONYMS AND ABBREVIATIONS

Authority	California High-Speed Rail Authority
BMP	best management practice
BRT	bus rapid transit
Caltrans	California Department of Transportation
COG	Council of Governments
EIR	environmental impact report
EIS	environmental impact statement
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HCM	Highway Capacity Manual
HDM	Highway Design Manual
HOV	high-occupancy vehicle
HSR	high-speed rail
PMT	Program Management Team
RC	Regional Consultant
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SR	State Route

EXECUTIVE SUMMARY

The California High-Speed Rail Authority (Authority) has prepared this *Merced to Fresno Section: Central Valley Wye Geology, Soils, and Seismicity Technical Report* (Central Valley Wye Geology, Soils, and Seismicity Technical Report) to support the *Merced to Fresno Section: Central Valley Wye Supplemental Environmental Impact Report (EIR)/Supplemental Environmental Impact Statement (EIS)* (Supplemental EIR/EIS). The Supplemental EIR/EIS tiers from the original *Merced to Fresno Section Final EIR/EIS* (Merced to Fresno Final EIR/EIS) (Authority and FRA 2012a). When the Authority Board of Directors and the Federal Railroad Administration approved the Merced to Fresno Section in 2012, they deferred a decision on the wye connection for a future environmental analysis. Since then, the Authority and Federal Railroad Administration have identified four new alternatives for consideration.

This technical report characterizes existing conditions and analyzes geology, soils, and seismicity effects of the four Central Valley Wye alternatives:

- State Route (SR) 152 (North) to Road 13 Wye Alternative
- SR 152 (North) to Road 19 Wye Alternative
- Avenue 21 to Road 13 Wye Alternative
- SR 152 (North) to Road 11 Wye Alternative

Geology, soils, and seismicity comprise primary seismic hazards, secondary seismic hazards, geologic hazards, and mineral resources. This technical report addresses effects resulting from the high-speed rail (HSR) track alignment for the Central Valley Wye. The Central Valley Wye alternatives also include electrical interconnections and PG&E network upgrades, which are not evaluated in this technical report. This report includes federal, state, regional, and local regulations and requirements; methods used for the analysis of effects; the affected environment; potential effects on geology, soils, and seismicity in the Central Valley Wye study area that could result from construction and operations of the Central Valley Wye alternatives; and impact avoidance and minimization features (IAMF) that would avoid, minimize, or reduce effects. As discussed in the Supplemental EIR/EIS, Section 3.9, Geology, Soils, Seismicity, and Paleontological Resources, there would be no significant impacts as a result of Central Valley Wye construction or operations; therefore, no mitigation measures are required.

Summary of Effects

The potential direct effects of the Central Valley Wye alternatives on geology, soils, and seismicity resource areas are summarized in this section. The Central Valley Wye would not have any indirect effects on geology, soils, and seismicity.

Primary Seismic Hazards

The Central Valley Wye would not result in exposure to surface fault ruptures because none of the alternatives would lie within a known earthquake fault zone. However, strong ground shaking from earthquakes on faults some distance from the Central Valley Wye could affect construction activities involving excavation, earth stabilization, and erection of structures, and lead to personal injury, loss of life, and damage to property during operations. IAMFs would involve conducting additional seismic studies to establish up-to-date estimations of levels of ground motion. The Authority would also conduct detailed seismic response evaluations and other measures to reduce the potential for failures from ground motions and would design structures to withstand design seismic activity. Automatic train control systems would be employed to minimize operational risks. With these features incorporated, the Central Valley Wye is not likely to result in effects on geology, soils, and seismicity resources.

Secondary Seismic Hazards

Liquefaction, lateral spreading, and seismically induced ground failure and slope failure hazards during construction could be an issue at river and stream channel crossings and at proposed bridges. The probability of seismically induced dam failure is considered very low; however, failure of Buchanan Dam, Hidden Dam, Friant Dam, or Pine Flat Dam could affect portions of the

HSR alignment. Operations would be affected if damage to the HSR infrastructure occurred due to secondary seismic hazards. The Authority has adopted IAMFs to minimize the risk from secondary seismic hazards including site-specific geotechnical investigations and slope-stability evaluations to implement ground improvement measures. The Authority will also install an automatic control system to temporarily shut down HSR operations during or after a potentially damaging earthquake to reduce risks. With these features incorporated, the Central Valley Wye is not likely to result in effects on geology, soils, and seismicity resources.

Geologic Hazards

Ground subsistence; expansive, corrosive, and collapsible soils; soil erosion; difficult excavations, and subsurface gas hazards may affect construction activities. In general, geologic hazards would compromise the structural integrity and long-term operations of the HSR. Ground subsistence could occur at water crossings where soft or loose soils are prevalent and would affect construction personnel and result in personal injury, loss of life, and damage to property. Soil expansion presents a risk to the operations of the track system and track right-of-way for long-term authorizations. Corrosive soils could result in eventual loss in the structural capacity of buried steel or concrete components. The design characteristics of the Central Valley Wye would reduce these effects, including engineered ground improvements guidelines and standards; groundwater withdrawal controls; addition of soil additives to reduce expansion potential; removal of soils that exhibit high-corrosivity; pre-wetting of soils to minimize collapsible soils; and wind and water erosion minimization features. With these features incorporated, the Central Valley Wye is not likely to result in effects on geology, soils, and seismicity resources.

Mineral and Energy Resources

Mineral and geothermal resources are unlikely to be affected during construction and operation of the Central Valley Wye because no mineral or geothermal resources are known to exist along the Central Valley Wye alternative alignments. A small number of oil and gas wells would need to be relocated before construction of the Central Valley Wye. The Authority would minimize the effects related to relocation of active oil and gas wells by compensating owners for well relocation and any loss of production. With these features incorporated, the Central Valley Wye is not likely to result in effects on mineral and energy resources.

1 INTRODUCTION

1.1 Background of HSR Program

The Authority proposes to construct, operate, and maintain an electric-powered high-speed rail (HSR) system in California. When completed, the nearly 800-mile train system would provide new passenger rail service to more than 90 percent of the state's population. More than 200 weekday trains would serve the statewide intercity travel market. The HSR would be capable of operating speeds of up to 220 miles per hour, with state-of-the art safety, signaling, and automatic train control systems. The system would connect and serve the major metropolitan areas of California, extending from San Francisco and Sacramento in the north to San Diego in the south.

The Authority commenced its environmental planning process with the 2005 *Final Program EIR/EIS for the Proposed California High-Speed Train System* (Authority and FRA 2005) (Statewide Program EIR/EIS), and then began preparing second-tier, project environmental evaluations for sections of the statewide HSR system. The 2012 *Merced to Fresno Section Final EIR/EIS* (Merced to Fresno Final EIR/EIS) (Authority and FRA 2012a) was the first project-level EIR/EIS that the Authority certified and the Federal Railroad Administration (FRA) approved. The Merced to Fresno Final EIR/EIS identified the Hybrid Alignment as the preferred alternative and examined two design options for an east-west connection to the San Jose to Merced Section, referred to as the "wye connection" (Authority and FRA 2012a: pages 2-3 and 2-21). When the Authority Board of Directors and the FRA approved the Merced to Fresno Section later in 2012, they deferred a decision on the wye connection for a future environmental analysis. The Authority and FRA have prepared the Supplemental EIR/EIS as the next step in the environmental review process to select a Central Valley Wye connection. Chapter 2 of the Supplemental EIR/EIS provides a detailed history of how the Authority developed the Central Valley Wye alternatives.

1.2 Organization of this Technical Report

This technical report includes the following sections:

- Section 2, Merced to Fresno Section: Central Valley Wye, provides a description of the Central Valley Wye alternatives.
- Section 3, Laws, Regulations, and Orders, identifies the federal, state, and local laws, guidance, and policies relevant to the geology, soils, and seismicity for the Central Valley Wye.
- Section 4, Methods for Evaluating Effects, describes the methods used to determine and evaluate potential effects.
- Section 5, Affected Environment, describes the existing conditions.
- Section 6, Effects Analysis, describes direct effects, both adverse and beneficial.
- Section 7, References, provides a list of the references cited in this technical report.
- Section 8, Preparer Qualifications, identifies the individuals involved in preparing this report and their credentials.

Additional details on geology, soils, and seismicity are provided in:

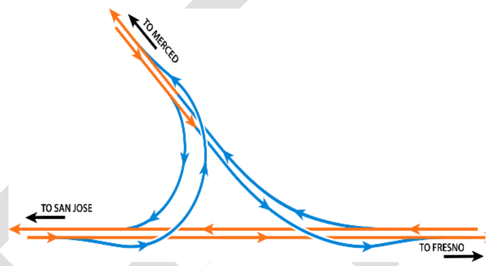
- Appendix A, California High-Speed Rail Impact Avoidance and Minimization Features for Geology, Soils, and Seismicity

2 MERCED TO FRESNO SECTION: CENTRAL VALLEY WYE

The Central Valley Wye would create the east-west HSR connection between the San Jose to Merced Section to the west and the north-south Merced to Fresno Section to the east.[1] The four Central Valley Wye alternatives addressed in the Supplemental EIR/EIS (Figures 2-1 to 2-4) are:

- SR 152 (North) to Road 13 Wye Alternative
- SR 152 (North) to Road 19 Wye Alternative
- Avenue 21 to Road 13 Wye Alternative
- SR 152 (North) to Road 11 Wye Alternative

Central Valley Wye Schematic



This section describes the common design features of the four alternatives, followed by descriptions of each alternative.

2.1 Common Features

The Central Valley Wye alternatives would cross rural areas in unincorporated Merced and Madera Counties, and would travel through the southern portion of Chowchilla and the rural-residential community of Fairmead. Volume 3 of the Supplemental EIR/EIS provides detailed design drawings that support the descriptions of the Central Valley Wye alternatives.

The HSR alignment would be entirely grade-separated, meaning that crossings of roads, railroads, and other transport facilities would use overpasses or underpasses so that the HSR would operate independently of other modes of transport. The HSR right-of-way would also be fenced to prevent public or vehicle access. The Central Valley Wye project footprint would primarily consist of the train right-of-way, which would accommodate two sets of tracks in an area with a minimum width of 100 feet. Additional right-of-way would be required to accommodate grade separations, embankments, traction power facilities, and transitional portions of the Central Valley Wye that allow for bidirectional interface between north-south and east-west trending alignments.

The Central Valley Wye alternatives would include at-grade, below-grade, and above-grade (elevated) track segments. The at-grade track would be laid on an earthen railbed raised 6–10 feet (embankment heights are in excess of 35 feet) off the ground level, set on ties with rock ballast; fill and ballast for the railbed would be obtained from permitted borrow sites and quarries. Below-grade track would be laid in open cut, trench, or cut-and-cover tunnel at a depth that would allow roadway and other grade-level uses above the track. Elevated track segments would span some waterways, roadways, railroad, and other HSR tracks, and would consist of precast, prestressed concrete box girders, cast-in-place concrete box girders, or steel box girders. The height of elevated track sections would depend on the height of existing structures below, or clearances to existing roads or other HSR facilities, and would range from 35 to 90 feet above grade. Columns would be spaced approximately 100–120 feet apart on average.

[1] The term *wye* refers to the Y-like formation created at the point where train tracks branch off the mainline to continue in different directions. The transition of mainline track to a wye requires splitting two tracks into four tracks that cross over one another before the wye "legs" (segments) can diverge in opposite directions to allow two-way travel. For the Merced to Fresno Section of the HSR system, the two tracks traveling east-west from the San Jose to Merced Section must become four tracks—a set of two tracks branching toward Merced to the north and a set of two tracks branching toward Fresno to the south.

2.2 SR 152 (North) to Road 13 Wye Alternative

The SR 152 (North) to Road 13 Wye Alternative (Figure 2-1) follows the existing Henry Miller Road and SR 152 rights-of-way as closely as possible in the east-west direction, and the Road 13, SR 99, and BNSF Railway (BNSF) rights-of-way in the north-south direction. Deviations from these existing transportation routes or corridors are necessary to accommodate design requirements; specifically, wider curves are necessary to accommodate the speed of the HSR compared to lower-speed roadway alignments. The SR 152 (North) to Road 13 Wye Alternative would not follow existing transportation rights-of-way where it transitions from following one transportation corridor to another.

2.2.1 Alignment and Ancillary Features

The SR 152 (North) to Road 13 Wye Alternative would extend approximately 52 miles, mostly at-grade on raised embankment, although it would also have aerial structures and a segment of retained cut (depressed alignment). The wye configuration of this alternative would be located southwest of the city of Chowchilla, with the east-west axis along the north side of SR 152 and the north-south axis on the east side of Road 13.

As shown on Figure 2-1, this alternative would begin in Merced County at the intersection of Henry Miller Road and Carlucci Road, and would continue at-grade on embankment due east toward Elgin Avenue, where it would curve southeast toward the San Joaquin River and Eastside Bypass. Approaching Willis Road, the alignment would cross the San Joaquin River on an aerial structure, then would return to embankment. It would then cross the Eastside Bypass on an aerial structure. After crossing the Eastside Bypass, the alignment would continue east and cross SR 59 at-grade just north of the existing SR 152/SR 59 interchange, entering Madera County. The SR 152/SR 59 interchange would be reconstructed a little to the south and SR 59 would be grade-separated to pass above the HSR on an aerial structure. The alignment would continue east at-grade along the north side of SR 152 toward Chowchilla, splitting into two legs (four tracks) near Road 11 to transition to the Merced to Fresno Section: Hybrid Alignment, and would cross Ash Slough on an aerial structure. All but the northbound track of the San Jose to Merced section of the alignment (leg) would then return to at-grade embankment. The northbound track would rise to cross over the tracks of the San Jose to Fresno leg on aerial structure as it curves north toward Merced. The SR 152 (North) to Road 13 Wye Alternative legs would be routed as described below and as shown on Figure 2-1:

- The southbound track of the San Jose to Merced leg[2] would be at-grade. This split (where tracks separate) would be west of Chowchilla, at approximately Road 11. The two San Jose to Merced tracks would continue north on the eastern side of Road 13, crossing Ash Slough and the Chowchilla River, and then would cross over Road 13 to its west side. As the tracks return to grade, they would curve northwest, crossing Dutchman Creek on an aerial structure, and follow the west side of the Union Pacific Railroad (UPRR)/SR 99 corridor. At Sandy Mush Road, the alignment would descend into a shallow cut (depressed) section for approximately 0.5 mile, with a retained cut-and-cover undercrossing[3] at Caltrans' Sandy Mush Road overhead. The alignment would return to grade and continue along the west side of the UPRR/SR 99 corridor, connecting to the Merced to Fresno Section: Hybrid Alignment at Ranch Road.

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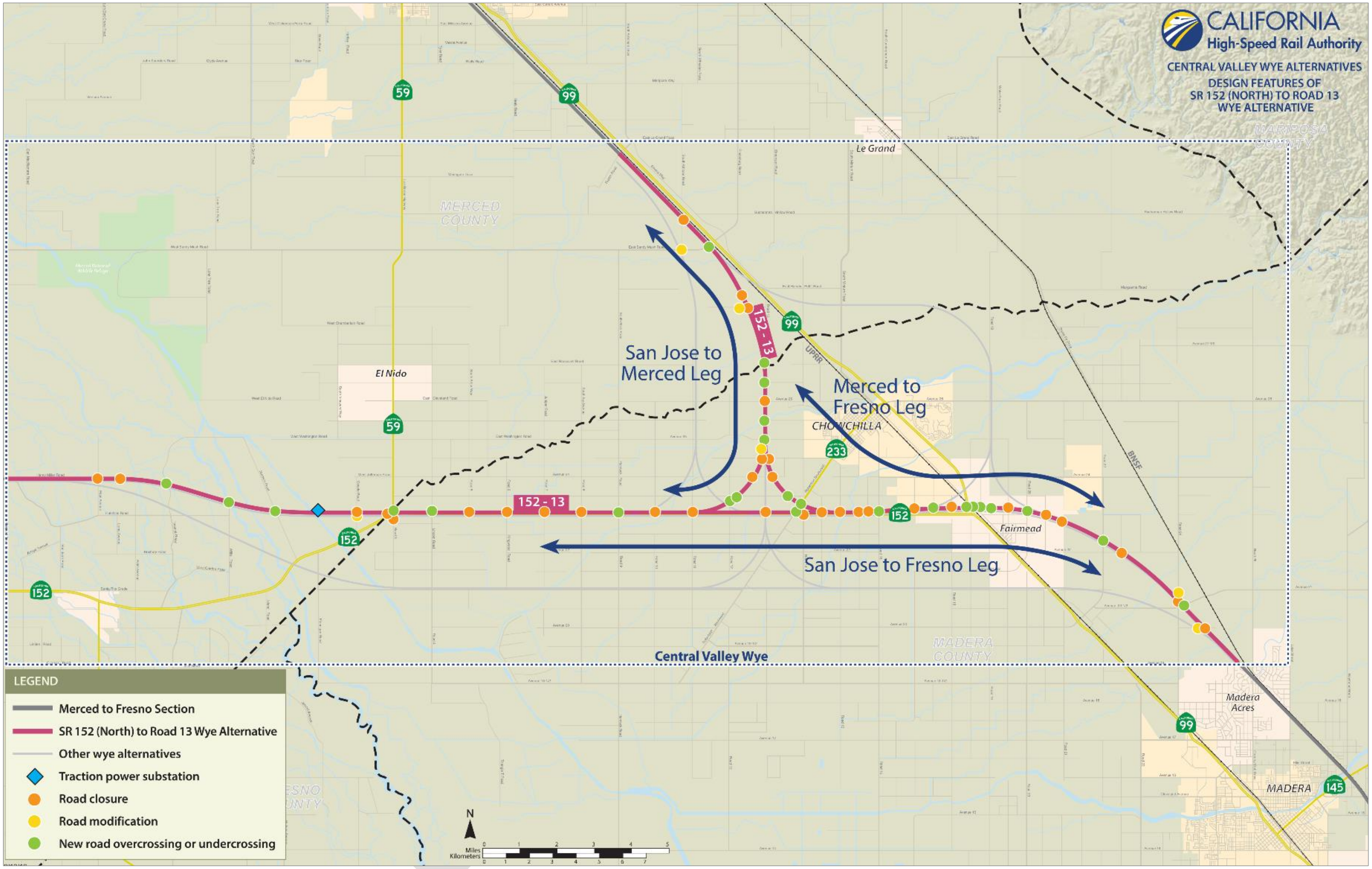
[2] A track is included within a leg; e.g., southbound track of the San Jose to Merced leg.

[3] An undercrossing is a road or track crossing under an existing road or track.



Source: Authority, 2016; ESRI, 2013; ESRI/National Geographic, 2015

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Figure 2-1 SR 152 (North) to Road 13 Wye Alternative Alignment and Key Design Features

- The San Jose to Fresno leg of this alternative would continue east from the split near Road 11 and along the north side of SR 152 toward Chowchilla. It would be predominantly at-grade, crossing several roads and Berenda Slough on aerial structures. The alignment would pass south of Chowchilla at-grade then would rise to cross over the UPRR/SR 99 corridor and Fairmead Boulevard on an aerial structure. East of the UPRR/SR 99 corridor, the alternative would extend at-grade through Fairmead, north of Avenue 23. At approximately Road 20, the alignment would curve southeast toward the BNSF corridor and cross Dry Creek on a short aerial structure. The San Jose to Fresno leg would align parallel to the west side of the BNSF corridor as it meets the Merced to Fresno Section: Hybrid Alignment at Avenue 19.
- The Merced to Fresno leg of the alternative would split from the San Jose to Fresno leg near Road 14, where the southbound track of the Merced to Fresno leg would ascend on aerial structure, crossing over the tracks of the San Jose to Fresno leg. The northbound track would curve northwest, rise on a high embankment crossing over several roads, and continue on an at-grade embankment until joining the San Jose to Merced leg near Avenue 25.

Wildlife undercrossing structures would be installed in at-grade embankments along this alternative where the alignment intersects wildlife corridors.

2.2.2 State Highway or Local Roadway Modifications

The SR 152 (North) to Road 13 Wye Alternative would require the permanent closure of 38 public roadways at selected locations and the construction of 24 overcrossings[4] or undercrossings in lieu of closure. Figure 2-1 shows the anticipated state highway and local roadway closures and modifications. Fourteen of these permanent road closures would be located at SR 152, where roads currently cross at-grade but need to be closed to convert SR 152 to a fully access-controlled corridor. The 14 proposed closures are Road 5, Road 6, Road 7, Road 8, Road 10, Road 11, Road 13, Road 14, Road 14 1/2, Road 15, Road 15 1/2, Road 15 3/4, Road 17, and Road 18. Planned new grade separations along SR 152 at the SR 59/SR 152 Interchange, Road 4/Lincoln Road, Road 12, and Road 17 1/2 would maintain access to, and across, SR 152. These roadways would be reconfigured to two 12-foot lanes with two 8-foot shoulders. Each of the new interchanges would require realigning SR 152. Three new interchanges are proposed between SR 59 and SR 99 to provide access to SR 152: at Road 9/Hemlock Road, SR 233/Robertson Boulevard, and Road 16.

The distance between over- or undercrossings would vary from less than 2 miles to approximately 5 miles where other roads are perpendicular to the proposed HSR. Between these over- or undercrossings, 24 additional roads would be closed, as shown on Figure 2-1. Local roads paralleling the proposed HSR alignment and used by small communities and farm operations may be shifted and reconstructed to maintain their function. Access easements would be provided to maintain access to properties severed by HSR.

2.2.3 Freight or Passenger Railroad Modifications

The SR 152 (North) to Road 13 Wye Alternative would cross over the UPRR right-of-way south of Chowchilla. This alternative would maintain required vertical (at least 23.3 feet) clearance over UPRR operational right-of-way to avoid or minimize impacts on UPRR rights-of-way, spurs, and facilities (BNSF and UPRR 2007). Where the SR 152 (North) to Road 13 Wye Alternative would parallel UPRR operational right-of-way, a horizontal clearance of more than 50 feet would be maintained.

2.2.4 Summary

Table 2-1 summarizes the design features for the SR 152 (North) to Road 13 Wye Alternative.

[4] An overcrossing is a road or track crossing over an existing road or track.

Table 2-1 Design Features of the SR 152 (North) to Road 13 Wye Alternative

Feature	SR 152 (North) to Road 13 Wye
Total length (linear miles)[1]	52
At-grade profile (linear miles)[1]	48.5
Elevated profile (linear miles)[1]	3
Below-grade profile (linear miles)[1]	0.5
Number of straddle bents	32
Number of railroad crossings	1
Number of major water crossings	12
Number of road crossings	62
Approximate number of public roadway closures	38
Number of roadway overcrossings and undercrossings	24
Traction power substation sites	1
Switching and paralleling stations	3 switching stations, 8 paralleling stations
Signaling and train-control elements	18
Communication towers	9
Wildlife crossing structures	39

Source: Authority, 2016

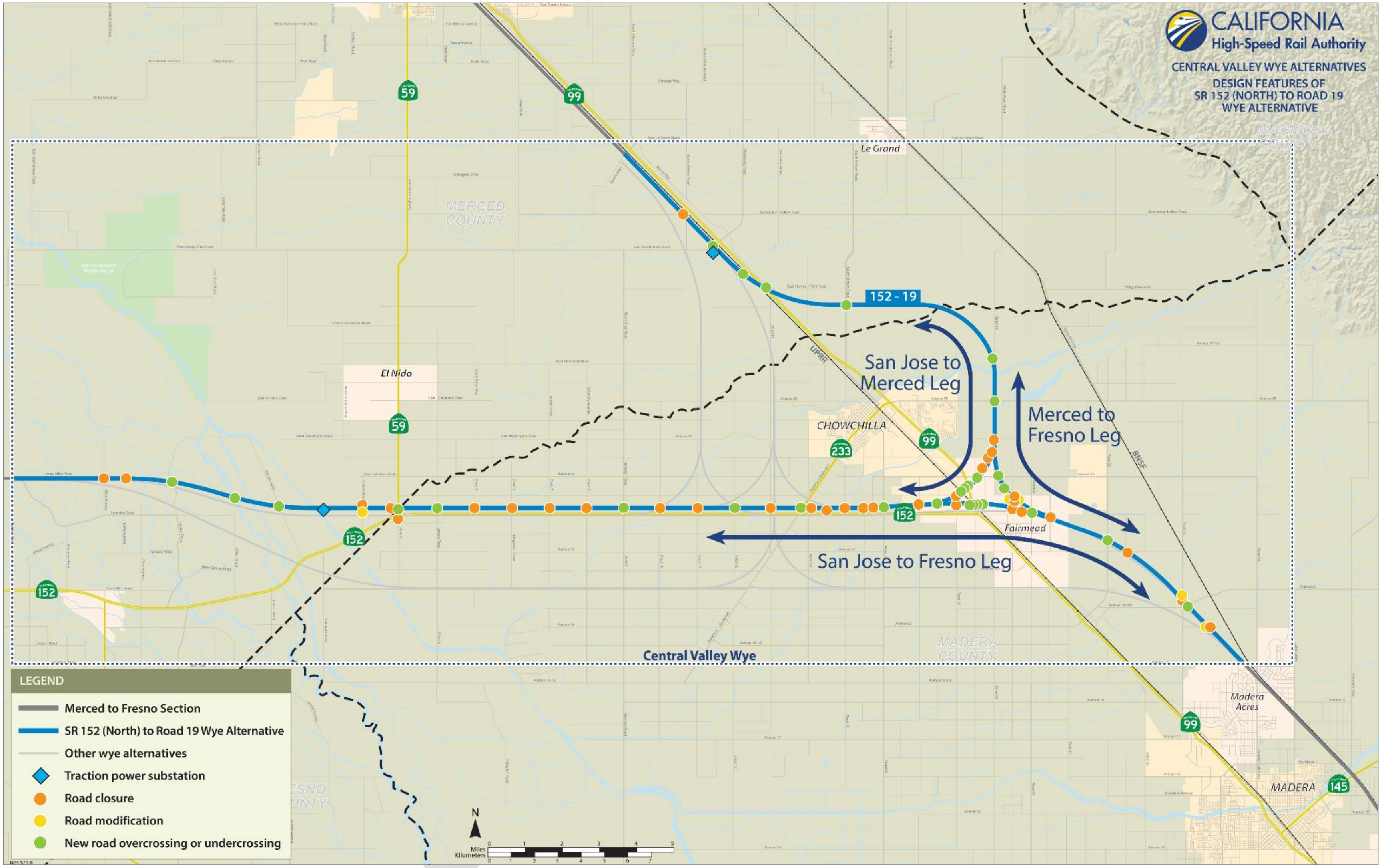
[1] Lengths shown are based on equivalent dual-track alignments and are one-way mileages. For example, the length of single-track elevated structure will be divided by a factor of 2 to convert to dual-track equivalents.

2.3 SR 152 (North) to Road 19 Wye Alternative

The SR 152 (North) to Road 19 Wye Alternative (Figure 2-2) is designed to follow the existing Henry Miller Road and SR 152 rights-of-way as closely as practicable in the east-west direction and Road 19, SR 99, and BNSF rights-of-way in the north-south direction. Deviations from these existing transportation corridors would be necessary to accommodate design requirements; specifically, larger curves would be necessary to accommodate the high speed of the HSR compared to lower-speed roadway alignments. The SR 152 (North) to Road 19 Wye Alternative would not follow existing transportation rights-of-way as it transitions from following one transportation corridor to another.

2.3.1 Alignment and Ancillary Features

The SR 152 (North) to Road 19 Wye Alternative would extend approximately 55 miles, mostly at-grade on embankment, although it would also have aerial structures, retained cut (depressed alignment), and depressed tunnel undercrossings of major railroad and highway corridors. The wye configuration of this alternative would be located southeast of the city of Chowchilla and north of Fairmead, with the east-west axis along the north side of SR 152 and the north-south axis on the east side of Road 19.



Source: Authority, 2016; ESRI, 2013;; ESRI/National Geographic, 2015

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Figure 2-2 SR 152 (North) to Road 19 Wye Alternative Alignment and Key Design Features

Beginning at the intersection of Henry Miller Road and Carlucci Road (at the same point in Merced County as the SR 152 [North] to Road 13 Wye Alternative), this alternative would continue east toward Elgin Avenue, where it would curve southeast toward the San Joaquin River. It would cross the river on an aerial structure, returning to an at-grade embankment, then onto another aerial structure to cross the Eastside Bypass. After crossing the Eastside Bypass, the alignment would continue east and cross SR 59 at-grade just north of the existing SR 152/SR 59 interchange, where it would enter Madera County. It would continue east at-grade along the north side of SR 152 toward Chowchilla, crossing Ash Slough and Berenda Slough on aerial structures. As it crosses Road 16, the alignment would split into two legs (four tracks) to transition to the Merced to Fresno Section: Hybrid Alignment. East of Road 17, the San Jose to Merced leg would curve northeast, rising to cross the UPRR/SR 99 corridor on an aerial structure, and then would continue north along the east side of Road 19.

As the alignment approaches Avenue 25, the San Jose to Merced and Merced to Fresno legs would converge, requiring the northbound track of the San Jose to Merced leg to rise on an aerial structure and cross over the tracks of the Merced to Fresno leg.

- The San Jose to Merced leg would continue north to just south of Ash Slough, where it would curve west, cross Ash Slough and the Chowchilla River on aerial structures, and continue west approximately 0.5 mile south of Harvey Pettit Road. West of South Minturn Road, the leg would curve northwest and descend below-grade into a series of three tunnels crossing under the SR 99 and UPRR corridors and the Caltrans Sandy Mush Road overhead. The UPRR tracks would be reconstructed on the roof of the HSR cut-and-cover tunnels, while maintaining the same horizontal and vertical alignment. Construction of this type of below-grade crossing would require temporarily realigning the UPRR tracks. Approximately 0.6 mile north of Sandy Mush Road, the alternative would ascend to grade and continue along the UPRR/SR 99 corridor to connect with the Merced to Fresno Section: Hybrid Alignment at Ranch Road.
- The San Jose to Fresno leg would continue east from Road 16 and, east of Road 18, ascend on an aerial structure to cross SR 99 north of the SR 99/SR 152 interchange. East of the UPRR/SR 99 corridor, the leg would continue north of Avenue 23 through Fairmead, descending to grade east of Road 18 3/4. The alternative would then curve southeast toward the BNSF corridor, crossing Dry Creek on a short aerial structure, and continuing along the west side of the BNSF corridor to join the Merced to Fresno Section: Hybrid Alignment at Avenue 19.
- The Merced to Fresno leg would split from the San Jose to Fresno leg near Road 20 1/2. The southbound track of the Merced to Fresno leg would ascend on an aerial structure and cross over the tracks of the San Jose to Fresno leg. The Merced to Fresno leg would curve northwest, rise on aerial structures over several road crossings, and then continue at-grade to join the San Jose to Merced leg near Avenue 25.

Wildlife undercrossing structures would be provided in at-grade embankments where the alignment intersects wildlife corridors.

2.3.2 State Highway or Local Roadway Modifications

The SR 152 (North) to Road 19 Wye Alternative would require the permanent closure of 36 public roadways at selected locations and the construction of 29 overcrossings or undercrossings. Table 2-2 and Figure 2-2 show the anticipated state highway and local roadway closures and modifications. Fourteen of these permanent road closures would be located at SR 152 where roads currently cross at-grade but must be closed to convert SR 152 to a fully access-controlled corridor. The proposed 14 closures are Road 5, Road 6, Road 7, Road 8, Road 10, Road 11, Road 13, Road 14, Road 14 1/2, Road 15, Road 15 1/2, Road 15 3/4, Road 17, and Road 18. New grade separations are planned along SR 152 at the SR 59/SR 152 interchange, Road 4/Lincoln Road, Road 12, SR and Road 17 1/2. These roadways would be reconfigured to two 12-foot lanes with two 8-foot shoulders, and several of these interchanges would require realigning SR 152. Interchanges between SR 59 and SR 99 that would provide access to SR 152 are Road 9/Hemlock Road, SR 233/Robertson Boulevard, and Road 16.

The distance between over- or undercrossings would vary from less than 2 miles to approximately 5 miles where roads would be perpendicular to the proposed HSR. Between these over- or undercrossings, 22 additional roads would be closed (Figure 2-2). Local roads paralleling the proposed HSR alignment and used by small communities and farm operations may be shifted and reconstructed to maintain their function. Access easements would be provided to maintain access to properties severed by HSR.

The SR 152 (North) to Road 19 Wye Alternative would cross over SR 99 at three locations. South of Chowchilla, both the San Jose to Merced and the San Jose to Fresno legs would rise on aerial structures to cross SR 99. Another crossing of SR 99 would be at the northern end of the alternative, where it descends below-grade into an undercrossing tunnel segment. SR 99 would be temporarily realigned during construction, and would be reconstructed on the roof of the undercrossing tunnel.

2.3.3 Freight or Passenger Railroad Modifications

The SR 152 (North) to Road 19 Wye Alternative would cross over the UPRR corridor at three separate locations. South of Chowchilla, both the San Jose to Merced and the San Jose to Fresno legs would rise on aerial structures to cross the UPRR operational right-of-way. In these instances, the alternative would maintain required vertical (at least 23.3 feet) clearance over UPRR operational right-of-way to avoid or minimize impacts on UPRR rights-of-way, spurs, and facilities (BNSF and UPRR 2007). The third crossing of the UPRR corridor would be at the northern end of the alternative, where the alignment would descend into an undercrossing tunnel. The UPRR tracks would be reconstructed on the roof of the HSR tunnel, maintaining the same vertical alignment. Construction of this crossing would require the temporary detour (shoofly)[5] of the UPRR tracks. Where the SR 152 (North) to Road 19 Wye Alternative would parallel UPRR operational right-of-way, a horizontal clearance of more than 50 feet would be maintained.

2.3.4 Summary

Table 2-2 summarizes the design features for the SR 152 (North) to Road 19 Wye Alternative.

Table 2-2 Design Features of the SR 152 (North) to Road 19 Wye Alternative

Feature	SR 152 (North) to Road 19 Wye
Total length (linear miles)[1]	55
At-grade profile (linear miles)[1]	48.5
Elevated profile (linear miles)[1]	3.5
Below-grade profile (linear miles)[1]	3
Number of straddle bents	31
Number of railroad crossings	3
Number of major water crossings	13
Number of road crossings	65
Approximate number of public roadway closures	36
Number of roadway overcrossings and undercrossings	29
Traction power substation sites	2

[5] A shoofly is a temporary track alignment that detours trains around a construction site.

Feature	SR 152 (North) to Road 19 Wye
Switching and paralleling stations	3 switching stations, 7 paralleling stations
Signaling and train-control elements	21
Communication towers	6
Wildlife crossing structures	41

Source: Authority, 2016

[1] Lengths shown are based on equivalent dual-track alignments and are one-way mileages. For example, the length of single-track elevated structure will be divided by a factor of 2 to convert to dual-track equivalents.

2.4 Avenue 21 to Road 13 Wye Alternative

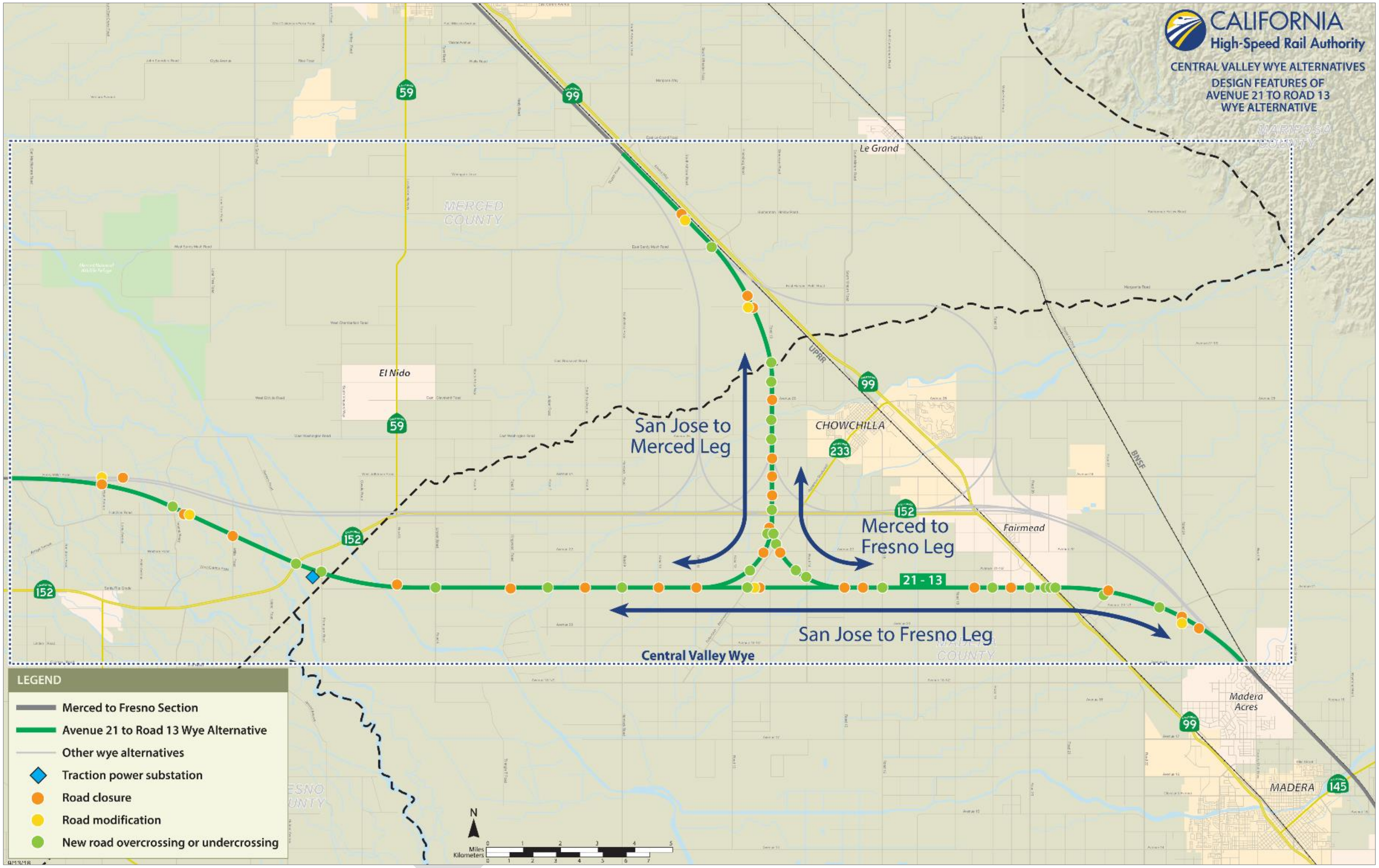
The Avenue 21 to Road 13 Wye Alternative (Figure 2-3) is designed to follow the existing Henry Miller Road and Avenue 21 rights-of-way as closely as practicable in the east-west direction and the Road 13, SR 99, and BNSF rights-of-way in the north-south direction. Deviations from these existing transportation corridors would be necessary to accommodate design requirements; specifically, larger curves would be necessary to accommodate the high speeds of the HSR compared to lower-speed roadway alignments. The Avenue 21 to Road 13 Wye Alternative would not follow existing transportation rights-of-way as it transitions from following one transportation corridor to another.

2.4.1 Alignment and Ancillary Features

The Avenue 21 to Road 13 Wye Alternative would extend approximately 53 miles, mostly at-grade on embankment, although it would also have aerial structures and a short segment of retained cut (depressed alignment). The wye configuration of this alternative would be located approximately 4 miles southwest of the city of Chowchilla, with the east-west axis along the north side of Avenue 21 and the north-south axis on the east side of Road 13.

Beginning at the intersection of Henry Miller Road and Carlucci Road (at the same point in Merced County as the SR 152 [North] to Road 13 Wye Alternative), west of Elgin Avenue this alternative would curve southeast toward the San Joaquin River and Eastside Bypass. East of Willis Road, the alignment would rise to an aerial structure to cross the river, SR 152, and the Eastside Bypass. The alignment would continue east along the north side of Avenue 21, crossing Ash Slough on an aerial structure. Southwest of Chowchilla, near Road 11, the alignment would split into two legs (four tracks) for transition to the Merced to Fresno Section: Hybrid Alignment. The San Jose to Merced leg would curve northeast, cross Road 13, and continue north along the east side of Road 13. At the beginning of the San Jose to Merced leg, the northbound track alternative would rise onto an aerial structure to cross over the tracks of the San Jose to Fresno leg. The Avenue 21 to Road 13 Wye Alternative legs would be routed as described below and shown on Figure 2-3:

- As the San Jose to Merced leg approaches SR 152, it would converge with the Merced to Fresno leg, requiring the northbound track of the San Jose to Merced leg to rise on an aerial structure and cross over the tracks of the Merced to Fresno leg. The San Jose to Merced leg would continue north on an elevated alignment crossing Ash Slough, the Chowchilla River, and Road 13 on aerial structures. As the leg returns to grade, it would curve northwest, cross Dutchman Creek on an aerial structure, and follow along the west side of the UPRR/SR 99 corridor. At Sandy Mush Road, the alternative would descend into a shallow cut (depressed) section for approximately 0.5 mile, with a retained cut-and-cover undercrossing tunnel segment at the Caltrans Sandy Mush Road Overhead. The alternative would return to grade and continue along the UPRR/SR 99 corridor, connecting to the Merced to Fresno Section: Hybrid Alignment at Ranch Road.



Source: Authority, 2016; ESRI, 2013;; ESRI/National Geographic, 2015

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Figure 2-3 Avenue 21 to Road 13 Wye Alternative Alignment and Key Design Features

- The San Jose to Fresno leg would continue east from the split near Road 11 along the north side of Avenue 21 toward Chowchilla. It would be predominantly at-grade on embankment, ascending to cross Berenda Slough on an aerial structure. East of the wye configuration, the alignment would extend south of Chowchilla, ascend on an aerial structure east of Road 19 1/2, and cross the UPRR/SR 99 corridor. The alternative would extend south of Fairmead and curve southeast toward the BNSF corridor, cross Dry Creek on an aerial structure, and run adjacent to the west side of the BNSF corridor to its meeting with the Merced to Fresno Section: Hybrid Alignment at Avenue 19.
- The Merced to Fresno leg would split from the San Jose to Fresno leg near Road 15. The southbound track of the Merced to Fresno leg would ascend on an aerial structure and cross over the tracks of the San Jose to Fresno leg. The Merced to Fresno leg would curve northwest, rise on aerial structures over several road crossings, and then continue on an at-grade embankment to join the San Jose to Merced leg near SR 152.

Wildlife undercrossing structures would be provided along this alternative in at-grade embankment portions of the HSR corridor where the alignment intersects wildlife corridors.

2.4.2 State Highway or Local Roadway Modifications

The Avenue 21 to Road 13 Wye Alternative would require the permanent closure of 30 public roadways at selected locations and the construction of 28 overcrossings or undercrossings. Table 2-3 and Figure 2-3 show the anticipated state highway and local roadway closures. This alternative would require the fewest roadway and state highway modifications.

The Avenue 21 to Road 13 Wye Alternative would rise on aerial structures and cross over state highway facilities in three locations: SR 59 at Harmon Road, SR 152 at Road 13, and SR 99 at Avenue 21. Where other roads would be perpendicular to the proposed HSR, over- or undercrossings are planned at distances from less than 2 miles to 5 miles. Between these over- and undercrossings, some roads may be closed. Local roads paralleling the HSR alignment and used by small communities and farm operations may be shifted and reconstructed to maintain their function. Access easements would be provided to maintain access to properties severed by HSR.

2.4.3 Freight or Passenger Railroad Modifications

The Avenue 21 to Road 13 Wye Alternative would cross the UPRR operational right-of-way on an aerial structure south of Fairmead and maintain a vertical (at least 23.3 feet) clearance over UPRR operational right-of-way to avoid or minimize impacts on other UPRR rights-of-way, spurs, and facilities. A horizontal clearance of more than 50 feet would be maintained where the Avenue 21 to Road 13 Wye Alternative would parallel UPRR operational right-of-way.

2.4.4 Summary

Table 2-3 summarizes the design features for the Avenue 21 to Road 13 Wye Alternative.

Table 2-3 Design Features of the Avenue 21 to Road 13 Wye Alternative

Feature	Avenue 21 to Road 13 Wye
Total length (linear miles)[1]	53
At-grade profile (linear miles)[1]	48.5
Elevated profile (linear miles)[1]	4
Below-grade profile (linear miles)[1]	0.5
Number of straddle bents	32
Number of railroad crossings	1
Number of major water crossings	11
Number of road crossings	58
Approximate number of public roadway closures	30
Number of roadway overcrossings and undercrossings	28
Traction power substation sites	1
Switching and paralleling stations	3 switching stations, 7 paralleling stations
Signaling and train-control elements	15
Communication towers	6
Wildlife crossing structures	44

Source: Authority, 2016

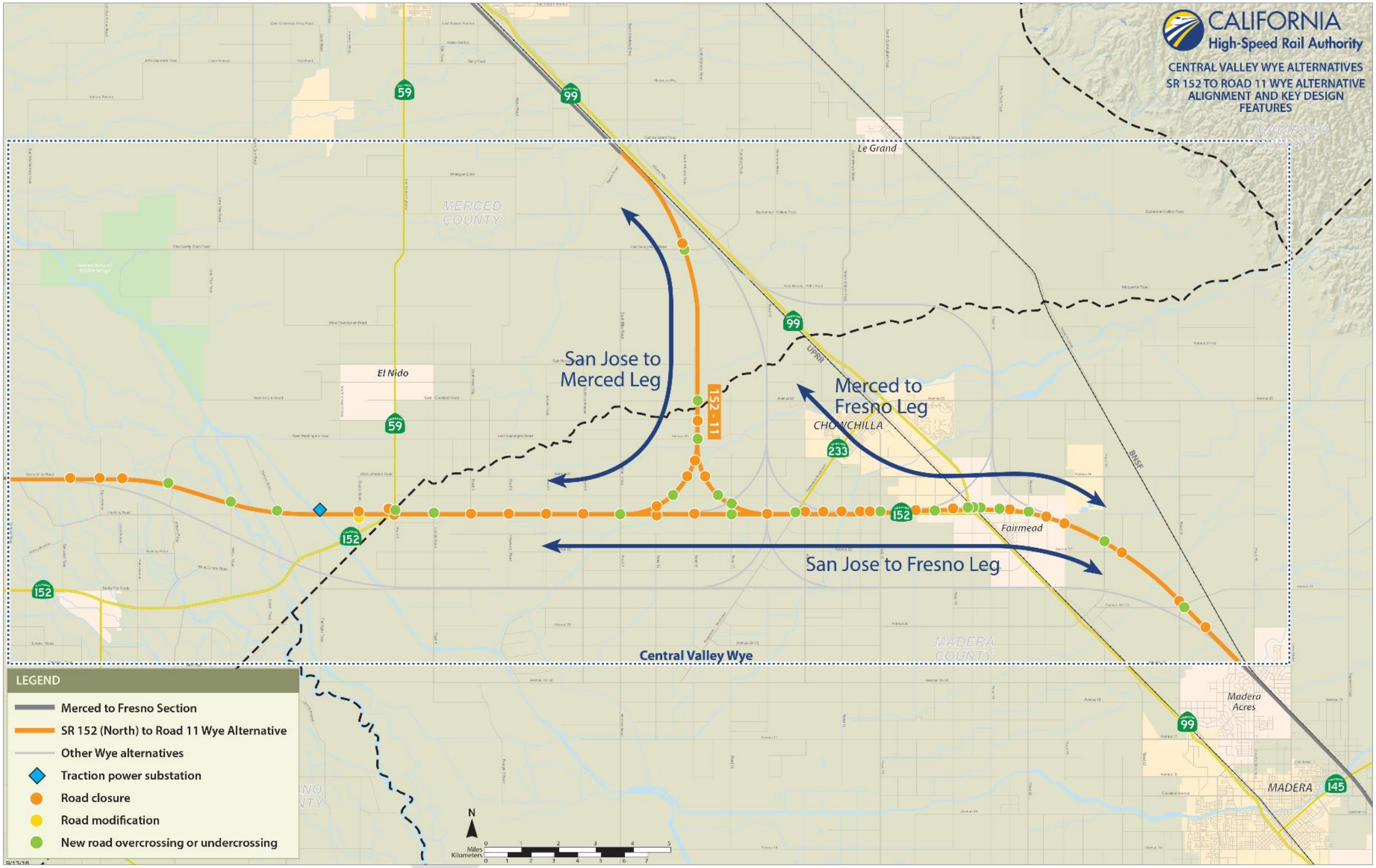
[1] Lengths shown are based on equivalent dual-track alignments and are one-way mileages. For example, the length of single-track elevated structure will be divided by a factor of 2 to convert to dual-track equivalents.

2.5 SR 152 (North) to Road 11 Wye Alternative

The SR 152 (North) to Road 11 Wye Alternative (Figure 2-4) follows the existing Henry Miller Road and SR 152 rights-of-way as closely as practicable in the east-west direction, and the Road 11, SR 99, and BNSF rights-of-way in the north-south direction. Deviations from these existing transportation corridors are necessary to accommodate design requirements; specifically, wider curves are necessary to accommodate the speed of the HSR compared to lower-speed roadway alignments. The SR 152 (North) to Road 11 Wye Alternative would not follow existing transportation rights-of-way where it transitions from following one transportation corridor to another.

2.5.1 Alignment and Ancillary Features

The SR 152 (North) to Road 11 Wye Alternative would extend approximately 51 miles, mostly at-grade on raised embankment, although it would also have aerial structures. The wye configuration of this alternative would be located west-southwest of the city of Chowchilla, with the east-west axis along the north side of SR 152 and the north-south axis on the east side of Road 11.



Source: Authority, 2016; ESRI, 2013;ESRI/National Geographic, 2015

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Figure 2-4 SR 152 (North) to Road 11 Wye Alternative Alignment and Key Design Features

Like the other three alternatives, this alternative would begin in Merced County at the intersection of Henry Miller Road and Carlucci Road, and would continue at-grade on embankment east toward Elgin Avenue, where it would curve southeast toward the San Joaquin River and Eastside Bypass. Approaching Willis Road, the alignment would rise to cross the San Joaquin River on an aerial structure, return to embankment, then cross the Eastside Bypass on an aerial structure. After crossing the Eastside Bypass, this alternative would continue east, crossing SR 59 at-grade just north of the existing SR 152/SR 59 interchange, entering Madera County. To accommodate the SR 152 (North) to Road 11 Wye Alternative, the SR 152/SR 59 interchange would be reconstructed slightly to the south, and SR 59 would be grade-separated to pass above the HSR on an aerial structure. The alignment would continue east at-grade along the north side of SR 152 toward Chowchilla, splitting into two legs (four tracks) near Road 10 to transition to the Merced to Fresno Section: Hybrid Alignment, and would cross Ash Slough on an aerial structure. All but the northbound track of the San Jose to Merced leg of the alternative would then return to at-grade embankment; the northbound track would rise to cross over the tracks of the San Jose to Fresno leg on an aerial structure as it curves north toward Merced. The SR 152 (North) to Road 11 Wye Alternative legs would be routed as described below and shown on Figure 2-4:

The southbound track of the San Jose to Merced leg would turn north at-grade. This split would be west of Chowchilla, at approximately Road 10. The two San Jose to Merced tracks would continue north on the eastern side of Road 11, crossing the Chowchilla River, and then would cross over Road 11 to follow its west side. As the tracks return to grade, they would curve northwest, crossing Dutchman Creek on an aerial structure, following the west side of the UPRR)/SR 99 corridor. The alignment would continue north, crossing over Sandy Mush Road on an aerial structure. The alignment would return to grade and continue along the west side of the UPRR/SR 99 corridor, connecting to the Merced to Fresno Section: Hybrid Alignment at Ranch Road.

- The San Jose to Fresno leg would continue east from the wye split near Road 10, along the north side of SR 152 toward Chowchilla. It would be predominantly at-grade, ascending on aerial structures at several road crossings and Berenda Slough. The leg would pass south of Chowchilla at-grade then rise to cross over the UPRR/SR 99 corridor and Fairmead Boulevard on an aerial structure. East of the UPRR/SR 99 corridor, the alignment would extend at-grade through Fairmead, north of Avenue 23. At approximately Road 20, the leg would curve southeast toward the BNSF corridor and cross Dry Creek on a short aerial structure. The SR 152 (North) to Road 11 Wye Alternative would align parallel to the west side of the BNSF corridor as it meets the Merced to Fresno Section: Hybrid Alignment at Avenue 19.
- The Merced to Fresno leg would split from the San Jose to Fresno leg near Road 13. The southbound track of the Merced to Fresno leg would ascend on an aerial structure and cross over the tracks of the San Jose to Fresno leg. The Merced to Fresno leg would curve northwest, rise on a high embankment crossing over several roads, and continue at-grade on embankment to join the San Jose to Merced leg near Avenue 25.

Wildlife undercrossing structures would be installed in at-grade embankments along this alternative where the alignment intersects wildlife corridors.

2.5.2 State Highway or Local Roadway Modifications

The SR 152 (North) to Road 11 Wye Alternative would require the permanent closure of 33 public roadways at selected locations and the construction of 24 overcrossings or undercrossings in lieu of closure. Table 2-4 and Figure 2-4 show the anticipated state highway and local roadway closures and modifications. Fourteen of these permanent road closures would be located at SR 152 where roads currently cross at-grade but need to be closed in order to convert SR 152 to a fully access-controlled corridor. The 14 proposed closures are Road 5, Road 6, Road 7, Road 8, Road 10, Road 11, Road 13, Road 14, Road 14 1/2, Road 15, Road 15 1/2, Road 15 3/4, Road 17, and Road 18. Planned new grade separations along SR 152 at the SR 59/SR 152 Interchange, Road 4/Lincoln Road, Road 12, and Road 17 1/2 would maintain access to SR 152.

These roadways would be reconfigured to two 12-foot lanes with two 8-foot shoulders. Several of these new interchanges would require realigning SR 152. Three new interchanges are proposed between SR 59 and SR 99 to provide access to SR 152: at Road 9/Hemlock Road, SR 233/Robertson Boulevard, and Road 16.

The distance between over- or undercrossings would vary from less than 2 miles to approximately 5 miles where other roads are perpendicular to the proposed HSR Between these over- or undercrossings, 19 additional roads would be closed. Local roads paralleling the proposed HSR alignment and used by small communities and farm operations may be shifted and reconstructed to maintain their function. Access easements would be provided to maintain access to properties severed by HSR.

2.5.3 Freight or Passenger Railroad Modifications

The SR 152 (North) to Road 11 Wye Alter native would cross over the UPRR right-of-way as it passes south of Chowchilla. This alternative would maintain required vertical (at least 23.3 feet) clearance over UPRR operational right-of-way to avoid or minimize impacts on UPRR rights-of-way, spurs, and facilities (BNSF and UPRR 2007). Horizontal clearance (greater than 50 feet) would be maintained where the SR 152 (North) to Road 11 Wye Alternative would parallel UPRR operational right-of-way.

2.5.4 Summary

Table 2-4 summarizes the design features for the SR 152 (North) to Road 11 Wye Alternative.

Table 2-4 Design Features of the SR 152 (North) to Road 11 Wye Alternative

Feature	SR 152 (North) to Road 11 Wye
Total length (linear miles)[1]	51
At-grade profile (linear miles)[1]	46.5
Elevated profile (linear miles)[1]	4.5
Below-grade profile (linear miles)[1]	0
Number of straddle bents	27
Number of railroad crossings	1
Number of major water crossings	13
Number of road crossings	57
Approximate number of public roadway closures	33
Number of roadway overcrossings and undercrossings	24
Traction power substation sites	1
Switching and paralleling stations	3 switching stations, 7 paralleling stations
Signaling and train-control elements	19
Communication towers	9
Wildlife crossing structures	37

Source: Authority, 2016

[1] Lengths shown are based on equivalent dual-track alignments and are one-way mileages. For example, the length of single-track elevated structure will be divided by a factor of 2 to convert to dual-track equivalents.

2.6 Central Valley Wye Impact Avoidance and Minimization Features

The Authority has developed IAMFs that would avoid or minimize potential effects and mitigation measures that would avoid or reduce significant impacts that exist after the application of all appropriate IAMFs. IAMFs are standard practices, actions, and design features that are incorporated into the Central Valley Wye description. Mitigation measures consist of practices, actions, and design features that are applied to the Central Valley Wye after an impact is identified. Appendix A, California High-Speed Rail Impact Avoidance and Minimization Features for Geology, Soils, and Seismicity, presents complete descriptions of all IAMFs related to geology, soils, and seismicity. Volume 2 of the Supplemental EIR/EIS, Appendix 2-B, California High-Speed Rail: Impact Avoidance and Minimization Features, presents complete descriptions of all IAMFs.

The Authority and FRA will implement the following IAMFs to address potential Central Valley Wye effects on geology, soils, and seismicity. These IAMFs include measures that are specific to geology, soils, and seismicity resources and measures for biological resources, hydrology and water quality, and safety and security that relate to effects on geology, soils, and seismicity:

Geology and Soils

- GEO-IAMF#1: Geologic Resources
  - Groundwater Withdrawal
  - Unstable Soils
  - Subsidence
  - Water and Wind Erosion
  - Soils with Shrink-Swell Potential
- 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

Biological Resources

- BIO-IAMF#20: Dewatering and Water Diversion

Hydrology and Water Quality

- HYD-IAMF#3: Prepare and Implement a Construction Stormwater Pollution Prevention Plan

Safety and Security

- SS-IAMF#2: Safety and Security Management Plan
- SS-IAMF#4: Oil and Gas Wells

3 LAWS, REGULATIONS, AND ORDERS

This section provides a summary of federal, state, and local laws, regulations, orders, or plans that pertain to geology, soils, and seismicity in the geographic area that would be affected by the Central Valley Wye. For complete descriptions, refer to Section 3.9.2, Laws, Regulations, and Orders, of the Merced to Fresno Final EIR/EIS (Authority and FRA 2012a). Where applicable, the summaries that follow identify updates or amendments that have been made since the Merced to Fresno Final EIR/EIS was adopted.

3.1 Federal

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

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

3.2 State

3.2.1 Alquist-Priolo Earthquake Fault Zoning Act (Cal. Public Res. Code, § 2621 et seq.)

The Alquist-Priolo Earthquake Fault Zoning Act provides policies and criteria to assist city, county, and state agencies in exercising their responsibility to prohibit the location of developments and structures for human occupancy across the trace of active faults. This act also requires site-specific studies by licensed professionals for some types of proposed construction within delineated earthquake fault zones.

3.2.2 Seismic Hazards Mapping Act (Cal. Public Res. Code, §§ 2690–2699.6)

The Seismic Hazards Mapping Act requires site-specific hazard investigations be conducted by licensed professionals within the zones of required investigation to identify and evaluate seismic hazards and formulate mitigation measures prior to permitting most developments designed for human occupancy. The San Joaquin Valley has not been investigated by the California Geological Survey to identify these zones, so this law does not apply to the Central Valley Wye.

3.2.3 Surface Mining and Reclamation Act (Cal. Public Res. Code, § 2710 et seq.)

The Surface Mining and Reclamation Act addresses the need for a continuing supply of mineral resources and is intended to prevent or minimize the adverse effects of surface mining on public health, property, and the environment. The act also assigns specific responsibilities to local jurisdictions in permitting and oversight of mineral resources extraction activities.

3.2.4 California Building Standards Code (Cal. Public Res. Code, § 24) (Updated since the Merced to Fresno Final EIR/EIS)

The code governs the design and construction of buildings, associated facilities, and equipment, and applies to buildings in California. Updated provisions in the 2013 Edition of the California Building Code became effective January 1, 2014.

The California Building Standards Code governs the design and construction of buildings and associated facilities and equipment, and applies to buildings in California.

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

The Division of Oil Gas and Geothermal Resources (DOGGR) within the Department of Conservation oversees the drilling, operation, maintenance, and plugging and abandonment of oil, natural gas, and geothermal wells. 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.

3.3 Regional and Local

3.3.1 Dewatering Activities: Permit Varies by Regional Water Quality Control Board

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 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 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.

3.3.2 County or Municipal General Plans (Updated since the Merced to Fresno Final EIR/EIS)

The State of California requires all cities and counties to adopt general plans that provide objectives and policies addressing public health and safety, including protection against the effects of seismic ground motions, fault ruptures, and geological and soils hazards. California Government Code section 65302(g) requires general plans to include a safety element for the protection of the community from any unreasonable risks associated with the effects of seismically induced surface rupture, ground shaking, ground failure, tsunami, seiche, and dam failure; slope instability leading to mudslides and landslides; subsidence; and other geologic hazards known to the legislative body. Both of the counties (Merced and Madera) and the incorporated community (Chowchilla) that the Central Valley Wye would cross have health and safety elements in their general plans and corresponding ordinances to enforce general plan policies related to protection of public health and welfare from geologic hazards. In general, these policies and ordinances require soils engineering and geologic-seismic analysis of development, including public infrastructure, in areas prone to geologic or seismic hazards, and enforcement of the California Building Standards Codes.

Table 3-1 provides a list of the plans and policies adopted by the jurisdictions in the vicinity of the Central Valley Wye. The Authority identified and considered these local general plans and their policies in the preparation of this analysis. Regional plans have not been prepared for the management of geologic resources or seismic risks.

Table 3-1 Local Plans and Policies (Updated since the Merced to Fresno Final EIR/EIS)

Policy Title	Summary
Merced County	
2030 Merced County General Plan (2013) (Updated since the Merced to Fresno Final EIR/EIS)	Merced County adopted the *2030 Merced County General Plan* on December 10, 2013. The general plan includes the following goals and policies: ▪ 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: Require minimal disturbance of vegetation during construction to improve soil stability, reduce erosion, and improve stormwater quality.

Policy Title	Summary
	▪ 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. ▪ Policy HS-1.6: Prohibit habitable structures on areas of unconsolidated landslide debris or in areas vulnerable to landslides. ▪ Policy HS-1.7: Discourage construction and grading on slopes in excess of 30 percent. ▪ Policy HS-1.8: Require that the provisions of the International Building Code be used to regulate projects subject to hazards from slope instability. ▪ Policy HS-1.9: Require and enforce all standards contained in the International Building Code related to construction on unstable soils.
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.
Madera County	
Madera County General Plan Policy Document, Section 4 – Recreational and Cultural Resources, Part D – Historical and Cultural Resources (1995)	The *Madera County General Plan* was adopted in October 1995 and provides the framework for the protection of the county's geological resources. ▪ Policy 5.C.2: The County shall minimize sedimentation and erosion through control of grading, cutting of trees, removal of vegetation, placement of roads and bridges, and use of off-road vehicles. ▪ Policy 5.G.1: The County shall protect unique geologic resources from incompatible development. ▪ Policy 5.I.2: The County shall discourage the development of incompatible land uses in areas that have been identified as having potentially significant mineral resources. ▪ Policy 6.A.1: The County shall require the preparation of a soils engineering and geologic-seismic analysis prior to permitting development in areas prone to geological or seismic hazards (i.e., ground shaking, landslides, liquefaction, critically expansive soils). ▪ Policy 6.A.2: In landslide hazard areas, the County shall prohibit avoidable alteration of land in a manner that could increase the hazard, including concentration of water through drainage,

Policy Title	Summary
	irrigation, or septic systems; removal of vegetative cover, and steepening of slopes and undercutting the bases of slopes. ▪ Policy 6.A.3: The County shall limit the development in areas of steep or unstable slopes to minimize hazards from landslides. Development will be prohibited in areas with 30 percent or more unless it can be demonstrated that such development will not present a safety hazard.
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. ▪ Chapter 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.
City of Chowchilla	
City of Chowchilla 2040 General Plan (2011) (Updated since the Merced to Fresno Final EIR/EIS)	City of Chowchilla adopted the *City of Chowchilla 2040 General Plan* on May 2, 2011. The plan includes the following objectives and policies: ▪ Policy PS 1.1: Areas within the 2040 General Plan Planning Area known to be subject to geologic or seismic instability (e.g., liquefaction, slumping) shall be designated as Open Space to prohibit development and avoid creating a potential public safety hazard. ▪ Policy PS 1.2: Geologic and engineering studies are required for all new and redevelopment projects where known or questionable geological or seismic hazard conditions exist.
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. These are hereby adopted by reference as the Building Code, and made part of this chapter as though set forth in full, save and as set forth such portions as are amended, deleted, or added to as set forth in this chapter.

Sources: Merced County, 2013; Madera County, 1995; City of Chowchilla, 2011

4 METHODS FOR EVALUATING EFFECTS

This section identifies the methods used to evaluate the effects of the Central Valley Wye alternatives on geology, soils, and seismicity in the Central Valley Wye vicinity and includes the definition of resource study areas (RSA) and methods for the effects analysis.

4.1 Definition of Resource Study Area

Three RSAs are defined for effects related to geology, soils, and seismicity.

- The geology, soils, and seismicity RSA is defined as 150 feet on either side of the Central Valley Wye alternatives' footprints for all resources and conditions other than the following two larger RSAs.
- The resource hazards RSA, for such resource hazards as soil failures (e.g., adequacy of load-bearing soils), settlement, corrosivity, expansion, erosion, earthquake-induced liquefaction risks, subsidence, subsurface gas hazards, and mineral and energy resource extraction is the Central Valley Wye footprint plus a 0.5-mile buffer on either side of the project footprint.
- The seismicity, faulting, and dam failure inundation RSA, for earthquake faults and dams, encompasses the San Joaquin Valley within a 65 mile radius of the Central Valley Wye project footprint.

All RSAs for all resource topics evaluated in this section extend beyond the Central Valley Wye footprint and extend into the subsurface beneath the Central Valley Wye alternatives, such that the RSAs are three-dimensional.

4.2 Methodology for Effects Analysis

Analysts reviewed and assessed published maps, professional publications, and reports pertaining to the geology, soils, and seismicity of the Central Valley Wye vicinity to describe the affected environment and evaluate the potential environmental effects of the Central Valley Wye alternatives on geology, soils, and seismicity. This report does not include a discussion of NEPA and CEQA impacts and significance conclusions; that information is presented in Section 3.9, Geology, Soils, Seismicity, and Paleontological Resources, of the Supplemental EIR/EIS. Sources used in this report to evaluate potential effects include:

- U.S. Geological Survey (USGS) topographic maps
- USGS and California Geological Survey (CGS) geologic maps; Natural Resources Conservation Service soils maps
- DWR and USBR reports on water storage and groundwater
- CGS Seismic Hazard Zone maps
- USGS and CGS active fault maps
- USGS and CGS ground-shaking maps
- California Emergency Management Agency's dam inundation maps
- USGS and State of California mineral commodity producer databases
- DOGGR online databases for mineral resources, fossil fuels, and geothermal resources

The analysis in this report includes a review of geotechnical data collected for the current conceptual level of design. These data are summarized in the *Draft 15% Geotechnical Summary Report, California High-Speed Train Project Merced to Fresno Section: Central Valley Wye* (Draft 15% Geotechnical Summary Report) (Authority and FRA 2015). The Draft 15% Geotechnical Summary Report summarized the geologic setting for the Central Valley Wye alternatives, described site conditions, and provided preliminary evaluations and recommendations for addressing geologic hazards, natural chemical hazards and corrosion potential, and foundation support methods.

The geotechnical information presented in the Draft 15% Geotechnical Summary Report and used in this analysis includes representative boring logs along the four Central Valley Wye alternatives, as well as preliminary engineering interpretations. The Authority and FRA obtained much of the information on borings at stream and river crossings. This report also summarizes the results of geotechnical explorations conducted by Caltrans and others along or within the vicinity of the Central Valley Wye alternatives. Further site-specific geotechnical investigations will be conducted to support the final engineering design, which will include a detailed design of specific structures and foundations.

The effects analysis evaluates two risks:

- The potential of the proposed Central Valley Wye to increase the risk of personal injury, loss of life, and damage to property, including planned but not yet constructed facilities, as a result of existing geologic, soil, and seismic conditions
- The potential adverse effects of the Central Valley Wye on the existing geology, soils, and seismicity, such as erosion of topsoil

Both of these risks describe direct effects. The Central Valley Wye would not have any indirect effects on geology, soils, and seismicity.

The sections that follow describe the specific methods used to evaluate effects on soils, geologic hazards, primary seismic hazards, secondary seismic hazards, areas of difficult excavation, and resource hazards.

4.2.1 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 effects on expansive, erodible, or corrosive soils. NRCS soil survey data were also used to determine potential effects from the Central Valley Wye alternatives on soils associated with alluvial, floodplain, and basin areas.

4.2.2 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 California Geological Survey (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 et al. 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.

4.2.3 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 were considered. Direct primary seismic effects evaluated included surface fault ruptures, permanent offsets at the ground surface, and ground shaking.

4.2.4 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 as described above for primary seismic hazards (USGS 2015) were used, but analysts also utilized NRCS soil survey data (USDA-NRCS 2016, 2010, 2008, 2007, 2006), 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 and Madera 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 and DWR 2003; Merced County 2000).

4.2.5 Areas of Difficult Excavation

Analysts performed a qualitative analysis for effects 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 to determine specific locations where difficult excavations may occur and to plan for this during construction.

4.2.6 Resource Hazards

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

5 AFFECTED ENVIRONMENT

This section describes the affected environment for geology, soils, and seismicity in the Central Valley Wye vicinity, including the physiography and regional geologic setting, geologic hazards, primary and secondary seismic hazards, and geological resources.

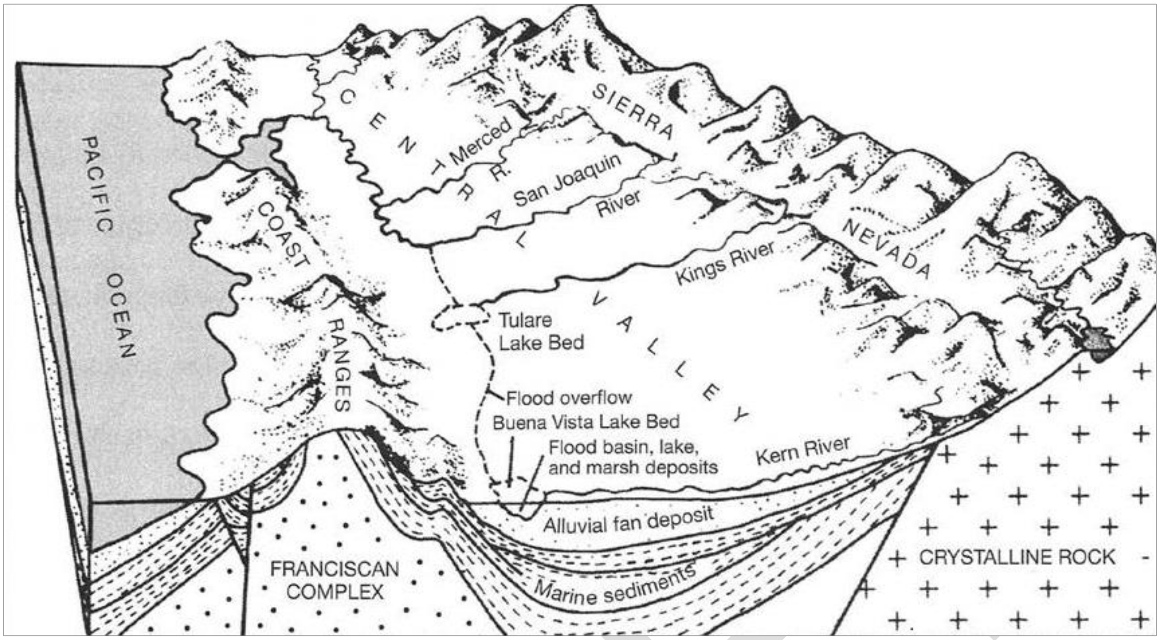
5.1 Physiography and Regional Geologic Setting

5.1.1 Physiography

The Central Valley Wye geology, soils, and seismicity RSA is in the Great Valley geomorphic province, which is characterized by relatively flat topography. The Great Valley is formed by the Great Valley geocline, which is a large, elongated, northwest-trending asymmetric structural trough. The northwest-trending axis of the geocline is closer to the western side of the valley, with the regional dip of the formations on the eastern side being less than that of the formations on the western side. The valley is bordered by the Coast ranges to the west, the Klamath Mountains and Cascade range to the north, the Sierra Nevada to the east, and the San Emigdio and Tehachapi Mountains to the south. Figure 5-1 shows a schematic depicting a transverse cross-section through the southern San Joaquin Valley.

The structural trough has a long, stable eastern shelf supported by metamorphic and igneous rocks of the west-dipping Sierran slope. The basement rocks of the western edge of the structural trough are composed of Jurassic-aged metamorphic, ultramafic, and igneous rocks of the Franciscan complex (Hackel 1966). This structural trough began receiving sediments in the late Jurassic period (208–145 million years ago). It has been filled with sediments derived from both marine and continental sources. The thickness of the valley sediments ranges from thin veneers along the valley edges to greater than 40,000 feet in the central portion of the valley. These sedimentary deposits range in age from the late Jurassic (208–145 million years ago) to Holocene (0–0.01 million years ago) epochs, with the older deposits (Jurassic to Eocene 55.8 to 33.9 million years ago) composing the marine sequence, and the younger deposits (Eocene to Holocene age) composing the continental sequence. The marine deposits were formed in offshore, shallow ocean shelf and basin environments. Continental sediments were derived from mountain ranges surrounding the valley and were deposited in lacustrine, fluvial, and alluvial environments (Norris and Webb 1990).

The Great Valley can be divided into the Sacramento Valley to the north and the San Joaquin Valley to the south, with the dividing line between the two at approximately the Sacramento River-San Joaquin River Delta. The Central Valley Wye is in the northern part of the San Joaquin Valley. The topography in this part of the Central Valley is flat. In the Central Valley Wye geology, soils, and seismicity RSA, there are approximately 200 feet of relief within an area approximately 28 miles in an east-west direction and 24 miles in a southeast-northwest direction. The western end of the geology, soils, and seismicity RSA at Carlucci Road is at an elevation of about 100 feet (WGS84 Datum). The northern extent at Ranch Road is at an elevation of about 195 feet, and the southern extent at Avenue 19 is at approximately 280 feet (Google Earth Pro 2016). A general downward gradient occurs in the geology, soils, and seismicity RSA to the west-southwest, determined principally by the gentle slope of the vast alluvial fans extending from the Sierra Nevada in the east to the center of the San Joaquin Valley.



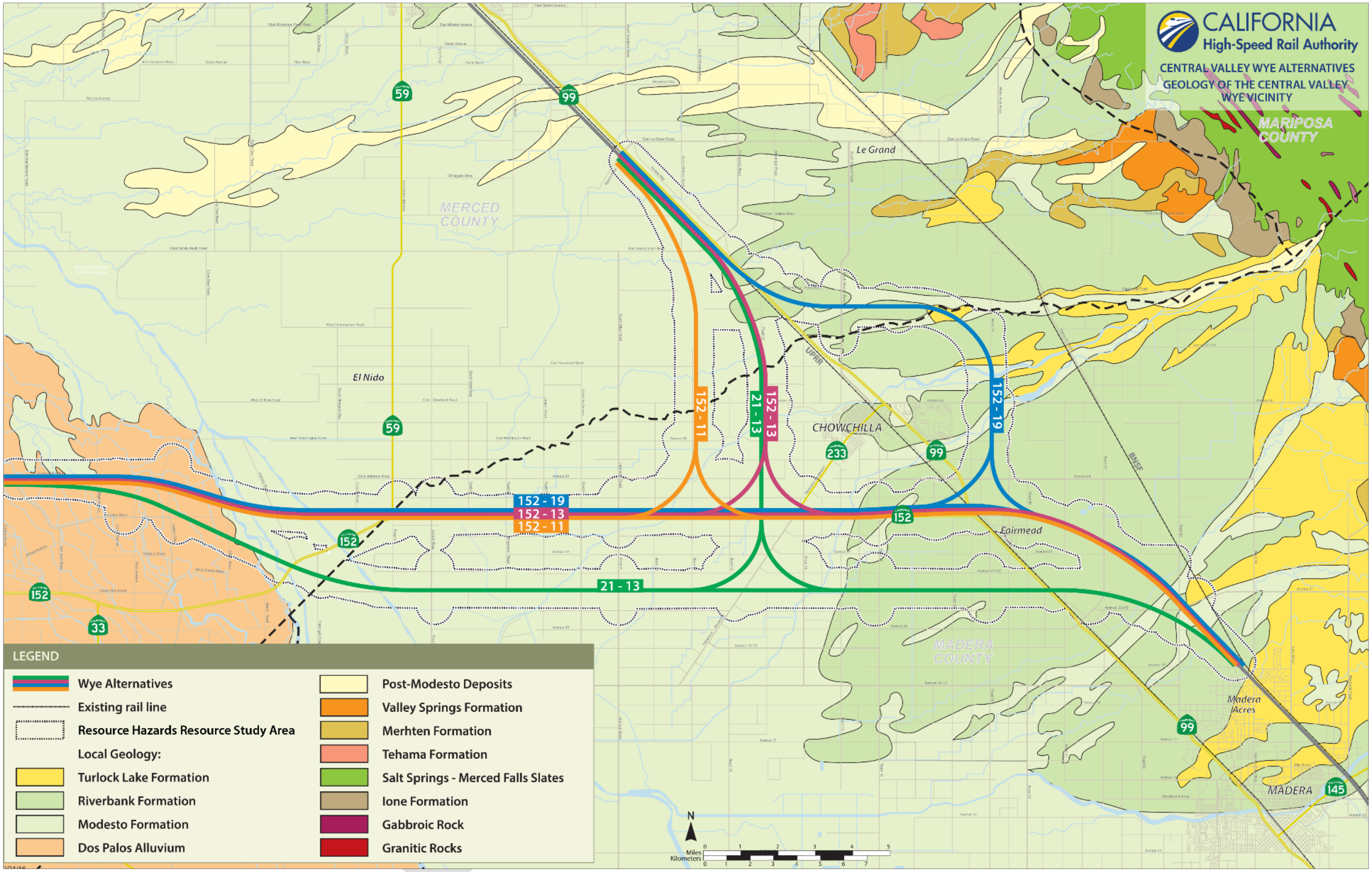
Source: Harden, 1998

Figure 5-1 Schematic Block Diagram, Southern San Joaquin Valley

5.1.2 Geology

This section discusses the geologic conditions of the Central Valley Wye vicinity with reference to the Central Valley Wye geologic map (Figure 5-2). The geologic map shows the locales of the various soil and rock units in the vicinity of the Central Valley Wye alternatives, as mapped by Marchand and Allwardt for the USGS (1978). Sediments underlying the Central Valley Wye are mostly derived from the Sierra Nevada range as they were washed into the valley and deposited by streams and mudflows as coalescing alluvial fans. Riverine, flood-basin, and lacustrine deposits underlie much of the basin floor of the San Joaquin Valley. In general, the mapped geologic units within the Central Valley Wye corridor include (from oldest to youngest) the Turlock Lake, Riverbank, and Modesto Formations, Dos Palos Alluvium, and post-Modesto Deposits. The Modesto, Riverbank, and Turlock Lake Formations are all Pleistocene in age and compose the major surface and near-subsurface stratigraphic and lithologic units in most of the Central Valley Wye vicinity. Dos Palos Alluvium, which is Holocene to late Pleistocene in age, blankets the older deposits to the west of the San Joaquin River. These formations are similar because of the arkosic (feldspar-rich) nature of their sand and silt components. Table 5-1 provides a summary of the geology of the Central Valley Wye vicinity.

The alluvium that covers the San Joaquin Valley floor consists predominantly of silt with gravel, sand, and some clay. These alluvial deposits have been divided into stratigraphic units based on geologic age, depositional environment, sediment source, geomorphology, and soil type. The Quaternary age alluvium within the Central Valley Wye vicinity (dated up to 1.6 million years old) includes all geologic formations identified in Table 5-1 and extends to depths of approximately 100 feet at the eastern extent of the Central Valley Wye to over 500 feet at the western extent. The Quaternary age alluvium is underlain by unconsolidated to weakly consolidated Tertiary alluvium extending to much greater depths. The Quaternary alluvial deposits are mainly of fluvial (river) origin but contain several extensive interbeds of lacustrine (lake) origin. The lenses of fluvial deposits consist of stream channel sediments of sand, gravel, and silt and extensive overbank deposits of finer grained sediments of clay and silt. The basement rock underlying the alluvial-filled San Joaquin Valley consists of metamorphic and granitic rock of the Sierra Nevada block.



Source: *CGS, 1991*

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Figure 5-2 Local Geological Map

Table 5-1 Summary of Mapped Geology of Resource Study Area

Geologic Formation	Geologic Unit Type	Description
Post-Modesto Deposits	Holocene	Alluvial deposits close to modern drainage ways
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, it varies from depths of approximately 165–755 feet, thickening toward the west

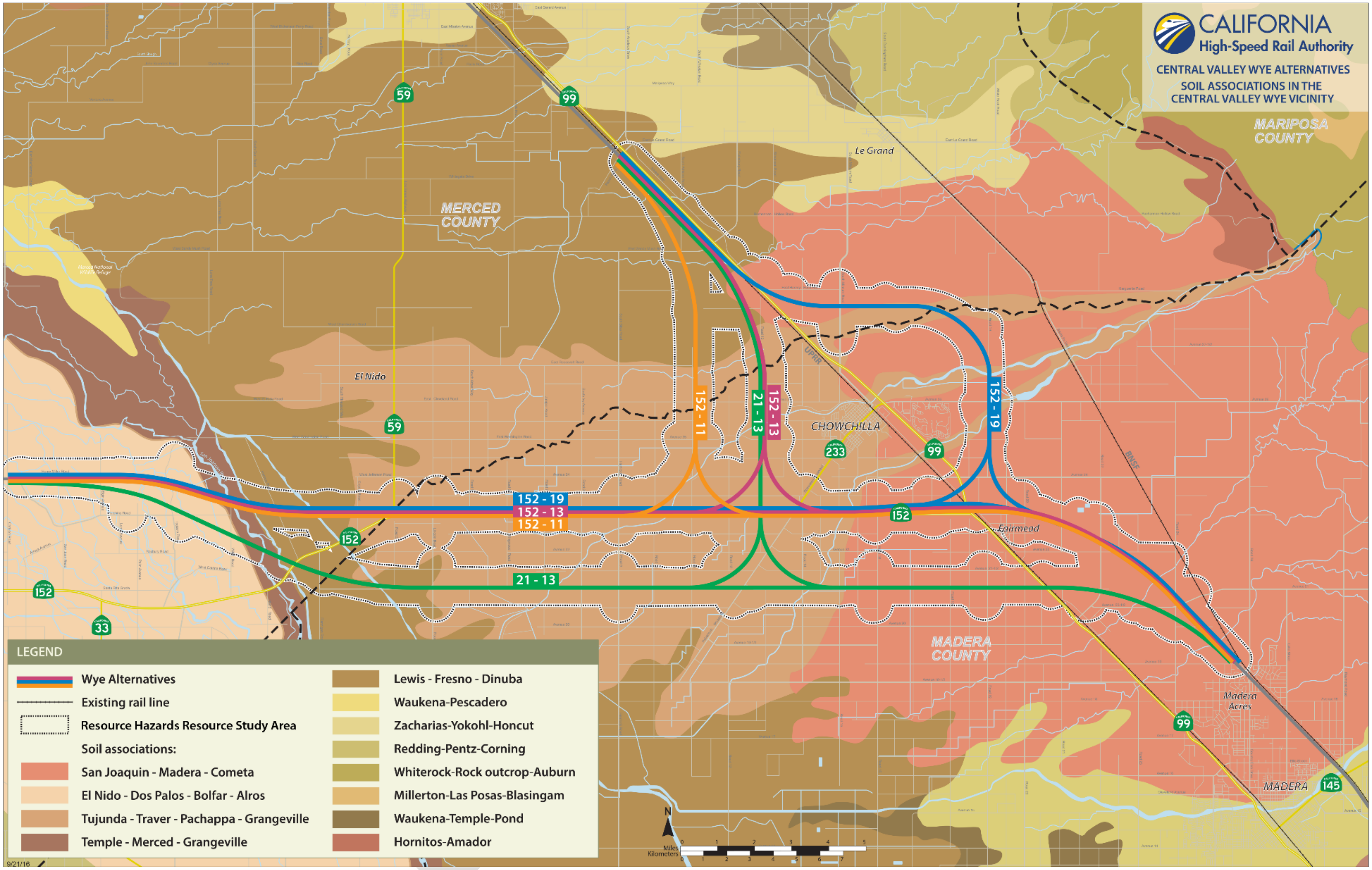
Source: Authority and FRA, 2015

5.1.3 Soils

Soils are typically considered for their resource value in agricultural production or for their potential development characteristics or constraints. Depending on type, some soils are susceptible to erosion or expansive behavior, while others are more suitable for construction. Since the 1930s, various government agencies and universities have conducted soil type mapping, emphasizing a soil's agricultural and engineering properties. Typically, the mapping is conducted on a county-wide (or geographic) basis using nomenclature that changes with time. Accordingly, soil descriptors can change at the county line and not be directly transferable from one county to another. Figure 5-3 illustrates soil associations along the Central Valley Wye alternatives, and represents a recent database compiled by the Natural Resources Conservation Service, the successor to the Soil Conservation Service, an agency within the U.S. Department of Agriculture (NRCS 2006). The Natural Resources Conservation Service soil types presented on this figure that are crossed by the Central Valley Wye alternatives are summarized in Table 5-2, which also indicates the susceptibility to various hazards. The soil hazards[6] present in the resource hazards RSA are described in this section.

- **Expansive Soils**—Clay soils that are susceptible to expansion and contraction swell with an increase in water content and shrink with a decrease in water content. Expansive soils provide an unstable subgrade support for foundations or other structures, and exert uplift or lateral pressures on foundations or walls with which they are in contact. Soils defined as expansive by the NRCS correspond closely to expansive soils as defined under current California Building Standards Code Section 1803.5.3 Expansive Soil. The NRCS recognizes a gradation of expansiveness from low to high, whereas California Building Standards Code recognizes only two categories: expansive and 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 (NRCS 2016).

[6] Hydrocompaction hazard is present in the extreme western edge of the San Joaquin Valley but not in the resource hazards RSA. 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 approximately 20 miles south of the resource hazards RSA (Authority and FRA 2015)



Source: NRCS, 2006

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Figure 5-3 Soil Associations in the Central Valley Wye Vicinity

Table 5-2 Resource Study Area Soil Types

Soil Association	SR 152 (North) to Road 13 Wye Alternative (acres)	SR 152 (North) to Road 19 Wye Alternative (acres)	Avenue 21 to Road 13 Wye Alternative (acres)	SR 152 (North) to Road 11 Wye Alternative (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 ▪ Moderate to highly corrosive to uncoated steel ▪ Slightly corrosive to concrete ▪ Medium to coarse texture soils susceptible to erosion ▪ Moderate potential for water erosion ▪ High potential for wind erosion
Lewis-Fresno-Dinuba	7,984	6,027	8,628	6,498	Merced and Madera		
Tujunga-Traver-Pachappa-Grangeville	15,601	14,892	13,982	15,562			
San Joaquin- Madera-Cometa	10,519	16,935	9,964	10,062	Merced and Madera	Older, low alluvial terraces	▪ High expansion potential ▪ Highly corrosive to uncoated steel ▪ Moderately corrosive to concrete ▪ Moderate potential for water erosion ▪ High potential for wind erosion
El Nido-Dos Palos-Bolfar-Alros	4,979	4,977	6,584	4,930	Merced	Basin areas (including saline-alkali basins)	▪ Moderate expansion potential ▪ Highly corrosive to uncoated steel ▪ Moderately corrosive to concrete ▪ High potential for water erosion ▪ Moderate to high potential for wind erosion

Source: NRCS, 2010

The soils within the Central Valley Wye vicinity generally occur within one of the three landform groups, as summarized in this section:

- **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. Consequently, alluvial fans tend to be coarse-grained, especially at their mouths where the energy of the stream or river is still high. At their edges, however, where energy levels can be low to quiescent, they can be relatively fine-grained. They are developed in nearly level and gently sloped ground conditions, along drainage ways, on alluvial fans, and on floodplains. Characteristics often vary greatly within short distances because the soils developed within compositionally variable stream deposits. Some areas may have compacted silt or sand or an iron-silica hardpan. Typically, these soils have little clay content, exhibit low to moderate expansion potential, are moderately to highly corrosive to uncoated steel, and are slightly corrosive to concrete. These soils also have slight potential for water and wind erosion, and some areas are slightly to moderately saline and alkaline at depths of 4–5 feet.
- **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. The hardpan can be composed of cemented silica or clay. These soils contain expansive clays, resulting in moderate to high expansion potential. These soils are highly corrosive to uncoated steel and moderately corrosive to concrete. They can have a moderate potential for water erosion and a high potential for wind erosion.
- **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. Most of these soils have cemented lime-silica hardpans in the subsoil. These soils exhibit low to high expansion potential, are highly corrosive to uncoated steel, and are moderately corrosive to concrete. They are also moderately to highly susceptible to water and wind erosion.

5.2 Geologic Hazards

5.2.1 Landslide Hazards

Landslides occur as a result of the downward movement of masses of loosened soil or rock down a hillside or moderately steep slope. Fundamentally, landslides are the result of a hill slope material's loss of strength, often because of an increase in pore-water pressures and the forces of gravity, causing a tendency to move downward. The high variability of landslides is caused by many factors including, but not limited to, steepness of slope, type of material, water content of slope soils, amount of vegetation, areas subject or prone to soil loss because of human activities, and earthquake or strong ground motions. Landslide categories vary from fast-moving debris flows to slow-moving soil creep.

The San Joaquin Valley is generally a broad, featureless alluvial plain that is relatively flat in its geomorphic expression. The lack of significant slopes in the vicinity of the Central Valley Wye indicates that the hazard from slope instability in the form of landslides or debris flows is considered low; however, potential may exist for localized small slides and minor slumps where the HSR would cross steeper river banks and creeks.

5.2.2 Ground Subsidence

Ground subsidence is the result of fluid (water or petroleum) extraction from underlying formations that causes the collapse of pore spaces previously occupied by the removed fluid. Subsidence is a gradual drop in ground surface elevation, unlike rapid collapse over a mine shaft or tunnel. It is most often caused by the large volumetric withdrawals of fluids from underground reservoirs. In many cases, ground shaking caused by tectonic activity can exacerbate the vertical sinking of land in an area over the withdrawal site. If volumes of either water, petroleum, or mined minerals removed from the subsurface are sufficiently great, the resulting subsidence may damage engineered structures. Subsidence depends on geologic and soil conditions and viable factors such as rainfall, aquifer draw, and recharge rates. Consequently, its occurrence is difficult to predict, but 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 localized angular distortions (resulting because a curved line is longer than a straight line) are sufficiently small that they are not expected to result in any substantial localized differential settlement. Furthermore, as the ground elevation lowers, subsidence has the potential to increase the area of depth of a floodplain. The USGS has documented subsidence across the San Joaquin Valley, including the Central Valley Wye area (Sneed et al. 2013). The Central Valley Wye alternatives would cross the Los Banos-Kettleman 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 subsidence (AMEC 2016). Questions included, for example, whether they observed that localized subsidence had had an effect on 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.

Four types of ongoing regional subsidence have been recognized in the San Joaquin Valley. In order of significance, they are: (1) subsidence resulting from consolidation settlement of unconsolidated deposits that occurs in response to groundwater pumping and associated lowering of groundwater levels; (2) subsidence because of saturation of loose alluvial and mudflow deposits (hydrocompaction); (3) subsidence because of oil and gas extraction; and (4) tectonic subsidence (Galloway et al. 1999). Of these, groundwater pumping and aquifer-system compaction and hydrocompaction have markedly lowered the ground surface across portions of the San Joaquin Valley. Comprehensive surveys undertaken in 1970 and 1983 determined that regional subsidence of 1 foot or more had affected about one-half of the entire San Joaquin Valley. Subsidence of more than 28 feet by 1970 and 29.7 feet as of 1981 was measured west of Mendota (Galloway et al. 1999, Ireland 1986). 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 (DWR and USBR 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 SR 152. The California Department of Water Resources measured 2.5 to 3 feet of subsidence on the Eastside Bypass levees from 2008 to 2012. Public agencies, private agencies, and consultants have formed a Subsidence Coordination Group under the auspices of the San Joaquin River Restoration Program to study and evaluate the groundwater overdraft issue and determine possible mitigations and solutions to eliminate future subsidence (Morberg pers. comm.).

The second type of ground settlement identified in the San Joaquin Valley is known as *hydrocompaction* (also hydrocompression and hydrocollapse), which occurs in areas underlain by collapsible soils. Such soils are deposited in a loose, highly porous state, then harden and remain essentially dry after deposition. The loose, porous structure of the soil is maintained by cementation along the particle edges by clay minerals, calcium carbonate, or other agents that are water soluble or prone to softening when saturated. In the San Joaquin Valley, the cementation is due largely to the clay mineral montmorillonite. Although these bonds between soil particles are strong enough to support more than 100 feet of overburden, softening of the bonding agent can result in a bulk volume change of the soil by as much as 10 percent.

Of the four types of subsidence, three are likely to affect the Central Valley Wye: (1) subsidence resulting from consolidation settlement of unconsolidated deposits that occurs in response to groundwater pumping and associated lowering of groundwater levels, (2) subsidence because of oil and gas extraction, and (3) tectonic subsidence. Hydrocompaction does not occur in the Central Valley Wye resource hazards RSA.

5.2.3 Poor Soil Conditions

Soil conditions generally considered to have a negative effect on engineered facilities include expansivity, corrosion potential, collapsible properties, and erosion potential. Each of these attributes, based on county soil surveys and summarized in Table 5-2, is discussed in this section for the Central Valley Wye alternatives.

5.2.3.1 Expansive Soils

Expansive soils are those that undergo a significant increase in volume during wetting, and shrink in volume as they dry (e.g., decrease in water content). Expansive soils can cause significant damage to structures because of increases in uplift pressures. Soils are generally classified as having low, moderate, and high expansive potentials, where the type and percentage of clay particles present in the soil are indicative of the soil's expansion potential. Predominantly fine-grained soils containing a high percentage of clays are potentially expansive, whereas predominantly coarse-grained soils such as sands and gravels are generally non-expansive.

Table 5-2 summarizes the expansive potential of soils traversed by the Central Valley Wye alternatives, and Figure 5-4 illustrates expansive soils in the Central Valley Wye vicinity. As shown on the figure, the potential for moderately expansive soils along the alternatives occur:

- Along the western portion between Carlucci Road and the San Joaquin River
- East of the San Joaquin River to Lincoln Road
- Along Road 13 between SR 152 and SR 99
- South of Fairmead between Road 15 and Road 23

Highly expansive soil potential exists along the Central Valley Wye alternatives:

- Western portion at Carlucci Road
- Along the San Joaquin River
- East of SR 99 along Road 19
- Northern portion of the Central Valley Wye alternatives along SR 99

5.2.3.2 Soil Corrosivity

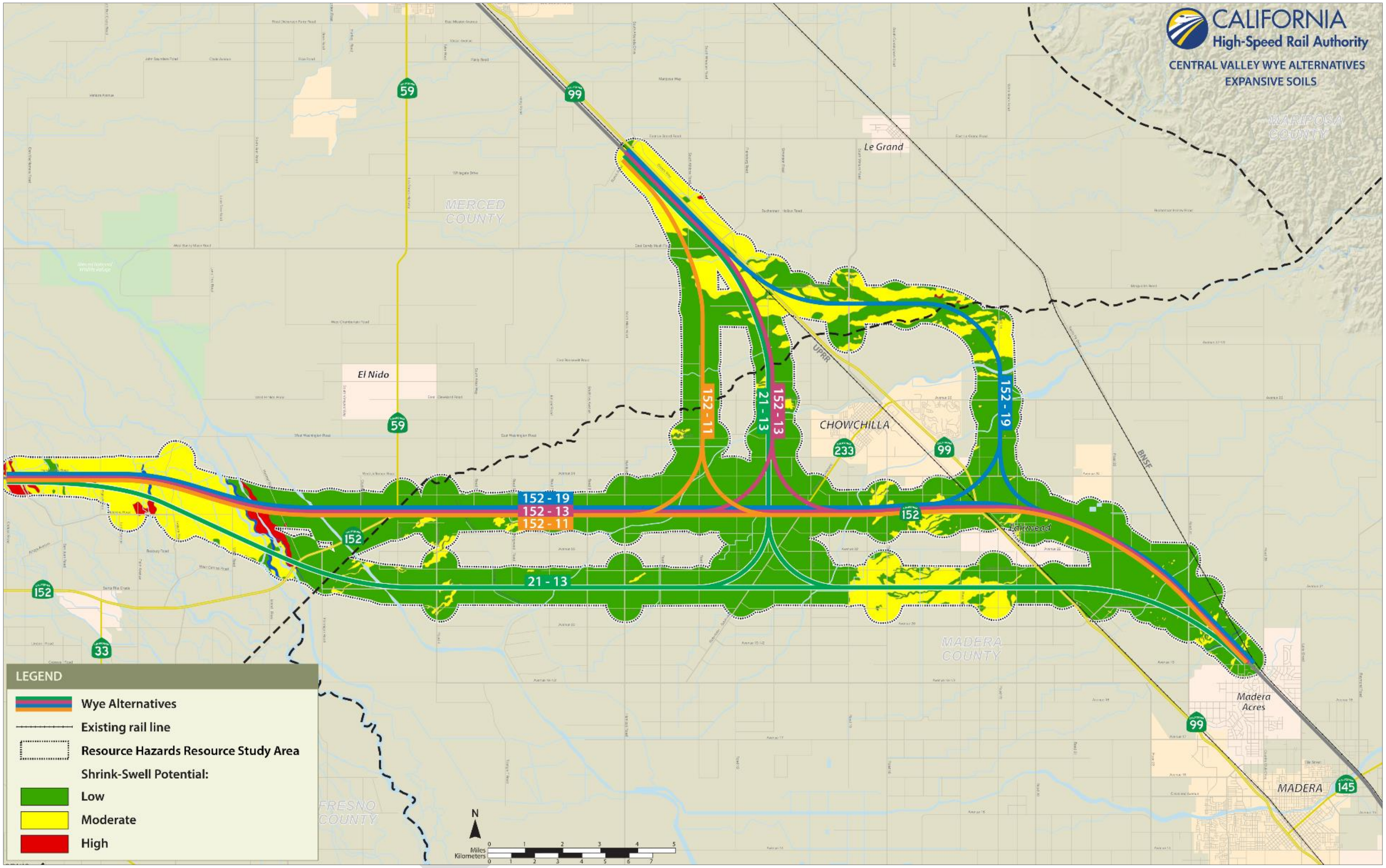
Soil corrosivity involves the measure of the potential of corrosion for steel and concrete caused by contact with some types of soil. Knowledge of potential soil corrosivity is often critical for the effective design parameters associated with cathodic protection of buried steel and concrete mix design for plain or reinforced concrete buried Central Valley Wye elements. Factors—including soil composition, soil and pore water chemistry, moisture content, and pH—affect the response of steel and concrete to soil corrosion. Soils with high moisture content, high electrical conductivity, high acidity, and high dissolved salts content are most corrosive. In general, sandy soils have high resistivities and are the least corrosive. Clay soils, including those that contain interstitial salt water, can be highly corrosive. Table 5-2 shows soil types with the potential to cause corrosion to Central Valley Wye infrastructure.

Figure 5-5 presents an illustration of the potential for corrosion to occur between native soil and buried concrete for the Central Valley Wye alternatives. Most of the Central Valley Wye exhibits a low potential for concrete corrosion except for the following:

- Moderate potential near San Joaquin River and Mariposa Slough, Lincoln Road, Road 11, and Road 13
- High potential east of the San Joaquin River along Flanagan Road, north of SR 152 along Road 11 and Road 13, and the northern portion of the resource hazards RSA along SR 99

Figure 5-6 is similar to Figure 5-5, except it illustrates potential corrosivity between native soils along the Central Valley Wye alternatives and buried, uncoated steel. In this case, the western and northern portions of the Central Valley Wye exhibit high potential for corrosion. East of Road

13 and south of the Chowchilla River, the resource hazards RSA exhibits a predominantly low potential for uncoated steel corrosion.



Source: USDA-NRCS SSURGO, 2007, 2008, 2010

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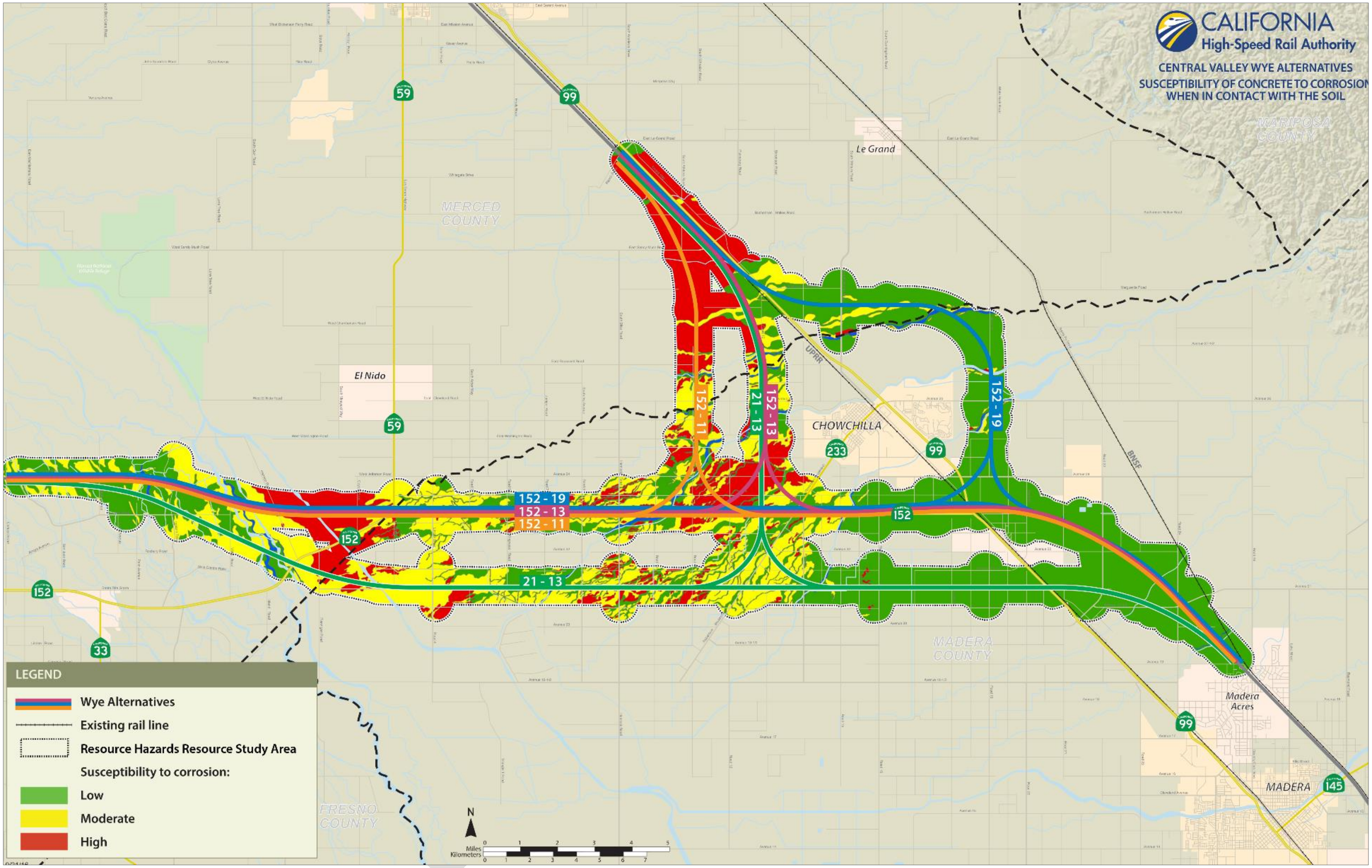
Figure 5-4 Expansive Soils in the Central Valley Wye Resource Study Area



Source: *USDA-NRCS SSURGO, 2007, 2008, 2010, 2016*

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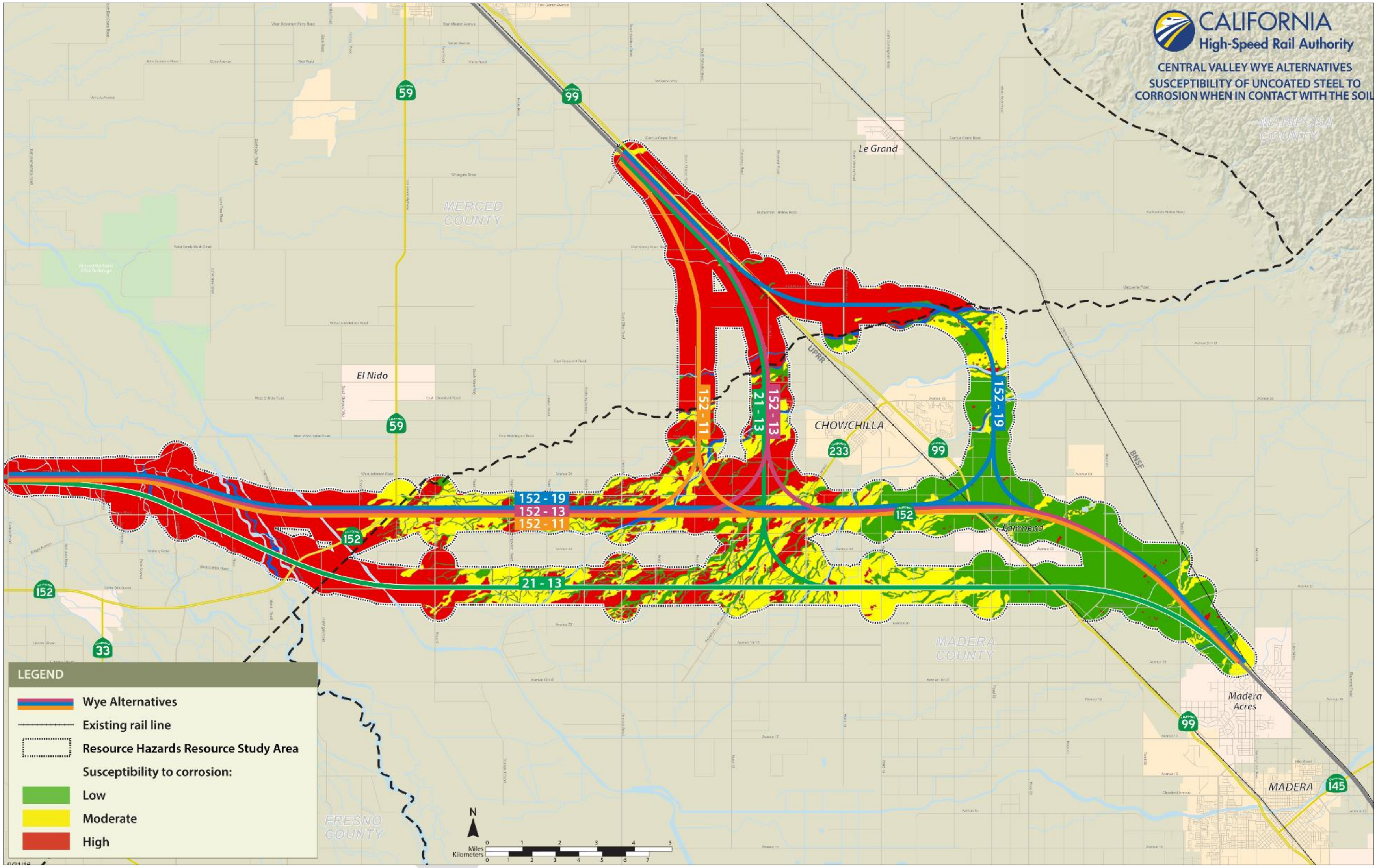
Figure 5-5 Susceptibility of Concrete to Corrosion when in Contact with the Soil



Source: *USDA-NRCS SSURGO, 2007, 2008, 2010, 2016*

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Figure 5-6 Susceptibility of Uncoated Steel to Corrosion when in Contact with the Soil

5.2.3.3 Collapsible Soils

Collapsible soils are soils that undergo settlement upon the addition of water, which weakens or destroys soil particle bonds of loosely packed structure, reducing the bearing capacity of the soil. Other mechanisms for soil collapse include the sudden closure of voids in a soil, whereby the sudden decrease in volume results in loss of the soil's internal structure, causing the soil to collapse. Specific soil types, such as loess and other fine-grained aeolian (e.g., wind-blown or deposited) soils, are most susceptible to collapse.

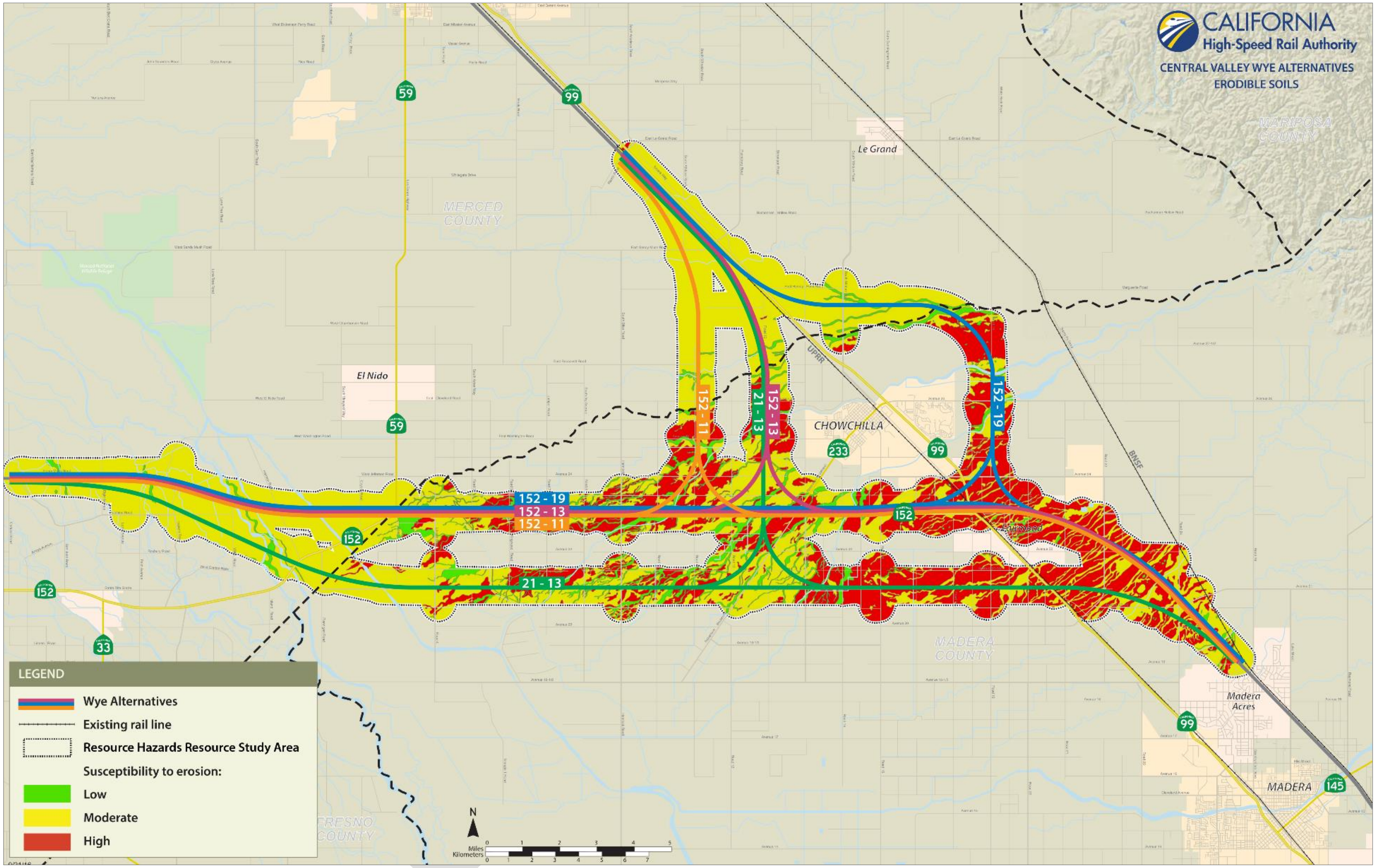
Collapsible soils in the San Joaquin Valley tend to occur locally along its western and southern margins as near-surface alluvial fan deposits, and commonly as mudflows, that remain above the natural water table. The nearest area of soils prone to hydrocompaction is located more than 20 miles south of the resource hazards RSA (Geotechnical Consultants, Inc. 2012). Hydrocompaction is not considered a significant geologic hazard in the vicinity of the proposed Central Valley Wye alternatives.

5.2.3.4 Erodible Soils

Certain soil types demonstrate a higher potential for erodibility because of the forces of flowing or impinging water (rainfall and runoff) than other soil types. This is expressed in the Revised Universal Soil Loss Equation by a factor designated K, the soil erodibility factor. The Authority noted evidence of active erosion in water channels between the SR 152 East Bypass Bridge and the bridge crossing at Avenue 21 in Madera County. Deep erosion gullies had developed in the silt and sand exposed by the channel and remedial work had been performed to protect the foundation pile columns supporting the Avenue 21 Bridge. Figure 5-7 presents the relative soil erodibility factors along the lengths of the Central Valley Wye alternatives. In this case, K is defined as a function of texture, organic matter content and cover, structure size class, and subsoil-saturated hydraulic conductivity. Soils with a relatively high silt content and low to negligible plasticity tend to be the most erodible; as a rule of thumb, values of K in excess of 0.4 are considered to be highly susceptible to erosion.

Figure 5-7 indicates that most of the Central Valley Wye alternatives would not be located in areas that are particularly susceptible to erosion. However, the following reaches show a K value greater than 0.4 and are therefore highly susceptible to erosion:

- Intermittently along SR 152 surrounding the SR 152 (North) to Road 13 Wye and SR 1525 (North) to Road 11 Wye alternatives
- Northern portion of the resource hazards RSA along SR 99, Road 13, Road 19, and Road 11
- Along Avenue 21 between approximately Road 15 and Road 19



Source: *USDA-NRCS SSURGO, 2007, 2008, 2010, 2016*

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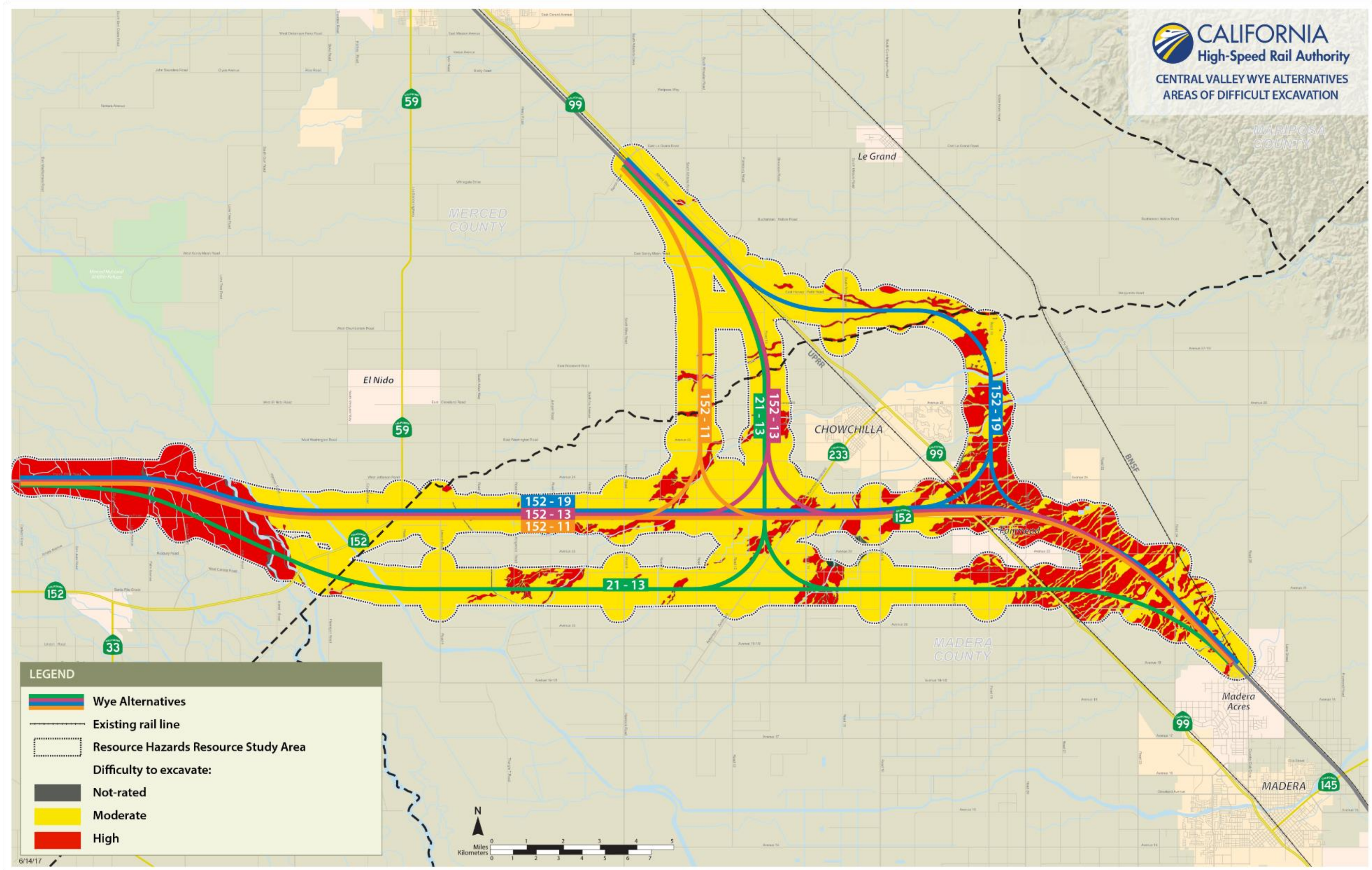
Figure 5-7 Erodible Soils in the Resource Study Area

5.2.4 Areas of Difficult Excavation

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 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 within the resource hazards RSA and can be rock-like in consistency. Cemented zones and hardpan form as a result of the soil-weathering process and are found in the subsoil in most of the surficial site soils previously described. These zones also can be difficult to excavate with conventional machinery, depending on the hardpan's or cemented layer's thickness and degree of cementation. 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. 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, along with infrastructure development in the resource hazards RSA, should limit the locations where hardpan and cemented zones pose potential difficulties for excavation.

It is possible that the combinations of soil conditions and 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. Any time 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 encountered on a widespread basis, localized areas where groundwater is near the surface and loose soil conditions exist cannot be ruled out, especially near stream crossings. 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 to plan for this during construction. Figure 5-8 indicates soils along the Central Valley Wye alternatives where difficult excavation conditions may be encountered. All of the wye alternatives in the resource hazards RSA traverse soils 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 involves a short section of tunnel with moderate difficulty to exacavate soils.



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

FINAL – JUNE 14, 2017

Figure 5-8 Difficult to Excavate Soils in the Resource Study Area

5.3 Primary Seismic Hazards

Primary seismic hazards are those hazards directly associated with earthquakes. These hazards include ground surface fault rupture and strong ground shaking.

5.3.1 Surface Fault Rupture

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 (e.g., 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.

The state enacted the Alquist-Priolo Earthquake Fault Zoning Act to regulate certain development projects near active faults to help identify and reduce the hazard of surface fault rupture. The purpose of the act is to prohibit the location of most structures intended for human occupancy across the trace of an active fault. The act requires that development permits for projects in “Earthquake Fault Zones” be withheld until geologic investigations demonstrate that the sites are not threatened by surface displacement from future fault rupture. To be zoned under the Alquist-Priolo Earthquake Fault Zoning Act, a fault must be considered active, or both sufficiently active and well-defined (CDMG 1997). The CGS defines an *active* fault as one that has had surface displacement within Holocene time (about the last 11,000 years) and a *sufficiently active* fault as one that has evidence of Holocene surface displacement along one or more of its segments or branches (CDMG 1997). The CGS considers a fault to be well defined if its trace is clearly detectable as a physical feature at or just below the ground surface.

To reduce confusion concerning fault activity and avoid duplication of the terms *active* and *potentially active* (which are codified in the text of the Alquist-Priolo Earthquake Fault Zoning Act), this document follows the nomenclature proposed by the Engineering Management Team in Technical Memorandum TM2.9.3. That document describes the identification of potential faults to be an iterative process beginning with the identification of potentially active and active faults, defined as:

- **Potentially Active Faults**—those faults exhibiting a ground rupture that occurred between 11,000 and 1.6 million years ago.
- **Active Fault**—those faults either having known or documented Holocene activity.

The terms *active* and *potentially active* are therefore used in this technical report. Figure 5-9 shows active and potentially active faults in the region.

The Central Valley Wye alternatives would not lie within a current Alquist-Priolo Earthquake Fault Zone or cross any mapped fault exhibiting offset of geologically recent deposits. Based on the available data obtained for this study, the potential hazard posed by surface rupture from fault offset is considered very low.

Source: USGS, 2010

FINAL – JULY 15, 2016

Figure 5-9 Regional Faults

5.3.2 Seismic Sources

As noted in Section 5.3.1, Surface Fault Rupture, the seismicity, faulting, and dam failure inundation RSA does not traverse any current Alquist-Priolo Earthquake Fault Zone where the State of California considers the hazard of fault rupture to be significant. Table 5-3 lists significant regional faults exhibiting geologically recent (late Pleistocene or Holocene) activity and considered capable of causing strong ground shaking along the proposed railway alignment.

Table 5-3 Significant Active Faults

Fault	Distance and Direction[1] (miles)—direction	Maximum Moment Magnitude (M)[2]
Great Valley	29—west	N/A
Ortigalita	37—west	7.1
Quien Sabe	53—southwest	6.6
Calaveras	57—southwest	7.0
San Andreas	59—southwest	7.9
Sargent	62—west	6.8
Greenville	62—northwest	7.2

Source: Authority and FRA, 2015
[1] Distances measured from approximate center of the Central Valley Wye alternatives
[2] M = moment magnitude. Magnitude based on Ellsworth values in Peterson et al. 2008; Sargent fault magnitude from U.S. Geological Survey (USGS). Open-Report 96-706/CGS OF 98-08.
N/A =not available

In addition to the faults listed in Table 5-3, the western margin of the San Joaquin Valley is underlain by potentially active thrust faults extending from the southeast to the northwest at a distance of about 300 miles. These faults, known as the Great Valley fault system, mark the Coast Range – Central Valley geomorphic boundary. These faults are “blind thrust faults,” because fault rupture at depth does not extend to the ground surface. Consequently, they remained unrecognized as a potential seismic source until relatively recently. While they are unlikely to pose a fault rupture hazard, a large earthquake on one or more nearby segments of the Great Valley faults could generate strong ground shaking. The Great Valley thrust fault system is considered to be the source of several historic earthquakes in the Central Valley including the 1983 Coalinga Earthquake (M6.5) and 1985 Kettleman Hills Earthquake (M6.1).

The National Seismic Hazard Mapping Program (Petersen et al. 2008) includes many segments of the Great Valley fault system, which is considered a seismic source in the USGS earthquake hazard model. There is presently considerable uncertainty regarding the location and fault parameters (e.g., recurrence interval, slip rate, length, segmentation model) for Great Valley faults.

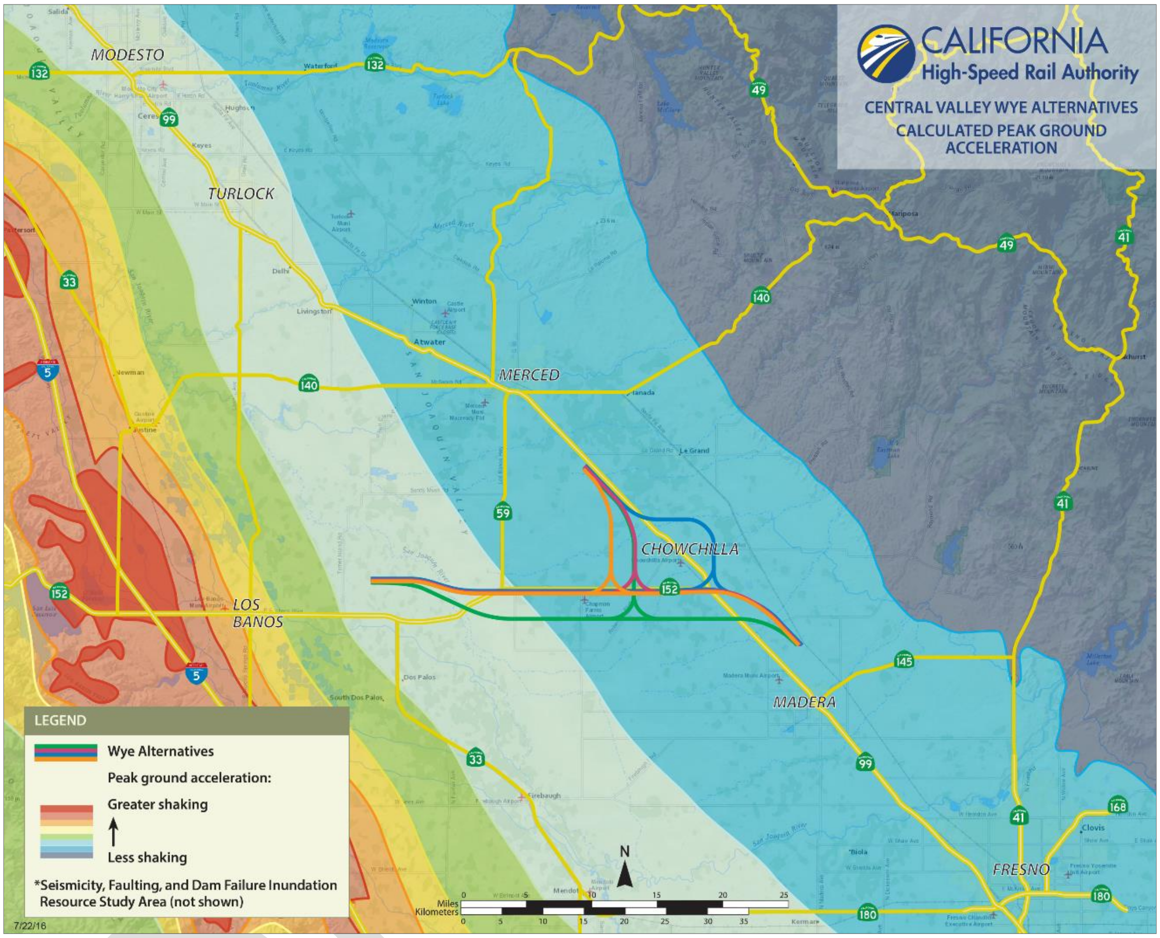
The Pleistocene-age San Joaquin and O’Neill faults are also mapped close to the western end of the San Joaquin Valley. The San Joaquin Fault is considered to have had Late Quaternary Fault displacement (within the last 700,000 years).

5.3.3 Seismic Ground Motion

During an earthquake, the seismicity, faulting, and dam failure inundation RSA is 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[7] of approximately 2,500 years (Geotechnical Consultants, Inc. 2012). The 0.35g level of ground surface shaking results from a 50 percent amplification of ground motion arriving in firm-ground or soft rock motions below the site, as ground motions propagate through the soil column. Information about ground motions available on the USGS website suggests that the primary cause of shaking likely would be a nearby shallow earthquake (magnitude M5.2 at 4.5 miles), but that large, distant (greater than 30 miles) events with a magnitude greater than M6.6 also generally contribute to the ground motion hazard.

[7] The *return period* of a seismic event is the average frequency that it is expected to recur.

Figure 5-10 presents the calculated peak ground accelerations for the Central Valley Wye for this particular level of activity.



Source: Authority and FRA, 2012b FINAL – JULY 22, 2016

Figure 5-10 Calculated Peak Ground Acceleration (2 percent probability of exceedances in 50 years)

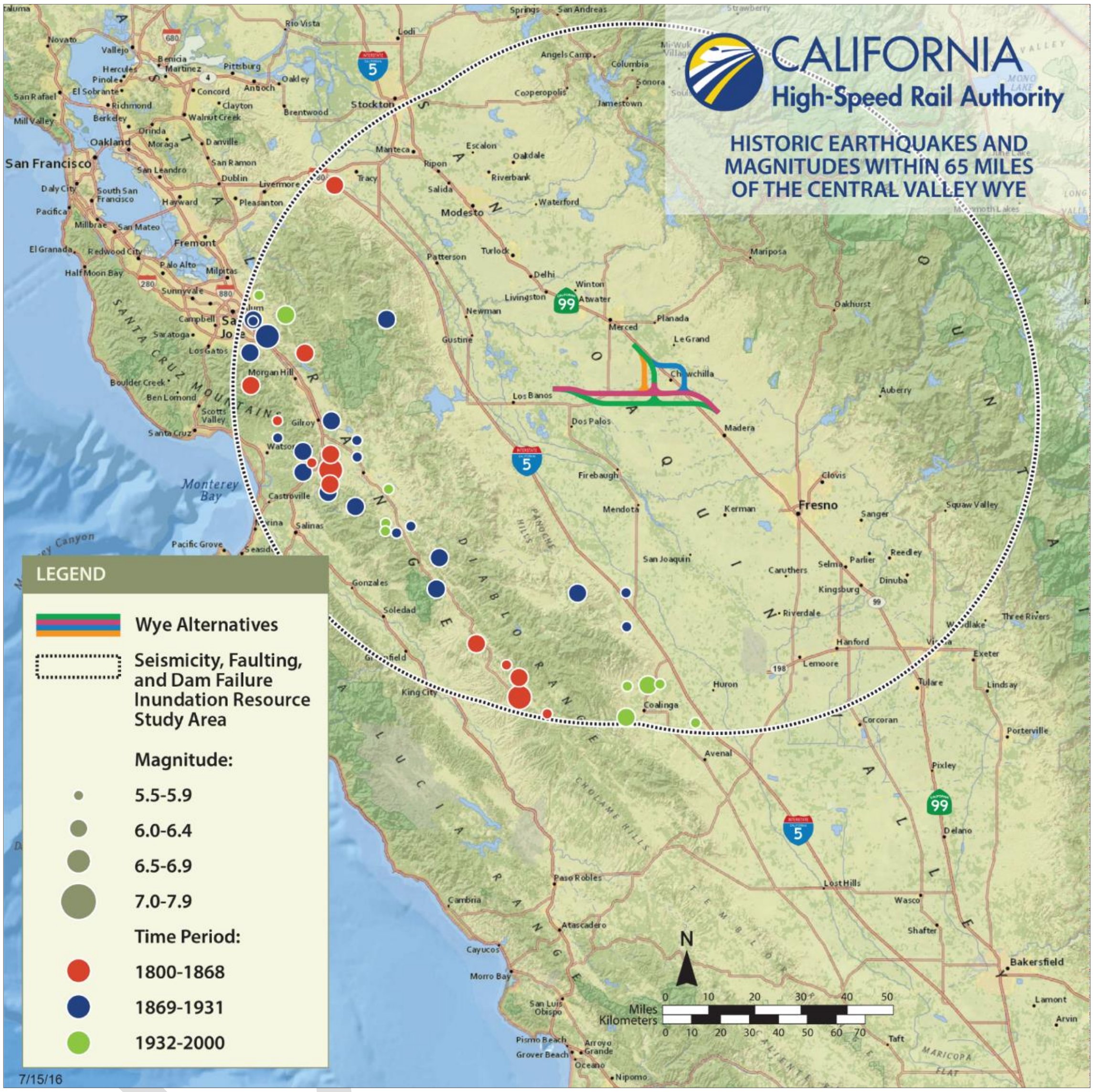
5.3.4 Historic Seismicity

The seismic activity of coastal California is dominated by the strike-slip faults of the San Andreas fault system and some reverse faults. The offset and ground deformation across these faults accommodates most of the relative movement between the Pacific and North American tectonic plates. In contrast, the San Joaquin Valley is a relatively stable geologic region exhibiting relatively low to moderate seismicity. The sedimentary deposits of the Central Valley are relatively undeformed compared with the highly deformed and uplifted rock of the Coast Ranges.

Catalogs of historic earthquakes spanning the 201-year interval between 1800 and 2000 report only six earthquakes of moment magnitude[8] (M) M6.5 or greater within approximately 65 miles of the seismicity, faulting, and dam failure inundation RSA (CGS 2016). These historic earthquakes occurred west of the San Joaquin Valley or along its western margin. Historic seismicity is lower still on the eastern side of San Joaquin Valley, where no historic earthquakes of M5.5 or greater have occurred within approximately 30 miles of the eastern extent of the seismicity, faulting, and

8 *Moment magnitude* is a measure of earthquake size based on the rigidity of the material that moved, the average amount of slip on the fault, and the size of the area that slipped.

dam failure inundation RSA during the 201-year time interval. Figure 5-11 shows historic earthquake activity in the Central Valley Wye region.



Source: CGS, 2001 FINAL – JULY 15, 2016

Figure 5-11 Regional Earthquakes 1800–2000

Table 5-4 lists major historic earthquakes with magnitudes of 6.4 or higher within 65 miles of the seismicity, faulting, and dam failure inundation RSA.

Table 5-4 Summary of Significant Historic Earthquakes in Region

Date	Location/Fault	Moment Magnitude (M)	Epicentral Latitude (degrees)	Epicentral Longitude (degrees)
1857, January 9	Fort Tejon/San Andreas	7.9	36.20	-120.80
1865, October 8	Santa Cruz Mountains	6.5	37.20	-121.90
1983, May 2	Coalinga/Unknown	6.4	36.23	-120.31
1911, July 1	Morgan Hill/ Calaveras	6.4	37.25	-121.75
1836, June 10	San Juan Bautista/Hayward or San Andreas	6.4	36.90	-121.50

Source: CGS, 2016
M = moment magnitude

5.4 Secondary Seismic Hazards

Secondary seismic hazards include phenomena that occur as a result of ground shaking, including liquefaction, lateral spreading, seismic settlement, seismically induced landsliding, and earthquake-induced flooding.

5.4.1 Liquefaction

Soil liquefaction is the process by which the shear strength of granular-saturated soils is reduced because of an increase in pore pressure during seismic shaking or human-induced events. Requisite conditions for liquefaction to occur include saturated granular soils that are not free-draining, with a loose-packed grain structure capable of progressive rearrangement of grains during repeated cycles of seismic loading. When liquefaction occurs, the particles rearrange to a denser state, but excess pore pressure is not dissipated; therefore, the shear strength of the soil decreases, thus reducing the soil's ability to support foundations for buildings and bridges.

In the past, the hazard posed by liquefaction has been considered relatively minor in the Great Valley. However, with recognition of the faults along the Coast Range – Central Valley boundary, localized deposits within the seismicity, faulting, and dam failure inundation RSA may be found to be potentially liquefiable. Potentially liquefiable deposits are particularly likely in high groundwater areas that are underlain by poorly compacted granular fills or geologically young, loose, alluvial stream deposits.

In addition, the groundwater table is quite deep (greater than 100 feet) over much of the alignment. Depth to groundwater ranges from 40 to 260 feet below ground surface in the seismicity, faulting, and dam failure inundation RSA and varies considerably (about 20 feet or more) each season, depending on rainfall conditions. In general, groundwater is typically shallower toward the northern end of the seismicity, faulting, and dam failure inundation RSA and deepest between Chowchilla and Madera Acres. Table 5-5 provides a summary of groundwater depths at different locations within the seismicity, faulting, and dam failure inundation RSA.

Table 5-5 Depth to Groundwater in the Vicinity of 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

Source: DWR, 2012
bgs = below ground surface

5.4.2 Lateral Spreading

One of the consequences of seismic liquefaction in sloping ground areas is the phenomenon known as lateral spreading, which refers to the movement of land laterally after the loss of support because of liquefaction. For this to occur, the liquefied area must be relatively near a free face or a vertical or sloping face such as a road cut or stream/river bank. The area crossed by the Central Valley Wye is relatively flat; therefore, lateral spreading in response to the liquefaction of subsurface soil is not expected. However, localized lateral spreading may occur in areas where the HSR would traverse creeks and river channels.

5.4.3 Seismically Induced Landslide Hazards

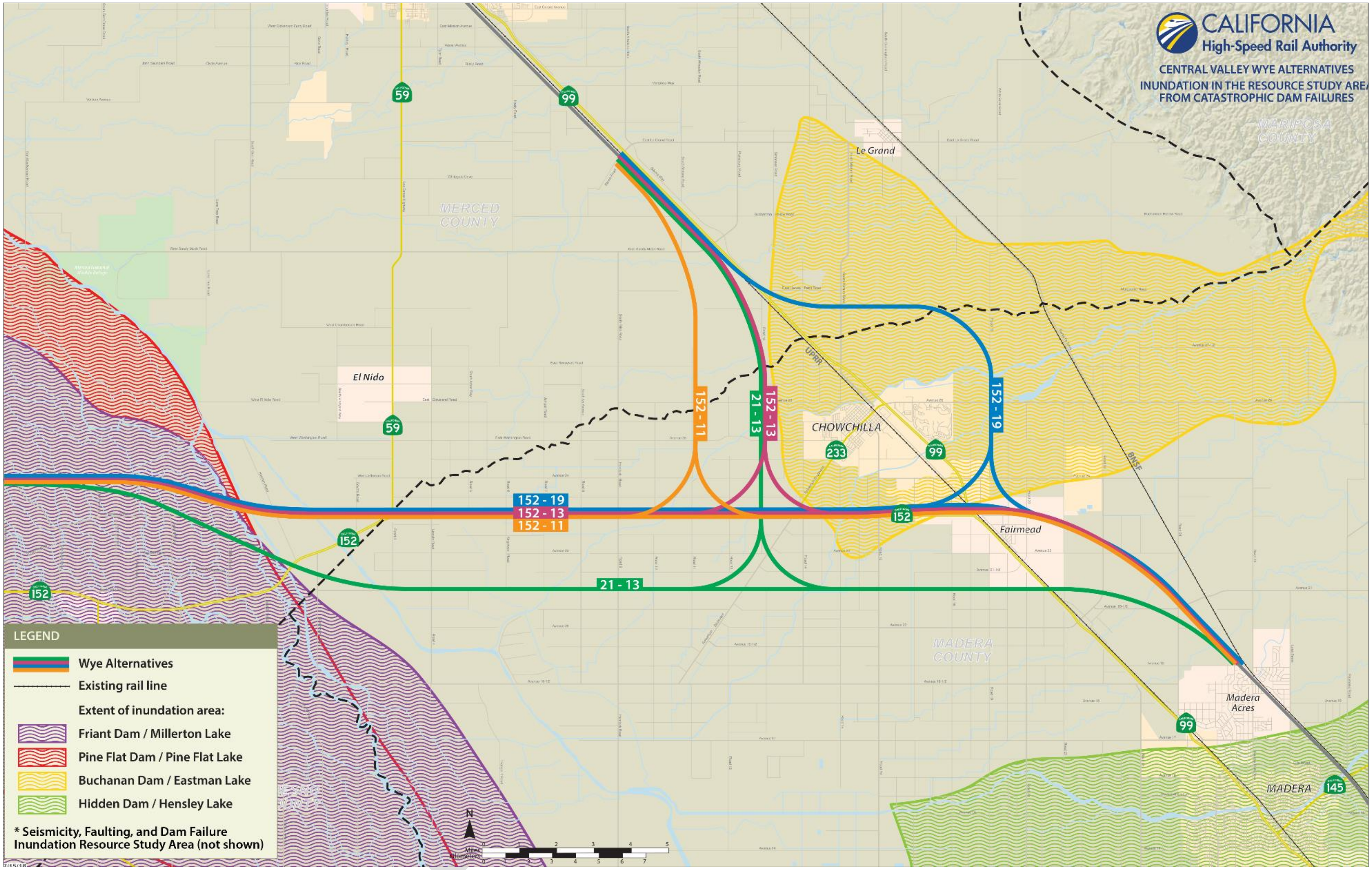
Landslides triggered by earthquakes historically have been a significant source of damage in California. Areas that are most susceptible to earthquake-induced landslides are steep slopes in poorly cemented or highly fractured rocks, areas underlain by loose, weak soils, and areas on or adjacent to existing landslide deposits. These types of geologic terrains do not exist in the relatively flat-lying areas the Central Valley Wye would cross. Accordingly, seismically induced landslide hazards for the Central Valley Wye are judged to be very low.

5.4.4 Seismically Induced Flood Hazards

Seismically induced flooding is caused by failure of water-retaining structures such as a dam, levee, or storage tank during a seismic event. Seiche or tsunami waves are another type of seismically induced flooding. A seiche refers to the movement of an enclosed body of water such as a bay, lake, river, or reservoir because of periodic oscillation. Seiches commonly occur as a result of intense seismic shaking or catastrophic landslides displacing large amounts of water in a short period of time. The period of oscillation varies and depends on the size of the waterbody. The period of a seiche can last for minutes or up to several hours and depends on the magnitude of oscillations, as well as the geometry of the waterbody. Seiches have been recorded to cause significant damage to nearby structures, including dams, shoreline facilities, and levees or embankments. Because no large bodies of water are near the Central Valley Wye, the risk of damage from seiches is considered to be low.

A tsunami is an ocean wave that develops as a result of the displacement of large amounts of water over a short period of time. Tsunamis are commonly associated with submarine faults that displace water in the ocean over long distances. Because of the distance from the ocean (about 100–120 miles), tsunamis do not present a potential hazard to the Central Valley Wye.

Review of the California Emergency Management Agency's dam inundation maps shows that the Central Valley Wye would cross over potential inundation areas of several reservoirs. Figure 5-12 shows the inundation areas relative to the Central Valley Wye. The inundation areas shown are conservative scenarios, assuming that the retained bodies of water are at their maximum elevation, and assuming catastrophic failure of the dam structures during seismic shaking. Potential flooding caused by dam failure is also discussed in the Hydrology and Water Resources Technical Report (Authority and FRA 2016).



Source: Madera County, 2011

FINAL – JULY 22, 2016

Figure 5-12 Inundation Areas from Catastrophic Dam Failures

Identified potential dam failures resulting in inundation of the flat-lying areas that could affect portions of the HSR alignment include Buchanan Dam, Hidden Dam, Friant Dam, and Pine Flat Dam. Two relatively large earthfill dams—Buchanan Dam and Millerton Lake Dam—are in the vicinity of the seismicity, faulting, and dam failure inundation RSA and impound large reservoirs. Dam breaches would result in rapidly moving waters that could erode embankments and bridge foundations or submerge parts of the alignment in the seismicity, faulting, and dam failure inundation RSA.

5.5 Geological Resources

5.5.1 Mineral Resources

Analysts obtained information on the mineral resource potential in the geology, soils, and seismicity RSA from publications of the Department of Conservation, CGS. The Surface Mining and Reclamation Act of 1975 directs the State Geologist to classify the non-fuel mineral resource zones of the state to show where economically significant mineral deposits occur based on scientific data.

According to the CGS, 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. Aggregate resources are the only mineral resources within the area of the Central Valley Wye alternatives. However, no active aggregate quarries lie within the resource hazards RSA.

5.5.2 Fossil Fuel Resources

The Chowchilla Gas Field is within the proposed resource hazards RSA, near the SR 152 crossing of the Merced–Madera county line. Most of the wells within the Chowchilla Gas Field are dry or plugged, and well operators abandoned them between 1930 and 1986. Figure 5-13 shows the oil and gas fields within 0.5 mile of the Central Valley Wye alternatives.

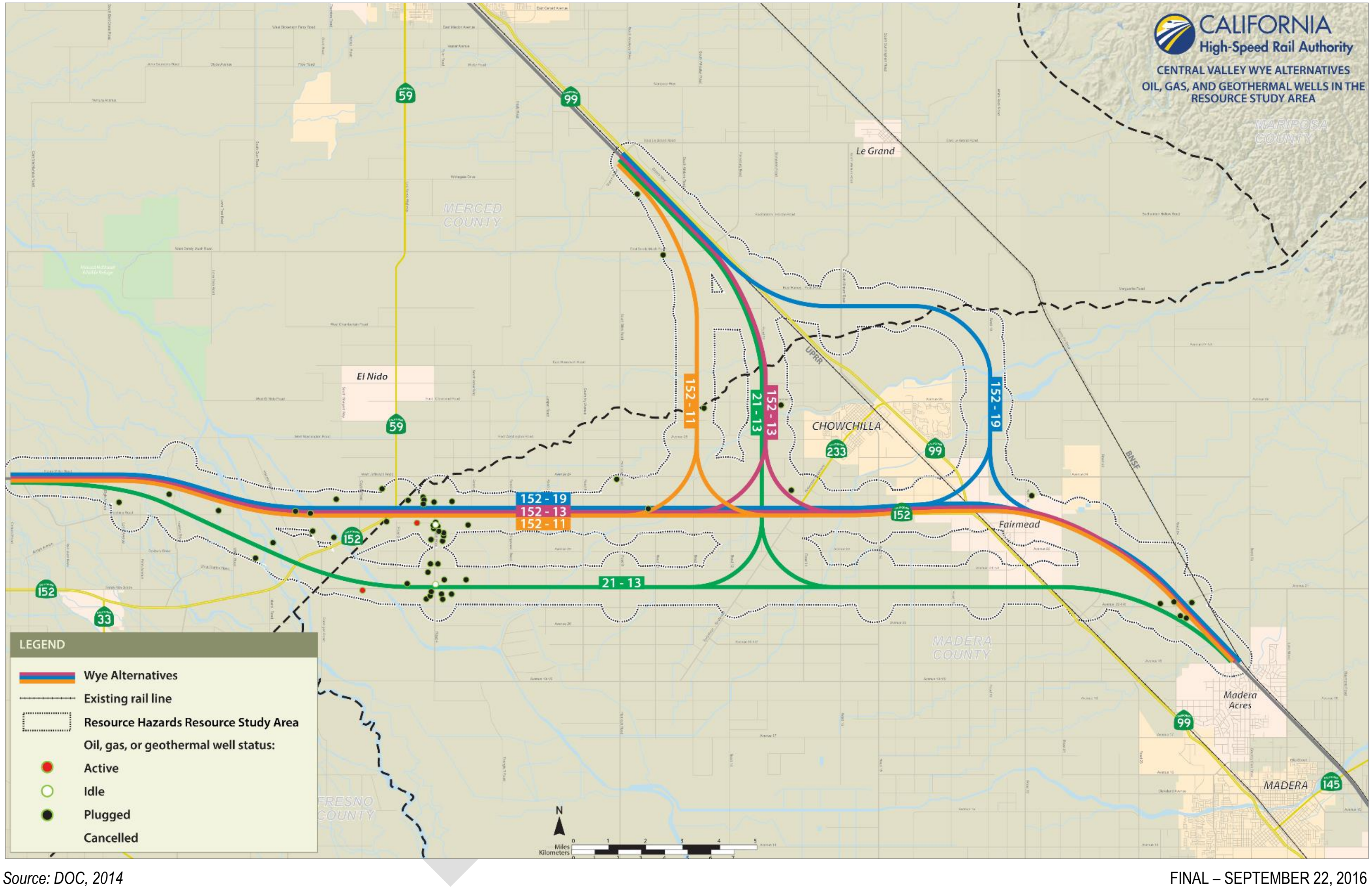
The Authority plotted locations of oil and gas wells (both active and abandoned) from data obtained from the DOGGR database (DOC 2015). The database showed the following oil and gas wells within 0.5 mile of the Central Valley Wye alternatives' footprints:

- SR 152 (North) to Road 13 Wye Alternative — 44 wells (1 active, 43 canceled, idle, or plugged and abandoned)
- SR 152 (North) to Road 19 Wye Alternative — 45 wells (1 active, 44 canceled, idle, or plugged and abandoned)
- Avenue 21 to Road 13 Wye Alternative — 34 wells (1 active, 33 canceled, idle, or plugged and abandoned)
- SR 152 (North) to Road 11 Wye Alternative — 44 wells (1 active, 43 canceled, idle, or plugged and abandoned)

Many wells overlap among the alternatives. For example, there is only one idle well, and it occurs along all four alternatives.

5.5.3 Geothermal Resources

Analysts reviewed the DOGGR California Geothermal Map (DOC 2002) and California Division of Mines and Geology Geothermal Resources Map (CDMG 1980) and found that none of the Central Valley Wye alternatives are in or near a Geothermal Resource Area as classified by DOGGR. Additionally, there are no producing or abandoned geothermal wells or geothermal springs along the alternative alignments.



Source: DOC, 2014

FINAL – SEPTEMBER 22, 2016

Figure 5-13 Oil, Gas, and Geothermal Wells in the Resource Study Area

6 EFFECTS ANALYSIS

6.1 Introduction

This section evaluates the environmental effects of the Central Valley Wye alternatives. Geologic, soil, and seismic conditions are similar throughout the three RSAs for geology, soils, and seismicity, therefore, the potential for geology, soils, and seismicity–related effects would be essentially the same for all four alternatives. Geologic risks within the three RSAs include unstable soils and settlement, expansive and corrosive soils, slope failures, seismic events, and secondary seismic hazards such as liquefaction, liquefaction-related slope movement, and liquefaction-related settlement. Potential effects on mineral and energy resources include the loss of availability of mineral and energy resources, potential decrease in oil and gas production, and safety risks associated with subsurface gas hazards. With incorporation of standard engineering design features and IAMFs, geologic hazards and effects associated with mineral and energy resources would be minimized.

6.2 Central Valley Wye Alternatives

Evaluation of the potential environmental effects of a particular project necessarily involves an analysis of the project's effect on the environment, as well as the environment's effect on the project. Similarly, the analysis must consider the effects that result from project construction as well as effects resulting from project operations, including maintenance activities. The following paragraphs summarize potential environmental consequences (or effects) related to the Central Valley Wye with regard to geology, soils, and seismicity. Table 6-1 provides a summary of the potential effects as a result of construction and operations of the Central Valley Wye alternatives. All effects are either not applicable, because the resource is not present or no effect is expected, or low, because the effects presented by the Central Valley Wye are minimal and would not present a substantial risk to people, existing infrastructure, or new HSR facilities. All four of the Central Valley Wye alternatives would result in the same overall effects.

Table 6-1 Summary of Potential Effects

Potential Effect	Effects of the Central Valley Wye Alternatives	
	Construction	Operations
Surface fault rupture	N/A	N/A
Seismic ground shaking	Low	Low
Liquefaction/seismically induced ground failure	Low	Low
Slope failure hazards/cut-and-fill	Low	Low
Preexisting landslides	Low	Low
Tsunami and seiche	N/A	N/A
Seismically induced dam failure	Low	Low
Ground subsidence	Low	Low
Expansive soils	Low	Low
Corrosive soils	Low	N/A
Collapsible soils	N/A	N/A
Soil erosion	Low	N/A
Dewatering	Low	N/A
Difficult excavation	Low	N/A

Potential Effect	Effects of the Central Valley Wye Alternatives	
	Construction	Operations
Subsurface gas	Low	N/A
Mineral and energy resources	Low	N/A

N/A = not applicable
Low/. Denotes a minor effect that would be reduced by appropriate design and IAMFs.

6.2.1 Surface Fault Rupture

6.2.1.1 SR 152 (North) to Road 13 Wye Alternative

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 (e.g., vertical or horizontal offset). Surface fault ruptures are the result of stresses relieved during an earthquake event that often cause damage to structures astride the rupture zone.

Construction

The SR 152 (North) to Road 13 Wye Alternative would not 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 is low.

Operations

As stated above, the SR 152 (North) to Road 13 Wye Alternative would not 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 is low.

6.2.1.2 SR 152 (North) to Road 19 Wye Alternative

Construction

Similar to SR 152 (North) to Road 13 Wye Alternative, the SR 152 (North) to Road 19 Wye Alternative would not lie within a current Alquist-Priolo Earthquake Fault Zone or cross any mapped fault exhibiting offset of geologically recent deposits.

Operations

Similar to the SR 152 (North) to Road 13 Wye Alternative, the SR 152 (North) to Road 19 Wye Alternative would not lie within a current Alquist-Priolo Earthquake Fault Zone or cross any mapped fault exhibiting offset of geologically recent deposits.

6.2.1.3 Avenue 21 to Road 13 Wye Alternative

Construction

Similar to SR 152 (North) to Road 13 Wye Alternative, the Avenue 21 to Road 13 Wye Alternative would not lie within a current Alquist-Priolo Earthquake Fault Zone or cross any mapped fault exhibiting offset of geologically recent deposits.

Operations

Similar to SR 152 (North) to Road 13 Wye Alternative, the Avenue 21 to Road 13 Wye Alternative would not lie within a current Alquist-Priolo Earthquake Fault Zone or cross any mapped fault exhibiting offset of geologically recent deposits.

6.2.1.4 SR 152 (North) to Road 11 Wye Alternative

Construction

Similar to SR 152 (North) to Road 13 Wye Alternative, the SR 152 (North) to Road 11 Wye Alternative would not lie within a current Alquist-Priolo Earthquake Fault Zone or cross any mapped fault exhibiting offset of geologically recent deposits.

Operations

Similar to the SR 152 (North) to Road 13 Wye Alternative, the SR 152 (North) to Road 11 Wye Alternative would not lie within a current Alquist-Priolo Earthquake Fault Zone or cross any mapped fault exhibiting offset of geologically recent deposits.

6.2.2 Seismic Ground Shaking

6.2.2.1 SR 152 (North) to Road 13 Wye Alternative

The faults and fault systems that exist to the west and southwest of the seismicity, faulting, and dam failure inundation RSA are known to produce seismic events capable of causing moderately intense ground shaking. The level of ground shaking is estimated to have peak ground acceleration at the ground surface of up to 0.45g. This level of shaking would result in significant loads to structures supported on the soil, and could also result in secondary seismic hazards such as liquefaction, liquefaction-induced slope failures, and post-seismic settlement as liquefaction-induced water pressures dissipate. The level of ground shaking could vary along the alternative depending on the amount of ground motion amplification or deamplification within specific soil layers; however, the likely level of seismically induced ground motion would be sufficient to cause damage regardless of the specific location.

Construction

Construction activities, particularly those involving excavation, earth stabilization, and erection of structures, could be affected by strong ground shaking. Although the seismicity, faulting, and dam failure inundation RSA is subject to ground shaking, the occurrence of a large earthquake during the relatively short construction period is considered unlikely, and actual risks from ground shaking during construction are considered low. This type of effect would be direct and permanent.

The Central Valley Wye design requires documentation of 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, Evaluate and Design for Large Seismic Ground Shaking). These design procedures and features 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 effects on HSR infrastructure from seismic events. The HSR design will 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 will be conducted, and measures such as enhanced structural detailing, more system redundancy, or special ground motion isolation systems will be implemented, as appropriate, to reduce the potential for failures from inertial forces resulting from the ground motions. These measures will implement professional standards using site-specific geotechnical data to reduce risk of ground movement at Central Valley Wye structures as a result of seismic activity.

In addition, the Authority will conform to guidelines specified by relevant transportation and building agencies and codes (GEO-IAMF#6, Geology and Soils) requiring Authority contractors to account for geotechnical properties during Central Valley Wye design and construction and thus address risk factors associated with seismically induced ground shaking.

Operations

Seismic ground shaking could produce hazards during the operation of the HSR system, including seismic-induced ground shaking and dam failures within the seismicity, faulting, and dam failure inundation RSA. This type of effect would be direct and permanent.

A key consideration during a seismic event is the response of the operating HSR to a seismic event that shakes the track The Central Valley Wye design requires documentation of 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). These design procedures and features 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 effects on Central Valley Wye operations from seismic events. Prior to final design, additional seismic studies will be conducted to establish the most up-to-date estimation of levels of ground motion and updated Caltrans seismic design criteria will be used in the design of any structures supported in or on the ground. During a seismic event, movement of the railbed would be transferred into the train. The train cars, the spring system for the train cars, and the track design will 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, suggests that the California HSR system would be able to satisfy life-safety requirements for the design earthquake.

To protect personal and property safety and HSR integrity in case of earthquake during HSR operations, the Authority will install a control system to shut down HSR operations temporarily during or after a potentially damaging earthquake to reduce risks (GEO-IAMF#4, Suspension of Operations during an Earthquake). A network of instruments will be installed to provide ground motion data that will be used with the HSR instrumentation and a controls system to temporarily shut down HSR operations in the event of an earthquake. Shutting down operations temporarily during or after a potentially damaging earthquake will minimize the risk of a moving train encountering structures that have been compromised by seismic activity.

The Authority will conform to guidelines specified by relevant transportation and building agencies and codes (GEO-IAMF#6) requiring Authority contractors to account for geotechnical properties during Central Valley Wye design and construction and thus address risk factors associated with seismically induced ground shaking.

6.2.2.2 SR 152 (North) to Road 19 Wye Alternative

Construction

The effects associated with seismic ground shaking for the SR 152 (North) to Road 19 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. The Authority will design structures to withstand design seismic activity (GEO-IAMF#3 and GEO-IAMF#6), minimizing the risks associated with seismic ground shaking.

Operations

The effects associated with seismic ground shaking for the SR 152 (North) to Road 19 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. The Authority will design structures to withstand design seismic activity (GEO-IAMF#3, GEO-IAMF#4, and GEO-IAMF#6), minimizing the risks associated with seismic ground shaking.

6.2.2.3 Avenue 21 to Road 13 Wye Alternative

Construction

The effects associated with seismic ground shaking for the Avenue 21 to Road 13 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. The Authority will design structures to withstand design seismic activity (GEO-IAMF#3 and GEO-IAMF#6), minimizing the risks associated with seismic ground shaking.

Operations

The effects associated with seismic ground shaking for the Avenue 21 to Road 13 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. The Authority will design structures to withstand design seismic activity (GEO-IAMF#3, GEO-IAMF#4, and GEO-IAMF#6), minimizing the risks associated with seismic ground shaking.

6.2.2.4 SR 152 (North) to Road 11 Wye Alternative

Construction

The effects associated with seismic ground shaking for the SR 152 (North) to Road 11 Wye Alternative are the same as described for the effects described for the SR 152 (North) to Road 13 Wye Alternative. The Authority will design structures to withstand design seismic activity (GEO-IAMF#3 and GEO-IAMF#6), minimizing the risks associated with seismic ground shaking.

Operations

The effects associated with seismic ground shaking for the SR 152 (North) to Road 11 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. The Authority will design structures to withstand seismic activity (GEO-IAMF#3, GEO-IAMF#4, and GEO-IAMF#6), minimizing the risks associated with seismic ground shaking.

6.2.3 Liquefaction and Other Types of Seismically Induced Ground Failure

6.2.3.1 SR 152 (North) to Road 13 Wye Alternative

Construction

Section 5.4, Secondary Seismic Hazards, discusses liquefaction, lateral spreading, and seismically induced ground failure. Liquefaction and lateral spreading during construction can be an issue at natural river and stream crossings, such as the San Joaquin River and other natural stream channels in the resource hazards RSA. Potential hazards also exist at proposed bridges (abutments and piers) that cross creeks and drainage crossings and at aerial, viaduct, and grade separation structures along the Central Valley Wye alternative alignments. This potential hazard is typically localized and would be evaluated by site-specific subsurface investigations. The effect of these secondary seismic hazards could vary. Retained fills and at-grade structures could be more affected by loss of bearing support. Elevated structures on deep foundations are capable of withstanding near-surface liquefaction, and retained-cut structures can be designed for increased loads from liquefied soil. Structures on or in the path of moving ground associated with slope instability or flow can be designed for earth loads of the moving soil.

Central Valley Wye design minimizes the risk from secondary seismic hazards. The Authority will 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 will include that site-specific geotechnical investigations will 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 will also be conducted, and engineering measures such as ground improvement, use of retaining walls, or regrading of slopes will be implemented, as appropriate, to reduce the potential for seismically induced slope failures. Localized instabilities that may occur will be handled as a maintenance issue. These measures will implement professional standards using site-specific geotechnical data to reduce risk of ground movement at Central Valley Wye structures as a result of seismic activity.

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

Operations

As discussed above under *Construction*, strong ground shaking during a seismic event can induce liquefaction or other types of seismically induced ground failure in areas where the soil is prone to such failure. To protect personal and property safety and HSR integrity in case of earthquake during HSR operations, the Authority will 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 a controls system to temporarily shut down HSR operations in the event of an earthquake.

6.2.3.2 SR 152 (North) to Road 19 Wye Alternative

Construction

The effects associated with liquefaction and other types of seismically induced ground failure for the SR 152 (North) to Road 19 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. The Authority will design structures to withstand design seismic activity (GEO-IAMF#3 and GEO-IAMF#6), minimizing the risks associated with liquefaction and other types of seismically induced ground failure.

Operations

The effects associated with liquefaction and other types of seismically induced ground failure for the SR 152 (North) to Road 19 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. The Authority will install an automatic control system to shut down HSR operations temporarily during or after a potentially damaging earthquake to reduce risks (GEO-IAMF#4).

6.2.3.3 Avenue 21 to Road 13 Wye Alternative

Construction

The effects associated with liquefaction and other types of seismically induced ground failure for the Avenue 21 to Road 13 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. The Authority will design structures to withstand design seismic activity (GEO-IAMF#3 and GEO-IAMF#6), minimizing the risks associated with liquefaction and other types of seismically induced ground failure.

Operations

The effects associated with liquefaction and other types of seismically induced ground failure for the Avenue 21 to Road 13 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. The Authority will install an automatic control system to shut down HSR operations temporarily during or after a potentially damaging earthquake to reduce risks (GEO-IAMF#4).

6.2.3.4 SR 152 (North) to Road 19 Wye Alternative

Construction

The effects associated with liquefaction and other types of seismically induced ground failure for the SR 152 (North) to Road 11 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. The Authority will design structures to withstand seismic activity (GEO-IAMF#3 and GEO-IAMF#6), minimizing the risks associated with liquefaction and other types of seismically induced ground failure.

Operations

The effects associated with liquefaction and other types of seismically induced ground failure for the SR 152 (North) to Road 11 Wye Alternative are the same as the effects described for the SR

152 (North) to Road 13 Wye Alternative. The Authority will install an automatic control system to shut down HSR operations temporarily during or after a potentially damaging earthquake to reduce risks (GEO-IAMF#4).

6.2.4 Slope Failure Hazards Associated with Cut-and-Fill Slopes

6.2.4.1 SR 152 (North) to Road 13 Wye Alternative

Construction

Unstable soils consist of loose or soft deposits of sands, silts, and clays that are not adequate to support the planned structure loads. These soils exhibit low shear strength and, when loaded, can fail through bearing failures or slope instabilities, depending on the extent to which construction would occur on unstable soils resistant to risk reduction. Although competent soils dominate the land beneath the SR 152 (North) to Road 13 Wye Alternative near the ground surface, unstable soils occur on a localized basis, particularly near the 31 river and stream crossings required for this alternative. The Hydrology and Water Resources Technical Report (Authority and FRA 2016) lists and discusses stream crossings and proximity of the alternative alignment to streams. During construction, after vegetative and other cover have been removed, exposed soils within the resource hazards RSA would be potentially subject to erosive forces. The longer the period of exposure to erosive forces, the greater is the potential for creep- or groundwater-related soil failures.

Temporary construction effects of the SR 152 (North) to Road 13 Wye Alternative on soft or loose soils could result in on-site or off-site slumps and small slope failures at stream crossings, instability of cut-and-fill slopes, or collapse of retaining structures used for retained fills or retained cuts. This type of effect would be direct and temporary.

The Central Valley Wye would minimize effects from potentially unstable soils through foundation design for site-specific conditions, such as the use of deep foundations (e.g., piles) based on site-specific geotechnical investigations.

During construction, soft or loose soils affect some design types more than others. For instance, unstable soils would present a greater risk to locations where retained fills are planned than to at-grade segments of the alignment because of the much greater load that retained fills would impose on the unstable soil. 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 increases. In these locations, the potential effect of loss in bearing or additional soil loads associated with the slump or slope failure would also be considered.

The design-build contractor would prepare a construction management plan (CMP) which would address how geologic constraints, including the risk of slope failure, would be avoided or minimized during construction (GEO-IAMF#1, Geologic Resources). Engineered ground improvements, such as regrading or groundwater controls, would stabilize soft or loose soils wherever they occur. In addition, the Central Valley Wye design would improve the stability of deep unstable soils by replacing unstable soils with competent soils, strengthening replacement materials with geosynthetics, and placing stone columns or vertical drains (GEO-IAMF#1B, Unstable Soils). The Central Valley Wye design minimizes effects of ground settlement due to 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#1A, Groundwater Withdrawal). These methods would improve the stability of deep unstable soils.

Permanent effects from unstable soils would be minimized through Central Valley Wye design measures before they result in damage or injury, including use of alternate foundation designs to offset the potential for settlement due to groundwater withdrawal (GEO-IAMF#1A). 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 effect 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 will incorporate slope monitoring by a registered engineering geologist into the operations and maintenance procedures at sites identified in the CMP (GEO-IAMF#2, Slope Monitoring). Monitoring will provide information to identify and repair any ground movement before it can damage track integrity. Central Valley Wye design will 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 (GEO-IAMF#5, Subsidence Monitoring). The track monitoring program will 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 temporary construction activities relative to the infrequency of large earthquakes (i.e., only one earthquake with a magnitude greater than 6.6 has occurred in the resource hazards RSA since 1800). If an earthquake were to occur, potential effects could range from no effect to the potential for partially built structures or slopes to fail. The magnitude of the effect would depend on the size of the earthquake and the specific state of the various Central Valley Wye features at the moment of the earthquake. Any structure supported in or on the ground will comply with Caltrans seismic design criteria (GEO-IAMF#3). These criteria 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 effects on HSR infrastructure from soil failure caused by seismic events.

The Authority will also 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 design and construction and thus address risk factors associated with bearing capacity and slope stability (GEO-IAMF#6).

Operations

Slopes could fail during project operation. In addition, unrelated to project activities, ongoing subsidence in the Central Valley could affect track integrity. Central Valley Wye design features would monitor for changing slopes (GEO-IAMF#2). Monitoring will provide information to identify and repair any ground movement before it can damage track integrity. Central Valley Wye design features would also monitor for ground subsidence (GEO-IAMF#5). The track monitoring program will provide early warning of reduced track integrity in case of ground settlement.

In addition, the risk exists that a large earthquake could occur during project operations. If an earthquake were to occur, potential effects could range from no effect to the potential for built structures or slopes to fail. The magnitude of the effect would depend on the size of the earthquake and the location and orientation of the various Central Valley Wye features with respect to the source of the earthquake. To protect personal and property safety and HSR integrity in case of earthquake during HSR operations, the Authority will 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 will be installed to provide ground motion data that will be used with the HSR instrumentation and a controls system to temporarily shut down HSR operations in the event of an earthquake. Shutting down operations temporarily during or after a potentially damaging earthquake will minimize the risk of a moving train encountering structures that have been compromised by seismic activity.

6.2.4.2 SR 152 (North) to Road 19 Wye Alternative

Construction

The effects resulting from slope failure hazards associated with cut-and-fill slopes for the SR 152 (North) to Road 19 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design would improve loose and unstable soils or would use alternative designs to avoid effects on structures from these conditions, and would monitor for slope changes and subsidence (GEO-IAMF#1A, GEO-IAMF#1B, GEO-IAMF#2, GEO-IAMF#3, GEO-IAMF#5, and GEO-IAMF#6).

Operations

The effects associated with slope failure hazards for the SR 152 (North) to Road 19 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design would monitor for changes in slope (GEO-IAMF#2) and subsidence (GEO-IAMF#5) and would shut down operations in case of earthquake (GEO-IAMF#4).

6.2.4.3 Avenue 21 to Road 13 Wye Alternative

Construction

The effects resulting from slope failure hazards associated with cut-and-fill slopes for the Avenue 21 to Road 13 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design would improve loose and unstable soils or would use alternative designs to avoid effects on structures from these conditions, and would monitor for slope changes and subsidence (GEO-IAMF#1A, GEO-IAMF#1B, GEO-IAMF#2, GEO-IAMF#3, GEO-IAMF#5, and GEO-IAMF#6).

Operations

The effects associated with slope failure hazards for the Avenue 21 to Road 13 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design would monitor for changes in slope (GEO-IAMF#2) and subsidence (GEO-IAMF#5) and would shut down operations in case of earthquake (GEO-IAMF#4).

6.2.4.4 SR 152 (North) to Road 11 Wye Alternative

Construction

The effects resulting from slope failure hazards associated with cut-and-fill slopes for the SR 152 (North) to Road 11 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design would improve loose and unstable soils or would use alternative designs to avoid effects on structures from these conditions, and would monitor for slope changes and subsidence (GEO-IAMF#1A, GEO-IAMF#1B, GEO-IAMF#2, GEO-IAMF#3, GEO-IAMF#5, and GEO-IAMF#6).

Operations

The effects associated with slope failure hazards for the SR 152 (North) to Road 11 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design would monitor for changes in slope (GEO-IAMF#2) and subsidence (GEO-IAMF#5) and would shut down operations in case of earthquake (GEO-IAMF#4).

6.2.5 Slope Failure Hazards Associated with Pre-Existing Landslides, Including Seismically Induced Landslides

6.2.5.1 SR 152 (North) to Road 13 Wye Alternative

Construction

The potential for landslides along the alternative is low because it traverses the floor of the Central Valley where gradients of natural slopes are generally gentle and regional seismicity is relatively low. In addition, no landslides, either statically or seismically induced, have been identified near the SR 152 (North) to Road 13 Wye Alternative. However, slopes along some rivers and streams could fail, either from additional earth loads at the top of the slope, undercutting by stream erosion at the toe of the slope, or additional seismic forces during a seismic event. The consequences of slope failure would be either loss of bearing support to the track facilities or increased load on structures that are in the path of the slope failure. The former presents the higher risk because of the flat topography along the SR 152 (North) to Road 13 Wye Alternative. Loss in bearing support would affect at-grade and retained-fill segments more than retained cuts and elevated structures supported on deep foundations.

The Central Valley Wye design minimizes slope instabilities that stream erosion could introduce. Design features include use of stabilizers, mulches, revegetation, and covering areas with biodegradable geotextiles (GEO-IAMF#1D, Water and Wind Erosion). These methods would be implemented in coordination with other erosion, sediment, stormwater, and fugitive dust control measures. Use of mulches, revegetation, stabilizers, and other measures as appropriate would slow water velocity and minimize sediment transport.

Landslide risks associated with seismic events would be minimized through design criteria. 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). These design procedures and features 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.

The Central Valley Wye design 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 compromising personal and property safety and HSR integrity by long-term slope changes (GEO-IAMF#2). Monitoring will provide information to identify and repair any ground movement before it can damage track integrity. Further, the Authority will 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 Central Valley Wye design and construction and thus address risk factors associated with bearing capacity and slope stability. Detailed slope stability evaluations would be conducted and measures, such as structural solutions (e.g., tie backs, soil nails, retaining walls) or geotechnical solutions (e.g., ground improvement, regrading of slopes), would be implemented, as appropriate, to reduce the potential for future slumps and slope failures. In the case of elevated structures, the location of the foundation would be sited during final design to avoid the area of slope failure.

Operations

Slopes could fail during project operation. Central Valley Wye design features would monitor for ground subsidence (GEO-IAMF#5). The track monitoring program will provide early warning of reduced track integrity in case of ground settlement.

In addition, the risk exists that a large earthquake could occur during project operations. If an earthquake were to occur, potential effects could range from no effect to the potential for built structures or slopes to fail. The magnitude of the effect would depend on the size of the earthquake and the location and orientation of the various Central Valley Wye features with respect to the source of the earthquake. To protect personal and property safety and HSR integrity in case of earthquake during HSR operations, the Authority will 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 will be installed to provide ground motion data that will be used with the HSR instrumentation and a controls system to temporarily shut down HSR operations in the event of an earthquake. Shutting down operations temporarily during or after a potentially damaging earthquake will minimize the risk of a moving train encountering structures that have been compromised by seismic activity..

6.2.5.2 SR 152 (North) to Road 19 Wye Alternative

Construction

The effects resulting from slope failure hazards associated with pre-existing landslides for the SR 152 (North) to Road 19 Wye Alternative are the same as the effects described for the SR 152

(North) to Road 13 Wye Alternative. Central Valley Wye design would reduce the effects by improving slope stability (GEO-IAMF#1D, GEO-IAMF#2, GEO-IAMF#3, and GEO-IAMF#6).

Operations

The effects resulting from slope failure hazards associated with pre-existing landslides for the SR 152 (North) to Road 19 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design features would monitor for ground subsidence (GEO-IAMF#5). The track monitoring program will provide early warning of reduced track integrity in case of ground settlement. Further, Central Valley Wye design features would shut down operations in case of earthquake (GEO-IAMF#4).

6.2.5.3 Avenue 21 to Road 13 Wye Alternative

Construction

The effects resulting from slope failure hazards associated with pre-existing landslides for the Avenue 21 to Road 13 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design would reduce the effects by improving slope stability (GEO-IAMF#1D, GEO-IAMF#2, GEO-IAMF#3, and GEO-IAMF#6).

Operations

The effects resulting from slope failure hazards associated with pre-existing landslides for the Avenue 21 to Road 13 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design features would monitor for ground subsidence (GEO-IAMF#5). The track monitoring program will provide early warning of reduced track integrity in case of ground settlement. Further, Central Valley Wye design features would shut down operations in case of earthquake (GEO-IAMF#4).

6.2.5.4 SR 152 (North) to Road 11 Wye Alternative

Construction

The effects resulting from slope failure hazards associated with pre-existing landslides for the SR 152 (North) to Road 11 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design would reduce the effects by improving slope stability (GEO-IAMF#1D, GEO-IAMF#2, GEO-IAMF#3, and GEO-IAMF#6).

Operations

The effects resulting from slope failure hazards associated with pre-existing landslides for the SR 152 (North) to Road 11 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design features would monitor for ground subsidence (GEO-IAMF#5). The track monitoring program will provide early warning of reduced track integrity in case of ground settlement. Further, Central Valley Wye design features would shut down operations in case of earthquake (GEO-IAMF#4).

6.2.6 Tsunami and Seiche Hazards

6.2.6.1 SR 152 (North) to Road 13 Wye Alternative

Construction

As noted in Section 5.4.4, Seismically Induced Flood Hazards, there are no large bodies of water close to the vicinity of the SR 152 (North) to Road 13 Wye Alternative. No hazard from seiches is anticipated. Similarly, the SR 152 (North) to Road 13 Wye Alternative is a significant distance from the Pacific Ocean; therefore, tsunami hazards are not anticipated.

Operations

As discussed under Construction, there would be no hazards from seiches and tsunamis.

6.2.6.2 SR 152 (North) to Road 19 Wye Alternative

Construction

The effects for SR 152 (North) to Road 19 Wye Alternative with regard to tsunami and seiche hazards are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. No hazards from tsunami or seiches are anticipated.

Operations

As discussed under Construction, there would be no hazards from seiches and tsunamis.

6.2.6.3 Avenue 21 to Road 13 Wye Alternative

Construction

The effects for the Avenue 21 to Road 13 Wye Alternative with regard to tsunami and seiche hazards are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. No hazards from tsunami or seiches are anticipated.

Operations

As discussed under Construction, there would be no hazards from seiches and tsunamis.

6.2.6.4 SR 152 (North) to Road 11 Wye Alternative

Construction

The effects for the SR 152 (North) to Road 11 Wye Alternative with regard to tsunami and seiche hazards are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. No hazards from tsunami or seiches are anticipated.

Operations

As discussed under Construction, there would be no hazards from seiches and tsunamis.

6.2.7 Seismically Induced Dam Failure Hazards

6.2.7.1 SR 152 (North) to Road 13 Wye Alternative

Section 5.4.4 discusses and illustrates potential inundation areas calculated from the unlikely catastrophic failure of identified dams upstream of the SR 152 (North) to Road 13 Wye Alternative vicinity. Figure 5-12 shows the potential inundation areas in the seismicity, faulting, and dam failure inundation RSA.

Construction

Identified potential dam failures resulting in inundation of the flat-lying areas that could affect portions of the HSR alignment include Buchanan Dam, Hidden Dam, Friant Dam, and Pine Flat Dam. The potential inundation effects are summarized in this section:

- Failure of Buchanan Dam, approximately 14 miles northeast of the city of Chowchilla, would result in floodwaters traveling westerly toward the city of Chowchilla. Dam failure would flood an area of 104 square miles that includes the city of Chowchilla and a portion of eastern Merced County.
- Hidden Dam is approximately 18 miles east of the city of Chowchilla. If Hidden Dam failed, floodwater would travel southwest, flooding the community of Madera Acres, the city of Madera, and a surrounding area of 132 square miles entirely within Madera County.
- The Friant Dam is approximately 18 miles east of the city of Madera. Failure of the Friant Dam would flood an area of 736 square miles in Fresno, Merced, and Madera Counties. Floodwater would likely inundate the westernmost portions of the Central Valley Wye alternatives in Merced County.

- Failure of Pine Flat Dam, 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 the Central Valley Wye alternatives in Merced County.

The probability of a seismically induced dam failure at one or more of the dams is considered very low because none of the dams cross 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 determined to be unlikely to fail in case of earthquake. While risk of seismically induced dam failure on one or more of the dams exists, these analyses indicate it would be an unlikely event. Moreover, it is unlikely a seismically induced dam failure would occur during construction given the relatively short duration of these temporary activities.

Operations

The potential for dam failure and resulting risks to HSR passengers during operations is a very unlikely event and the amount of time before inundation of portions of the HSR system (on the order of several hours) would allow for evacuation of people from the system. To protect personal and property safety and HSR integrity in case of earthquake during HSR operations, the Authority will 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 will be installed to provide ground motion data that will be used with the HSR instrumentation and controls system to shut down Central Valley Wye operations temporarily. Shutting down operations temporarily during or after a potentially damaging earthquake will minimize the risk of personal injury or property damage 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.

6.2.7.2 SR 152 (North) to Road 19 Wye Alternative

Construction

The effects associated with seismically induced dam failure hazards for the SR 152 (North) to Road 19 Wye Alternative would be the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. The likelihood of a seismically induced dam failure is considered very low.

Operations

The effects associated with seismically induced dam failure hazards for the SR 152 (North) to Road 19 Wye Alternative would be the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design minimizes the risk from seismically induced dam failure hazards by suspending operations during an earthquake (GEO-IAMF#4).

6.2.7.3 Avenue 21 to Road 13 Wye Alternative

Construction

The effects associated with seismically induced dam failure hazards for the Avenue 21 to Road 13 Wye Alternative would be the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. The likelihood of a seismically induced dam failure is considered very low.

Operations

The effects associated with seismically induced dam failure hazards for the Avenue 21 to Road 13 Wye Alternative would be the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design minimizes the risk from seismically induced dam failure hazards by suspending operations during an earthquake (GEO-IAMF#4).

6.2.7.4 SR 152 (North) to Road 11 Wye Alternative

Construction

The effects associated with seismically induced dam failure hazards for the SR 152 (North) to Road 11 Wye Alternative would be the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. The likelihood of a seismically induced dam failure is considered very low.

Operations

The effects associated with seismically induced dam failure hazards for the SR 152 (North) to Road 11 Wye Alternative would be the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design minimizes the risk from seismically induced dam failure hazards by suspending operations during an earthquake (GEO-IAMF#4).

6.2.8 Ground Subsidence

6.2.8.1 SR 152 (North) to Road 13 Wye Alternative

Construction

Construction on silty or clay soils in the resource hazards RSA could result in soil settlement if imposed loads cause compression of the underlying materials. It is a time-dependent process and 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 as would be imposed by new construction. Such loads could be experienced at approach fills for elevated guideways or from embankments constructed to support track structural sections; for example, ballast and subballast, placed to meet track grade requirements. This type of effect would be direct and permanent.

Although soils along the proposed SR 152 (North) to Road 13 Wye Alternative are generally competent (medium-dense, stiff, or better), localized deposits of soft or loose soils could occur at various locations, particularly at water crossings where soft or loose soils are more prevalent. This would primarily affect construction personnel on construction-related property, and could result in an increased risk of personal injury, loss of life, and damage to property if not addressed.

As previously discussed in Section 5.2.2, Ground Subsidence, the San Joaquin Valley has a long history of subsidence in response to water and mineral (oil and gas) extraction. Regional subsidence within the area has been documented; however, other areas to the west and south of the resource hazards RSA experience greater regional ground subsidence. The effect from historic subsidence in the San Joaquin Valley has caused serious and costly problems in construction and maintenance of water-transport structures, highways, and highway structures, and also changed the gradient and course of creeks and channels, thereby causing unexpected flooding. The SR 152 (North) to Road 13 Wye Alternative would traverse areas where subsidence ranging from 1 to 4 feet has occurred. The area of recorded subsidence extends to Road 12 in the resource hazards RSA.

The Central Valley Wye design would minimize the effects of settlement and subsidence wherever they occur through engineered ground improvements to stabilize compressible soils. In order to minimize effects of ground settlement due to construction on silty or clay soils, the Authority would either reduce settlement by controlling the amount of groundwater withdrawal from the Central Valley Wye or engineer the HSR infrastructure to accommodate settlement by using alternate foundation designs to offset the potential for settlement (GEO-IAMF#1A). The Authority would also stabilize soils that are subject to potential settlement, for example, by replacing unstable soils with competent soils and placing stone columns or vertical drains (GEO-IAMF#1B). These methods would improve deep unsuitable soils to protect against potential settlement.

In addition, construction of the Central Valley Wye near existing structures or buried utilities located close to the area of disturbance could result in settlement at some locations on all the alternative alignments. This type of effect 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. Several borings at river and stream crossings along the Central Valley Wye alternatives have revealed soft or loose silts. There are no substantive differences between the soils among the alternatives in this respect. This type of effect would be direct and temporary.

Central Valley Wye design will address subsidence in the design and construction processes (GEO-IAMF#1C, Subsidence). The design-build contractors will conduct topographic surveys for preparation of final design and compare the results of their surveys with results from surveys for the initial track design. The results will 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.

Conforming to guidelines specified by relevant transportation and building agencies and codes, identified under GEO-IAMF#6, will require Authority contractors to account for soil and geotechnical properties during Central Valley Wye design and construction and thus address risk factors associated with bearing capacity and slope stability.

As a result of these Central Valley Wye design features, geotechnical explorations to be undertaken prior to final design and prior to construction would identify the locations with potential for settlement. In such locations, where subsurface conditions may not be capable of supporting the additional loading induced by additional fill, engineering design features that address soft deposits of silty or clay soils would be incorporated, such as preloading to accelerate settlement or adding wick drains if applicable. The potential consequence of excessive settlement represents a high risk to HSR infrastructure if unaddressed. However, regional subsidence and localized settlement are typically slow processes that, with periodic maintenance, can be remedied in a timely manner by dressing or reballasting where required to maintain a safe track profile. Application of the engineering design features would reduce the potential for soil settlement to increase risk of personal injury, loss of life, and property damage.

Operations

There would be minimal ground subsidence hazards as a result of operations because Central Valley Wye design features will take into account soil and geotechnical factors in design and construction, control groundwater withdrawals, improve settlement-prone soils, as discussed above under Construction (GEO-IAMF#1A, GEO-IAMF#1B, GEO-IAMF#1C, and GEO-IAMF#6). Implementation of these features would reduce risks to HSR infrastructure, people, and property.

6.2.8.2 SR 152 (North) to Road 19 Wye Alternative

Construction

The effects associated with ground subsidence for the SR 152 (North) to Road 19 Wye Alternative are similar to the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design minimizes risks from ground subsidence by using engineered ground improvements to stabilize compressible soils, offsetting the effects of settlement as a result of groundwater withdrawal, and conforming to guidelines specified by relevant transportation and building agencies and codes (GEO-IAMF#1A, GEO-IAMF#1B, GEO-IAMF#1C, and GEO-IAMF#6).

Operations

The effects associated with ground subsidence for the SR 152 (North) to Road 19 Wye Alternative are similar to the effects described for the SR 152 (North) to Road 13 Wye Alternative. There would be minimal ground subsidence hazards as a result of operations because Central Valley Wye design features will take into account soil and geotechnical factors in design and construction, control groundwater withdrawals, and improve settlement-prone soils (GEO-IAMF#1A, GEO-IAMF#1B, GEO-IAMF#1C, and GEO-IAMF#6).

6.2.8.3 Avenue 21 to Road 13 Wye Alternative

Construction

The effects associated with ground subsidence for the Avenue 21 to Road 13 Wye Alternative are similar to the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design minimizes risks from ground subsidence by using engineered ground improvements to stabilize compressible soils, offsetting the effects of settlement as a result of groundwater withdrawal, and conforming to guidelines specified by relevant transportation and building agencies and codes (GEO-IAMF#1A, GEO-IAMF#1B, GEO-IAMF#1C, and GEO-IAMF#6).

Operations

The effects associated with ground subsidence for the Avenue 21 to Road 13 Wye Alternative are similar to the effects described for the SR 152 (North) to Road 13 Wye Alternative. There would be minimal ground subsidence hazards as a result of operations because Central Valley Wye design features will take into account soil and geotechnical factors in design and construction, control groundwater withdrawals, and improve settlement-prone soils (GEO-IAMF#1A, GEO-IAMF#1B, GEO-IAMF#1C, and GEO-IAMF#6).

6.2.8.4 SR 152 (North) to Road 11 Wye Alternative

Construction

The effects associated with ground subsidence for the SR 152 (North) to Road 11 Wye Alternative are similar to the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design minimizes risks from ground subsidence by using engineered ground improvements to stabilize compressible soils, offsetting the effects of settlement as a result of groundwater withdrawal, and conforming to guidelines specified by relevant transportation and building agencies and codes (GEO-IAMF#1A, GEO-IAMF#1B, GEO-IAMF#1C, and GEO-IAMF#6).

Operations

The effects associated with ground subsidence for the SR 152 (North) to Road 11 Wye Alternative are similar to the effects described for the SR 152 (North) to Road 13 Wye Alternative. There would be minimal ground subsidence hazards as a result of operations because Central Valley Wye design features will take into account soil and geotechnical factors in design and construction, control groundwater withdrawals, and improve settlement-prone soils (GEO-IAMF#1A, GEO-IAMF#1B, GEO-IAMF#1C, and GEO-IAMF#6).

6.2.9 Expansive Soils

6.2.9.1 SR 152 (North) to Road 13 Wye Alternative

Construction

Soils in the upper 5 feet of the soil profile in the resource hazards RSA along the SR 152 (North) to Road 13 Wye Alternative generally have moderate to high shrink-swell potential (expansive soils). Soils with high expansive potential shrink during dry conditions and expand when soaked. If unchecked, expansion presents a risk to the HSR track system. Soils with high expansion potential have been mapped in Merced County. A portion of Merced County, particularly in the vicinity of the resource hazards RSA, lies in a region where over 50 percent of the land area contains clay soils with high swelling potential (Olive 1989) (Figure 5-4). Table 6-2 shows soils with moderate and high expansion potential for each of the proposed Central Valley Wye alternatives.

Table 6-2 Resource Study Area Soils with Expansion Potential

Alternative	Soil Series with Moderate Expansion Potential	Soil Series with High Expansion Potential	Acres of Soils with Moderate to High Expansion Potential
SR 152 (North) to Road 13 Wye Alternative	Alros, Bolfar, El Nido, Escanso, Palazzo, Borden, Burchell, Fresno, Pachappa, Pozo, Wyman, Chino, Fresno/El Peco association, and Ramona	Dos Palos, Columbia, Lewis, Alamo, Cometa, Madera, San Joaquin, and San Joaquin-Alamo complex	10,534
SR 152 (North) to Road 19 Wye Alternative	Alros, Bolfar, El Nido, Escanso, Palazzo, Borden, Burchell, Fresno, Pachappa, Pozo, Wyman, Chino, Fresno/El Peco association, and Ramona	Dos Palos, Columbia, Lewis, Alamo, Cometa, Madera, San Joaquin, and San Joaquin-Alamo complex	12,742
Avenue 21 to Road 13 Wye Alternative	Alros, Bolfar, El Nido, Escanso, Palazzo, Borden, Burchell, Fresno, Pachappa, Pozo, Wyman, Chino, Fresno/El Peco association, and Ramona	Dos Palos, Columbia, Lewis, Alamo, Cometa, Madera, San Joaquin, and San Joaquin-Alamo complex	14,291
SR 152 (North) to Road 11 Wye Alternative	Alros, Bolfar, El Nido, Escanso, Palazzo, Borden, Burchell, Fresno, Pachappa, Pozo, Wyman, Chino, Fresno/El Peco association, and Ramona	Dos Palos, Columbia, Lewis, Alamo, Cometa, Madera, San Joaquin, and San Joaquin-Alamo complex	8,654

Source: Geotechnical Consultants, Inc., 2012

This type of effect is more critical in locations with at-grade segments than with elevated structures on deep foundations, retained fill, and retained cuts. The earth loads associated with at-grade segments of the Central Valley Wye alternatives may not be sufficient to overcome swell potential, and this swell would likely be variable along the alternative, which could lead to differential movement of the track system. This type of effect would be direct and permanent. Unlike Merced County, Madera County is underlain by soils with minimal to no swelling potential.

The Central Valley Wye design avoids effects of soils with moderate to high shrink-swell potential through adherence to standard construction practices that 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#1E, Soils with Shrink-Swell Potential). Additionally, the Authority will document the incorporation of specific guidelines and standards specified by relevant transportation and building agencies and codes into Central Valley Wye design and construction to build the HSR system in accordance with the best available practices (GEO-IAMF#6). These guidelines characterize soils and thus address risk factors associated with expansive soils, thereby minimizing the risk of construction on soils with moderate to high shrink-swell potential.

Operations

Risk from expansive soils during operations of the Central Valley Wye would be minimal because, as discussed under Construction, the design characteristics of the Central Valley Wye include replacing expansive soils, stabilizing moisture content, or otherwise avoiding the effects of expansive soils (GEO-IAMF#1E and GEO-IAMF#6). By reducing the risk of expansive soils during construction, there would be minimal risk to HSR infrastructure, people, and property during operations.

6.2.9.2 SR 152 (North) to Road 19 Wye Alternative

Construction

The effects associated with expansive soils for the SR 152 (North) to Road 19 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Table 6-2 shows soils with moderate and high expansion potential for each of the proposed Central Valley Wye alternatives. The design characteristics of the Central Valley Wye include measures to treat or replace expansive soils and to implement best available practices as specified by relevant transportation and building agencies and codes, which would minimize the effects associated with expansive soils (GEO-IAMF#1E and GEO-IAMF#6).

Operations

The effects associated with expansive soils for the SR 152 (North) to Road 19 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Risk from expansive soils during operations of the Central Valley Wye would be minimal because the design characteristics of the Central Valley Wye include replacing expansive soils, stabilizing moisture content, or otherwise avoiding the effects of expansive soils that would present a risk to HSR infrastructure, people, and property (GEO-IAMF#1E and GEO-IAMF#6).

6.2.9.3 Avenue 21 to Road 13 Wye Alternative

Construction

The effects associated with expansive soils for the Avenue 21 to Road 13 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Table 6-2 shows soils with moderate and high expansion potential for each of the proposed Central Valley Wye alternatives. The design characteristics of the Central Valley Wye include measures to treat or replace expansive soils and to implement best available practices as specified by relevant transportation and building agencies and codes, which would minimize the effects associated with expansive soils (GEO-IAMF#1E and GEO-IAMF#6).

Operations

The effects associated with expansive soils for the Avenue 21 to Road 13 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Risk from expansive soils during operations of the Central Valley Wye would be minimal because the design characteristics of the Central Valley Wye include replacing expansive soils, stabilizing moisture content, or otherwise avoiding the effects of expansive soils that would present a risk to HSR infrastructure, people, and property (GEO-IAMF#1E and GEO-IAMF#6).

6.2.9.4 SR 152 (North) to Road 11 Wye Alternative

Construction

The effects associated with expansive soils for the SR 152 (North) to Road 11 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Table 6-2 shows soils with moderate and high expansion potential for each of the proposed Central Valley Wye alternatives. The design characteristics of the Central Valley Wye include measures to treat or replace expansive soils and to implement best available practices as specified by relevant transportation and building agencies and codes, which would minimize the effects associated with expansive soils (GEO-IAMF#1E and GEO-IAMF#6)

Operations

The effects associated with expansive soils for the SR 152 (North) to Road 11 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Risk from expansive soils during operations of the Central Valley Wye would be minimal because the design characteristics of the Central Valley Wye include replacing expansive soils, stabilizing moisture content, or otherwise avoiding the effects of expansive soils that would present a risk to HSR infrastructure, people, and property (GEO-IAMF#1E and GEO-IAMF#6).

6.2.10 Corrosive Soils

6.2.10.1 SR 152 (North) to Road 13 Wye Alternative

Construction

Soils in the resource hazards RSA along the SR 152 (North) to Road 13 Wye Alternative have moderate to high corrosivity to uncoated steel, as well as concrete, in some locations. The potential for corrosion to uncoated steel and concrete presents a risk to the HSR track system. Consequences of corrosion could include eventual loss in the structural capacity of buried steel or concrete components. If left unaddressed, corrosion damage to uncoated steel and concrete of the HSR system could present a potential risk to personal safety of passengers and property of the HSR system. This type of effect would be direct and permanent.

The retained fill and at-grade segments of the SR 152 (North) to Road 13 Wye Alternative 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. As necessary, final designs would include epoxy-coated steel or double corrosion-protection ground anchors to avoid long-term corrosion issues.

Conforming to guidelines specified by relevant transportation and building agencies and codes (GEO-IAMF#6) will require Authority contractors to account for soil properties during Central Valley Wye design and construction and thus address risk factors associated with corrosive soils. For example, the Central Valley Wye design reduces the risk from 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 using coated or corrosion-resistant steel or concrete materials.

Operations

There would be no corrosive soil hazards as a result of operations because corrosive soils would be replaced during construction (GEO-IAMF#6).

6.2.10.2 SR 152 (North) to Road 19 Wye Alternative

Construction

The effects associated with corrosive soils for the SR 152 (North) to Road 19 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. The Authority and construction contractors would apply standard engineering design to reduce risks from corrosive soils (GEO-IAMF#6). This could include importing non-corrosive soils or using coated or corrosion resistant steel or concrete materials.

Operations

The effects associated with corrosive soils for the SR 152 (North) to Road 19 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. There would be no corrosive soil hazards as a result of operations because corrosive soils would be replaced during construction (GEO-IAMF#6).

6.2.10.3 Avenue 21 to Road 13 Wye Alternative

Construction

The effects associated with corrosive soils for the Avenue 21 to Road 13 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. The Authority and construction contractors would apply standard engineering features to reduce risks from corrosive soils (GEO-IAMF#6). This could include importing non-corrosive soils or using coated or corrosion resistant steel or concrete materials.

Operations

The effects associated with corrosive soils for the Avenue 21 to Road 13 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. There would be no corrosive soil hazards as a result of operations because corrosive soils would be replaced during construction (GEO-IAMF#6).

6.2.10.4 SR 152 (North) to Road 11 Wye Alternative

Construction

The effects associated with corrosive soils for the SR 152 (North) to Road 11 Wye Alternative are the same effects as the effects described for the SR 152 (North) to Road 13 Wye Alternative. The Authority and construction contractors would apply standard engineering design features to reduce risks from corrosive soils (GEO-IAMF#6). This could include importing non-corrosive soils or using coated or corrosion resistant steel or concrete materials.

Operations

The effects associated with corrosive soils for the SR 152 (North) to Road 11 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. There would be no corrosive soil hazards as a result of operations because corrosive soils would be replaced during construction (GEO-IAMF#6).

6.2.11 Collapsible Soils

6.2.11.1 SR 152 (North) to Road 13 Wye Alternative

Construction

Collapsible soils are soils that undergo rapid settlement upon the addition of water. Soil types susceptible to collapse include loess and other fine-grained, windblown soils, both of which are common to the San Joaquin Valley. Collapsible soils in the San Joaquin Valley tend to occur locally along its western and southern margins as near-surface alluvial fan deposits, and commonly as mudflows, that remain above the natural water table. The nearest locations prone to collapsible soils are mapped more than 20 miles south of the Central Valley Wye vicinity (Geotechnical Consultants, Inc. 2012). Therefore, collapsible soils are not considered a significant geologic hazard in the vicinity of the proposed SR 152 (North) to Road 13 Wye Alternative.

Should collapsible soils be encountered, special engineering or construction considerations would be employed. The Authority can apply standard geotechnical engineering practices, such as pre-wetting, to minimize the hazards related to collapsible soils, including a subsurface drilling and laboratory testing program (GEO-IAMF#6). Pre-wetting would allow the soils to be collapsed before the load is applied. Laboratory testing would allow susceptible soils to be identified before construction is begun.

Operations

There would be no collapsible soil hazards as a result of operations because any such soils, which are not known to occur near the Central Valley Wye, would be encountered during construction, and techniques would be applied to minimize the hazards (GEO-IAMF#6).

6.2.11.2 SR 152 (North) to Road 19 Wye Alternative

Construction

The effects associated with collapsible soils for the SR 152 (North) to Road 19 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Collapsible soils are not known to occur near the proposed SR 152 (North) to Road 19 Wye Alternative and are therefore not considered a significant geologic hazard. Should collapsible soils be encountered, special engineering or construction considerations will be employed, such as pre-wetting, to minimize the hazards (GEO-IAMF#6).

Operations

The effects associated with collapsible soils for the SR 152 (North) to Road 19 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. There would be no collapsible soil hazards as a result of operations because any such soils, which are not known to occur near the Central Valley Wye, would be encountered during construction, and techniques would be applied to minimize the hazards (GEO-IAMF#6).

6.2.11.3 Avenue 21 to Road 13 Wye Alternative

Construction

The effects associated with collapsible soils for the Avenue 21 to Road 13 Wye Alternative are the same as the effects described above for the SR 152 (North) to Road 13 Wye Alternative. Collapsible soils are not known to occur near the proposed Avenue 21 to Road 13 Wye Alternative and are therefore not considered a significant geologic hazard. Should collapsible soils be encountered, special engineering or construction considerations will be employed, such as pre-wetting, to minimize the hazards (GEO-IAMF#6).

Operations

The effects associated with collapsible soils for the Avenue 21 to Road 13 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. There would be no collapsible soil hazards as a result of operations because any such soils, which are not known to occur near the Central Valley Wye, would be encountered during construction, and techniques would be applied to minimize the hazards (GEO-IAMF#6).

6.2.11.4 SR 152 (North) to Road 11 Wye Alternative

Construction

The effects associated with collapsible soils for the SR 152 (North) to Road 11 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Collapsible soils are not known to occur near the proposed SR 152 (North) to Road 11 Wye Alternative and are therefore not considered a significant geologic hazard. Should collapsible soils be encountered, special engineering or construction considerations will be employed, such as pre-wetting, to minimize the hazards (GEO-IAMF#6).

Operations

The effects associated with collapsible soils for the SR 152 (North) to Road 11 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. There would be no collapsible soil hazards as a result of operations because any such soils, which are not known to occur near the Central Valley Wye, would be encountered during construction, and techniques would be applied to minimize the hazards (GEO-IAMF#6).

6.2.12 Soil Erosion

6.2.12.1 SR 152 (North) to Road 13 Wye Alternative

Construction

Potential soil erosion is discussed in Section 5.2.3, Poor Soil Conditions, and the particularly susceptible areas are illustrated on Figure 5-7. The potential for soil erosion (soils with a K value greater than 0.4) has been previously identified near the SR 152 East Bypass Bridge and the bridge crossing at Avenue 21 in Madera County. Deep erosion gullies had developed in the silt and sand exposed by the channel and remedial work had been performed to protect the foundation pile columns supporting the Avenue 21 Bridge.

Accelerated soil erosion, including loss of topsoil, could occur as a result of construction. Soils that have a high potential for wind or water erosion are included in Table 5-2. With the development of any alternative, the potential for more surface water runoff exists during construction when existing vegetation is removed and the unprotected soils are exposed to both wind and water erosion. Increased surface water runoff could also result from temporary, impermeable work surfaces.

If exposed soils are not protected from wind or water erosion, such as when vegetation is cleared for work areas and material stockpiles, both the exposed work areas and any stockpiles could erode and result in decreased air and water quality and loss of high-value soil. The potential for erosion from water increases slightly from west to east in the resource hazards RSA. Standard construction practices, such as those listed in the Caltrans *Construction Site BMP Manual* (Caltrans 2003a) and *Construction Site Best Management Practice (BMP) Field Manual and Troubleshooting Guide* (Caltrans 2003b), would be followed to reduce the potential for erosion. These could include soil stabilization, watering for dust control, perimeter silt fences, and sediment basins. In addition, implementation of local and state regulations regarding soil erosion, such as stormwater best management practices (BMP) and temporary soil erosion guidelines, would be followed in the design and construction of the HSR facility.

The Central Valley Wye design also minimizes water and wind erosion through adoption of BMPs, including use of stabilizers, mulches, revegetation, and covering areas with biodegradable geotextiles (GEO-IAMF#1D). The Authority will also document the incorporation of specific guidelines and standards, as identified by relevant transportation and building agencies and codes, into Central Valley Wye design and construction to build the HSR system in accordance with the best available practices (GEO-IAMF#6). In complying with these guidelines and standards, the Authority will take soil properties into account for design and construction of the Central Valley Wye and reduce the potential for effects associated with wind and water erosion during construction.

Operations

There would be no soil erosion hazards as a result of operations. Central Valley Wye design features and standard construction practices will address erosion hazards during the construction phase, including revegetating the construction area and controlling erosion until the vegetation is established.

6.2.12.2 SR 152 (North) to Road 19 Wye Alternative

Construction

The effects associated with soil erosion for the SR 152 (North) to Road 19 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design measures include the use of BMPs and adherence to relevant transportation and building agency guidelines and standards that would take into account soil properties and minimize soil erosion hazards (GEO-IAMF#1D and GEO-IAMF#6).

Operations

The effects associated with soil erosion for the SR 152 (North) to Road 19 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. There would be no soil erosion hazards as a result of operations. Central Valley Wye design features and standard construction practices will address erosion hazards during the construction phase, including revegetating the construction area and controlling erosion until the vegetation is established.

6.2.12.3 Avenue 21 to Road 13 Wye Alternative

Construction

The effects associated with soil erosion for the Avenue 21 to Road 13 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design measures include the use of BMPs and adherence to relevant transportation and building agency guidelines and standards that would take into account soil properties and minimize soil erosion hazards (GEO-IAMF#1D and GEO-IAMF#6).

Operations

The effects associated with soil erosion for the Avenue 21 to Road 13 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. There would be no soil erosion hazards as a result of operations. Central Valley Wye design features and standard construction practices will address erosion hazards during the construction phase, including revegetating the construction area and controlling erosion until the vegetation is established.

6.2.12.4 SR 152 (North) to Road 11 Wye Alternative

Construction

The effects associated with soil erosion for the SR 152 (North) to Road 11 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design measures include the use of BMPs and adherence to relevant transportation and building agency guidelines and standards that would take into account soil properties and minimize soil erosion hazards (GEO-IAMF#1D and GEO-IAMF#6).

Operations

The effects associated with soil erosion for the SR 152 (North) to Road 11 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. There would be no soil erosion hazards as a result of operations. Central Valley Wye design features and standard construction practices will address erosion hazards during the construction phase, including revegetating the construction area and controlling erosion until the vegetation is established.

6.2.13 Erosion and Soil Settlement as a Result of Dewatering

6.2.13.1 SR 152 (North) to Road 13 Wye Alternative

Construction

Dewatering during construction can potentially result in erosion and soil settlement. Construction in areas prone to soil settlement can result in an increased risk of personal injury and damage to property. 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.

If in-water construction occurs where open or flowing water is present, the Authority will implement a dewatering plan (BIO-IAMF#20, Dewatering and Water Diversion). Dewatering in open water increases the potential for erosion. However, the dewatering plan under BIO-IAMF#20 includes measures to reduce the potential for work to disrupt water flows and will not allow sediment from construction to enter the water.

Construction could also require dewatering of groundwater. Dewatering of groundwater could increase the likelihood of settlement. Should dewatering be necessary during construction, the amount of dewatering likely would be relatively small and conducted in widely spaced locations, even where waterbodies are crossed more than once. This type of impact from groundwater dewatering would be direct and temporary because once construction is completed, dewatering would cease. Typical track construction remains on the surface and may extend 1 to 2 feet below the surface for clearing and grading. Extensive groundwater dewatering is not foreseen for the SR 152 (North) to Road 13 Wye Alternative. If groundwater dewatering should occur, it will be conducted in compliance with the SWRCB Construction General Permit (HYD-IAMF#3, Prepare and Implement a Construction Stormwater Pollution Prevention Plan), minimizing the potential of contaminants to be discharged into groundwater, and minimizing short-term increases in sediment transport caused by construction, including erosion control requirements, stormwater management, and channel dewatering for affected stream crossings. Dewatering activities will 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.

In addition, the construction contractor will dispose of groundwater generated by construction during dewatering activities in the event groundwater is encountered during excavation, 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 2014) to protect groundwater quality. The Central Valley Wye will be in compliance with both Caltrans and the Authority's MS4 requirements. Refer to the Hydrology and Water Resources Technical Report (Authority and FRA 2016) and Section 3.8, Hydrology and Water Resources, in the Supplemental EIR/EIS for additional information.

To monitor any earth movement, the Authority will 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#1C). Further, the Authority will conform to guidelines specified by relevant transportation and building agencies and codes (GEO-IAMF#6), requiring Authority contractors to account for geotechnical properties during Central Valley Wye design and construction and thus address risk factors associated with soil settlement associated with dewatering.

Operations

No dewatering would be involved for operations.

6.2.13.2 SR 152 (North) to Road 19 Wye Alternative

Construction

The effects associated with surface dewatering for the SR 152 (North) to Road 19 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design measures involve development and implementation of a dewatering plan (BIO-IAMF#20).

The effects associated with groundwater dewatering for the 152 (North) to Road 19 Wye Alternative, however, are different from those of the SR 152 (North) to Road 13 Wye Alternative. The SR 152 (North) to Road 19 Wye Alternative has a tunnel segment crossing under SR 99 that is up to 60 feet deep, including subgrade. The HSR aerial structure foundations sit on drilled shaft piles that can be 60 feet deep, depending on geotechnical conditions, and the roadway underpasses can be as deep as 40 feet, including subgrade. Most of the water depths in the resource hazards RSA are greater than 50 feet, so construction would not encounter groundwater or require dewatering for the at-grade or below-grade sections of the track, with the exception of the SR 152 (North) to Road 19 Wye Alternative tunnel section crossing under SR 99. Accordingly, dewatering activities would likely be required only during construction of the SR 152 (North) to Road 19 Wye Alternative tunnel section of the Central Valley Wye. Central Valley Central Valley Wye design measures involve preparation of a Construction Stormwater Pollution Prevention Plan (HYD-IAMF#3), which will minimize effects of groundwater dewatering and disposal of groundwater generated by construction during dewatering activities.

The effects associated with potential earth movement or settlement associated with dewatering for the SR 152 (North) to Road 19 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design measures involve conducting topographic surveys to establish benchmark elevations (GEO-IAMF#1C) to determine whether subsidence occurs, and conforming to guidelines specified by relevant transportation and building agencies and codes (GEO-IAMF#6).

Operations

No dewatering would be involved for project operations.

6.2.13.3 Avenue 21 to Road 13 Wye Alternative

Construction

The effects associated with dewatering for the Avenue 21 to Road 13 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design measures involve development and implementation of a dewatering plan (BIO-IAMF#20) and preparation of a Construction Stormwater Pollution Prevention Plan (HYD-IAMF#3), which will minimize effects of groundwater dewatering and disposal of groundwater generated by construction during dewatering activities.

The effects associated with potential earth movement or settlement associated with dewatering for the Avenue 21 to Road 13 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design measures involve conducting topographic surveys to establish benchmark elevations (GEO-IAMF#1C) to determine whether subsidence occurs, and conforming to guidelines specified by relevant transportation and building agencies and codes (GEO-IAMF#6).

Operations

No dewatering would be involved for project operations.

6.2.13.4 SR 152 (North) to Road 11 Wye Alternative

Construction

The effects associated with dewatering for the SR 152 (North) to Road 11 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design measures involve development and implementation of a dewatering plan (BIO-IAMF#20) and preparation of a Construction Stormwater Pollution Prevention Plan (HYD-IAMF#3), which will minimize effects of groundwater dewatering and disposal of groundwater generated by construction during dewatering activities.

The effects associated with potential earth movement or settlement associated with dewatering for the SR 152 (North) to Road 11 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Central Valley Wye design measures involve conducting topographic surveys to establish benchmark elevations (GEO-IAMF#1C) to determine whether subsidence occurs, and conforming to guidelines specified by relevant transportation and building agencies and codes (GEO-IAMF#6).

Operations

No dewatering would be involved for project operations.

6.2.14 Difficult Excavations

6.2.14.1 SR 152 (North) to Road 13 Wye Alternative

Construction

Upper layers of soil in the resource hazards RSA contain cemented zones and hardpan that can be difficult to excavate with conventional machinery and could increase the risk of personal injury, loss of life, or property damage during construction excavations. These effects would primarily affect construction personnel on construction-related property. Excavations in these types of soils are relatively common, and contractors are familiar with methods to handle excavations in hardpan.

Excavations in loose, cohesionless deposits that extend below groundwater levels could also result in difficult excavations that could increase the risk of personal injury, loss of life, or property damage for construction personnel on construction-related property. At these locations, hydrostatic pressures can result in instabilities of the excavation side-slopes or heave of the excavation base, leading to loss of ground support. These conditions can be encountered in localized areas such as at river crossings. These types of design issues are routinely handled during construction through the use of temporary dewatering with deep groundwater wells and well points that lower the water level, sheet pile walls systems to stabilize the soil, or 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. This type of effect would be direct and temporary.

Locations where retained-cut alignment segments are planned would be most affected by hardpan and shallow groundwater conditions. Both the retained-fill and at-grade design types 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.

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 Central Valley Wye design and construction and thus address 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 pre-drilling rock bits for drilled piers/piles or the use of backhoe-mounted hydraulic impact hammers for shallow excavations, would be used..

Operations

Because excavation is not anticipated during operations and maintenance activities, there would be no difficult excavation hazards as a result of Central Valley Wye operations.

6.2.14.2 SR 152 (North) to Road 19 Wye Alternative

Construction

The effects associated with difficult excavation for the SR 152 (North) to Road 19 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. The Central Valley Wye design would minimize risk associated with difficult excavations in areas of hardpan and shallow groundwater through use of standard construction techniques and by conforming to guidelines specified by relevant transportation and building agencies and codes (GEO-IAMF#6).

Operations

The effects associated with difficult excavation for the SR 152 (North) to Road 19 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Because excavation is not anticipated during operations and maintenance activities, there would be no difficult excavation hazards as a result of Central Valley Wye operations.

6.2.14.3 Avenue 21 to Road 13 Wye Alternative

Construction

The effects associated with difficult excavation for the Avenue 21 to Road 13 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. The Central Valley Wye design would minimize risk associated with difficult excavations in areas of hardpan and shallow groundwater through use of standard construction techniques and by conforming to guidelines specified by relevant transportation and building agencies and codes (GEO-IAMF#6).

Operations

The effects associated with difficult excavation for the Avenue 21 to Road 13 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Because excavation is not anticipated during operations and maintenance activities, there would be no difficult excavation hazards as a result of Central Valley Wye operations.

6.2.14.4 SR 152 (North) to Road 11 Wye Alternative

Construction

The effects associated with difficult excavation for the SR 152 (North) to Road 11 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. The Central Valley Wye design would minimize risk associated with difficult excavations in areas of hardpan and shallow groundwater through use of standard construction techniques and by conforming to guidelines specified by relevant transportation and building agencies and codes (GEO-IAMF#6).

Operations

The effects associated with difficult excavation the SR 152 (North) to Road 11 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. Because excavation is not anticipated during operations and maintenance activities, there would be no difficult excavation hazards as a result of Central Valley Wye operations.

6.2.15 Subsurface Gas Hazards

6.2.15.1 SR 152 (North) to Road 13 Wye Alternative

Construction

The SR 152 (North) to Road 13 Wye Alternative would pass through the Chowchilla Gas Field, located near where SR 152 crosses the Merced–Madera county line. Most of the wells within the Chowchilla Gas Field are dry or plugged as a result of well operators abandoning them between 1930 and 1986. Construction of the Central Valley Wye could pose a safety risk to construction workers and people in the HSR vicinity, in case of oil or gas pipeline rupture associated with HSR construction. This type of effect would be direct and temporary. The Authority plotted locations of oil and gas wells (both active and abandoned) from data obtained from the DOGGR database (DOC 2015). The database contained the following oil and gas wells within the resource hazards RSA:

- SR 152 (North) to Road 13 Wye Alternative—44 wells (1 active, 1 cancelled, 1 idle, 41 plugged and abandoned)

To prevent open wells that would pose a safety threat to the Central Valley Wye, wells within 200 feet of the HSR will be identified and inspected; and will be capped, abandoned, or relocated by the well operator with compensation from the Authority (SS-IAMF#4, Oil and Gas Wells). Active wells would be capped and relocated to nearby locations using directional drilling techniques, if feasible. Appurtenant facilities such as pipelines will also potentially need to be relocated if they fall within the Central Valley Wye footprint.

The use of safe and explosion-proof equipment, regular testing for gases, and development of a safety and security management plan (SS-IAMF#2, Safety and Security Management Plan**)**, would reduce the effect because these measures would improve safety. Conforming to guidelines specified by relevant transportation and building agencies and codes (GEO-IAMF#6), will further require Authority contractors to account for geotechnical properties during Central Valley Wye design and construction and thus address potential increased risk associated with construction near oil and gas fields.

Operations

There would be no subsurface gas hazards as a result of operations. Existing oil and gas wells and associated pipelines within 200 feet of the Central Valley Wye would be relocated during construction and thus there would be no potential exposure to subsurface gas resources.

6.2.15.2 SR 152 (North) to Road 19 Wye Alternative

Construction

The effects associated with subsurface gas hazards for the SR 152 (North) to Road 19 Wye Alternative are similar to the effects described for the SR 152 (North) to Road 13 Wye Alternative. The DOGGR database contained the following oil and gas wells within the resource hazards RSA (DOC 2015):

- SR 152 (North) to Road 19 Wye Alternative—45 wells (1 active, 1 cancelled, 1 idle, 42 plugged and abandoned)

The Authority will follow safety and security measures and design standards that would minimize the risk from subsurface gas hazards by accounting for these hazards in the design of the Central Valley Wye and relocating oil and gas wells and appurtenant facilities that occur within 200 feet of the Central Valley Wye (SS-IAMF#4, SS-IAMF#2, and GEO-IAMF#6).

Operations

The effects associated with subsurface gas hazards for the SR 152 (North) to Road 19 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. There would be no subsurface gas hazards as a result of operations. Existing oil and gas wells and associated pipelines within 200 feet of the Central Valley Wye would be relocated during construction and thus there would be no potential exposure to subsurface gas resources.

6.2.15.3 Avenue 21 to Road 13 Wye Alternative

Construction

The effects associated with subsurface gas hazards for the Avenue 21 to Road 13 Wye Alternative are similar to the effects described for the SR 152 (North) to Road 13 Wye Alternative. The DOGGR database contained the following oil and gas wells within the resource hazards RSA (DOC 2015):

- Avenue 21 to Road 13 Wye Alternative—34 wells (1 active, 3 cancelled, 1 idle, 29 plugged and abandoned)

The Authority will follow safety and security measures and design standards that would minimize the risk from subsurface gas hazards by accounting for these hazards in the design of the Central Valley Wye and relocating oil and gas wells and appurtenant facilities that occur within 200 feet of the Central Valley Wye (SS-IAMF#4, SS-IAMF#2, and GEO-IAMF#6).

Operations

The effects associated with subsurface gas hazards for the Avenue 21 to Road 13 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. There would be no subsurface gas hazards as a result of operations. Existing oil and gas wells and associated pipelines within 200 feet of the Central Valley Wye would be relocated during construction and thus there would be no potential exposure to subsurface gas resources.

6.2.15.4 SR 152 (North) to Road 11 Wye Alternative

Construction

The effects associated with subsurface gas hazards for the SR 152 (North) to Road 11 Wye Alternative are similar to the effects described for the SR 152 (North) to Road 13 Wye Alternative. The DOGGR database contained the following oil and gas wells within the resource hazards RSA (DOC 2015):

- SR 152 (North) to Road 11 Wye Alternative—44 wells (1 active, 1 cancelled, 1 idle, 41 plugged and abandoned)

The Authority will follow safety and security measures and design standards that would minimize the risk from subsurface gas hazards by accounting for these hazards in the design of the Central

Valley Wye and relocating oil and gas wells and appurtenant facilities that occur within 200 feet of the Central Valley Wye (SS-IAMF#4, SS-IAMF#2, and GEO-IAMF#6).

Operations

The effects associated with subsurface gas hazards for the SR 152 (North) to Road 11 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. There would be no subsurface gas hazards as a result of operations. Existing oil and gas wells and associated pipelines within 200 feet of the Central Valley Wye would be relocated during construction and thus there would be no potential exposure to subsurface gas resources.

6.2.16 Mineral and Energy Resources

6.2.16.1 SR 152 (North) to Road 13 Wye Alternative

Construction

Construction of the Central Valley Wye could reduce the availability of mineral or energy resources in the resource hazards RSA by reducing access to production sites. Potential mineral resources (including aggregate), fossil fuels (oil and natural gas), and geothermal resources are discussed in Sections 5.5.1, Mineral Resources, 5.5.2, Fossil Fuels Resources, and 5.5.3, Geothermal Resources, respectively, and oil and gas fields are shown on Figure 5-13. Aggregate resources are the only mineral resource within the Central Valley Wye vicinity although no aggregate mining occurs in the resource hazards RSA. Accordingly, no loss of availability of minerals of statewide significance or hazards associated with encountering surface or subsurface deposits of such minerals is anticipated.

The Central Valley Wye alternative alignments do 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.

The number of oil and gas wells within the resource hazards RSA is provided in Section 6.2.15, Subsurface Gas Hazards. As discussed in that section, the Authority would identify and inspect oil and gas wells within 200 feet of the HSR, and the well operator will cap, abandon, or relocate the wells to minimize subsurface gas hazards. Relocating wells will involve capping an existing well and redrilling into the target zone from a nearby location. Data collected from exploration activities are used to optimize the entrance to the target zone when drilling and developing a well. However, relocated wells may not result in the same level of production as the existing wells. The production rate from a new well cannot be estimated before it is installed. Accordingly, construction of the Central Valley Wye could reduce the availability of energy resources by reducing access to production sites. This type of effect would be direct and, because these resources are nonrenewable, permanent. However, production lost during well relocation is expected to be small on a regional basis, because of the small number of potentially affected wells.

Central Valley Wye design would minimize the effects related to relocation of active oil and gas wells because production would be maintained to the greatest extent possible, so that regional productivity would not be affected. Further, the Authority will 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 will conform to guidelines specified by relevant transportation and building agencies and codes (GEO-IAMF#6) requiring Authority contractors to account for geotechnical properties during Central Valley Wye design and construction and thus address potential loss of productivity from these fields. While a small number of individual wells may be affected by the Central Valley Wye, the Central Valley Wye would not result in damage to the geologic horizons containing the oil or natural gas.

Operations

There would be no effects on mineral and energy resources as a result of operations. No new geographic areas would be developed or used during Central Valley Wye operations, and thus access to potential mineral resource reserves would not be precluded.

6.2.16.2 SR 152 (North) to Road 19 Wye Alternative

Construction

The effects on mineral and energy resources for the SR 152 (North) to Road 19 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. No aggregate mining and no geothermal resources are known to occur in the resource hazards RSA and therefore no loss of availability of minerals of statewide significance or hazards associated with encountering surface or subsurface deposits of such minerals is anticipated. The Authority would minimize the effects related to relocation of active oil and gas wells by compensating owners for well relocation and any loss of production. Because a small number of wells would be affected and the Central Valley Wye would not result in damage to the geologic horizons containing oil and natural gas, the impact on production and availability of oil and gas resources would be minimal.

Operations

The effects on mineral and energy resources for the SR 152 (North) to Road 19 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. There would be no effects on mineral resources as a result of operations. No new geographic areas would be developed or used during Central Valley Wye operations, and thus access to potential mineral resource reserves would not be precluded.

6.2.16.3 Avenue 21 to Road 13 Wye Alternative

Construction

The effects on mineral and energy resources for the Avenue 21 to Road 13 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. No aggregate mining and no geothermal resources are known to occur in the resource hazards RSA and therefore no loss of availability of minerals of statewide significance or hazards associated with encountering surface or subsurface deposits of such minerals is anticipated. The Authority would minimize the effects related to relocation of active oil and gas wells by compensating owners for well relocation and any loss of production. Because a small number of wells would be affected and the Central Valley Wye would not result in damage to the geologic horizons containing oil and natural gas, the impact on production and availability of oil and gas resources would be minimal.

Operations

The effects on mineral and energy resources for the Avenue 21 to Road 13 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. There would be no effects on mineral resources as a result of operations. No new geographic areas would be developed or used during Central Valley Wye operations, and thus access to potential mineral resource reserves would not be precluded.

6.2.16.4 SR 152 (North) to Road 11 Wye Alternative

Construction

The effects on mineral and energy resources for the SR 152 (North) to Road 11 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. No aggregate mining and no geothermal resources are known to occur in the resource hazards RSA and therefore no loss of availability of minerals of statewide significance or hazards associated with encountering surface or subsurface deposits of such minerals is anticipated. The Authority would minimize the effects related to relocation of active oil and gas wells by compensating owners for well relocation and any loss of production. Because a small number of wells would be affected and the Central Valley Wye would not result in damage to the geologic horizons containing oil and natural gas, the impact on production and availability of oil and gas resources would be minimal.

Operations

The effects on mineral and energy resources for the SR 152 (North) to Road 11 Wye Alternative are the same as the effects described for the SR 152 (North) to Road 13 Wye Alternative. There would be no effects on mineral resources as a result of operations. No new geographic areas would be developed or used during Central Valley Wye operations, and thus access to potential mineral resource reserves would not be precluded.

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Caltrans	California Department of Transportation
CDMG	California Division of Mines and Geology
CGS	California Geological Survey
DOC	California Department of Conservation
DWR	California Department of Water Resources
Fed. Reg.	*Federal Register*
FRA	Federal Railroad Administration
NRCS	Natural Resources Conservation Service
USGS	U.S. Geological Survey

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8 PREPARER QUALIFICATIONS

The following individuals have made significant contributions to development of this technical report:

Anne Winslow	MS, Earth Systems, Stanford University BS, Earth Systems, Stanford University 4 years of experience
Jennifer Anderson	BA, Environmental Studies, University of Southern California 4 years of experience
Lesley Scheuber	BS, Environmental Economics and Policy, University of California, Berkeley 3 years of experience
Diana Roberts	BS, Psychology, Georgia Institute of Technology MA, Linguistics, Cornell University MS (Candidate), Environmental Studies, San Jose State University 7 years of experience
Sarah Mello	BS, Integrated Science and Technology, James Madison University 2 years of experience