California High-Speed Rail Authority

Merced to Fresno Section: Central Valley Wye

Paleontological Resources Technical Report

December 2016

CALIFORNIA High-Speed Rail Authority

U.S. Department of Transportation
Federal Railroad Administration

TABLE OF CONTENTS

Tables

Figures

Appendix

ACRONYMS AND ABBREVIATIONS

2012 technical report	*Paleontological Resources Technical Report, Merced to Fresno Section Project EIR/EIS*
Authority	California High-Speed Rail Authority
BMP	best management practice
BNSF	BNSF Railway
BRT	bus rapid transit
CEQA	California Environmental Quality Act
Caltrans	California Department of Transportation
Central Valley Wye	Merced to Fresno Section: Central Valley Wye
Conditions of Receivership	Society of Vertebrate Paleontology *Conditions of Receivership for Paleontologic Salvage Collections*
COG	Council of Governments
EIR	environmental impact report
EIS	environmental impact statement
Environmental Methods	*California High-Speed Rail Project Environmental Impact Report/Environmental Impact Statement Environmental Methodology Guidelines, Version 5*
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
HCM	Transportation Research Board *Highway Capacity Manual*
HDM	Transportation Research Board *Highway Design Manual*
HOV	high-occupancy vehicle
HSR	high-speed rail
Merced to Fresno Final EIR/EIS	*2012 Merced to Fresno Section Final Environmental Impact Report/Environmental Impact Statement*
NB	Northbound
NEPA	National Environmental Policy Act
PG	(California-licensed) professional geologist
PMT	Program Management Team
PRMMP	Paleontological Resources Mitigation and Monitoring Plan
RC	Regional Consultant
RSA	resource study area
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SB	Southbound
SR	State Route
Standard Guidelines	Society of Vertebrate Paleontology *Standard Guidelines for the Assessment and Mitigation of Adverse Impacts to Nonrenewable Paleontologic Resources* (1995)

Standard Procedures	Society of Vertebrate Paleontology *Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources* (2010)
Statewide Program EIR/EIS	*Statewide Program Environmental Impact Report/Environmental Impact Statement for the Proposed California High-Speed Train System*
SVP	Society of Vertebrate Paleontology
UCMP	University of California Museum of Paleontology
UPRR	Union Pacific Railroad
Version 5 Environmental Methods	*California High-Speed Rail Project Environmental Impact Report/Environmental Impact Statement Environmental Methodology Guidelines, Version 5*

EXECUTIVE SUMMARY

The California High-Speed Rail Authority (Authority) has prepared this Merced to Fresno Section: Central Valley Wye Paleontological Resources 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 paleontological resource 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

Paleontological resources (fossils and trace fossils) are the preserved remains or traces of animals and plants that can provide important information about the evolution of life on earth over the past billion years or more. This technical report addresses effects resulting from the high-speed rail 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 identifies relevant federal, state, regional, and local regulations and requirements; methods used for the analysis of effects; the affected environment; potential effects on paleontological resources in the Central Valley Wye resource 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 Central Valley Wye alternatives would cross several units that have produced abundant and diverse fossil assemblages and thus are considered highly sensitive for paleontological resources. Construction and ground disturbance have the potential to damage or destroy significant (scientifically important) fossil resources. Effects would be permanent because once lost, such resources cannot be recovered. However, design characteristics of the Central Valley Wye include provisions for avoiding loss of scientifically important fossil resources in areas of high paleontological sensitivity through engagement of a paleontological resources specialist for direct monitoring during construction (GEO-IAMF #7), implementation of a Paleontological Resource Monitoring and Mitigation Plan (GEO-IAMF #8), and provisions to halt construction if paleontological resources are found (GEO-IAMF #9). Operations and maintenance activities are not expected to disturb previously undisturbed substrate materials; as a result, there would be no loss of paleontological resources as a result of operations. If future maintenance activities require ground disturbance affecting previously undisturbed substrate units, the potential for loss affecting scientifically important resources would be similar to that associated with construction.

1 INTRODUCTION

This report presents a paleontological resources technical evaluation for the California High-Speed Rail (HSR) Merced to Fresno Section: Central Valley Wye (Central Valley Wye), prepared in support of environmental reviews required under the National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA).

1.1 Background of HSR Program

The Authority proposes to construct, operate, and maintain an electric-powered 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), and then began preparing second-tier, project environmental evaluations for sections of the statewide HSR system.[1] 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—and supporting materials including this technical report—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 Purpose of this Technical Report

This report supplements the Authority's previously prepared *Paleontological Resources Technical Report, Merced to Fresno Section Project EIR/EIS* (2012 technical report) (Authority and FRA 2012b) with respect to the Central Valley Wye in support of the Supplemental EIR/EIS currently in preparation. As such, its role is to:

- Provide updated analysis consistent with the Authority's current adopted systemwide environmental methodology guidelines, which were put in place subsequent to the preparation of the 2012 technical report
- Evaluate the Central Valley Wye footprint as currently proposed, including areas not covered in the 2012 technical report

The updated resource evaluation and effects analysis presented in this report are consistent with the Authority's and FRA's *California High Speed Rail Project EIR/EIS Environmental Methodology Guidelines Version 5* (Version 5 Environmental Methods), adopted in June 2014 (Authority and FRA 2014a). To the extent feasible within this framework, evaluation, and analysis are consistent with the approaches used for nearby sections of the HSR system, including not only the Merced

[1] The Program EIR/EIS documents consist of the *Final Program Environmental Impact Report (EIR)/Environmental Impact Statement (EIS) for the Proposed California High-Speed Train System* (Authority and FRA 2005); the *San Francisco Bay Area (Bay Area) to Central Valley High-Speed Train Final Program EIR/EIS* (Authority and FRA 2008); the *Bay Area to Central Valley High-Speed Train Revised Final Program EIR* (Authority 2010), and the *Bay Area to Central Valley High-Speed Train Partially Revised Final Program EIR* (Authority 2012).

to Fresno Section but also the Fresno to Bakersfield Section. Where this report deviates from the prior studies, the differences reflect the updated Version 5 Environmental Methods.

1.3 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 as currently proposed.
- Section 3, Regulatory Context and Standards of Practice for Paleontological Resources, introduces federal, state, and local laws, regulations, and policies relevant to paleontological resources conservation. It also provides a brief description of applicable professional standards, including the analysis protocols adopted by the Authority for project-level NEPA/CEQA documents.
- Section 4, Resource Evaluation, describes the approach used to inventory paleontological resources in the Central Valley Wye area, briefly describes the geology of the Central Valley Wye area, and presents an evaluation of paleontological sensitivity by geologic unit. Because the 2012 technical report followed a different analysis methodology, and the evaluation of paleontological sensitivity is a key aspect of paleontological resources risk analysis, this baseline information is presented as a complete, stand-alone section rather than a supplement.
- Section 5, Potential for Effects on Paleontological Resources, assesses the potential for construction and operations of the Central Valley Wye to result in loss of nonrenewable paleontological resources and associated loss of paleontological data. This is also presented as a new stand-alone section that conforms to the Authority's current adopted systemwide environmental methodology.
- Section 6, References, provides complete reference information for the published, online, agency, institutional, and individual sources consulted in the preparation of this report.
- Section 7, Preparer Qualifications, identifies and presents the credentials of the qualified and licensed staff who oversaw the preparation of this report.

Supporting information is provided in:

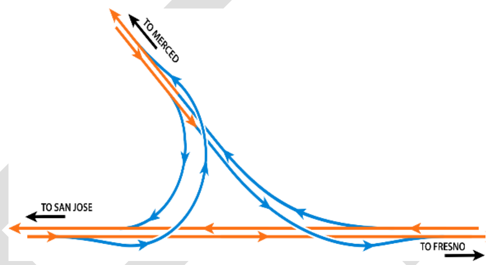
- Appendix A, Database Search Results, which presents the results of the database searches used in the paleontological sensitivity evaluation.

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.[2] 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.

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

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[2] 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.

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.

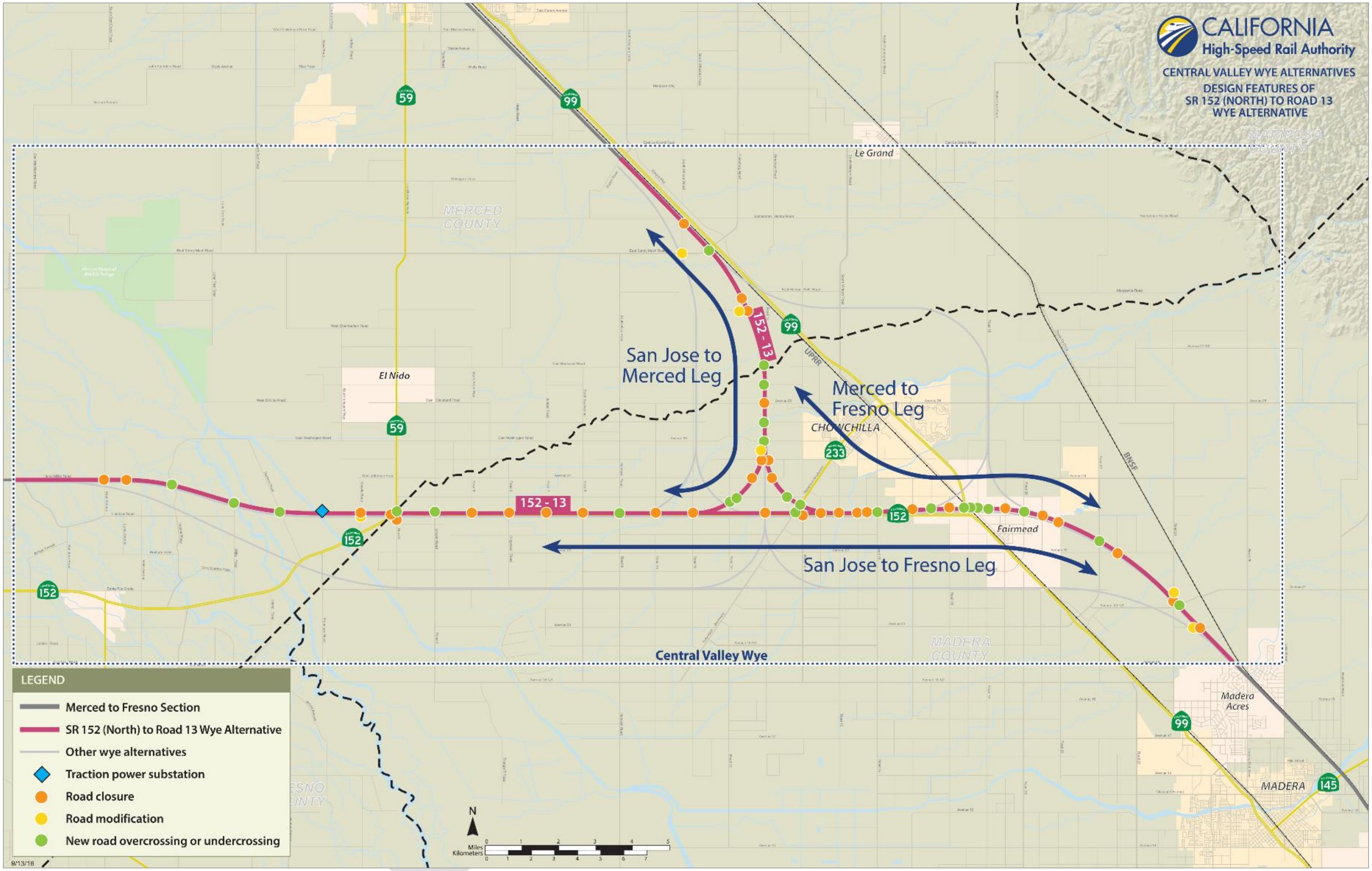
2.2.1 Alignment and Ancillary Features

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[3] 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[4] 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.

[3] A track is included within a leg; e.g., southbound track of the San Jose to Merced leg.
[4] An undercrossing is a road or track crossing under an existing road or track.



Source: ESRI, 2013; CAL FIRE, 2004; ESRI/National Geographic, 2015; Authority, 2016

FINAL – SEPTEMBER 13, 2016

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[5] 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). In areas where the SR 152 (North) to Road 13 Wye Alternative parallels the UPRR right-of-way, the alternative maintains a minimum horizontal clearance of 102 feet from the centerline to the UPRR right-of-way.

2.2.4 Summary

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

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[5] 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	1 switching station, 8 paralleling stations
Signaling and train-control elements	18
Communication towers	9
Wildlife crossing structures	39

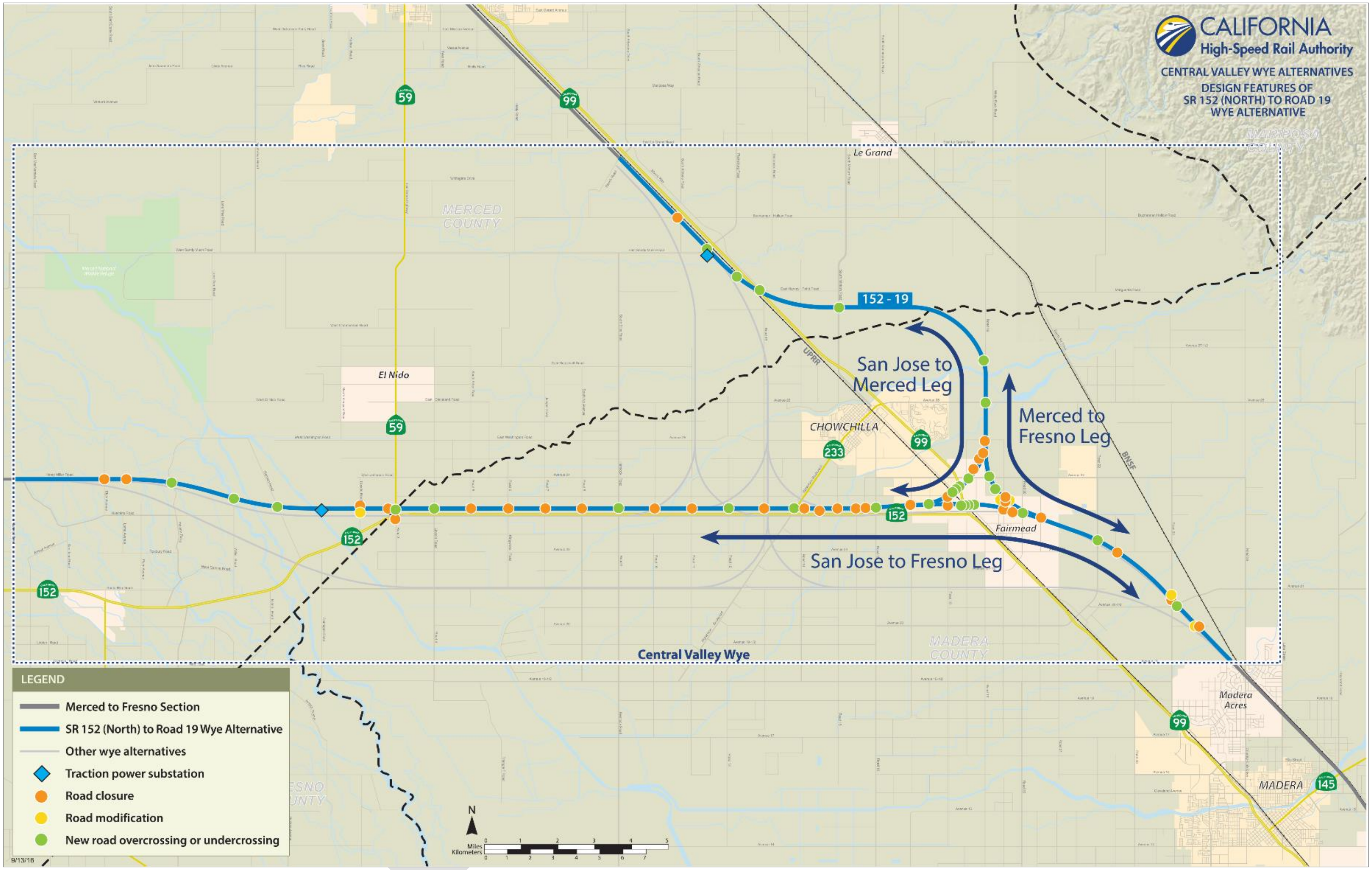
Source: Authority, 2016
[1] Lengths shown are based on equivalent dual-track alignments and are one-way mileages. For example, the length of single-track elevated structure will be divided by a factor of 2 to convert to dual-track equivalents.

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: ESRI, 2013; CAL FIRE, 2004; ESRI/National Geographic, 2015; Authority, 2016

FINAL – SEPTEMBER 13, 2016

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)[6] of the UPRR tracks. In areas where the SR 152 (North) to Road 19 Wye Alternative parallels the UPRR right-of-way, the alternative maintains a minimum horizontal clearance of 102 feet from the centerline to the UPRR right-of-way.

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
Switching and paralleling stations	2 switching stations, 7 paralleling stations

6 A shoofly is a temporary track alignment that detours trains around a construction site.

Feature	SR 152 (North) to Road 19 Wye
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

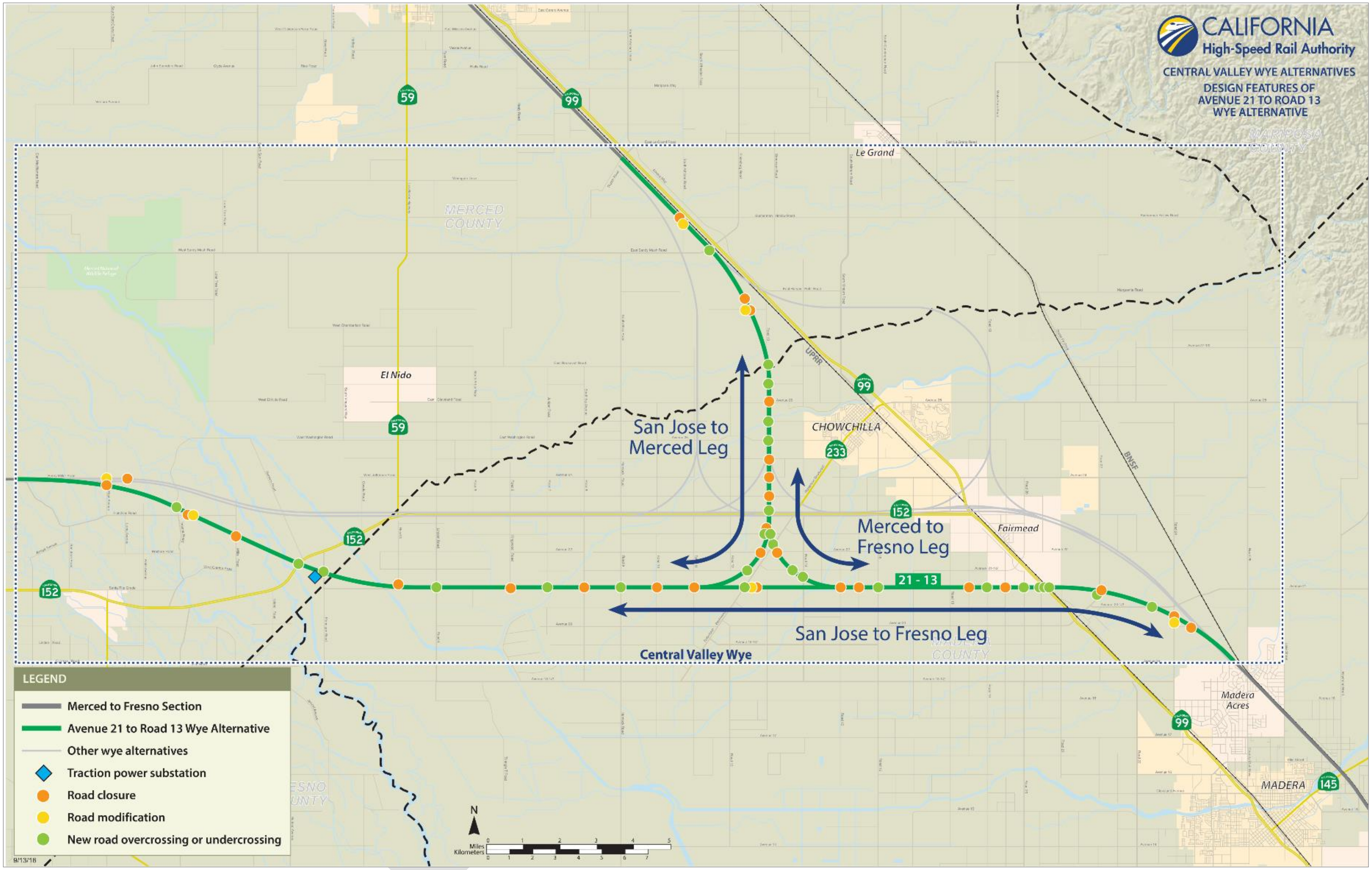
The Avenue 21 to Road 13 Wye Alternative (Figure 2-3) is designed to follow the existing Henry Miller Road and Avenue 21 rights-of-way as closely as practicable in the east-west direction and the Road 13, SR 99, and BNSF rights-of-way in the north-south direction. Deviations from these existing transportation 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: ESRI, 2013; CAL FIRE, 2004; ESRI/National Geographic, 2015; Authority, 2016

FINAL – SEPTEMBER 13, 2016

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. In areas where the Avenue 21 to Road 13 Wye Alternative parallels the UPRR right-of-way, the alternative maintains a minimum horizontal clearance of 102 feet from the centerline to the UPRR 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

Feature	Avenue 21 to Road 13 Wye
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	1 switching station, 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.

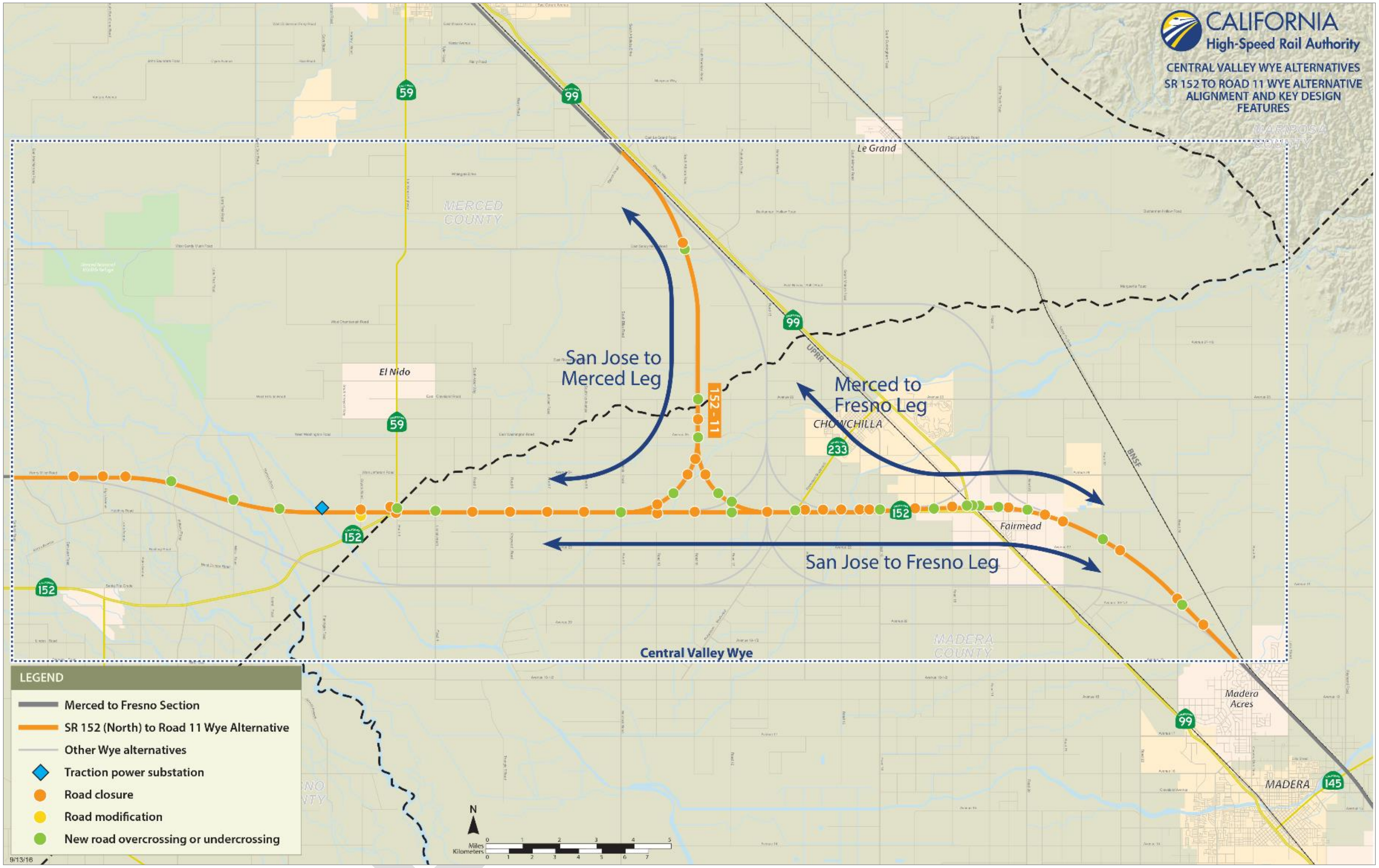
2.5 SR 152 (North) to Road 11 Wye Alternative

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.

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:



Source: ESRI, 2013; CAL FIRE, 2004; ESRI/National Geographic, 2015; Authority, 2016

FINAL – SEPTEMBER 13, 2016

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

- 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). In areas where the SR 152 (North) to Road 11

Wye Alternative parallels the UPRR right-of-way, the alternative maintains a minimum horizontal clearance of 102 feet from the centerline to the UPRR 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	1 switching station, 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 impact avoidance and minimization features (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. As discussed in the Supplemental EIR/EIS, Section 3.9, there would be no significant impacts as a result of Central Valley Wye construction or operations; therefore, no mitigation measures are required. Volume 2 of the Supplemental EIR/EIS, Appendix 2-B, California High-Speed Rail: Impact Avoidance and Minimization Features, provides full descriptions of all IAMFs for the Central Valley Wye.

The Authority and FRA will incorporate the following resource-specific IAMFs into the design to address potential Central Valley Wye effects on paleontological resources:

- **GEO-IAMF #7: Engage a Paleontological Resources Specialist to Direct Monitoring during Construction**. Prior to Construction (any ground disturbing activities), the Contractor shall designate a paleontological resources specialist (PRS) for the project (approved by the Authority) who will be responsible for determining where and when paleontological resources monitoring should be conducted. Paleontological resources monitors (PRMs) will be selected by the PRS based on their qualifications, and the scope and nature of their monitoring will be determined and directed based on the Paleontological Resource Monitoring and Mitigation Plan (PRMMP). The PRS will be responsible for developing worker environmental awareness (WEAP) training. The paleontological resources WEAP training will be provided concurrently with the training provided for cultural resources WEAP training. All management and supervisory personnel and construction workers involved with ground-disturbing activities will be required to take this training before beginning work on the project and will be provided with the necessary resources for responding in case paleontological resources are found during construction. The PRS will document any discoveries, as needed, evaluate the potential resource, and assess the significance of the find under the criteria set forth in CEQA Guidelines Section 15064.5. The PRMMP will be submitted to the Authority for review and approval.

- **GEO-IAMF #8: Prepare and Implement a Paleontological Resource Monitoring and Mitigation Plan.** During construction, paleontological monitoring, protection, and recovery measures will be restricted to those construction-related activities that will result in the disturbance of paleontologically sensitive sediments. The PRMMP will include a description of when and where construction monitoring will be required; emergency discovery procedures; sampling and data recovery procedures; procedures for the preparation, identification, analysis, and curation of fossil specimens and data recovered; and procedures for reporting the results of the monitoring and mitigation program. The PRMMP will be consistent with Society of Vertebrate Paleontology (SVP 2010) guidelines or their successors for mitigating construction impacts on paleontological resources. The PRMMP will also be consistent with the SVP (1996) conditions for receivership of paleontological collections and any specific requirements of the designated repository for any fossils collected.
- **GEO-IAMF #9 Halt Construction When Paleontological Resources Are Found**. If fossil or fossil-bearing deposits are discovered at any time during construction-related activity, regardless of the individual making a paleontological discovery, construction activity in the immediate vicinity of the discovery will cease to minimize the potential for resource impacts. This requirement will be spelled out in both the PRMMP and the WEAP. Construction activity may continue elsewhere provided that it continues to be monitored as appropriate. If the discovery is made by someone other than a PRM or the PRS, a PRM or the PRS will immediately be notified. The PRS shall prepare and submit monthly reports to the Authority documenting PRMMP implementation for compliance monitoring.

3 REGULATORY CONTEXT AND STANDARDS OF PRACTICE FOR PALEONTOLOGICAL RESOURCES

3.1 Federal

3.1.1 American Antiquities Act of 1906 (16 U.S.C. §§ 431–433)

The American Antiquities Act was enacted with the primary goal of protecting cultural resources in the United States. As such, it prohibits appropriation, excavation, injury, or destruction of "any historic or prehistoric ruin or monument, or any object of antiquity" located on lands owned or controlled by the federal government. The act also establishes penalties for such actions and sets forth a permit requirement for collection of antiquities on federally owned lands.

Neither the American Antiquities Act itself nor its implementing regulations (43 C.F.R. § 3) specifically mention paleontological resources. However, many federal agencies have interpreted objects of antiquity as including fossils. Consequently, the American Antiquities Act represents an early cornerstone for efforts to protect the nation's paleontological resources.

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

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

3.2 State

3.2.1 California Environmental Quality Act (Cal. Public Res. Code, § 21000 et seq.) and State CEQA Guidelines

The CEQA statute includes "objects of historic…significance" in its definition of the environment (Cal. Public Res. Code, § 21060.5), and section 15064.5 of the State CEQA Guidelines further defines historical resources as including "any object…site, area, [or] place… that has yielded, or may be likely to yield, information important in prehistory." This has been widely interpreted as extending CEQA protection to paleontological resources. This perspective is reflected in the cultural resources section of the State CEQA Guidelines Appendix G sample environmental checklist, which includes a question asking whether the proposed project would "directly or indirectly destroy a unique paleontological resource or site." However, neither the CEQA statute nor the State CEQA Guidelines defines what constitutes a "unique paleontological resource" or a "unique paleontological site" and thus merits consideration per this checklist item. In fact, neither the CEQA statute nor the State CEQA Guidelines gives direction regarding the treatment of paleontological resources in general (unique and nonunique) under CEQA. Because of the breadth of the CEQA definition of "historical resources," the general guidance regarding significance determinations in section 15064.5(b) of the State CEQA Guidelines may be interpreted as applying to impacts on paleontological resources, but this section focuses for the most part on factors specifically related to eligibility for state and local register listing; it does not address the essence of "[yielding] information important in prehistory" from a paleontological perspective. The most relevant guidance appears in State CEQA Guidelines section 15064.5(b)(1), which defines a "[s]ubstantial adverse change in the significance of an historical resource"—and by extension, a significant impact on such resources, including paleontological resources—as the "physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings such that … [its] significance … would be materially impaired."

3.2.2 California Public Resources Code

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

3.3 Regional and Local Plans and Regulations

Many local jurisdictions protect cultural and "heritage" resources in a manner that extends to paleontological resources and some provide explicit protection for fossil resources, especially where such resources have become part of a city or county's identity and are a source of civic pride. The goal of local codes, ordinances, and general plan policies is typically to recognize the importance of heritage resources as part of a jurisdiction's unique character and accord them appropriate protection as development proceeds. Unlike regulations at the federal and state levels and the professional standards discussed in Section 3.4, Professional Standards and Authority's Environmental Methodology Guidelines, local jurisdiction regulations typically reflect, rather than shape, the practice of paleontological resources conservation. Nonetheless, because both federal and state regulations (40 C.F.R. § 1506.2(d), 64 Fed. Reg. 28545, 14(n)(15), CEQA Guidelines § 15125(d)) require environmental documents to evaluate the consistency of a proposed undertaking with local plans and regulations, this section summarizes relevant local jurisdiction policies to support supplemental NEPA and CEQA analysis for the Central Valley Wye. This added information is limited to general plan guidance since none of the local jurisdictions relevant to the Central Valley Wye have ordinances or codes related to paleontological resources).

Table 3-1 summarizes the local jurisdiction general plan policies relevant to the Central Valley Wye. Please note that only the jurisdictions with adopted policy language specifically applicable to paleontological resources are included in the table. Note also that the current Merced County General Plan (Merced County 2013) was not in force at the time the 2012 technical report was prepared.

Table 3-1 General Plan Policies Relevant to Central Valley Wye

Policy Title	Summary
2030 Merced County General Plan (2013), Recreation and Cultural Resources (RCR) Element	▪ Goal RCR-2 stresses protection of the cultural, archaeological, and historic resources of the County "in order to maintain its unique character" ▪ Under Goal RCR-2, Policy RCR-2.9 (Historical and Cultural Resources Investigation, Assessment, and Mitigation Guidelines), calls for the "establish[ment] and adopt[ion] of mandatory guidelines for use during the environmental review processes for private and public projects to identify and protect historical, cultural, archaeological, and paleontological resources, and unique geological features." ▪ Policy RCR2.9-2 is supported by Implementation Program RCR-B (Historic and Cultural Resources Investigation, Assessment and Mitigation Guidelines), planned for accomplishment during the 2016−2020 timeframe: *Prepare and formally adopt guidelines and standards for the preparation of assessments of historical, cultural, archaeological, and paleontological resources, and unique geological features prepared pursuant to Policy RCR2.9. At a minimum, the guidelines shall include resource survey guidelines covering personnel qualifications, research and field techniques, investigation and documentation, data collection and recordation, and resource preservation,*

Policy Title	Summary
	avoidance, minimization, and mitigation strategies. The guidelines shall specify broad categories of acceptable mitigation consistent with Public Resources Code section 21083.2 and State CEQA Guidelines section 15126.4[b], as they may be amended for any identified adverse effects to historic and cultural resources, paleontological resources, or unique geological feature.
Madera County General Plan Policy Document (1995), Section 4 – Recreational and Cultural Resources, Part D – Historical and Cultural Resources	▪ Goal 4.D (Historical and Cultural Resources) calls out the need to "identify, protect, and enhance Madera County's important historical, archaeological, paleontological, and cultural sites and their contributing environment." ▪ Under Goal 4.D, several policies provide specifics relevant to paleontological resources: – Policy 4.D.2: "The County shall coordinate with the cities and advisory councils in the county to promote the preservation and maintenance of Madera County's paleontological, archaeological, and historical resources." – Policy 4.D.3: "The County shall require that discretionary development projects identify and protect from damage, destruction, and abuse, important historical archaeological, paleontological, and cultural sites and their contributing environment." – Policy 4.D.8: "The County shall support the registration of cultural resources in appropriate landmark designations (i.e., National Register of Historic Places, California Historical Landmarks, Points of Historical Interest, or Local Landmark). The County shall assist private citizens seeking these designations for their property." – Implementation Program 4.4: "The County shall prepare, adopt, and implement procedures for review and approval of all County-permitted projects involving ground disturbance and all building and/or demolition permits that will affect buildings, structures, or objects 45 years of age or older." – Implementation Program 4.5: "The County shall develop preservation incentive programs for owners of important cultural and paleontological resources, using such mechanisms as the Mills Act, the Historic Preservation Easement program, the Certified Local Government program, and the Heritage Tourism program."

Source: Merced County, 2013; Madera County, 1995

3.4 Professional Standards and Authority's Environmental Methodology Guidelines

Although federal and state regulations establish protection for paleontological resources, the legal framework is nonspecific regarding some critical details:

- What resources merit protection?
- What constitutes a significant adverse impact on those resources?
- What level of protection is adequate?

This gap has been filled in two ways: through processes and protocols developed by individual practitioners and professional societies—in particular the Society for Vertebrate Paleontology (SVP)—and through guidelines developed by federal, state, and local lead agencies under NEPA and CEQA, respectively.

As early as 1976, the SVP recognized the need for a standardized approach to the analysis and mitigation of paleontological resources impacts and began informal efforts to address the issue, with a committee formally convened by the late 1980s and the landmark *Assessment and Mitigation of Adverse Impacts to Nonrenewable Paleontologic Resources: Standard Guidelines*

(Standard Guidelines) (SVP Conformable Impact Mitigation Guidelines Committee 1995) published several years later. Shortly thereafter, to foster responsible disposition of salvaged materials, SVP issued its *Conditions of Receivership for Paleontologic Salvage Collections* (Conditions of Receivership) (SVP Conformable Impact Mitigation Guidelines Committee 1996), and in 2012 the original Standard Guidelines were updated with publication of the *Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources* (Standard Procedures) (SVP Conformable Impact Mitigation Guidelines Committee 2010).

The SVP Standard Guidelines/Standard Procedures and Conditions of Receivership together have provided the most influential standard for paleontological resources impact analysis, mitigation, and conservation practice. The SVP approach has substantially molded a number of lead agency guidelines, including those of the California Department of Transportation (Caltrans) (Caltrans 2012), which in turn provided the model for the Version 5 Environmental Methods adopted by the Authority in 2014.

Throughout the planning and environmental reviews for the HSR system, the Authority has emphasized the need for consistent environmental analysis methodology, reflected in the development and implementation of standardized environmental methodology guidelines for resource analyses in the project-level NEPA/CEQA documents for individual HSR sections. At the time the 2012 technical report was prepared, the Authority was working under the prior (Version 4) systemwide environmental methodology guidelines, which included paleontology requirements based directly on the SVP Standard Guidelines. The Version 4 methodology was modified for the 2012 technical report. The analysis presented in this technical report reflects the current Version 5 Environmental Methods (Authority and FRA 2014a). As a result, this report is both a supplement and an update to the 2012 technical report.

The portion of the Version 5 Environmental Methods that addresses paleontological resources was based largely on the methodology laid out in Chapter 8, Paleontology, of the Caltrans *Standard Environmental Reference* (Caltrans 2012). The Caltrans methodology is a good model for the Authority needs because it is not only consistent with the discipline-standard SVP Standard Guidelines/Standard Procedures but was also developed to meet Caltrans' responsibilities under both NEPA and CEQA. The key difference between the Caltrans approach and the Authority's Version 5 Environmental Methods is that the latter replaced Caltrans' multiple sequential technical reports with a single project-specific technical report that meets the requirements of both the Caltrans Paleontological Identification Report and Paleontological Evaluation Report. This streamlines the technical report preparation process without loss of scientific substance.

4 RESOURCE EVALUATION

Fossil materials represent a three-dimensional resource. They may be found at the ground surface where fossiliferous strata are surface-exposed, but may also be present below the surface within buried rock or sediment units. As a result, lead agencies often cannot be certain whether fossil resources will actually be encountered until earthwork has been completed. The current approach to paleontological resource effects analysis—reflected in the SVP guiding documents, the Caltrans Standard Environmental Reference (Caltrans 2012), and the approach used in the 2012 technical report as well as the Version 5 Environmental Methods (Authority and FRA 2014a)—is thus essentially a risk analysis. The goal is to identify the likelihood of impact and provide flexible strategies to support appropriate adaptive management in response to information that may literally "come to light" during construction.

This strategy reflects the (well-substantiated) working assumption that a geologic unit that has produced fossil finds in the past is likely to do so again, and in other locations. A geologic unit with a track record of producing important fossils is thus considered to have high paleontological potential or sensitivity. Moreover, the same paleontological potential is considered to apply throughout the three-dimensional extent of the unit, everywhere that unit occurs, regardless of whether fossils have actually been found in a given location or not. This is sometimes described as the concept of "sensitive anywhere, sensitive everywhere." By the same token, geologic units that have not produced past fossil finds are generally considered less sensitive throughout their regional extent. Consequently, the evaluation of paleontological potential—and by extension, of the potential for effects on fossil resources—depends not on fossil finds within a certain distance of the project footprint but, rather, on fossil finds in the geologic units affected by the project, wherever those units occur.

In this context, the Version 5 Environmental Methods (Authority and FRA 2014a) lay out four steps in analyzing a project's potential to affect paleontological resources, as follows; this is similar in philosophy to the approach used in the 2012 technical report, but differs in detail.

1. Define resource study area (RSA) and identify the geologic units potentially affected by project construction and operations.
2. Evaluate the potential of the affected geologic units to contain significant fossils (their *paleontological potential* or *paleontological sensitivity*).
3. Identify/assess the nature and extent of effects on paleontologically sensitive units as a result of construction and operations, taking into consideration all ground-disturbing activities, including, but not necessarily limited to, site preparation, excavation, grading, tunneling, and foundation drilling.
4. Evaluate impact significance. The determination of significance will be made in the Supplemental EIR/EIS.

This section describes the methods used to define the RSA, identify potentially affected geologic units, and assess their paleontological sensitivity. It also presents the results of that resource inventory. Analysis of effects is presented in Section 5. Please note that because the current Version 5 Environmental Methods use different criteria and terminology for the evaluation of paleontological potential/paleontological sensitivity from that used in the 2012 technical report, this technical report presents complete updated baseline information for the Central Valley Wye.

4.1 Definition of Resource Study Area

Resource evaluation and effect analysis for each environmental resource begins by identifying an appropriate RSA—that is, the area potentially affected by project activities and therefore warranting consideration in the identification of baseline conditions for the resource. For paleontological resources, the RSA becomes a study volume: fossil remains may be buried well below the surface and thus represent a three-dimensional resource. The principal mechanism for effects on paleontological resources is damage and loss as a result of ground-disturbing activities; where ground disturbance extends into the subsurface, as is typical for excavation, grading, and foundation drilling, the effect area (surface disturbance) becomes an effect volume (three-dimensional extent of disturbance). Accordingly, for paleontological resources, the Version

5 Environmental Methods (Authority and FRA 2014a) define the RSA as encompassing all of the geologic units affected by ground disturbance throughout the entirety of their (three-dimensional) extent. For this analysis, consistent with the Version 5 Environmental Methods, affected geologic units were considered to include those exposed at the surface within the anticipated Central Valley Wye project footprint and a surrounding 150-foot-wide buffer, as well as those present in the subsurface below this area, to the depth potentially encountered by construction or operations. The area evaluated for paleontological sensitivity (RSA) is thus much broader than the project footprint because of the "sensitive anywhere, sensitive everywhere" rule that governs paleontological resources risk analysis.

4.2 Resource Inventory Methods

Establishing the baseline environmental condition for paleontological resources (i.e., evaluating the potential that significant fossil resources are present in the RSA), entailed the following steps:

- Compile geologic mapping for Central Valley Wye vicinity
- Identify geologic units potentially affected by Central Valley Wye construction and operations
- Compile information on lithology and fossil content of affected units
- Based on fossil content, evaluate paleontological sensitivity, per the criteria established in the Version 5 Environmental Methods (Authority and FRA 2014a)

The Central Valley Wye vicinity has been mapped more than once, by different workers, at scales ranging from 1:24,000 to 1:250,000 and 1:750,000. The geologic map for the Central Valley Wye corridor was compiled from existing sources of published mapping, including maps of the U.S. Geological Survey and California Geological Survey (formerly Division of Mines and Geology). The compilation was performed in ArcInfo 10.0 using maps in a variety of electronic formats, primarily high-resolution PDF and TIFF (.tif); geologic mapping for this area is not currently available in ArcGIS format. Maps obtained in PDF were converted to TIFF format before use. All graphic coverages were georeferenced, and where needed, they were "rubber-sheeted" to improve the accuracy of placement across the map area. All of the specific maps used as primary sources are referenced in Section 4.3, Central Valley Wye Area Geology and Paleontology; complete reference information is provided in Section 8, References. To maximize detail, resource evaluation focused on the 1:24,000-scale mapping with the less detailed coverage used for additional context.

A key challenge for this effort (and other similar undertakings) centers on the reliability of available mapping. Most workers with experience in the primary collection of geologic data would agree that no geologic map is perfectly reliable, and that conclusions based on any map are limited by the accuracy of the mapping. With this in mind, multiple map sources were cross-checked to the extent feasible.

To identify affected geologic units, the polygon representing the Central Valley Wye construction limits plus the 150-foot-wide buffer was overlaid on the compilation geologic map in ArcInfo. All surface-exposed geologic units within the footprint were considered potentially affected. Where grading, excavation, or foundation drilling would be required, the Central Valley Wye could also have the potential to involve geologic units that are present at depth but are not exposed at the surface along the alignment. Accordingly, subsurface stratigraphy was also evaluated. Where the potential for effect was uncertain, units were included rather than excluded, to give a conservative assessment of potential effects.

Sources consulted for information on the lithology and fossil content of the potentially affected geologic units included the published geologic and paleontological literature; university and museum databases, including those of the University of California Museum of Paleontology (UCMP) in Berkeley, Sierra College Natural History Museum, and Natural History Museum of Los Angeles County; and relevant theses and dissertations. Specific references are cited in the text, with complete information provided in Section 6, References. Appendix A, Database Search Results, provides the results of the museum database searches in full.

Table 4-1 shows the criteria used to evaluate paleontological potential (sensitivity); these criteria reflect the Version 5 Environmental Methods (Authority and FRA 2014a). The criteria for sensitivity evaluation are one of the principal differences between the methods used in the 2012 technical report and this report.

Table 4-1 Paleontological Potential/Sensitivity Categories

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

Source: Authority and FRA 2014a

4.3 Central Valley Wye Area Geology and Paleontology

4.3.1 Regional Geologic Setting

The Central Valley Wye lies in the heart of California's Great Valley geomorphic province, which comprises the Sacramento Valley to the north and the San Joaquin Valley to the south. Together, these two major valleys form a regionally extensive depression—bounded by the Tehachapi Mountains to the south, the Klamath Mountains to the north, and the Sierra Nevada and Coast ranges to the east and west respectively—with a combined length of about 400 miles and an average width of about 50 miles (Norris and Webb 1990, Harden 1998).

The San Joaquin Valley contains a thick accumulation of sedimentary deposits ranging from Jurassic to Holocene in age. Under the western portion of the valley, basal sediments are believed to overlie Franciscan metasedimentary or mélange basement. To the east, the base of the sequence likely rests on crystalline rocks allied to the Sierra Nevada massif. Mesozoic units now in the subsurface record marine deposition. They are overlain in turn by Tertiary strata reflecting marine, estuarine, and terrestrial conditions; and by Quaternary riverine and alluvial strata recording uplift and erosion of the Sierra Nevada and Coast ranges (e.g., Norris and Webb 1990).

To the west, the Coast ranges province comprises a series of rugged, northwest-trending mountain ranges and valleys reflecting relatively young uplift associated with the active Pacific–North American plate boundary system (Atwater 1989, Norris and Webb 1990, Buising and Walker 1995). The Diablo range is the easternmost of the Coast ranges at the latitude of the Central Valley Wye. It is separated by the Santa Clara Valley—the onland continuation of the San Francisco Bay depression (Iwamura 1995), bounded on the west by a complex zone of reverse and dextral faults, including the Monte Vista, Berrocal, Shannon, and Sargent, and on the east by the dominantly dextral strike-slip southern Hayward and Calaveras faults and related structures (Helley and Wesling 1990, Wagner et al. 1991, Stanley et al. 2002)—from the Santa Cruz Mountains to the west. The Diablo range is broadly antiformal, with a central "core" dominated by Mesozoic metasedimentary rocks and mélange of the Franciscan complex (Wagner et al. 1991), with local exposures of mafic and ultramafic rocks assigned to the Jurassic Coast Range Ophiolite (e.g., near San Benito Mountain and along the Ortigalita fault in the vicinity of Del Puerto Canyon; Wagner et al. 1991, Evarts et al. 1999). The east front of the Diablo range is marked by dissected exposures of a generally eastward-younging sedimentary sequence ranging in age from Cretaceous through Quaternary. Where present, the lower portion of this sequence typically records deposition in a deep-marine environment, while the upper terrestrial portion documents the progressive uplift and erosion of the Diablo range (Unruh et al. 1992, Richesin 1996).

To the east, the Sierra Nevada geomorphic province records the uplift and dissection of a Mesozoic magmatic arc system broadly similar to the modern Cascade Range (e.g., Norris and Webb 1990). The central portion of the range exposes plutonic rocks representing the roots of the arc. Along the valley margin, crystalline rocks are overlain by generally westward-younging metavolcanic and metasedimentary rocks ranging in age from Paleozoic to Mesozoic. These strata are in turn overlain by Miocene through Quaternary fluvial and alluvial sediments that pass laterally into valley floor strata and reflect erosional dissection of the progressively uplifting Sierran massif (Jennings 1977, Bartow 1991).

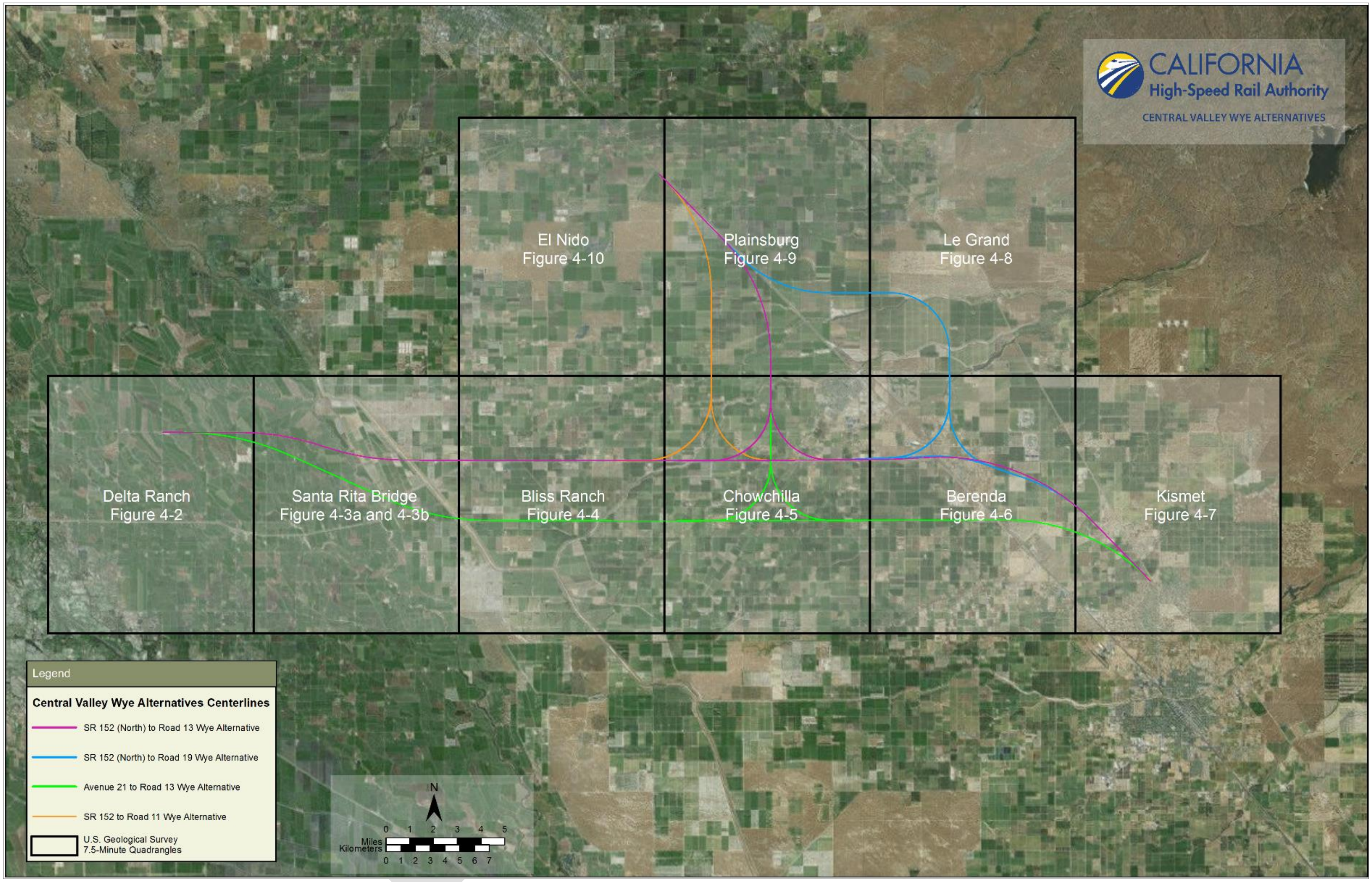
The next section of this report provides more detailed information on the geologic units exposed along the Central Valley Wye alternative alignments. It includes information on all units expected to be disturbed by construction and operations, including those exposed at the surface as well as those in the subsurface and likely to be involved in excavation or drilling.

4.3.2 Geology and Paleontology of Central Valley Wye Alternative Alignments

Figure 4-1 is an index map showing the Central Valley Wye alternatives in relation to U.S. Geological Survey 7.5-minute topographic quadrangle boundaries. Figures 4-2 through 4-10 provide a geologic map of the Central Valley Wye alternative alignments and surrounding area, based on 1:24,000-scale U.S. Geological Survey mapping; each figure covers one 7.5-minute quadrangle.

Based on the maps compiled in the figures, Table 4-2 lists the surface-exposed geologic units potentially affected by construction and operation of the Central Valley Wye, by 7.5-minute quadrangle. For most of the quadrangles, the primary data source used to identify affected units was the 1:24,000-scale mapping of Marchand (1976), which is the most detailed coverage available for the majority of the alignment. The primary source for the Delta Ranch Quadrangle, which is not covered by Marchand's (1976) mapping, was the 1:24,000-scale work of Lettis (1982). Additional sources were used as a supplement and double-check, as discussed in Section 4.2, Resource Inventory Methods.

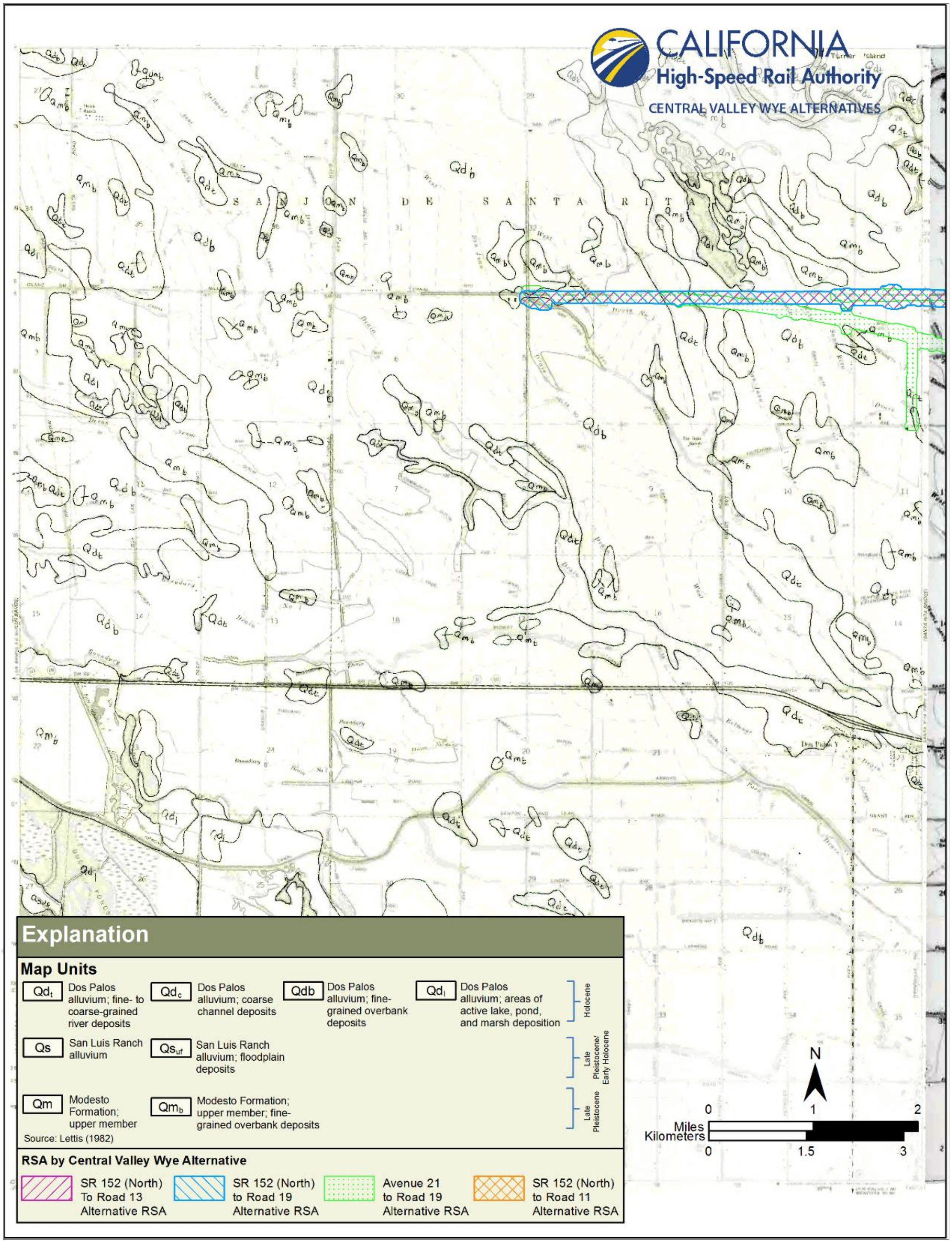
Descriptions of the affected geologic units—including lithology and fossil content—are presented after Table 4-2. Paleontological sensitivity, evaluated per the Version 5 Environmental Methods (Authority and FRA 2014a), is summarized in a separate section (Section 4.4, Summary Paleontological Sensitivity Evaluation by Geologic Unit) following the geologic unit descriptions.



Sources; Lettis, 1982; Marchand, 1976; Authority, 2016

FINAL – JUNE 29, 2016

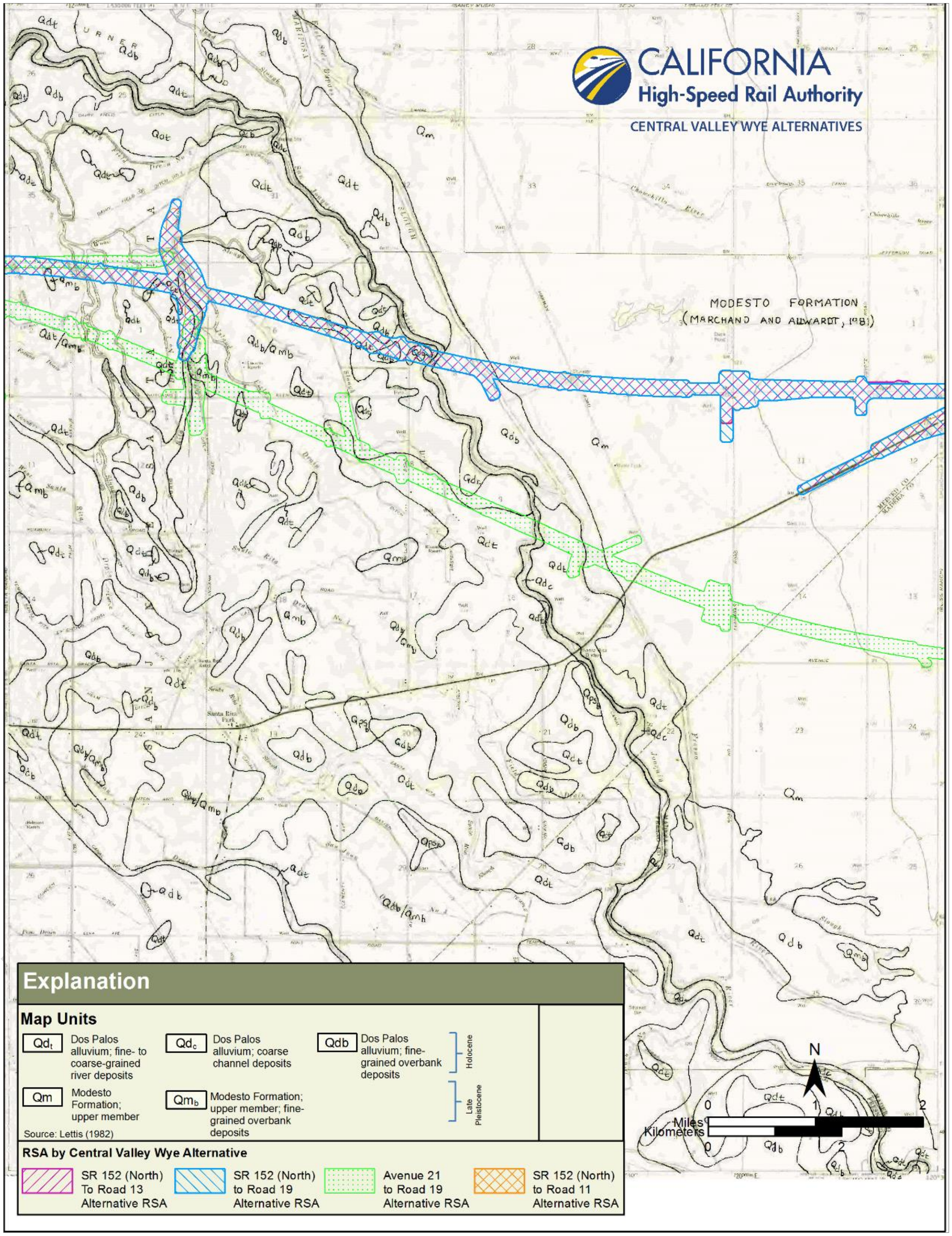
Figure 4-1 Location Map for Geologic Maps on Figures 4-2 through 4-10



Source: Lettis, 1982; Authority, 2016

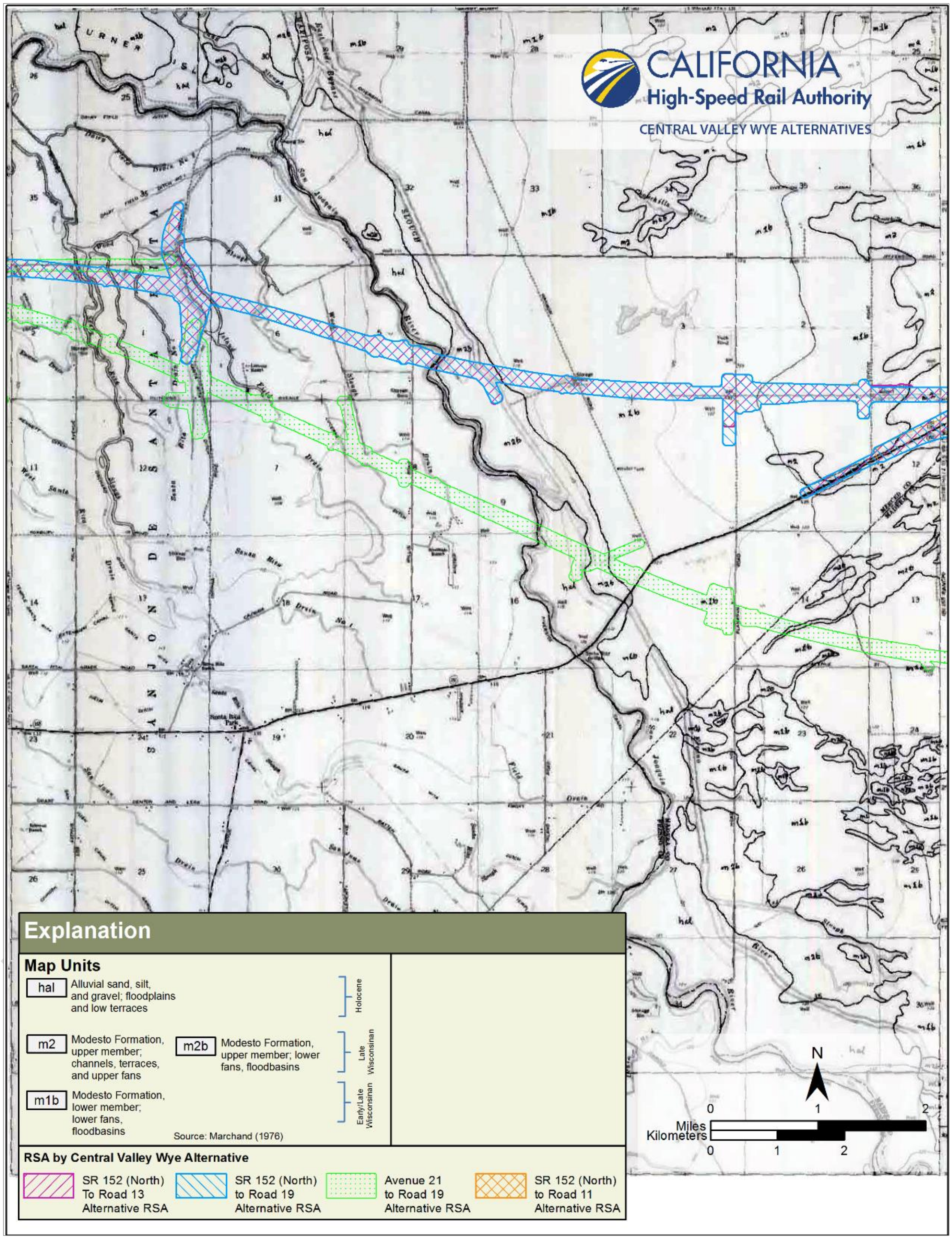
FINAL – SEPTEMBER 23, 2016

Figure 4-2 Geology of Central Valley Wye Alternatives, U.S. Geological Survey Delta Ranch 7.5-Minute Quadrangle



Source: Marchand, 1976; Authority, 2016 FINAL – SEPTEMBER 23, 2016

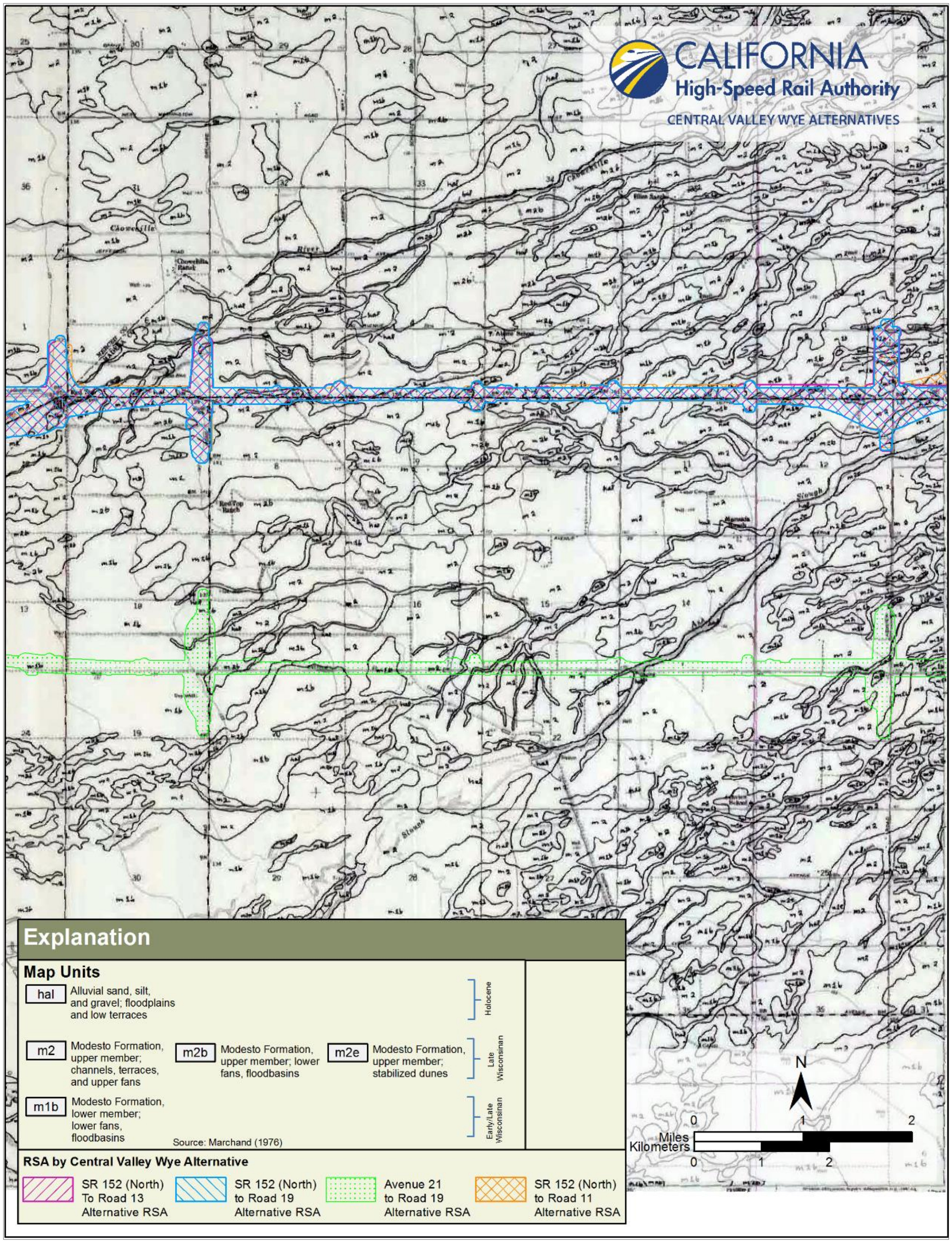
Figure 4-3a Geology of Central Valley Wye Alternatives, U.S. Geological Survey Santa Rita Bridge 7.5-Minute Quadrangle



Source: Marchand, 1976; Authority, 2016

FINAL – SEPTEMBER 23, 2016

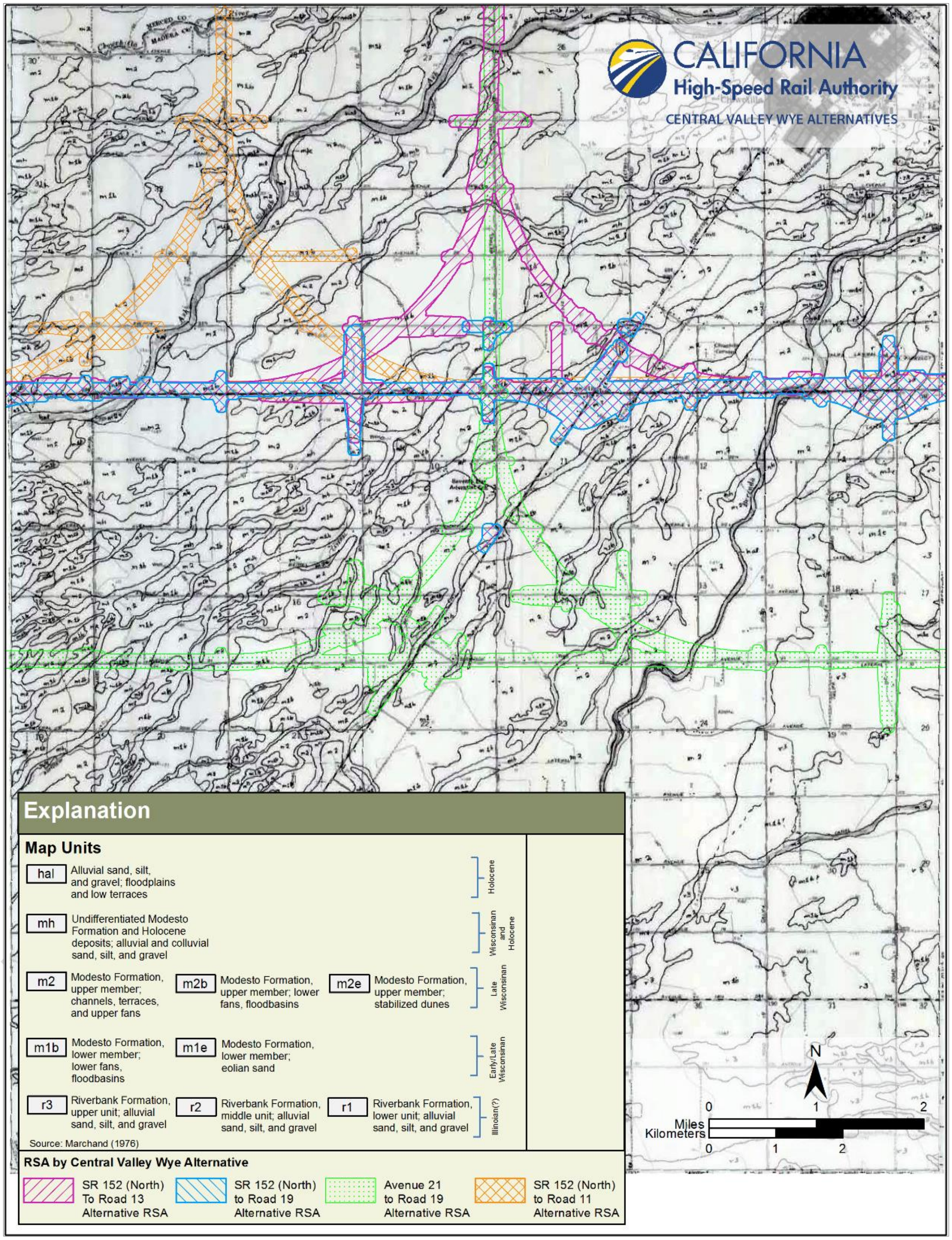
Figure 4-3b Geology of Central Valley Wye Alternatives, U.S. Geological Survey Santa Rita Bridge 7.5-Minute Quadrangle



Source: Marchand, 1976; Authority, 2016

FINAL – SEPTEMBER 23, 2016

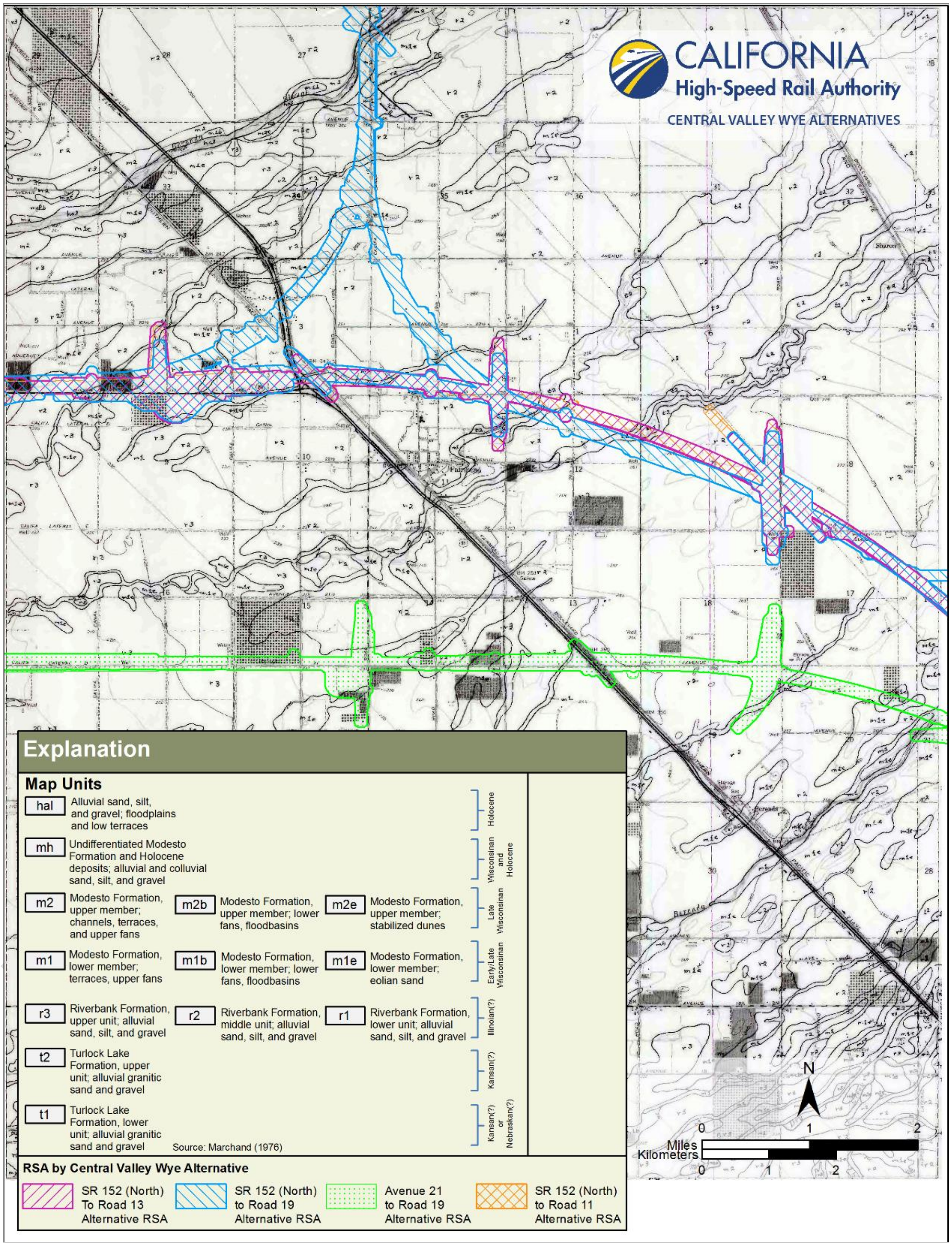
Figure 4-4 Geology of Central Valley Wye Alternatives, U.S. Geological Survey Bliss Ranch 7.5-Minute Quadrangle



Source: Marchand, 1976; Authority, 2016

FINAL – SEPTEMBER 23, 2016

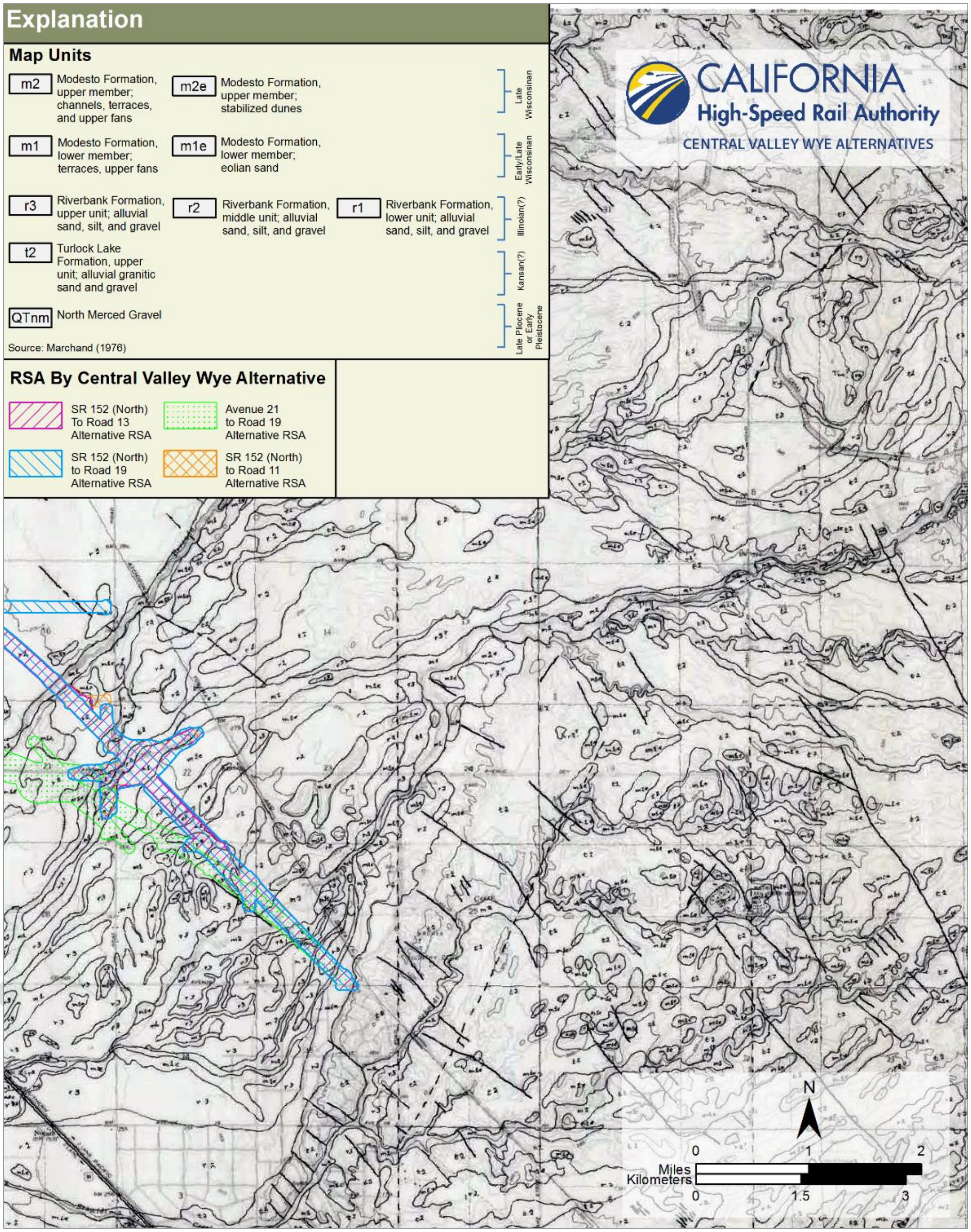
Figure 4-5 Geology of Central Valley Wye Alternatives, U.S. Geological Survey Chowchilla 7.5-Minute Quadrangle



Source: Marchand, 1976; Authority, 2016

FINAL – SEPTEMBER 23, 2016

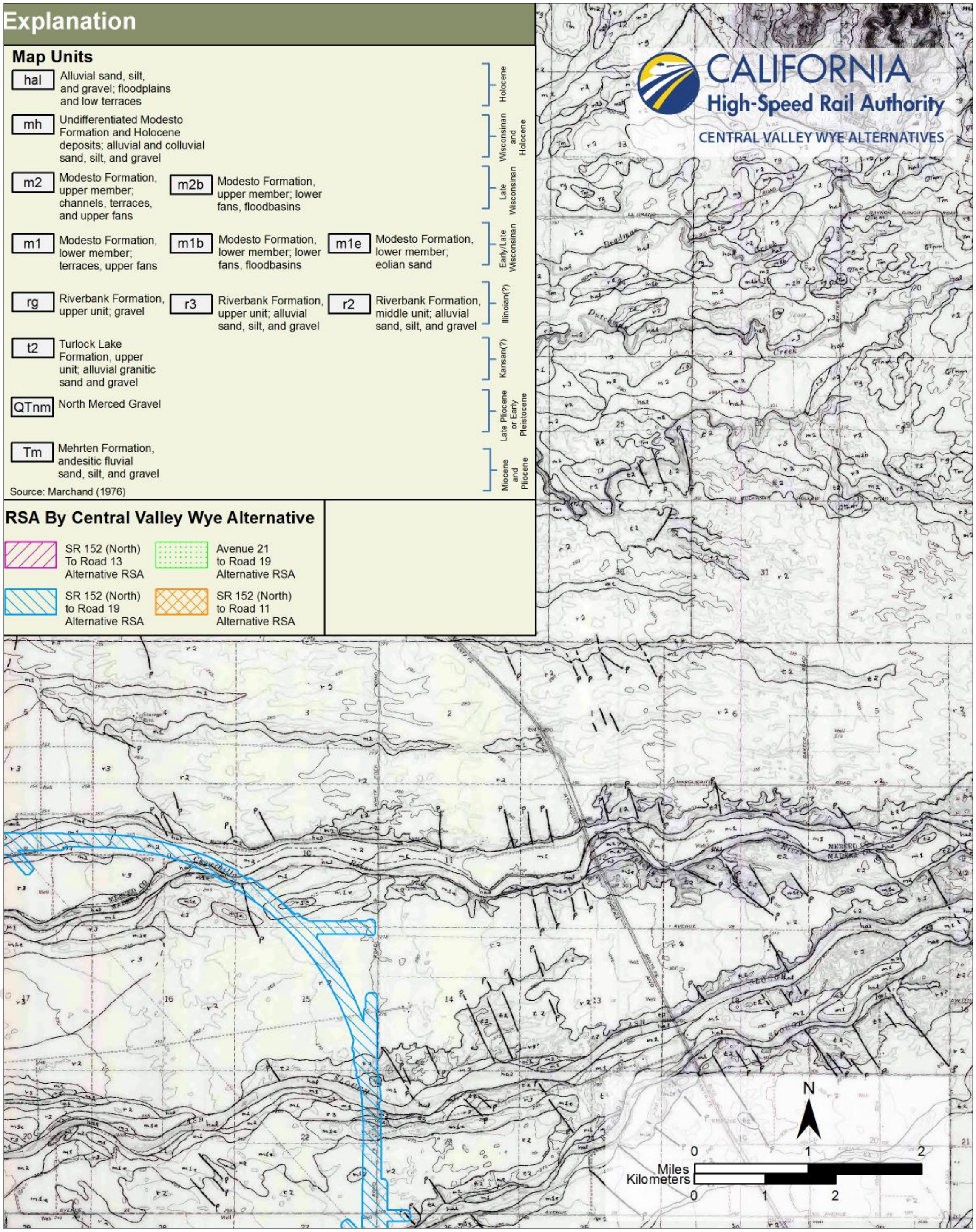
Figure 4-6 Geology of Central Valley Wye Alternatives, U.S. Geological Survey Berenda 7.5-Minute Quadrangle



Source: Marchand, 1976; Authority, 2016

FINAL – SEPTEMBER 23, 2016

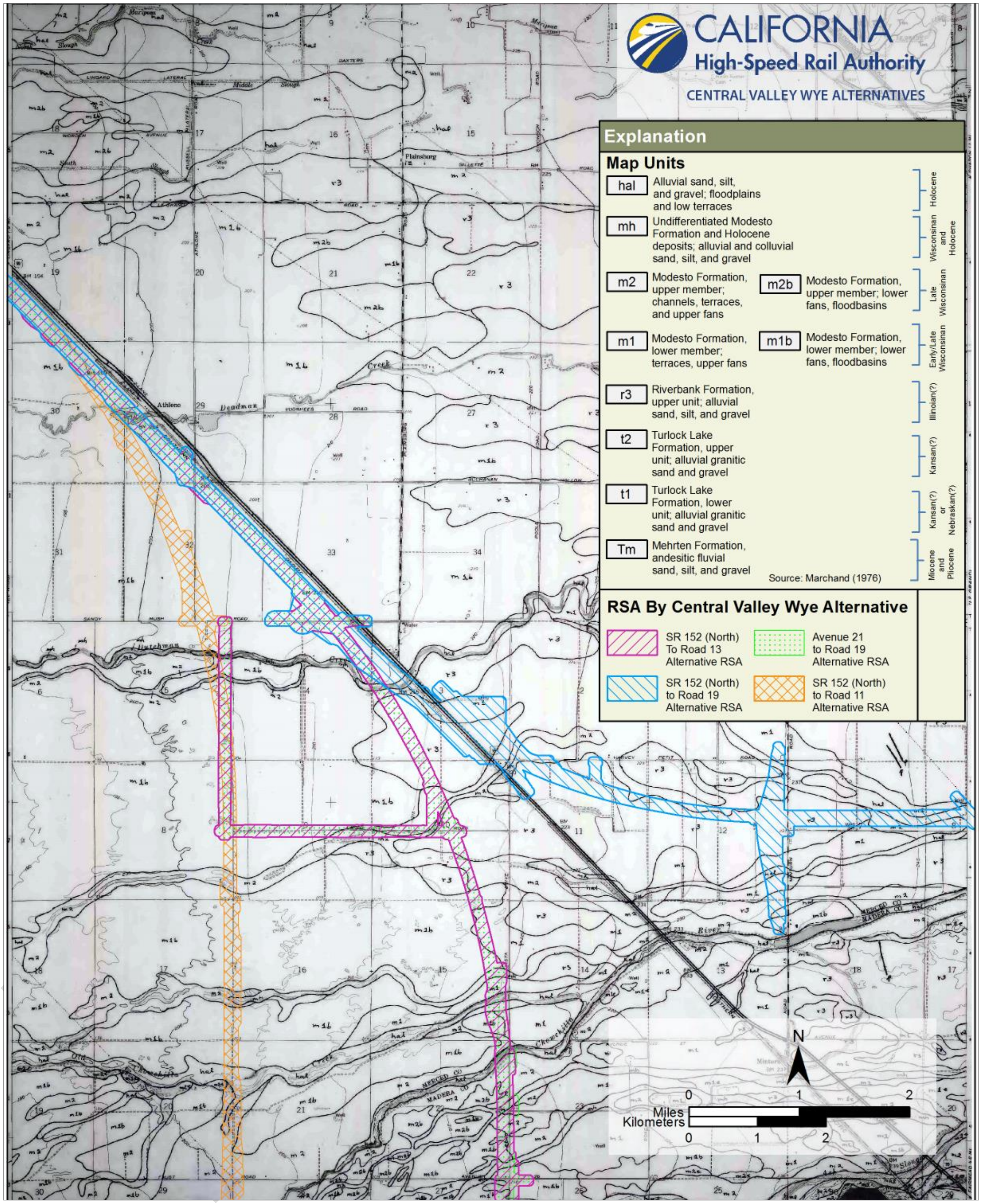
Figure 4-7 Geology of Central Valley Wye Alternatives, U.S. Geological Survey Kismet 7.5-Minute Quadrangle



Source: Marchand, 1976; Authority, 2016

FINAL – SEPTEMBER 23, 2016

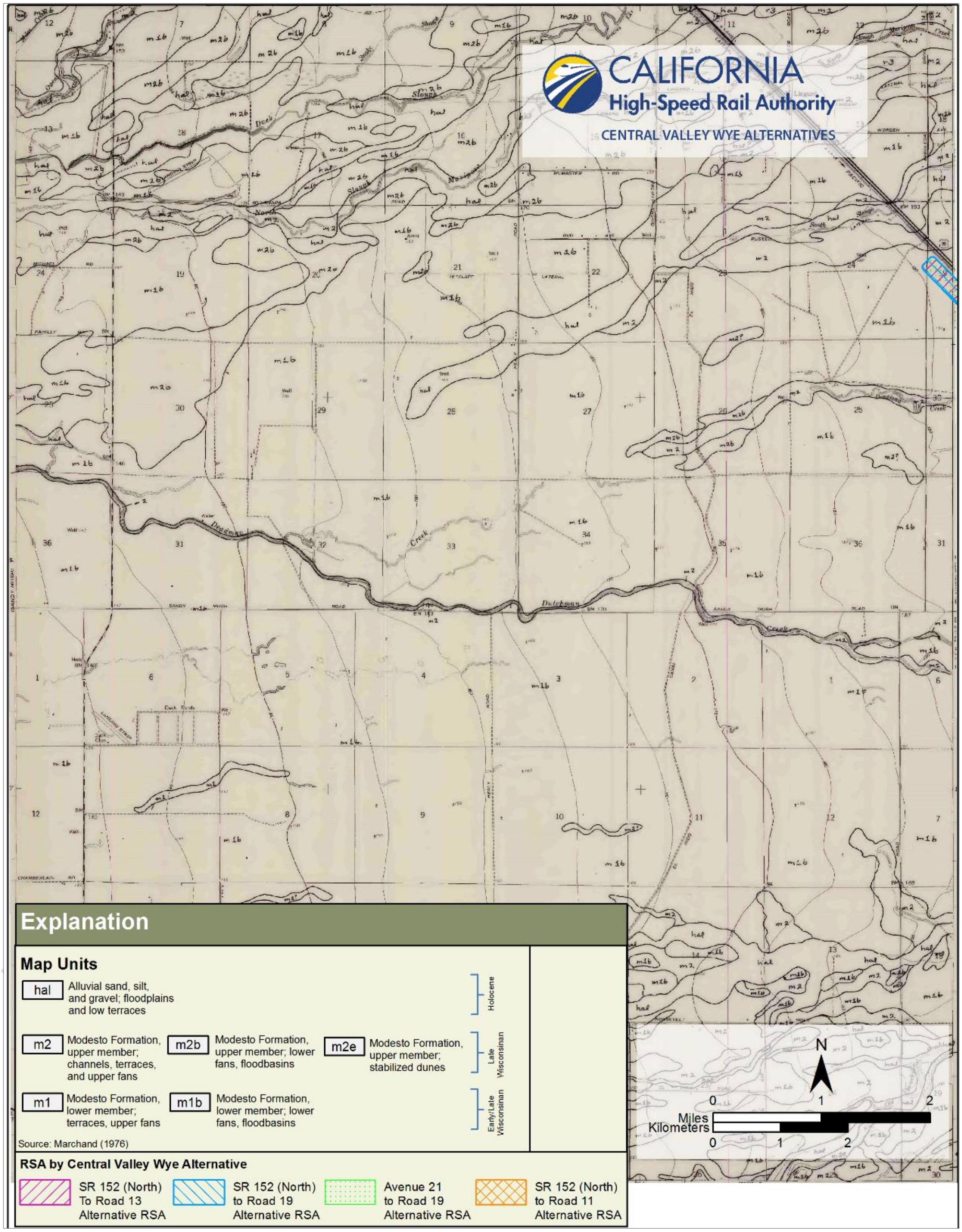
Figure 4-8 Geology of Central Valley Wye Alternatives, U.S. Geological Survey Le Grand 7.5-Minute Quadrangle



Source: Marchand, 1976; Authority, 2016

FINAL – SEPTEMBER 27, 2016

Figure 4-9 Geology of Central Valley Wye Alternatives, U.S. Geological Survey Plainsburg 7.5-Minute Quadrangle



Source: Marchand, 1976; Authority, 2016

FINAL – SEPTEMBER 27, 2016

Figure 4-10 Geology of Central Valley Wye Alternatives U.S. Geological Survey El Nido 7.5-Minute Quadrangle

Table 4-2 Surface-Exposed Geologic Units of Central Valley Wye Alignment by U.S. Geological Survey 7.5-Minute Topographic Quadrangle

Quadrangle	Map Source	Geologic Units
Delta Ranch	Lettis 1982	**Qd1—**Dos Palos alluvium, areas of active lake, pond, or marsh deposition; **Qdt—**Dos Palos alluvium, fine- to coarse-grained terrace, levee, point bar, and channel deposits of San Joaquin River and associated sloughs; **Qdb—**Dos Palos alluvium, fine-grained overbank deposits of San Joaquin River floodplain and associated sloughs; **Qmb—**Modesto Formation, upper member, fine-grained overbank deposits
	Wagner et al. 1991	**Qdp—**Dos Palos Alluvium; **Qm—**Modesto Formation
Santa Rita Bridge	Lettis 1982	**Qd_t—**Dos Palos alluvium, fine- to coarse-grained river deposits; **Qd_c—**Dos Palos alluvium, coarse-grained channel deposits; **Qd_t/Qm_b—**undifferentiated Dos Palos alluvium and Modesto Formation, upper member; overbank deposits; **Qm—**Modesto Formation, upper member, fine-grained lower fan deposits; **Qm_b—**Modesto Formation, upper member, fine-grained overbank deposits
	Marchand 1976	**hal—**Holocene alluvial sand, silt, and gravel associated with floodplains and low terraces; **m2, m2b—**Modesto Formation, upper member; **m1b—**Modesto Formation, lower member
	Wagner et al. 1991	**Qdp—**Dos Palos Alluvium; **Qm—**Modesto Formation
Bliss Ranch	Marchand 1976	**hal—**Holocene alluvial sand, silt, and gravel associated with floodplains and low terraces; **m2, m2b—**Modesto Formation, upper member; **m1, m1b—**Modesto Formation, lower member
	Wagner et al. 1991	**Qm—**Modesto Formation
Chowchilla	Marchand 1976, Marchand and Allwardt 1978	**hal—**Holocene alluvial sand, silt, and gravel associated with floodplains and low terraces; **mh—**undifferentiated Holocene and Modesto Formation alluvial and colluvial sand, silt, and gravel; **m2, m2b—**Modesto Formation, upper member; **m1, m1a, m1b—**Modesto Formation, lower member
	Wagner et al. 1991	**Qm—**Modesto Formation; **Qr—**Riverbank Formation
Berenda	Marchand 1976	**hal—**Holocene alluvial sand, silt, and gravel associated with floodplains and low terraces; **m2—**Modesto Formation, upper member; **m1, m1b, m1e—**Modesto Formation, lower member; **r3—**Riverbank Formation, upper unit; **r2—**Riverbank Formation, middle unit; **t2—**Turlock Lake Formation, upper unit
	Wagner et al. 1991	**Qm—**Modesto Formation; **Qr—**Riverbank Formation; **Qtl—**Turlock Lake Formation
Kismet	Marchand 1976	**m2—**Modesto Formation, upper member; **m1, m1a, m1e—**Modesto Formation, lower member; **r3—**Riverbank Formation, upper unit; **r2—**Riverbank Formation, middle unit; **r1—**Riverbank Formation, lower unit; **t2—**Turlock Lake formation, upper unit; **t1—**Turlock Lake Formation, lower unit
	Wagner et al. 1991	**Qm—**Modesto Formation; **Qr—**Riverbank Formation; **Qtl—**Turlock Lake Formation

Quadrangle	Map Source	Geologic Units
Le Grand	Marchand 1976	**hal—**Holocene alluvial sand, silt, and gravel associated with floodplains and low terraces; **m2—**Modesto Formation, upper member; **m1, m1b, m1c, m1e —**Modesto Formation, lower member; **r3, rg—**Riverbank Formation, upper unit; **r2—**Riverbank Formation, middle unit; **r1—**Riverbank Formation, lower unit; **t2—**Turlock Lake Formation, upper unit
	Wagner et al. 1991	**Qm—**Modesto Formation; **Qr—**Riverbank Formation; **Qtl—**Turlock Lake Formation
Plainsburg	Marchand 1976	**hal—**Holocene alluvial sand, silt, and gravel associated with floodplains and low terraces; **mh—**undifferentiated Holocene and Modesto Formation alluvial and colluvial sand, silt, and gravel; **m2, m2e—**Modesto Formation, upper member; **m1, m1b—**Modesto Formation, lower member; **r3—**Riverbank Formation, upper unit
	Wagner et al. 1991	**Qm—**Modesto Formation; **Qr—**Riverbank Formation
El Nido	Marchand 1976	**m1b—**Modesto Formation, lower member
	Wagner et al. 1991	**Qm—**Modesto Formation

Source: Lettis, 1982; Wagner et al. 1991; Marchand 1976, Marchand and Allwardt 1978

As summarized in Table 4-2, the alignments for the Central Valley Wye alternatives are situated on alluvial materials of Holocene and Pleistocene age (Marchand 1976, Wagner et al. 1991). In general, the surface-exposed materials are younger to the west and dominantly older to the east. The following paragraphs provide more information on the specific geologic units within the anticipated three-dimensional extent of disturbance. Units are discussed in order from younger to older, west to east.

4.3.2.1 Holocene Alluvial Materials

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

Past work reflects several approaches to Holocene stratigraphy along the valley margins and in the San Joaquin Valley itself. In general, where map coverage was available, this report follows the breakdown of Marchand (1976), who recognizes three units based on geomorphology and occurrence. Portions of the Central Valley Wye project footprint are situated on Marchand's hal unit, comprising sand, silt, and gravel deposited in floodplain and low-level terrace settings. Aeolian (dune) sand and lacustrine, marsh, and swamp deposits are also present in the general area but have not been mapped along the alignment (Marchand 1976). In the Delta Ranch 7.5-minute quadrangle, which is outside the area of Marchand's 1976 mapping, we rely on the usage of Lettis (1982) and the 1:250,000 compilation map of Wagner et al. (1991), which employ a different nomenclature. More specifically, both Lettis (1982) and Wagner et al. (1991) show this portion of the alignment as situated on exposures of the Dos Palos Alluvium of Holocene age, and the Modesto Formation. The Dos Palos Alluvium is regionally underlain by the San Luis Ranch Alluvium of Late Pleistocene−Early Holocene age (Lettis 1982, Wagner et al. 1991).

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

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

4.3.2.2 Modesto Formation

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

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

4.3.2.3 Riverbank Formation

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

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

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

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

4.3.2.4 Turlock Lake Formation

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

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

4.3.2.5 Deeper Subsurface Units

Several additional geologic units are regionally extensive in the deeper subsurface underlying the Turlock Lake Formation: from youngest to oldest, the North Merced Gravel, the Laguna Formation, and the Mehrten Formation. These units would only have the potential to be affected by Central Valley Wye construction in the event of deep foundation drilling or excavation. Impacts are currently considered unlikely and in any case would be limited, but they are included here for completeness. Brief descriptions of lithology, depositional environment, and fossil content follow.

North Merced Gravel

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

Laguna Formation

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

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

Mehrten Formation

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

The Mehrten Formation has produced numerous and diverse fossil finds from at least 54 documented localities (UCMP 2016). Specimens in the UCMP collection include microfossils such as foraminifera (*Cyclammina pacifica*, *Dentalina dusenbergae*, *Gaudryina* sp., *Globanomalina lillisi*, *Lenticulina* sp., *Melonis* sp., and*Trochammina* sp.), as well as ostracodes (*Buntonia* sp. and *Pseudonosaria ovata*) (UCMP 2016). The Mehrten Formation has also produced abundant plant fossils, including the holotype of *Arctostaphylos oakdalensis* along with remains of sedge (*Cyperus* sp.), rush (*Juncus* sp.), several shrubs—indigo bush (hypotypes and homeoptypes of *Amorpha condoni*), bayberry (*Mahonia marginata*), coffeeberry and related species (hypotypes of *Rhamnus precalifornica* and *R. moragensis*), gooseberry (a cotype of *Ribes mehrtensis*), *Ceanothus*, *Celtis, and Toxicodendron*—and a number of trees, including madrone (*Arbutus matthesii*), pine (*Pinus sturgis*), aspens and cottonwoods (*Populus alexandri*, *P. garberii*, *P. pliotremuloides*, *P. parcedentata*), laurel (hypotype and homeotypes of *Persea coalingensis*), sycamore (*Platanus paucidentata*), oaks and live oaks (plesiotypes and homeotypes of *Quercus wislizenoides* as well as remains of *Q. dispersa*, *Q. douglasioides*, *Q. pliopalmeri*, *Q. prelobata*, *Q. pseudolyrata*, *Q. remingtonii* plus at least one unidentified *Quercus* species), locust (a plesiotype of *Robinia californica*), willows (*Salix edenensis*, *S. hesperia*, *S. garberii*, *S. laevigatoides*, *S. wildcatensis*), redwood (*Sequoia* sp.), bay (*Umbellularia salicifolia)*, and an extinct tree related to the modern soapberry (plesiotypes of *Sapindus oklahomensis*) (UCMP 2016). Among the vertebrates represented in the Mehrten Formation are a salmonid fish (*Smilodonichthys rastrosus*), blackfish (*Orthodon* sp.), salamanders (*Aneides lugubris*, *Batrachoseps* sp.), pond turtle (*Clemmys* [*Actinemys*] *marmorata*, *Clemmys* sp.), tortoises (*Geochelone orthopygia*, *Geochelone* sp., *Gopherus* sp., *Hesperotestudo* sp.), hare (*Hypolagus* sp.), the extinct rodent *Cupidinimus*, beaver (*Castor* sp., *Dipoides williamsi*), raccoon (*Procyon* sp.), numerous horses (*Dinohippus coalingensis*, *Hipparion mohavense*, *Hipparion* sp., *Nannippus tehonensis*, *Nannippus* sp., *Neohipparion molle, Neohipparion* sp., *Pliohippus coalengensis, P. interpolatus, P. tantalus, Pliohippus* sp.), camelids (*Paracamelus* sp., *Pliauchenia* sp.), rhinoceroses (*Aphelops* sp., *Teleoceras* sp.), antelocaprids (*Merycodus* sp., *Sphenophalos* sp., *Tetrameryx* sp.), giant ground sloths (*Megalonyx mathisi, Pliometanastes protistus*), fox (*Vulpes* sp.), proboscids (*Mammut americanum*, *Platybelodon* sp.), canids (*Borophagus parvus, Osteoborus* sp.), and saber-toothed cat (*Machairodus coloradensis*) (UCMP 2016).

4.4 Summary Paleontological Sensitivity Evaluation by Geologic Unit

Table 4-3 summarizes the paleontological sensitivity of the geologic units described in this section, based on the criteria established in the Version 5 Environmental Methods (Authority and FRA 2014a). More detailed information on fossil content by unit, used in making the evaluations in Table 4-2, as well as specific references for the sources of information, are given in the preceding sections. Figures 4-2 through 4-10 show the geology of the Central Valley Wye alternatives.

Table 4-3 Paleontological Potential/Sensitivity by Geologic Unit

Geologic Unit	Paleontological Sensitivity	Comments
Holocene alluvial units, including Dos Palos Alluvium	Low	There are no records indicating potential to yield significant fossils.
San Luis Ranch Alluvium, alluvium of San Luis Ranch	High	These units have produced vertebrate fossils.
Undifferentiated Modesto Formation and Holocene alluvial and colluvial materials	High	This unit is mapped in areas where Holocene alluvium and Modesto Formation cannot be reliably distinguished in the field or cannot be accurately delineated at the scale of the source maps. Because the Modesto Formation has yielded vertebrate fossils from a number of localities and is considered highly sensitive, this unit is also considered to have high sensitivity.
Modesto Formation, all members	High	This unit has produced vertebrate fossils from a number of localities.
Riverbank Formation, all units	High	This unit has produced numerous and diverse vertebrate fossils from a number of localities, notably the Arco Arena site and Teichert Gravel Pit in Sacramento County and the famous Fairmead Landfill in Madera County.
Turlock Lake Formation, all units	High	The Turlock Lake Formation has produced numerous and diverse vertebrate fossils from localities that include the famous Fairmead Landfill site in Madera County.
North Merced Gravel	Low	The North Merced Gravel is not known to be fossiliferous.
Laguna Formation	High	The Laguna Formation has produced limited vertebrate remains.
Mehrten Formation	High	The Mehrten Formation has produced abundant plant and vertebrate remains from a number of localities.

Source: Author's Compilation, 2016

5 POTENTIAL FOR EFFECTS ON PALEONTOLOGICAL RESOURCES

5.1 Methods for Evaluating Effects

As discussed in Section 1, Introduction, this supplemental technical report reflects the Authority's current adopted Version 5 Environmental Methods (Authority and FRA 2014a).

As Section 4.1, Definition of Resource Study Area, briefly identifies, the mechanism for effects on paleontological resources is direct damage and loss, typically as a result of ground-disturbing activities, including but not limited to clearing, grading, excavation, tunneling, and drilling. Analysis therefore evaluated the risk to paleontological resources based on the anticipated three-dimensional extent of ground disturbance and the paleontological sensitivity (potential to contain scientifically important fossils) of the geologic units involved. The analysis was qualitative but did take into account the proportionality between extent of loss and loss of information.

The severity of the potential effect relates to the extent of loss of significant fossils, and the significance of fossil materials roughly equates to their scientific importance. For purposes of project-level documents, the HSR program—through the Version 5 Environmental Methods—defines *significant fossils* as those that provide taxonomic, taphonomic, phylogenetic, stratigraphic, ecologic, or climatic information. Significant fossils may include body fossils, traces, tracks, and trackways. Vertebrate fossils of all types and sizes are typically considered significant because of their comparative rarity and their informational potential. Invertebrate fossils, plant fossils, and microfossils may also be scientifically important and therefore significant; this usage is consistent with both the Caltrans and SVP approaches (Caltrans 2012, SVP Impact Mitigation Guidelines Revision Committee 2010). Effects were considered in the context of the Central Valley Wye's location on the floor of the San Joaquin Valley.

5.2 Potential Effects by Alternative

For all of the Central Valley Wye alternatives, ground disturbance would involve geologic units that have produced abundant and diverse fossil resources, including vertebrate remains, and are thus considered highly sensitive for paleontological resources (i.e., likely to produce additional similar finds in the future). Work involving these units—which include the Modesto, Riverbank, and Turlock Lake Formations, and also the undifferentiated Modesto Formation and Holocene "mh" unit of Marchand (1976)—would thus have the potential to damage or destroy significant (scientifically important) fossil resources. In the event the Laguna Formation, and, particularly, the abundantly fossiliferous Mehrten Formation are involved in deeper foundation excavation or drilling, there would also be potential for loss of significant fossil resources. Once damaged or lost, such resources cannot be recovered; effects are therefore considered permanent.

The geologic and paleontological baseline referenced in the effects analysis for the Central Valley Wye is shown on Figures 4-2 through 4-10 and described in the accompanying text in Section 4, Resource Evaluation.

5.2.1 SR 152 (North) to Road 13 Wye Alternative

5.2.1.1 Construction

The SR 152 (North) to Road 13 Wye Alternative would be located on the floor of the San Joaquin Valley, which is underlain by several geologic units that have yielded abundant, diverse, and scientifically important fossil finds, including but not limited to numerous vertebrate remains. As shown on Figures 4-2 through 4-10, the alignment would traverse complexly dissected exposures of Holocene and Pleistocene alluvial materials that essentially form a "layer cake" of valley fill with older units in the subsurface overlain at varying depths by progressively younger strata toward the present-day ground surface.

The potential for effects on paleontological resources relates to the paleontological sensitivity of the geologic units involved in construction ground disturbance—that is, their potential to produce significant (scientifically important) fossil materials. The SR 152 (North) to Road 13 Wye Alternative would be located on the floor of the San Joaquin Valley, which is underlain by several geologic units that have yielded abundant, diverse, and scientifically important fossil finds, including but not limited to numerous vertebrate remains. Despite the richness of the fossil resources documented in the Central Valley Wye area, however, no paleontological resources or sites identified as meriting consideration as unique have been identified within the SR 152 to Road 13 Wye Alternative RSA. As a result, no loss of unique resources is anticipated.

However, where geologic units with high paleontological sensitivity (high potential to produce scientifically important fossil finds) are present, construction-related ground disturbance—including but not necessarily limited to site preparation, grading, excavation, tunneling, and drilling (in particular, large-diameter drilling for foundation piers or pilings)—could result in damage or loss affecting other significant (but non-unique) paleontological resources. Effects are possible in two situations:

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

The following geologic units are identified as having high paleontological sensitivity: Modesto Formation, undifferentiated Modesto Formation and Holocene sediments (mh unit of Marchand 1976), Riverbank Formation, Turlock Lake Formation, and San Luis Ranch Alluvium, as well as the deeper, underlying Laguna and Mehrten Formations. Ground disturbance involving these units has the potential to result in damage or loss affecting scientifically important (significant) fossil resources. The potential for effects could increase with the extent of disturbance, but even activity that is limited in extent could have the potential to result in the loss of scientifically important resources.

The following geologic units are identified as having low paleontological sensitivity: Dos Palos alluvium, other unnamed Holocene alluvial units, and North Merced Gravel. Ground disturbance involving these units is not expected to result in damage or loss of scientifically important (significant) fossil resources. Because these units have not been documented as containing scientifically important (significant) paleontological resources, an increased extent of disturbance is not expected to produce a substantive increase in the potential for loss of scientifically important resources.

Because of the need for ground-disturbing activity in areas underlain by paleontologically sensitive geologic materials, the design of the Central Valley Wye includes provisions to avoid damage and loss of significant paleontological resources and concomitant loss of scientific information, in the form of IAMFs for paleontological resources.

To reduce or avoid damage and loss of scientifically important resources consistent with the current prevailing standard for paleontological resources protection, the Contractor will designate a PRS who will be responsible for determining where and when paleontological resources monitoring should be conducted prior to any ground disturbing activities (GEO-IAMF #7: Engage a Paleontological Resources Specialist to Direct Monitoring during Construction). PRMs will be selected by the PRS based on their qualifications, and the scope and nature of their monitoring will be determined and directed based on the PRMMP. The PRS will be responsible for developing WEAP training, which all management and supervisory personnel and construction workers involved with ground-disturbing activities will be required to take before beginning work and will be provided with the necessary resources for responding in case paleontological resources are found during construction. The PRS will document any discoveries, as needed, evaluate the potential resource, and assess the significance of the find under the criteria set forth in CEQA Guidelines Section 15064.5. The PRMMP will be submitted to the Authority for review and approval (GEO-IAMF #7).

The PRMMP will include a description of when and where construction monitoring will be required; emergency discovery procedures; sampling and data recovery procedures; procedures for the preparation, identification, analysis, and curation of fossil specimens and data recovered; and procedures for reporting the results of the monitoring and mitigation program. The PRMMP will be consistent with Society of Vertebrate Paleontology (SVP 2010) guidelines or their successors for mitigating construction impacts on paleontological resources. The PRMMP will also be consistent with the SVP (1996) conditions for receivership of paleontological collections and any specific requirements of the designated repository for any fossils collected (GEO-IAMF #8).

If fossil or fossil-bearing deposits are discovered during construction, regardless of the individual making a paleontological discovery, construction activity in the immediate vicinity of the discovery will cease, in order to minimize the potential for resource impacts (GEO-IAMF #9 Halt Construction When Paleontological Resources Are Found). This requirement will be spelled out in both the PRMMP and the WEAP training. Construction activity may continue elsewhere, provided that it continues to be monitored as appropriate. If the discovery is made by someone other than a PRM or the PRS, a PRM or the PRS will immediately be notified. The PRS will prepare and submit monthly reports to the Authority documenting PRMMP implementation for compliance monitoring (GEO-IAMF #9).

5.2.1.2 Operations

Routine operations and maintenance of the SR 152 (North) to Road 13 Wye Alternative is not expected to require disturbance of previously undisturbed substrate materials. With no ground disturbance in previously undisturbed materials, there would be no loss of significant paleontological resources. If future maintenance activities require ground disturbance affecting previously undisturbed substrate units, the potential for effects would be similar to that described for Central Valley Wye construction.

5.2.2 SR 152 (North) to Road 19 Wye Alternative

The paleontology of the SR 152 (North) to Road 19 Wye Alternative is similar to that of the SR 152 (North) to Road 13 Wye Alternative. Although there are some differences in the geologic units exposed at the surface due to the differences in routing, all of the same geologic units would be involved, as summarized in Table 4-2 and shown on Figures 4-2 through 4-10. Additionally, despite the differences in routing and in the locations and footprints of ancillary facilities, both the overall construction process and Central Valley Wye operations and maintenance would be very similar under these two alternatives. The potential for damage and loss of significant paleontological resources would therefore be very similar under the SR 152 (North) to Road 19 Wye Alternative to that described above for the SR 152 (North) to Road 13 Wye Alternative. Accordingly, the SR 152 (North) to Road 19 Wye Alternative would incorporate the same IAMFs to avoid and reduce effects on paleontological resources during construction: engagement of a PRS for direct monitoring during construction (GEO-IAMF #7), implementation of a PRMMP (GEO-IAMF #8), and provisions to halt construction if paleontological resources are found (GEO-IAMF #9) (see discussion above for a full description of these design characteristics). With no ground disturbance in previously undisturbed materials, operation of the SR 152 (North) to Road 19 Wye Alternative would not result in damage or loss of significant paleontological resources. If future maintenance activities require ground disturbance affecting previously undisturbed substrate units, the potential for effects would be similar to that during construction.

5.2.3 Avenue 21 to Road 13 Wye Alternative

The Avenue 21 to Road 13 Wye Alternative is geologically and paleontologically very similar to the SR 152 (North) to Road 13 Wye Alternative (see Table 4-2 and Figures 4-2 through 4-10). The same geologic units discussed for the other the SR 152 (North) to Road 13 Wye Alternative would also be involved in the Avenue 21 to Road 13 Wye Alternative, although there are some differences in the geologic units exposed at the surface along the alignment, due to the differences in routing. Unlike the other three Central Valley Wye alternatives, the Avenue 21 to Road 13 Wye Alternative would be located in close proximity to the well-documented Fairmead Landfill site, where strata assigned to the Riverbank and Turlock Lake Formations have yielded a particularly rich and diverse vertebrate fauna. However, because of the “sensitive anywhere, sensitive everywhere” approach that governs paleontological resources sensitivity evaluation (discussed in Section 4, Resource Evaluation), the Riverbank and Turlock Lake Formations are considered highly sensitive wherever they occur, in part due to the Fairmead Landfill finds; the finds at Fairmead Landfill elevate the level of caution with which these units should be treated throughout their extent, rather than the landfill site representing a uniquely sensitive locality.

Although there are differences in routing and in the locations and footprints of some ancillary facilities, both the overall construction process and Central Valley Wye operations and maintenance would be very similar under the Avenue 21 to Road 13 Wye Alternative to that under the SR 152 (North) to Road 13 Wye Alternative. The potential for damage and loss of significant paleontological resources would therefore be very similar under the Avenue 21 to Road 13 Wye Alternative to that described above for the SR 152 (North) to Road 13 Wye Alternative. Accordingly, the Avenue 21 to Road 13 Wye Alternative would incorporate the same IAMFs to avoid and reduce effects on paleontological resources during construction: engagement of a PRS for direct monitoring during construction (GEO-IAMF #7), implementation of a PRMMP (GEO-IAMF #8), and provisions to halt construction if paleontological resources are found (GEO-IAMF #9) (see discussion above for a full description of these design characteristics). With no ground disturbance in previously undisturbed materials, operation of the Avenue 21 to Road 13 Wye Alternative would not result in damage or loss of significant paleontological resources. If future maintenance activities require ground disturbance affecting previously undisturbed substrate units, the potential for effects would be similar to that during construction.

5.2.1 SR 152 (North) to Road 11 Wye Alternative

The paleontology of the SR 152 (North) to Road 11 Wye Alternative is very similar to that of the SR 152 (North) to Road 13 Wye Alternative. Although there are some differences in the geologic units exposed at the surface, due to the differences in routing, all of the same geologic units would be involved, as summarized in Table 4-2 and shown on Figures 4-2 through 4-10. Additionally, despite the differences in routing and in the locations and footprints of ancillary facilities, both the overall construction process and Central Valley Wye operations and maintenance would be very similar under these two alternatives. As a result, the SR 152 (North) to Road 11 Wye Alternative would avoid the potential to result in loss affecting significant paleontological resources as described for the SR 152 (North) to Road 13 Wye Alternative, during both the construction and operations phases, through engagement of a PRS for direct monitoring during construction (GEO-IAMF #7), implementation of a PRMMP (GEO-IAMF #8), and provisions to halt construction if paleontological resources are found (GEO-IAMF #9). See the discussion under the SR 152 (North) to Road 13 Wye Alternative section for a full description of these design characteristics.

The potential for damage and loss of significant paleontological resources would therefore be very similar under the SR 152 (North) to Road 11 Wye Alternative to that described above for the SR 152 (North) to Road 13 Wye Alternative. Accordingly, the SR 152 (North) to Road 11 Wye Alternative would incorporate the same IAMFs to avoid and reduce effects on paleontological resources during construction: engagement of a PRS for direct monitoring during construction (GEO-IAMF #7), implementation of a PRMMP (GEO-IAMF #8), and provisions to halt construction if paleontological resources are found (GEO-IAMF #9) (see discussion above for a full description of these design characteristics). With no ground disturbance in previously undisturbed materials, operation of the SR 152 (North) to Road 11 Wye Alternative would not result in damage or loss of significant paleontological resources. If future maintenance activities require ground disturbance affecting previously undisturbed substrate units, the potential for effects would be similar to that during construction.

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BNSF	BNSF Railway
CAL FIRE	California Department of Forestry and Fire Protection
Cal. Public Res. Code	California Public Resources Code
Caltrans	California Department of Transportation
C.F.R.	Code of Federal Regulations
ESRI	Environmental Systems Research Institute
Fed. Reg.	*Federal Register*
FRA	Federal Railroad Administration
Fresno COG	Fresno Council of Governments
SVP	Society of Vertebrate Paleontology
UCMP	University of California Museum of Paleontology
UPRR	Union Pacific Railroad
U.S.C.	United States Code

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7 PREPARER QUALIFICATIONS

This report was prepared under the supervision of Anna Buising, Ph.D., P.G. (CA-PG-7955). Dr. Buising has extensive experience managing a wide range of NEPA, CEQA, and permitting efforts for infrastructure, municipal public works, flood protection, land development, and habitat restoration projects. Dr. Buising has also led numerous paleontological resources compliance efforts and has substantial experience as licensed staff overseeing, preparing, and peer reviewing various types of paleontology technical studies and reports (including Caltrans Paleontological Identification Reports, Paleontological Evaluation Reports, and Paleontological Mitigation Plans) for a wide range of infrastructure, transportation, and development projects throughout California.

Dr. Buising has been an invited presenter on geologic and regulatory topics at numerous venues, and has taught CEQA and paleontological resources compliance for private, university, and municipal clients. She is a recognized expert on the Neogene stratigraphy of the eastern San Francisco Bay region and adjacent central California. While a tenured faculty member at California State University, Hayward (now California State University, East Bay), she and her students were among the first researchers to use the Neogene stratigraphic record to test quantitative reconstructions of past movement on the San Andreas fault system at the latitude of the Bay Area. Dr. Buising has continued active research on Bay Area stratigraphy and slip partitioning histories and remains involved in advising graduate student research. She also regularly provides stratigraphic consulting for fault trench studies. Results of her work have been presented in a number of venues, including publications of the U.S. Geological Survey, Society for Sedimentary Geology, and American Geophysical Union.