California High-Speed Rail Authority

Merced to Fresno Section: Central Valley Wye

Hydrology and Water Resources Technical Report

December 2016

CALIFORNIA High-Speed Rail Authority

U.S. Department of Transportation
Federal Railroad Administration

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ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
AF/year	acre-feet per year
Authority	California High-Speed Rail Authority
Basin Plan	*Water Quality Control Plan for the Sacramento River and San Joaquin River Basins*
BFE	base flood elevation
BMP	best management practices
BNSF	BNSF Railway
Caltrans	California Department of Transportation
cfs	cubic feet per second
CVFPB	Central Valley Flood Protection Board
CWA	Clean Water Act
DWR	California Department of Water Resources
EIR	environmental impact report
EIS	environmental impact statement
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FRA	Federal Railroad Administration
GIS	geographic information system
HSR	high-speed rail
HU	hydrologic unit
IAMF	impact avoidance and minimization feature
MS4	municipal separate storm sewer system
NPDES	National Pollutant Discharge Elimination System
RSA	resource study area
RWQCB	Regional Water Quality Control Board
SFHA	special flood-hazard areas
SR	State Route
SWPPP	stormwater pollution prevention plan
SWRCB	State Water Resources Control Board
TMDL	total maximum daily load
TPSS	traction power substation
UPRR	Union Pacific Railroad
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
Water Plan	California Water Plan, Update 2013

EXECUTIVE SUMMARY

The California High-Speed Rail Authority (Authority) has prepared this *Merced to Fresno Section: Central Valley Wye Hydrology and Water Resources Technical Report* (Central Valley Wye Hydrology and Water 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 2012). When the Authority Board of Directors and the Federal Railroad Administration (FRA) 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 FRA have identified four new alternatives for consideration.

This technical report characterizes existing conditions and analyzes hydrology and water quality 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

Hydrology and water resources comprise surface water hydrology, water quality, groundwater, and floodplains. 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 hydrology and water 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 3.8, Hydrology and Water Resources, there would be no significant impacts as a result of Central Valley Wye construction or operations; therefore, no mitigation measures are required.

Summary of Effects

The potential effects from implementation of the Central Valley Wye alternatives on hydrology and water quality resource areas are discussed in this section.

Surface Water Hydrology

The Central Valley Wye would require waterbody crossings (across natural waterbodies and canals and ditches) and increase impervious surfaces that could result in changes to drainage patterns and increased runoff that could affect irrigation and stormwater systems. Construction could redirect and increase the volume and rate of shallow overland flows, increasing the potential for erosion and sedimentation in areas of exposed soils and areas along channel banks. Operations and maintenance activities could intermittently affect drainage patterns, resulting in short-term increases in localized siltation or changes in sediment loads in surface waters. Operations could result in permanent effects on drainage patterns related to surface stormwater runoff and hydraulic capacity and connectivity of natural waterbodies from train movement. The effects on surface water hydrology have been minimized by designing the alternative alignments to follow existing transportation rights-of-way to the maximum extent feasible and by incorporating design standards (Appendix B), the latest version of Authority Technical Memorandum *2.6.5 Hydraulics and Hydrology Guidelines,* and best management practices (BMP) as part of IAMFs. By following existing transportation rights-of-way, new waterbody crossings (i.e., crossing waterbodies in currently undisturbed locations) and resulting changes to drainage patterns would be minimized. IAMFs would be implemented as part of the Central Valley Wye design to minimize the potential for erosion and siltation, and prevent or minimize stormwater runoff and sediment loading. IAMFs are standard practices, actions, and design features, such as the inclusion of

flood protection standards and the implementation of stormwater management and treatment measures, incorporated into the Central Valley Wye design. IAMFs reduce the severity of effects, such as the rate of stormwater runoff, temporary changes to river and stream hydrology, and potential erosion and siltation due to increased volumes and rates of flow. With these features incorporated, the Central Valley Wye is not likely to result in effects on surface water hydrology.

Surface Water Quality

Construction of the Central Valley Wye alternatives would result in temporary and permanent areas of ground disturbance and could introduce sediments and other contaminants (e.g., fuels, oils, lubricants, pesticides) to surface waterbodies that could affect water quality. The Authority will implement various erosion and sedimentation controls as part of IAMFs to stabilize disturbed soils and prevent erosion from occurring along slopes or to prevent sediments from entering nearby storm drains and waterbodies. Waste management, materials pollution controls, and spill prevention and response measures would also avoid hazardous substances and other materials from being discharged to waters. During operations, the trains and tracks would not be expected to be major pollutant sources. Central Valley Wye stormwater system would divert runoff and pollutants from roads and tracks, and the stormwater system design would accommodate runoff and provide stormwater quality treatment for the new roads to diminish the amount of contaminants reaching waterbodies and affecting surface water quality. Routine vegetation removal along the tracks and associated infrastructure may require land disturbance, resulting in increased susceptibility to erosion and sedimentation along slopes, or require the use of herbicides or pesticides. The Authority will implement erosion and sediment control measures and design features to minimize the effects of erosion, sedimentation, and hazardous substances on water quality. Accordingly, the Central Valley Wye alternatives would not be expected to contribute to a violation of regulatory standards, create or contribute runoff water that would provide substantial additional sources of polluted runoff, or otherwise substantially degrade water quality.

Groundwater

Groundwater could be affected during construction of the Central Valley Wye through the discharge of pollutants that seep into groundwater supplies. An increase in impervious surfaces could also affect groundwater recharge, although the extent of these surfaces is small compared to the size of the groundwater recharge area. The Central Valley Wye design includes the use of permeable and vegetated areas to provide for soil infiltration for the purpose of stormwater treatment, manage and control surface runoff to minimize potential for groundwater contamination, minimize the use and contact of hazardous materials, construction materials, equipment, and maintenance supplies with stormwater that may infiltrate into groundwater, and to minimize the effects from an overall increase in impermeable surfaces relative to the existing condition. With these features, the Central Valley Wye alternatives would not contribute to a violation of any groundwater quality or regulatory standards, would not result in substantial reduction of groundwater supplies, and would not interfere with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level.

Floodplains

Changes to the hydraulic capacity and connectivity of natural watercourses, including floodways, could occur as a result of construction of the Central Valley Wye alternatives. Construction, operation and maintenance in a floodplain could temporarily impede or redirect flood flows because of the presence of construction equipment and materials in the floodplain. The potential for changes in flood flows that could lead to flooding as a result of construction and operations activities would be minimized with the implementation of design standards and flood protection measures as part of the Central Valley Wye design. Water crossings would be designed to maintain existing hydraulic capacity and connectivity and to minimize any increase in water surface elevation. Flood protection measures would avoid placing structures that would impede or redirect flood flows within the 100-year flood-hazard area and would avoid causing any measureable change in water surface elevation that would result in conditions that exceed the

capacity of the existing flood channels or floodplains. The design would prevent the trains from impeding flood flows during a storm event through use of aerial tracks over waterbody crossings and major floodplains or floodways. Maintenance materials and structures that could impede flood flows would be small compared to the surrounding areas, and not result in a large obstruction to surface flows. Contractors would avoid effects on flood flows by implementing flood protection measures during maintenance-related activities, and would not conduct work during a storm event. With these measures in place, conditions within the floodplains after construction of the Central Valley Wye would remain similar to existing conditions.

1 INTRODUCTION

1.1 Background of HSR Program

The California High-Speed Rail Authority (Authority) proposes to construct, operate, and maintain an electric-powered high-speed rail (HSR) system in California. When completed, the nearly 800-mile train rail 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 system 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 Environmental Impact Report (EIR)/Environmental Impact Statement (EIS) for the Proposed California High-Speed Train System* (Statewide Program EIR/EIS) (Authority and FRA 2005), and then began preparing second-tier, project environmental evaluations for sections of the statewide HSR system. The 2012 *Merced to Fresno Section Final EIR/EIS* (Merced to Fresno Final EIR/EIS) (Authority and FRA 2012) 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 Project Section, referred to as the "wye connection" (Authority and FRA 2012: pages 2-3 and 2-21). When the Authority Board of Directors and the FRA approved the Merced to Fresno Section later in 2012, they deferred a decision on the wye connection for a future environmental analysis. The Authority and FRA have prepared the Supplemental EIR/EIS as the next step in the environmental review process to select a Central Valley Wye connection. Chapter 2, Alternatives, of the Supplemental EIR/EIS provides a detailed history of how the Authority developed the Central Valley Wye alternatives.

1.2 Organization of this Technical Report

This technical report includes the following sections:

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

Additional details on hydrology and water resources are provided in:

- Appendix A, California High-Speed Rail Impact Avoidance and Minimization Features for Hydrology and Water Resources, provides the list of relevant minimization and avoidance features discussed in this technical report.
- Appendix B, Applicable Design Standards for Hydrology and Water Resources, provides the list of relevant design standards assumed in this technical report to be part of the Central Valley Wye alternatives.

- Appendix C, Construction General Permit SWPPP Risk Level Assessment, presents the analysis and data for the construction site risk assessment performed for the Central Valley Wye.

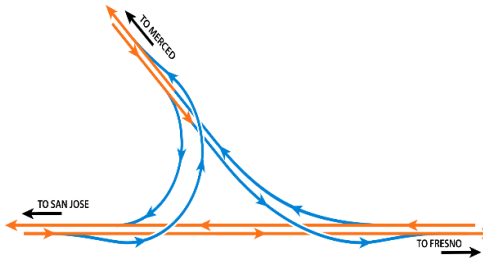
2 MERCED TO FRESNO SECTION: CENTRAL VALLEY WYE

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

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

Central Valley Wye Schematic



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

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

compared to lower-speed roadway alignments. The SR 152 (North) to Road 13 Wye Alternative would not follow existing transportation rights-of-way where it transitions from following one transportation corridor to another.

2.2.1 Alignment and Ancillary Features

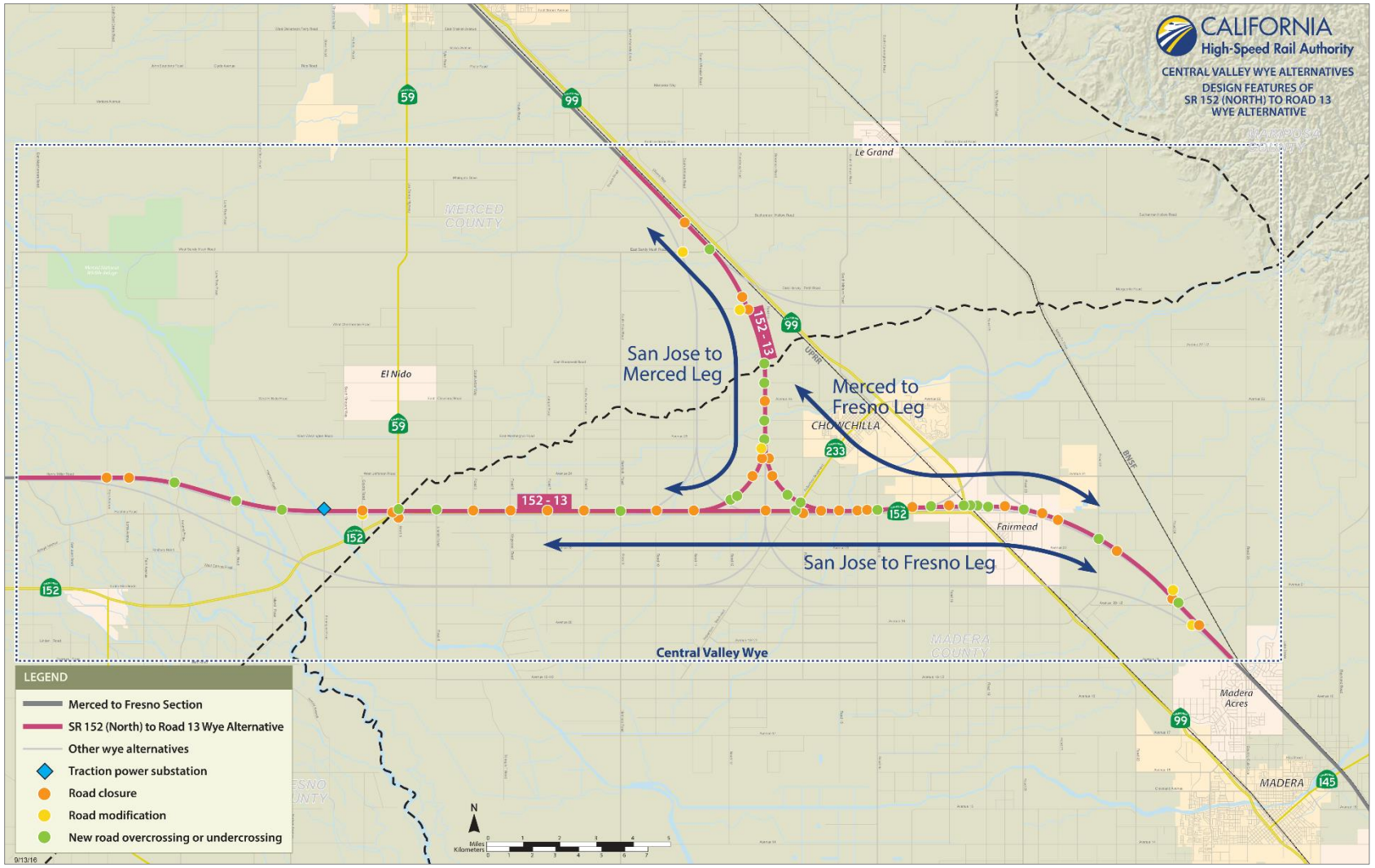
The SR 152 (North) to Road 13 Wye Alternative would extend approximately 52 miles, mostly at-grade on raised embankment, although it would also have aerial structures and a segment of retained cut (depressed alignment). The wye configuration of this alternative would be located southwest of the city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

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

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

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

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



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

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

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

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

2.2.2 State Highway or Local Roadway Modifications

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

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

2.2.3 Freight or Passenger Railroad Modifications

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

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

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

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

Source: Authority, 2016

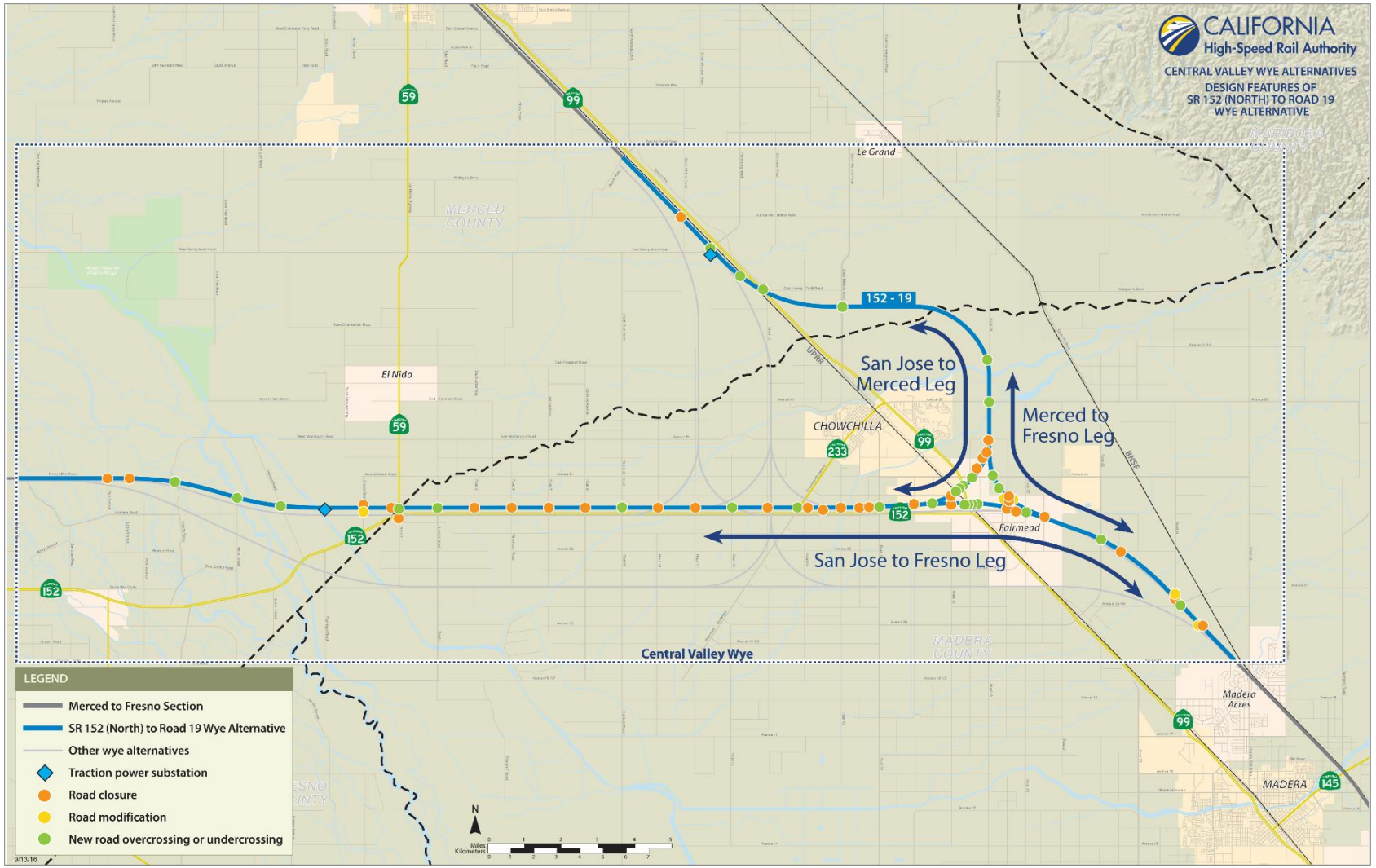
[1] Lengths shown are based on equivalent dual-track alignments and are one-way mileages. For example, the length of single-track elevated structure will be divided by a factor of 2 to convert to dual-track equivalents.

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;ESRI/National Geographic, 2015

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

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

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

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

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

2.3.2 State Highway or Local Roadway Modifications

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

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

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

2.3.3 Freight or Passenger Railroad Modifications

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

[5] 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

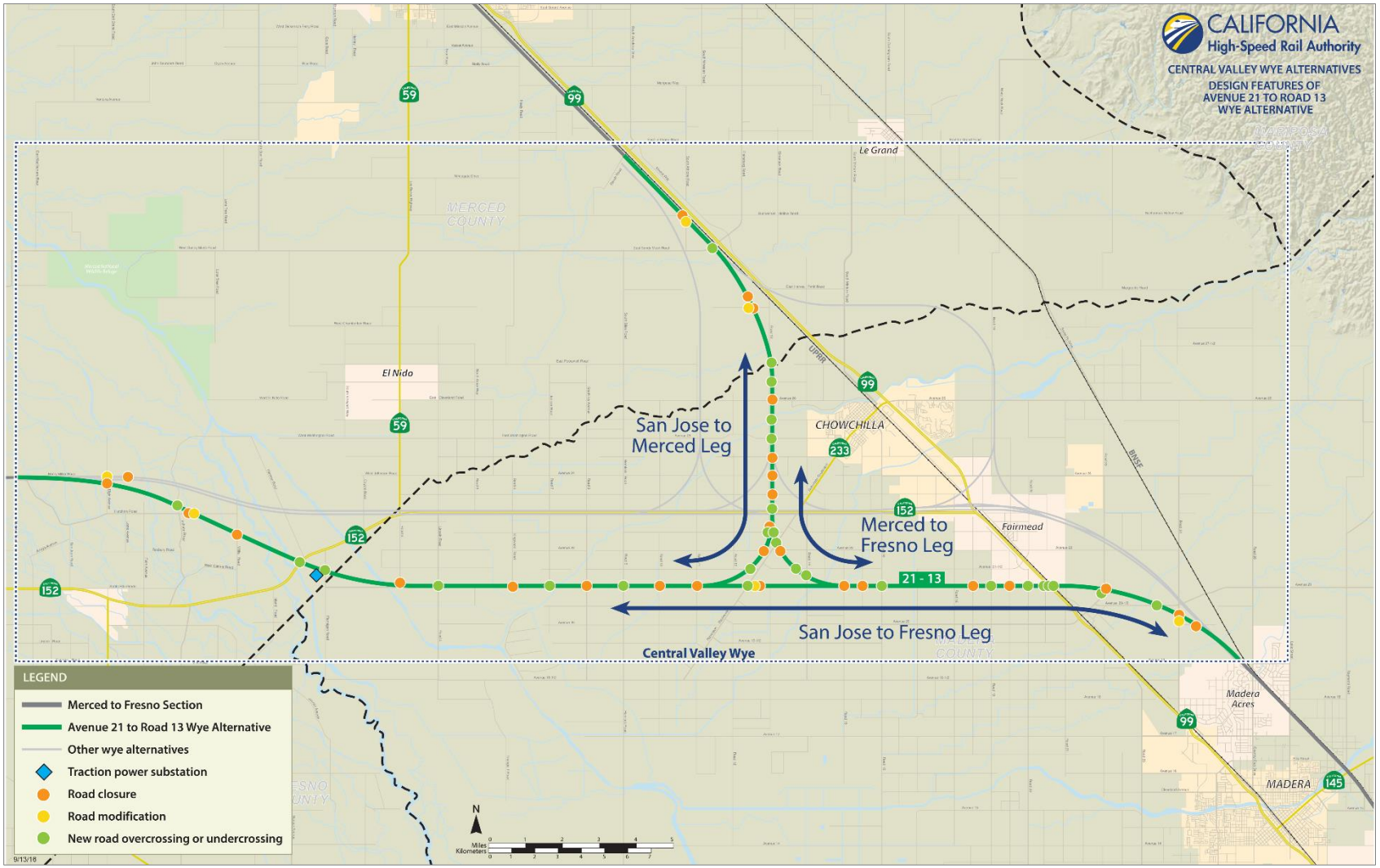
The Avenue 21 to Road 13 Wye Alternative (Figure 2-3) is designed to follow the existing Henry Miller Road and Avenue 21 rights-of-way as closely as practicable in the east-west direction and the Road 13, SR 99, and BNSF rights-of-way in the north-south direction. Deviations from these existing transportation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

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

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

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

2.4.2 State Highway or Local Roadway Modifications

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

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

2.4.3 Freight or Passenger Railroad Modifications

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

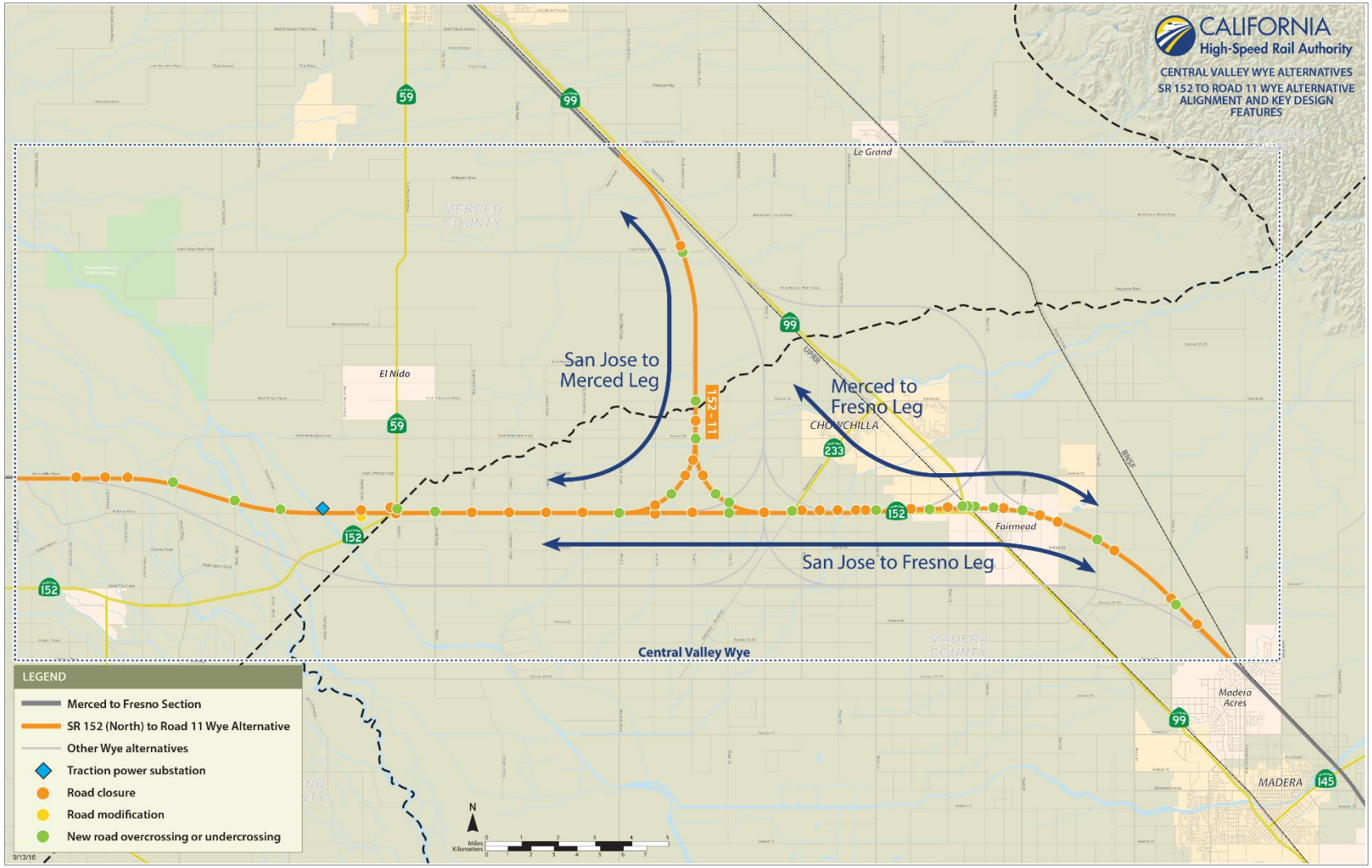
2.5 SR 152 (North) to Road 11 Wye Alternative

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; ESRI/National Geographic, 2015

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

The Authority and FRA will implement the following IAMFs to address potential Central Valley Wye effects on hydrology and water resources. These IAMFs include measures that are specific to hydrology and water resources and IAMFs for other resources (biology, geology, and hazardous materials and waste) that are also related to effects on hydrology and water resources:

2.6.1.1 Hydrology and Water Resources

- HYD-IAMF#1: Stormwater Management

- HYD-IAMF#2: Flood Protection
- HYD-IAMF#3: Prepare and Implement a Construction Stormwater Pollution Prevention Plan
- HYD-IAMF#4: Prepare and Implement an Industrial Stormwater Pollution Prevention Plan

2.6.1.2 Biological Resources

- BIO-IAMF#18: Construction Utility Requirements and Waste Disposal
- BIO-IAMF#20: Dewatering and Water Diversion

2.6.1.3 Geology and Soils

- GEO-IAMF#1: Geological Resources
  - GEO-IAMF#1A: Groundwater Withdrawal
  - GEO-IAMF#1B: Unstable Soils
  - GEO-IAMF#1D: Water and Wind Erosion
- GEO-IAMF#6: Geology and Soils

2.6.1.4 Hazardous Materials and Waste

- HMW-IAMF#1: Transport of Materials
- HMW-IAMF#3: Environmental Management System
- HMW-IAMF#4: Spill Prevention
- HMW-IAMF#5: Undocumented Contamination

3 LAWS, REGULATIONS AND ORDERS

This section provides a summary of federal, state, and local laws, regulations, orders, programs, or plans that pertain to hydrology and water resources in the geographic area that is affected by the Central Valley Wye. For complete descriptions, refer to Section 3.8.2, Laws, Regulations, and Orders, of the Merced to Fresno Final EIR/EIS (Authority and FRA 2012: pages 3.8-1 through 3.8-7). Where applicable, the summaries that follow identify updates or amendments that have been made since the Merced to Fresno Final EIR/EIS was adopted.

3.1 Federal

3.1.1 Clean Water Act (33 U.S.C. § 1251 et seq.) (Updated since the Merced to Fresno Final EIR/EIS)

The Clean Water Act (CWA) is the primary federal law protecting the quality of the nation's surface waters, including lakes, rivers, and coastal wetlands. The CWA prohibits any discharge of pollutants into the nation's waters unless specifically authorized by a permit. Since publication of the Merced to Fresno EIR/EIS, the CWA has been updated to include the Clean Water Rule, defining the term "waters of the U.S.", which includes new definitions of tributaries, wetlands, and ditches. The following subsections discuss applicable sections of the CWA.

3.1.1.1 Basin Planning (§ 102)

CWA Section 102 requires the planning agency of each state (in California, the State Water Resources Control Board [SWRCB]) to prepare a basin plan to set forth regulatory requirements for protection of surface water quality, which include designated beneficial uses for surface waterbodies, as well as specified water quality objectives to protect those uses. Continued coordinated monitoring of water is necessary to confirm the degree to which discharges of runoff from a project may or may not adversely affect receiving water beneficial uses and attainment by the receiving water of assigned water quality objectives indicates the degree to which a project may affect water quality of existing surface waters.

3.1.1.2 Water Quality Impairments (§ 303(d)) (Updated since the Merced to Fresno Final EIR/EIS)

Section 303(d) requires each state to develop a list of impaired surface waters that do not meet or that the state expects would not meet state water quality standards as defined by that section. It also requires each state to develop total maximum daily loads (TMDL) of pollutants for impaired waterbodies. The TMDL must account for the pollution sources causing the water to be listed by the state. The SWRCB has combined its 303(d) List and the 305(b) Report into the proposed 2012 California Integrated Report—303(d) and 305(b) Report, known as the Integrated Report—303(d) List of Water Quality Limited Segments and 305(b) Surface Water Quality Assessment. After approval of the 303(d) List portion of the California Integrated Report by the SWRCB, the complete California Integrated Report was submitted to the U.S. Environmental Protection Agency (USEPA). The USEPA partially approved the 303(d) List portion of the California Integrated Report on June 26, 2015. The USEPA added Topaz Lake to the California 303(d) List prior to final approval on July 30, 2015.

In California, the Regional Water Quality Control Boards (RWQCB) adopt water quality control plans, or basin plans, that establish water quality objectives to provide reasonable protection of beneficial uses and a program of implementation for achieving water quality objectives within the basin plan areas. The *Water Quality Control Plan for the Sacramento River and San Joaquin River Basins* (Basin Plan) (Central Valley RWQCB 2016) is the applicable basin plan for the Central Valley Wye study area.

CWA section 303(d) requires states to identify and list waters that are not attaining state water quality standards. For these waters, the RWQCB establishes TMDLs and a program of implementation to meet the TMDLs.

3.1.1.3 Clean Water Quality Certification (§ 401)

Under Section 401, applicants for a federal license or permit to conduct activities that may result in the discharge of a dredged or fill material into waters of the U.S. must obtain certification that the discharge of fill would not violate water quality standards, including water quality objectives and beneficial uses. The state in which the discharge would originate or the interstate water pollution control agency with jurisdiction over affected waters issue the certification. In California, the RWQCBs and the SWRCB issue Section 401 certifications.

3.1.1.4 Permit for Discharge of Fill Material in Wetlands and Other Waters (§ 404)

Under Section 404, the U.S. Army Corps of Engineers (USACE) and the USEPA regulate the discharge of dredged and fill materials into the waters of the U.S. Project sponsors must obtain a permit from USACE for discharges of dredged or fill materials into jurisdictional waters over which the USACE exerts jurisdiction.

3.1.1.5 National Pollutant Discharge Elimination System Program (§ 402)

Under Section 402, the National Pollutant Discharge Elimination System (NPDES) Program regulates all point source discharges, including, but not limited to, construction-related runoff discharges to surface waters and some post-development. In California, project sponsors must obtain an NPDES permit from the SWRCB.

In California, the SWRCB administers the NPDES program, and the RWQCBs have implementation and enforcement responsibilities. The NPDES program is applicable to all discharges to waters of the U.S., including stormwater discharges associated with construction activities, industrial operations, municipal drainage systems, and point sources in order to protect surface water quality. In general, the NPDES permit program controls, minimizes, or reduces surface water effects. Three types of the NPDES program stormwater permits would be relevant to the Central Valley Wye and are discussed in the following sections—the Construction General Permit, Caltrans NPDES permit, and municipal separate storm sewer systems (MS4) NPDES permits. The Authority requested and received designation as a nontraditional permittee of the Phase II Small MS4 permit (Order No. 2013-0001-DWQ).

The Construction General Permit separates projects into Risk Levels 1, 2, or 3. Risk levels are based on potential erosion and transport to receiving waters. A preliminary analysis indicates that the Central Valley Wye would fall under Risk Level 2. Appendix C, Construction General Permit SWPPP Risk Level Assessment, presents the risk analysis for the Central Valley Wye.

3.1.1.6 Omnibus Public Land Management Act of 2009 (16 U.S.C. §§ 10001-10203) (New since the Merced to Fresno Final EIR/EIS)

The Omnibus Public Land Management Act (Public Law 111-11) was signed into law by President Obama on March 30, 2009, and includes the San Joaquin River Restoration Settlement Act (16 U.S.C. §§ 10001-10011), which authorizes implementation of the San Joaquin River Restoration Settlement (Natural Resources Defense Council, et al., v. Kirk Rodgers, et al. Settlement Agreement (Settlement). The San Joaquin River Restoration Program (SJRRP) was initiated in accordance with the terms and conditions of the Settlement. The SJRRP is a comprehensive long-term effort to restore flows to a 153-mile- long portion of the San Joaquin River from Friant Dam to the confluence of the Merced River. The SJRRP goals are to restore a self-sustaining Chinook salmon fishery while reducing or avoiding adverse water supply effects from restoration flows. The implementing agencies of the SJRRP include the U.S. Bureau of Reclamation (USBR); U.S. Fish and Wildlife Service; National Marine Fisheries Service; California Department of Water Resources (DWR); and California Department of Fish and Wildlife (USBR and DWR 2012).

3.1.1.7 Stormwater Discharges: Construction General Permit (Updated since the Merced to Fresno Final EIR/EIS)

Under the federal CWA, entities discharging stormwater from construction sites must comply with the conditions of an NPDES permit. The SWRCB is the permit authority in California and has adopted the Construction General Permit that applies to projects resulting in 1 or more acres of soil disturbance. For projects disturbing more than 1 acre of soil, the SWRCB requires permittees to prepare a stormwater pollution prevention plan (SWPPP). The SWPPP specifies site management activities that permittees or their construction contractors must implement during site development. These management activities include construction stormwater best management practices (BMP), erosion and sedimentation controls, runoff controls, and construction equipment maintenance. These BMPs are part of the IAMFs that the Authority would implement during design and construction of the Central Valley Wye. Section 2.6, Central Valley Wye Impact Avoidance and Minimization Features, lists the IAMFs relevant to protection of hydrology and water resources, and Appendix A provides full descriptions of these IAMFs.

The SWRCB requires permittees to file a Notice of Intent before discharging any stormwater from construction activities and requires that the permittees or their construction contractors implement and maintain the SWPPP on-site. On July 1, 2010, the SWRCB Water Quality Order No. 2009-0009-DWQ, NPDES No. CAS000002, the statewide Construction General Permit, superseded the previous statewide General Permit. The SWRCB later revised this permit with Order No.

2010-0014-DWQ and Order No. 2012-006-DWQ. The RWQCBs oversee compliance with Construction General Permits within their jurisdictions. A preliminary analysis indicates that the project would fall under Risk Level 1, the lowest risk level. The Central Valley Wye is within the jurisdiction of the Central Valley RWQCB, which is discussed under RWQCBs permits in Section 3.3, Regional and Local. Because all of the Central Valley Wye alternatives would disturb more than 1 acre of soil, the Authority and the FRA would be required to obtain coverage under the Construction General Permit.

3.1.1.8 Stormwater Discharges: California Department of Transportation (Caltrans) National Pollutant Discharge Elimination System Permit (Updated since the Merced to Fresno Final EIR/EIS)

Caltrans operates under a permit (Order No. 2012-0011-DWQ, NPDES No. CAS000003) that regulates stormwater discharge from Caltrans properties, facilities, and activities and requires that the Caltrans construction program comply with the adopted statewide Construction General Permit (Stormwater Discharges: Construction General Permit, discussed above). The Caltrans permit is applicable to those portions of the Central Valley Wye alternatives that would involve modifications to state highways.

3.1.1.9 Stormwater Discharges: Municipal Separate Storm Sewer System (MS4) National Pollutant Discharge Elimination System Permits (Updated since the Merced to Fresno Final EIR/EIS)

CWA section 402(p) requires that states develop and implement stormwater management programs to meet the requirements for stormwater discharges from municipal separate storm sewer systems (MS4). In California, the SWRCB administers the NPDES program, and the RWQCBs have implementation and enforcement responsibilities. The SWRCB and the RWQCBs issue MS4 permits in two phases. The agencies issue Phase I MS4 permits to groups of co-permittees encompassing an entire metropolitan area. The SWRCB adopted the Phase II MS4 General Permit (SWRCB Water Quality Order No. 2013-0001-DWQ, NPDES No. CAS000004) to provide NPDES permit coverage to municipalities not covered under the NPDES Phase I Rule (i.e., small MS4s generally for fewer than 100,000 people). The Central Valley Wye lies within jurisdiction of the Phase II NPDES Program. The Authority requested designation as a non-traditional permittee of the Phase II Small Separate Storm Water (MS4) permit (Order No. 2013-0001-DWQ; SWRCB 2014); the permit became effective on August 22, 2014. This order is the only MS4 permit for which the Authority has obtained coverage as a nontraditional discharge. The

Authority's MS4 permit replaces city-specific MS4 permits, which would otherwise be applicable to the Central Valley Wye. The Central Valley RWQCB is currently working with Phase I and II permittees to develop a region-wide MS4 permit that could include both Phase I and II MS4 permittees in the Central Valley region. Low-impact development (LID) design standards and a post construction stormwater management program are required under the MS4 permit. The region-wide MS4 permit would promote greater watershed and drainage area coordination, water quality measure protections, and program implementation efficiencies. The MS4 permits require the discharger to develop and implement a stormwater management program, further discussed in the following section.

3.1.1.10 Stormwater Management Programs (Updated since the Merced to Fresno Final EIR/EIS)

As part of NPDES Phase I MS4 permit compliance, municipalities implement stormwater management programs to limit to the maximum extent practicable the discharge of pollutants from storm sewer systems. A single state agency or a coalition, often consisting of more than one municipality (such as cities and counties) may implement these programs. Each program includes BMPs intended to reduce the quantity and improve the quality of stormwater discharged to the stormwater system. Discharges to storm sewer systems must comply with the stormwater management program requirements.

The following stormwater management program is relevant to watersheds within the Central Valley Wye alternatives' footprints:

- Merced Storm Water Group (cities of Atwater and Merced, Merced County, and the Merced Irrigation District Storm Water Management Program) (MSWG 2007).

Stormwater discharges in the cities of Atwater, Merced, and Chowchilla; Merced and Madera Counties; and the Merced Irrigation District are permitted under Phase II Small MS4 General Permit Number CAS000004, Water Quality Order No. 2013-0001-DWQ (MSWG 2007).

In accordance with NPDES permit obligations, Merced Storm Water Group have prepared a Storm Water Management Program that outlines BMPs that the cities of Atwater and Merced, Merced County, Merced Irrigation District and other co-permittees implement to reduce the quantity of stormwater and to prevent the discharge of pollutants in stormwater (MSWG 2007). Merced County and the city of Chowchilla implement the *Madera County Storm Water Management Plan* (Madera County 2013).

The stormwater management programs and plans identify six BMP measures that are necessary for effectively managing stormwater. These BMPs include tasks relating to public education and outreach, public involvement and participation, illicit discharge detection, construction site stormwater runoff management, post-construction runoff controls in new and redevelopments, and pollution prevention for municipal operations (MSWG 2007; Madera County 2013).

3.1.2 Sections 9 and 10 of the Rivers and Harbors Act (33 U.S.C. § 401 et seq.)

The Rivers and Harbors Act is a primary federal law regulating activities that may affect navigation on the nation's waterways. Sections 9 and 10 of the Rivers and Harbors Act grant USACE control over obstructions to navigable waters of the U.S. Section 9 outlines the requirements for approval to build dams, dikes, bridges, or causeways in a navigable waterway. Section 10 gives the USACE exclusive authority to approve construction of smaller structures, such as wharves, booms, and bulkheads, as well as to approve dredging and filling operations.

3.1.3 Section 14 of the Rivers and Harbors Act (33 U.S.C. § 408)

Section 14 of the Rivers and Harbors Act requires USACE permission for the use, including modifications or alterations, of any flood control facility work built by the United States to avoid impairing the usefulness of the federal facility. The USACE is to grant permission for occupation or use by an appropriate real estate instrument in accordance with existing real estate regulations. The USACE grants permission through the issuance of a Section 408 permit.

3.1.4 Local Flood Protection Works; Maintenance and Operation of Structures and Facilities (33 C.F.R. § 208.10a)

33 Code of Federal Regulations (C.F.R.) Part 208.10a(5) addresses relatively minor, low impact modifications to locally or federally maintained USACE projects, including modifications to pipes, roads, and similar infrastructure that do not adversely affect the functioning of the project and flood protection measures. Part 208.10 requires that construction of improvements, including crossings, do not reduce the capacity of a channel within a federal flood control project. A Part 208.10 permission from the USACE would be required where the Central Valley Wye crosses the right-of-way of a federal flood control facility or interferes with its operations or maintenance without changing the system's structural geometry or hydraulic capacity.

3.1.5 Floodplain Management (USEO 11988) (Updated since the Merced to Fresno Final EIR/EIS)

U.S. Presidential Executive Order (USEO) 11988 of May 24, 1977, requires executive departments and agencies to avoid, to the extent possible, the long- and short-term adverse effects associated with the occupancy and modification of floodplains and to avoid, to the extent possible, the long- and short-term adverse effects associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative. U.S. Department of Transportation Order 5650.2 contains policies and procedures for the transportation agencies to implement USEO 11988 on transportation projects. On January 30, 2015, the President issued USEO 13690, which amended USEO 11988. Amendments include requiring federal agencies to use, where possible, natural systems, ecosystem processes, and nature-based approaches when identifying alternatives for locating development in floodplains; and an option of establishing a floodplain based on a climate-informed approach. The amended USEO 11988 requirements are included, where applicable, to address impacts related to floodplains and flood risks.

The Lower San Joaquin River Levee District is responsible for maintaining and operating the Eastside Bypass levees. Madera County Flood Control and Water Conservation District is responsible for the levees at Ash Slough and Berenda Slough. The USACE has listed the San Joaquin River, Eastside Bypass, Ash Slough, Berenda Slough, and Chowchilla River levees in their Levee Safety Program. The Levee Safety Program assures safety and reduces flood risk of our nation's levee systems. As a local sponsor, the California Department of Water Resources (DWR) receives funding for the operation and maintenance of these levees. The Central Valley Flood Protection Board (CVFPB) categorized the Eastside Bypass levee as a medium concern for overall physical condition. Medium concern factors include inadequate levee freeboard, inadequate levee geometry, structural instability, and excessive seepage, as well as inadequate channel capacity to convey design flows.

3.1.6 National Flood Insurance Act (42 U.S.C. § 4001 et seq.)

The purpose of the National Flood Insurance Act is to identify flood-prone areas and provide insurance. The act requires purchase of insurance for buildings in special flood-hazard areas (SFHA). The act is applicable to any federally assisted acquisition or construction projects in an area identified as having special flood hazards. Projects should avoid construction in, or develop a design to be consistent with, the Federal Emergency Management Agency- (FEMA) identified flood-hazard areas.

3.1.7 Floodplain Management and Protection (U.S. Department of Transportation Order 5650.2) and Flood Disaster Protection Act (42 U.S.C. §§ 4001–4128)

The Flood Disaster Protection Act requires landowners to purchase of insurance for buildings in SFHAs identified and mapped by FEMA. If a project is proposed within a floodplain, an analysis and discussion prepared for the development permit would identify any risk to, or resulting from, the action; the effects on natural and beneficial floodplain values; the degree to which the action

provides direct or indirect support for development in the floodplain; and measures to minimize harm or to restore or preserve the natural and beneficial floodplain values affected by the project.

3.2 State

3.2.1 Porter-Cologne Water Quality Control Act (Cal. Water Code § 13000 et seq.)

The Porter-Cologne Water Quality Control Act requires the regulation of all pollutant discharges, including wastes in project runoff that could affect the quality of the state's water. Any entity proposing to discharge a waste must file a Report of Waste Discharge with the appropriate RWQCB or SWRCB. The RWQCBs are responsible for implementing CWA sections 401, 402, and 303(d). Because the HSR project is a project of statewide importance, the Authority would file any Reports of Waste Discharge with SWRCB. The act also provides for the development and periodic reviews of basin plans that designate beneficial uses of California's major rivers and groundwater basins and establish water quality objectives for those waters.

The Porter-Cologne Water Quality Control Act established the RWQCBs. The Central Valley Wye area lies within the boundary of the Central Valley RWQCB, which makes water quality decisions for the region. Its responsibilities include setting water quality standards for surface waters and groundwater, implementing the NPDES program, issuing waste discharge requirements, determining compliance with those requirements, and taking appropriate enforcement actions.

The SWRCB and RWQCBs are the principal agencies with responsibility for the coordination and control of water quality under this act. The SWRCB allocates water rights, adjudicates water rights disputes, develops statewide water protection plans, establishes water quality standards, and with the nine regional RWQCBs guides policy in the major watersheds of the state.

3.2.2 Streambed Alteration Agreement (Cal. Fish and Game Code §§ 1601–1603)

The California Fish and Game Code requires the Authority to notify the California Department of Fish and Wildlife prior to implementing any HSR project that would divert, obstruct, or change the natural flow or bed, channel, or bank of any river, stream (including intermittent streams), or lake. If the California Department of Fish and Wildlife determines that a project may substantially adversely affect fish and wildlife resources, they would prepare a lake or streambed alteration agreement. The agreement includes reasonable conditions necessary to protect those resources and must comply with the California Environmental Quality Act. The agency may proceed with the project in accordance with a final agreement.

3.2.3 Colbey-Alquist Floodplain Management Act (Cal. Water Code § 8400 et seq.)

The Colbey-Alquist Flood Plain Management Act encourages local governments to adopt and enforce land use regulations to accomplish floodplain management. The act also provides state assistance and guidance for flood control.

3.2.4 Central Valley Flood Protection Board (Cal. Code Regs., tit. 23, § 1)

The Central Valley Flood Protection Board (CVFPB) exercises regulatory authority within its jurisdiction to maintain the integrity of the existing flood control system and designated floodways by issuing permits for encroachments. The CVFPB has mapped designated floodways along more than 60 streams and rivers in the Central Valley. In addition, Table 8.1 of the California Code of Regulations, title 23, division 1 contains several hundred stream reaches and waterways that are regulated streams. Projects that encroach within a designated floodway or regulated stream, or within 10 feet of the toe of a state–federal flood control structure (levee), require an encroachment permit. To obtain an encroachment permit, project proponents must submit an application, including an environmental assessment questionnaire and demonstrate the project would not reduce the channel flow capacity and that it would comply with channel and levee safety requirements.

In cooperation with USACE, the CVFPB enforces standards for the construction, maintenance, and protection of adopted flood control plans that would protect public lands from floods. The jurisdiction of the CVFPB includes the Central Valley, including all tributaries and distributaries of the Sacramento River, the San Joaquin River, and designated floodways (Cal. Code Regs., tit. 23, § 2). The CVFPB has all the responsibilities and authorities necessary to oversee future modifications as approved by USACE pursuant to assurance agreements with USACE and the USACE Operation and Maintenance Manuals under 33 C.F.R. Part 208.10 and Title 33 United States Code section 408.

The CVFPB does not allow work activities, such as excavation, cut-and-fill construction, and obstruction within the floodway and on levees adjacent to a regulated stream during the flood season, as defined in California Code of Regulations, title 23, division 1. The flood season, as defined by the CVFPB for floodways, is November 1 through July 15. The CVFPB grants exemptions to this time restriction if it determines that forecasts for weather or river flood conditions are favorable. The CVFPB permits uses that do not impede the free flow in the floodway or jeopardize public safety within a designated floodway. These permitted uses include structures that do not impede flows and are anchored to prevent the structure from floating; roads, pipelines, fences, and walls that do not obstruct flood flows; storage yards for equipment and materials that are securely anchored or can be removed upon notice.

3.2.5 Central Valley Flood Protection Act (Cal. Water Code § 9600 et seq.; Updated since the Merced to Fresno Final EIR/EIS)

The Central Valley Flood Protection Act establishes the 200-year flood event as the minimum level of flood protection for urban and urbanizing areas. DWR and CVFPB collaborated with local governments and planning agencies to prepare the *2012 Central Valley Flood Protection Plan*, which the CVFPB adopted on June 29, 2012 (DWR 2012a: pages 1-24 to 1-26). The objective of the *2012 Central Valley Flood Protection Plan* is to create a systemwide approach to flood management and protection improvements for the Central Valley and San Joaquin Valley.

3.2.6 Sustainable Groundwater Management Act (Cal. Water Code §§ 113, 10720, 10750.1, 10927, 10933, 12924; new since the Merced to Fresno Final EIR/EIS)

On September 16, 2014, Governor Edmund G. Brown Jr. signed legislation to strengthen local management and monitoring of groundwater basins. It establishes requirements for locally controlled groundwater sustainability agencies to adopt groundwater sustainability plans for high- and medium-priority basins, depending on whether or not a basin is in critical overdraft. The Sustainable Groundwater Management Act established a new structure for managing groundwater resources at a local level by local agencies. It requires, by June 30, 2017, the formation of locally-controlled groundwater sustainability agencies in the state's high- and medium-priority groundwater basins and subbasins. The act phases adoption of groundwater sustainability plans. Plans are due by January 31, 2020 for all high- or medium-priority basins in overdraft condition and by January 31, 2022 for all other high- and medium-priority basins unless the basin is legally adjudicated or otherwise managed sustainably.

3.3 Regional and Local

This section discusses regional and local programs, policies, regulations and permitting requirements. Cities and counties within the Central Valley Wye vicinity, as well as regional agencies, have developed ordinances, policies, and other regulatory mechanisms, which will minimize negative effects during a project's construction and operations.

3.3.1 Dewatering Activities: Regulation by Regional Water Quality Control Board (Updated since the Merced to Fresno Final EIR/EIS)

Care is required for the removal of nuisance water from a construction site (known as dewatering) because of the high turbidity and other pollutants potentially associated with this activity. The Central Valley RWQCB's Order No. R5-2013-0074 (NPDES No. CAG95001),

Waste Discharge Requirements General Order for Dewatering and Other Low-Threat Discharges to Surface Waters (General Dewatering Permit), updates the regulation of discharges to surface water from dewatering activities. The SWRCB's Order No. 2003-0003-DWQ, General Waste Discharge Requirements for Discharges to Land with a Low Threat to Water Quality (Low Threat Discharge Permit), as updated by Resolution No. R5-2013-0145, Approving Waiver of Reports of Waste Discharge and Waste Discharge Requirements for Specific Types of Discharge within the Central Valley Region, continues to cover discharges to land from dewatering activities.

3.3.2 General Plan Policies and Ordinances

Table 3-1 summarizes local and regional laws and regulations that were identified and considered in preparation of this analysis.

Table 3-1 Local and Regional Laws and Regulations

Policy Title	Summary
Merced County	
2030 Merced County General Plan Public Facilities and Services Element (2013)	Goal PFS-3: Ensure the management of stormwater in a safe and environmentally sensitive manner through the provision of adequate storm drainage facilities that protect people, property, and the environment. ▪ Policy PFS-3.1: Stormwater Management Plans (MPSP)—Require stormwater management plans for all Urban Communities to reduce flood risk, protect soils from erosion, control stormwater runoff, and minimize effects on existing drainage facilities. ▪ Policy PFS-3.2: Stormwater Facilities in New Development (RDR/MPSP)—Require that new development in unincorporated communities includes adequate stormwater drainage systems. This includes adequate capture, transport, and detention/retention of stormwater. ▪ Policy PFS-3.3: Community Drainage Systems (MPSP/SO)—Encourage development of community drainage systems rather than individual project level systems, in order to use land more efficiently and protect people, property and the environment in a more comprehensive manner. ▪ Policy PFS-3.4: Agency Coordination (IGC)—Coordinate with the U.S. Army Corps of Engineers and other appropriate agencies to develop stormwater detention/retention facilities and recharge facilities that enhance flood protection and improve groundwater recharge. ▪ Policy PFS-3.5: Pre-Development Storm Flows (MPSP)—Require on-site detention/retention facilities and velocity reducers when necessary to maintain pre-development storm flows and velocities in natural drainage systems. ▪ Policy PFS-3.6: Retention/Detention Facility (RDR/MPSP)—Encourage stormwater detention/retention project designs that minimize drainage concentrations and impervious coverage, avoid floodplain areas, are visually unobtrusive and, where feasible, provide a natural watercourse appearance and a secondary use, such as recreation.

Policy Title	Summary
2030 Merced County General Plan, Natural Resources Element (2013)	Goal NR-1: Preserve and protect, through coordination with the public and private sectors, the biological resources of the County. ▪ Policy NR-1.1: Habitat Protection (RDR/PSR)—Identify areas that have significant long-term habitat and wetland values including riparian corridors, wetlands, grasslands, rivers and waterways, oak woodlands, vernal pools, and wildlife movement and migration corridors, and provide information to landowners. ▪ Policy NR-1.2: Protected Natural Lands (RDR/PSR)—Identify and support methods to increase the acreage of protected natural lands and special habitats, including but not limited to, wetlands, grasslands, vernal pools, and wildlife movement and migration corridors, potentially through the use of conservation easements. ▪ Policy NR-1.4: Important Vegetative Resource Protection (SO)—Minimize the removal of vegetative resources which stabilize slopes, reduce surface water runoff, erosion, and sedimentation. ▪ Policy NR-1.5: Wetland and Riparian Habitat Buffer (PSR/RDR)—Identify wetlands and riparian habitat areas and designate a buffer zone around each area sufficient to protect them from degradation, encroachment, or loss. ▪ Policy NR-1.10: Aquatic and Waterfowl Habitat Protection (MPSP)—Cooperate with local, State, and Federal water agencies in their efforts to protect significant aquatic and waterfowl habitats against excessive water withdrawals or other activities that would endanger or interrupt normal migratory patterns or aquatic habitats. ▪ Policy NR-1.11: On-Going Habitat Protection and Monitoring (PSR)—Cooperate with local, State, and Federal agencies to ensure that adequate on-going protection and monitoring occurs adjacent to rare and endangered species habitats or within identified significant wetlands. ▪ Policy NR-1.12: Wetland Avoidance (RDR/PSR/MPSP)—Avoid or minimize loss of existing wetland resources by careful placement and construction of any necessary new public utilities and facilities, including roads, railroads, high speed rail, sewage disposal ponds, gas lines, electrical lines, and water/wastewater systems. ▪ Policy NR-1.13: Wetland Setbacks (RDR)—Require an appropriate setback, to be determined during the development review process, for development and agricultural uses from the delineated edges of wetlands. ▪ Policy NR-1.14: Temporary Residential Uses (RDR)—Ensure that buildings and structures approved for temporary residential use in significant wetland areas are not converted to permanent residential uses. ▪ Policy NR-1.16: Hazardous Waste Residual Repository Location (RDR)—Require new hazardous waste residual repositories (e.g., contaminated soil facilities) to be located at least a mile from significant wetlands, designated sensitive species habitat, and State and Federal wildlife refuges and management areas. ▪ Policy NR-1.17: Agency Coordination (MPSP/IGC/JP)—Consult with private, local, State, and Federal agencies to assist in the protection of biological resources and prevention of degradation, encroachment, or loss of resources managed by these agencies.

Policy Title	Summary
	▪ Policy NR-1.18: San Joaquin River Restoration Program Support (MPSP/SO)—Monitor the San Joaquin River Restoration Program efforts to ensure protection of landowners, local water agencies, and other third parties. ▪ Policy NR-1.19: Merced River Restoration Program Support (MPSP/SO)—Support the restoration efforts for the Merced River consistent with the Merced River Corridor Restoration Plan.
2030 Merced County General Plan, Health and Safety Element (2013)	Goal HS-2: Minimize the possibility of loss of life, injury, or damage to property as a result of flood hazards. ▪ Policy HS-2.1: Floodplain Management Priorities (RDR/MPSP)—Prepare and adopt a floodplain management program in flood hazard areas that gives priority to regulation of land uses over development of structural controls as a method of reducing flood damage. ▪ Policy HS-2.2: Countywide Flood Emergency Plan (RDR/MPSP)—Coordinate with the cities in Merced County to develop a Countywide flood emergency plan that is consistent with city general plans. ▪ Policy HS-2.3: Countywide Flood Control Authority (MPSP/IGC)—Work with the cities in Merced County to establish a Countywide flood control authority to coordinate efforts and develop opportunities for expanded Federal funding. ▪ Policy HS-2.4: Coordination to Improve Flood Control (FB/IGC)—Coordinate with State and local flood management agencies to develop funding mechanisms to finance the design and construction of flood facilities. ▪ Policy HS-2.5: Flood Control Project Funding (FB)—Support the efforts of local districts and communities in obtaining funding for local flood control projects. ▪ Policy HS-2.6: Flood Risk Consideration (RDR)—Prohibit new development in existing undeveloped areas (i.e., area devoted to agriculture or open space that is not designated for development) protected by a State flood control project without appropriately considering significant known flooding risks and taking reasonable and feasible action to mitigate the potential property damage to the new development resulting from a flood. ▪ Policy HS-2.7: Finding of Flood Protection for New Development (RDR)—The County shall not enter into a development agreement, approve any building permit or entitlement, or approve a tentative or parcel map unless it finds one of the following: a) The flood control facilities provide 200-year level of protection in urban and non-urban areas consistent with the current Central Valley Flood Protection Plan; b) Conditions imposed on the development will protect the property at a 200-year level of protection in urban and non-urban areas consistent with the current Central Valley Flood Protection Plan; or c) The local flood management agency has made "adequate progress" on the construction of a flood protection system which will result in protection equal or greater than the 200-year flood event in urban and non-urban areas consistent with the current Central Valley Flood Protection Plan. ▪ Policy HS-2.8: Floodwater Diversion (RDR)—Require new flood control projects or developments within areas subject to 100- and

Policy Title	Summary
	200-year frequency floods are done in a manner that will not cause floodwaters to be diverted onto adjacent property or increase flood hazards to property located elsewhere. ▪ Policy HS-2.9: Minimize Public Facility Impacts (RDR/MPSP)—Encourage all agencies that operate public facilities, such as roads, structures, wastewater treatment plants, gas, electrical, and water systems within areas subject to 100- and 200-year frequency floods to locate and construct facilities to minimize or eliminate potential flood damage. ▪ Policy HS-2.10: Essential Facility Location (RDR)—Prohibit the construction of essential facilities (including hospitals, healthcare facilities, emergency shelters, fire stations, emergency command centers, and emergency communications facilities) in the 100- and 200-year floodplain, unless it can be demonstrated that the structural and operational integrity of the facility can be maintained during flood events. ▪ Policy HS-2.11: National Flood Insurance Program (SO)—Continue to participate in the National Flood Insurance Program (NFIP). ▪ Policy HS-2.12: Relocation Assistance (IGC)—Support State and local flood management agencies to provide relocation assistance or other cost-effective strategies for reducing flood risk to existing economically disadvantaged communities located in non-urbanized areas. ▪ Policy HS-2.13: Open Space Use (RDR)—Encourage open space uses in flood hazard areas. ▪ Policy HS-2.14: Multipurpose Flood Control Projects (RDR)—Encourage multipurpose flood control projects that incorporate recreation, resource conservation, preservation of natural riparian habitat, and scenic values of the County's streams, creeks, and lakes. ▪ Policy HS-2.15: Flood Control Design (RDR)—Encourage flood control designs that respect the natural topography and vegetation of waterways while retaining dynamic flow and functional integrity. ▪ Policy HS-2.16: Adapting Infrastructure to Climate Change (RDR/MPSP)—Encourage increased stormwater and flood protection infrastructure capacity in order to accommodate changes in precipitation and extreme weather events. ▪ Policy HS-2.17: Flood Control Facility Construction (RDR)—Permit the construction of County flood control facilities in existing developments located within flood hazard areas to proceed only after a complete review of the environmental effects and project costs and benefits. ▪ Policy HS-2.18: Public Awareness Programs (PI)—Prepare public awareness programs to inform the general public and potentially affected property owners of flood hazards, potential dam failure inundation, and evacuation plans. ▪ Policy HS-2.19: Mutual Aid Resource (RDR)—Coordinate and use mutual aid resources to augment local resources in order to perform rescue operations, secure utilities and inundated areas, and control traffic in event of dam failure.

Policy Title	Summary
Merced County Ordinances	Merced County Code of Ordinances, Title 16 Building and Construction, Chapter 16.16 Building Code, Section 16.16.010 International Building Code adopted: The International Building Code, 2006 Edition, the Standards referenced in Chapter 35 and all Appendix Chapters, as adopted by the International Code Council, and California State Amendments to the code, are hereby adopted by reference and, except as herein otherwise provided, are applicable to and shall cover all construction within the unincorporated area of the county of Merced. Merced County Code of Ordinances, Title 18 Zoning, Chapter 18.41 Performance Standards, Section 18.41.030 Dust: • No urban land use shall create dust, dirt or mud, which leaves the boundaries of the project site. Implementation of the following measures shall help to reduce generation of dust, dirt or mud: – Schedule all grading activities to ensure that repeated grading will not be necessary. If a construction site has been disturbed (cleared, graded or excavated) and is to remain inactive for a period of three or more months, it shall be seeded with an annual grass and watered until growth is evident. If after disturbing, the site is inactive for three or more months during the dry period (June–October), as an alternative to seeding, a soil binding dust palliative, such as Hemicellulose extract (wood molasses) solution, may be applied. If seeded, grass shall be mowed (not disked under) to a maximum height of four inches for fire control. Grasses do not need to be maintained in a green/growing condition. Mowing should occur before the grass dries out to avoid fires that may result from blades striking rocks. • During clearing, grading, earth moving and other site preparation activities and all construction: – Exposed earth surfaces shall be watered as needed, whenever needed, in order to prevent dust from leaving the project site on that phase of the project presently under development. – Mud and dirt carried from the development onto adjacent roadways shall be cleaned up daily. Litter and debris shall be cleaned up daily to prevent it from leaving the project site and littering adjacent properties.
Madera County	
Madera County General Plan, Visual and Scenic Resources (1995)	Goal 1.H: To protect the visual and scenic resources of Madera County as important quality-of-life amenities for county residents and a principal asset in the promotion of recreation and tourism. ▪ Policy 1.H.2: The County shall require that new development incorporates sound soil conservation practices and minimizes land alterations. Land alterations should comply with the following guidelines: – Limit cuts and fills; – Limit grading to the smallest practical area of land; – Limit land exposure to the shortest practical amount of time; – Replant graded areas to ensure establishment of plant cover before the next rainy season;

Policy Title	Summary
	– Create grading contours that blend with the natural contours on-site or look like contours that would naturally occur; and – Prohibit overgrazing. ▪ Policy 1.H.3.c: Development in hillside areas will employ erosion and sediment control measures.
Madera County General Plan, Water Supply and Delivery (1995)	Goal 3.C: To ensure the availability of an adequate and safe water supply and the maintenance of high quality water in waterbodies and aquifers used as sources of domestic and agricultural water supply. ▪ Policy 3.C.3: The County shall limit development in areas identified as having severe water table depression to uses that do not have high water usage or to uses served by a surface water supply. ▪ Policy 3.C.5: The County shall require that new development adjacent to bodies of water used as domestic water sources adequately mitigate potential water quality impacts on these waterbodies.
Madera County General Plan, Storm Drainage and Flood Control (1995)	Goal 3.E: To provide efficient, cost-effective, and environmentally-sound storm drainage and flood-control facilities. ▪ Policy 3.E.2: The County shall require new development to provide protection from the 100- year flood as a minimum. ▪ Policy 3.E.5: The County shall encourage project designs that minimize drainage concentrations and impervious coverage and maintain, to the extent feasible, natural site drainage conditions. ▪ Policy 3.E.6: Future drainage system discharges shall comply with applicable state and federal pollutant discharge requirements. ▪ Policy 3.E.7: The County shall encourage the use of natural stormwater drainage systems to preserve and enhance natural features.
Madera County General Plan, Water Resources (1995)	Goal 5.C: To protect and enhance the natural qualities of Madera County's streams, creeks and groundwater. ▪ Policy 5.C.1: The County shall protect preserve areas with prime percolation capabilities and minimize placement of potential sources of pollution in-such areas. ▪ Policy 5.C.2: The County shall minimize sedimentation and erosion through control of grading, cutting of trees, removal of vegetation, placement of roads and bridges, and use of off-road vehicles. The County shall discourage grading activities during the rainy season, unless adequately mitigated, to avoid sedimentation of creeks and damage to riparian habitat. ▪ Policy 5.C.3: The County shall require new development of facilities near rivers, creeks, reservoirs, or substantial aquifer recharge areas to mitigate any potential impacts of release of pollutants in flood waters, flowing river, stream, creek, or reservoir waters. ▪ Policy 5.C.4: The County shall require the use of feasible and practical best management practices (BMPs) to protect streams from the adverse effects of construction activities, and shall encourage the urban storm drainage systems and agricultural activities to use BMPs.

Policy Title	Summary
	▪ Policy 5.C.6: The County shall require that natural watercourses are integrated into new development in such a way that they are accessible to the public and provide a positive visual element ▪ Policy 5.C.8: The County shall support the policies of the-San Joaquin River Parkway Plan to protect the San Joaquin River as an aquatic habitat and a water source.
Madera County General Plan, Open Space for the Preservation of Natural Resources (1995)	Goal 5.H: To preserve and enhance open space lands to maintain the natural resources of the county. ▪ Policy 5.H.1: The County shall support the preservation and enhancement of natural land forms, natural vegetation, and natural resources as open space. To the extent feasible, the County shall permanently protect as open space areas of natural resource value, including wetlands preserves, riparian corridors, woodlands, and floodplains. ▪ Policy 5.H.2: The County shall require that new development be designed and constructed to preserve the following types of areas and features as open space to the maximum extent feasible: – High erosion hazard areas; – Scenic and trail corridors; – Streams and streamside vegetation; – Wetlands; – Other significant stands of vegetation; – Wildlife corridors; and – Any areas of special ecological significance.
Madera County General Plan, Flood Hazards (1995)	Goal 6.B: To minimize the risk of loss of life, injury, damage to property, and economic and social dislocations resulting from flood hazards. ▪ Policy 6.B.1: The County shall require flood-proofing of structures in areas subject to flooding. ▪ Policy 6.B.3: The County shall restrict uses in designated floodways to those that are tolerant of occasional flooding and do not restrict or alter flow of flood waters. Such uses may include agriculture, outdoor recreation, mineral extraction, and natural resource areas. ▪ Policy 6.B.4: The County shall require that all development within areas subject to 100-year floods be designed and constructed in a manner that will not cause floodwaters to be diverted onto adjacent property or increase flood hazards to other areas.
Madera County Ordinances	Madera County Code of Ordinances, Title 14 Buildings and Construction, Chapter 14.50 Grading and Erosion Control requirements: Section 14.50.030 Requirements It is unlawful for any person, firm, corporation, local public agency or any political subdivision of the state of California to do, or cause to be done, any of the following without having first secured a permit from the county engineer: A. Any leveling, grading or moving of earth that will change or obstruct natural or built drainage channels or change the natural course of water flow; B. Any change of drainage that diverts water flow to a public road; C. Any placing of fill or obstructions in a drainage ditch, watercourse, channel or conduit carrying storm or drainage water;

Policy Title	Summary
	D. Placing of fill or excavated material in such a manner that it would become subject to excessive erosion; E. Any leveling of land which would cause flooding of adjacent properties or public roadways; F. Removal of natural vegetation or disturbance of the soil, except for cultivation of crops, where the area exceeds fifteen thousand square feet; G. Excavating and grading for buildings and other development as provided for under Chapter 70, Uniform Building Code; H. Excavation and grading for roads on private property. Section 14.50.050 Permit Application A. Application for Permit. Each application for a permit that is required by this chapter shall be made by the property owner or the authorized agent to the county engineer on a form furnished for that purpose. B. Applications for permit shall include the following information where applicable: 1. An accurate plot plan showing the exterior boundaries of the area affected and the location of any buildings or improvements; 2. A description of the work to be done together with the materials to be used therefor; 3. A description and location of the pattern of drainage to and from the site, the location of culverts and natural watercourses and the directions of flow; 4. The relocation plan for any existing waterway or drainage facility proposed to be altered; Details of any proposed drainage structures; 5. An erosion and sediment control plan including a time frame for implementation. C. Where the complexity of the project requires additional information, the following additional information may be required: 1. Drainage flow computations giving volume of runoff to and from the site; Present and proposed contours for the site; 2. Soils information describing type, depth, erodibility and capability for establishing vegetation. D. Applications shall conform to land use regulations as required by Title 18 (Zoning), of the Madera County Code. Section 14.50.080 Drainage and erosion control requirements A. Sediment Control. Sediment shall be retained on the site. Sediment basins, sediment traps, or similar sediment control measures shall be installed at the time of clearing and grading operations. B. Native vegetation shall be retained, protected and supplemented wherever possible. When vegetation must be removed, the method shall be one that will minimize the erosive effects from the removal. Exposure of soil to erosion by removing vegetation shall be limited to the area required for immediate construction operations. C. Grading operations shall be conducted so as to prevent damaging effects of sediment production on the site and on adjoining properties.

Policy Title	Summary
	Operations should be conducted during the period of May 1st through November 30th as much as possible. During the period of December 1st through April 30th, more stringent controls may be required. D. Control of Runoff. Provisions shall be made to control the increased runoff caused by changed soil and surface conditions during and after development. To prevent excess runoff, the rate of surface water runoff shall be structurally retarded through use of sediment basins, silt traps or similar measures. E. Slope Construction. Cuts shall be no steeper than 1:1 and fills shall be no steeper than 1½:1 unless soil conditions indicate a different slope is necessary for stability. Erosion control measures shall be specified to provide stabilization. Slopes shall not be constructed so as to endanger or disturb adjoining property. F. Slope Stabilization. Earth or paved interceptors and diversions shall be installed at the top of cut or fill slopes where there is a potential for surface runoff. Temporary mulching, seeding, or other suitable stabilization measures shall be used to protect exposed critical areas during construction or other land disturbance. G. Structural Protection. Retaining walls shall be designed to retain steep embankments. Slope stabilization using flexible or rigid paving materials and channel lining are all acceptable methods of providing erosion and drainage control when designed according to good civil engineering practice and standards. H. Grading. All land within a development shall be graded to drain and dispose of surface water. Where drainage swales are used to divert water they shall be vegetated or protected with rock, paving or other approved methods to prevent erosion. I. Protection of Watercourses. Fills placed against watercourses shall have suitable protection against erosion during flooding. Excavated materials shall not be deposited or stored in or alongside any river or watercourse where the materials so deposited are likely to be washed away by high water or storm runoff. J. Disposal of Cleared Vegetation. Vegetation removed during clearing operations shall be disposed of as follows: 1. Chipping all or some of the cleared vegetation for use as mulch or compost on the site; 2. Burning under fire permit; 3. Removing the material to an approved disposal site; 4. Burying the material on-site except below building sites or parking areas. K. Disposal of Excavated Materials. Excavated materials removed shall be disposed of as follows: 1. Topsoil may be stockpiled on the site for use on areas to be revegetated. Stockpiles shall be located far enough from streams or drainageways so as to insure that surface runoff cannot carry sediment downstream; 2. Backfill and compact soil promptly into trenches and pits to reduce the risk of erosion;

Policy Title	Summary
	3. Apply mulch or protective coverings on stockpiled material which will be exposed to rains; Remove material from the site to an approved location.
City of Chowchilla	
City of Chowchilla 2040 General Plan, Open Space and Conservation Element (2011)	Objective OS 11—Ensure adequate groundwater reserves are maintained for present and future domestic, commercial, and industrial uses. Objective OS 12—Ensure groundwater quality is maintained at a satisfactory level for domestic water consumption.
City of Chowchilla 2040 General Plan, Public Facilities and Services Element (2011)	▪ Policy PF 1.3—Develop and maintain Master Plans for water, wastewater collection and treatment, and storm water collection and disposal which address future growth demands and address public facilities and services including schools in a coordinated and comprehensive manner. ▪ Policy PF 6.1—The City shall condition approval of development projects on the provision of adequate storm drainage improvements. ▪ Policy PF-6.2: The City shall require the extension of storm drains to new areas in accordance with the phasing of a storm drainage master plan ▪ Policy PF 7.1—Natural and manmade channels, detention basins, and other drainage facilities shall be maintained to ensure that their full use and carrying capacity is not impaired. ▪ Policy PF 7.2—Continue to require new development to discharge storm water runoff at volumes no greater than the capacity of any portion of the existing downstream system by utilizing detention or retention or other approved methods, unless the project is providing drainage pursuant to an adopted drainage plan. Implementation Measure PF 7.2.A – Consolidate policies, programs, and standards for flood control and storm drainage in a Storm Drainage ordinance. ▪ Policy PF 7.3—When necessary, require new development to prepare hydrologic studies to assess storm runoff effects on the local drainage system and, if warranted, require new development to provide adequate drainage facilities and to mitigate increases in storm water flows and / or volume to avoid cumulative increases in downstream flows. Implementation Measure PF 7.3.A – Development projects requiring disposal of stormwater into Ash Slough, Berenda Slough, or Chowchilla River shall provide a hydrological assessment of a project's potential effects on the local and regional storm drainage systems, so that the City can determine appropriate mitigation to ensure that system capacity and peak flow restrictions re not exceeded. ▪ Policy PF 7.4—New and redevelopment projects shall prepare and provide to the City appropriate drainage studies that assess project storm runoff effects on the City storm drain system, as well as provide appropriate storm drainage facilities to ensure an increased risk of on- or off-site flooding does not result from project implementation. ▪ Policy PF-7.5—All drainage improvements shall comply with the City of Chowchilla Public Works Construction Standards.

Policy Title	Summary
City of Chowchilla 2040 General Plan, Public Safety Element (2011)	▪ Policy PS 2.2—Development of urban uses, with the exception of passive recreation use areas and pedestrian / bicycle trails within a floodway or floodplain subject to a 100-year flood event shall be prohibited. Implementation Measure PS 2.2.A – New and redevelopment projects shall provide site plans that identify applicable floodways, floodplains or other potential flood hazards. ▪ Policy PS 2.3—Preserve floodways and floodplains for non-urban uses with the exception of passive or active recreational development may be allowed in a floodplain with appropriate measures that avoid or minimize damage to recreation or structural improvements. Implementation Measure PS 2.3.A – The floodways of Ash and Berenda Sloughs, to the extent feasible, shall be preserved in their natural state, and shall not be channelized or otherwise altered. Floodways should remain undeveloped and allowed to function as natural flood protection features in the City where flood waters are temporary conveyed during storm events. Implementation Measure PS 2.3.B – The floodways of Ash Slough or Berenda Slough are not to be modified to accommodate new or redevelopment projects in the City beyond the installation of storm drain outfalls, utilities or bridges, or to restore floodway capacity, stabilize slough banks or to restore plant or wildlife habitat. ▪ Policy PS 2.4—Ensure that potential flooding impacts, including on-site flood damage, and potential inundation, are adequately addressed through the environmental review process and appropriate mitigation is imposed. Implementation Measure PS 2.4.B – The City of Chowchilla's development review process shall ensure no public or private infrastructure (e.g., bridge), or utility project constructed within a floodway or a 100-year floodplain will compromise the health, safety, and welfare of the City.
City of Chowchilla Code of Ordinances	City of Chowchilla Code of Ordinances, Title 17 Subdivisions, Chapter 17.32 Design and Improvement Standards, Section 17.32.060 Grading Plan requirements state that: A grading plan shall be prepared prior to the acceptance and approval of the final subdivision map. The grading plan shall depict the depth and extent of all excavations and embankments which constitute changes in original grade from that shown on the approved tentative subdivision map. All grades shall conform to the datum used in the city's benchmark system.

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

4 METHODS FOR EVALUATING EFFECTS

4.1 Definition of Resource Study Areas

RSAs are the geographic boundaries in which the environmental investigations specific to each resource topic were conducted. The RSA for effects on hydrology and water resources the project footprint for each of the Central Valley Wye alternatives within the associated watersheds, groundwater basins, and floodplains. The RSA also includes water resources adjoining, adjacent to, or downstream of the footprint that could receive runoff and sediment from the potential area of disturbance. The RSA for hydrology and water resources lies within the southern portion of the San Joaquin River Basin. RSA boundaries vary for surface water, groundwater, and floodplain. Table 4-1 describes these three hydrology and water resources RSAs and includes a general definition and a boundary description for each RSA within the Central Valley Wye.

The surface water RSA covers receiving waters in areas of disturbance from the Central Valley Wye, including waters from the Sierra Nevada foothills that drain to the San Joaquin River Basin, runoff resulting from the Central Valley Wye alternatives, and waterbodies discussed in this analysis (Figure 4-1). The groundwater RSA includes all aquifers underlying the Central Valley Wye alternatives' footprints (Figure 4-2). The floodplain RSA covers the FEMA-designated flood-hazard areas within the Central Valley Wye RSA, as well as any areas where the Central Valley Wye alternatives could affect flood frequency, extent, or duration (Figure 4-3).

Table 4-1 Hydrology and Water Resources Resource Study Area Definitions

Source	General Definition	RSA Boundary
Surface Water		
Construction and Operations	Receiving waters in areas of disturbance including waters from the Sierra Nevada foothills that drain to the San Joaquin River Basin, runoff resulting from the Central Valley Wye alternatives, and waterbodies discussed in this analysis	CalWater watershed boundaries generally defined by 5 miles south of Merced to the north, Madera to the south, 10 miles east of Los Banos to the west, and the Sierra Nevada foothills and reservoirs to the east (Figure 4-1)
Groundwater		
Construction and Operations	Aquifer(s) underlying the Central Valley Wye alternatives' footprints	Entire DWR groundwater basin boundaries of the aquifers underlying the Central Valley Wye alternatives' footprints (Figure 4-2)
Floodplain		
Construction and Operations	FEMA-designated flood-hazard areas within the potential areas of disturbance of the Central Valley Wye alternatives, as well as any areas where the Central Valley Wye could affect flood frequency, extent, and duration	Entire FEMA 100-year and 500-year[1] floodplain boundaries overlapping with the Central Valley Wye alternatives (Figure 4-3)

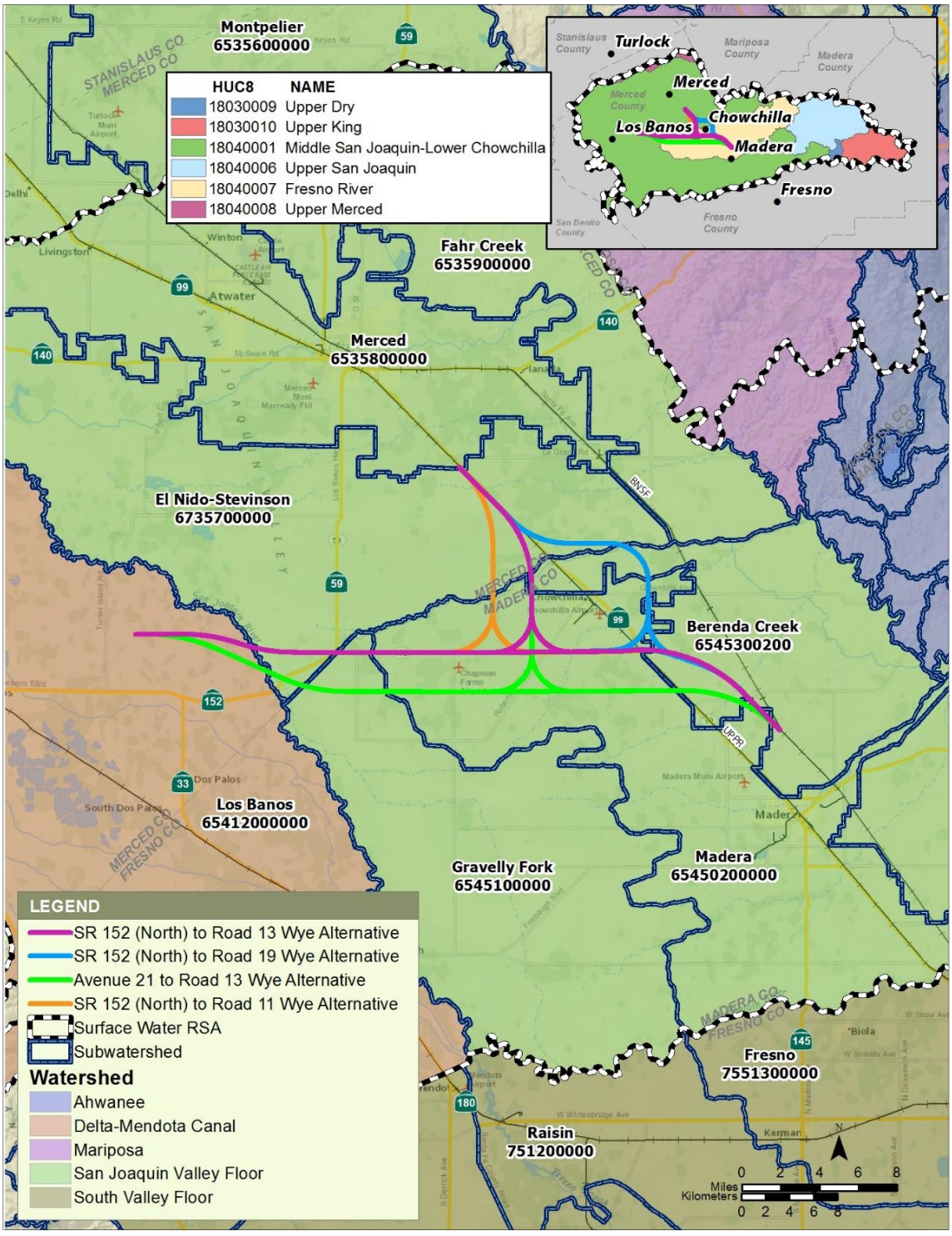
Source: Author compilation, 2016

[1] The 500-year floodplain boundaries include the 200-year floodplain boundaries, which are subject to the state's floodplain management under the Central Valley Flood Protection Act.

RSA = resource study area

CalWater is a state program that provides a standard watershed delineation scheme using the State Water Resources Control Board numbering scheme. CalWater provides a standard watershed delineation scheme using the State Water Resources Control Board numbering scheme. The watershed designation level used for defining the surface water RSA is the Hydrologic Unit Code 8 (HUC 8).

DWR = California Department of Water Resources FEMA = Federal Emergency Management Agency



Source: CalWater, 2007

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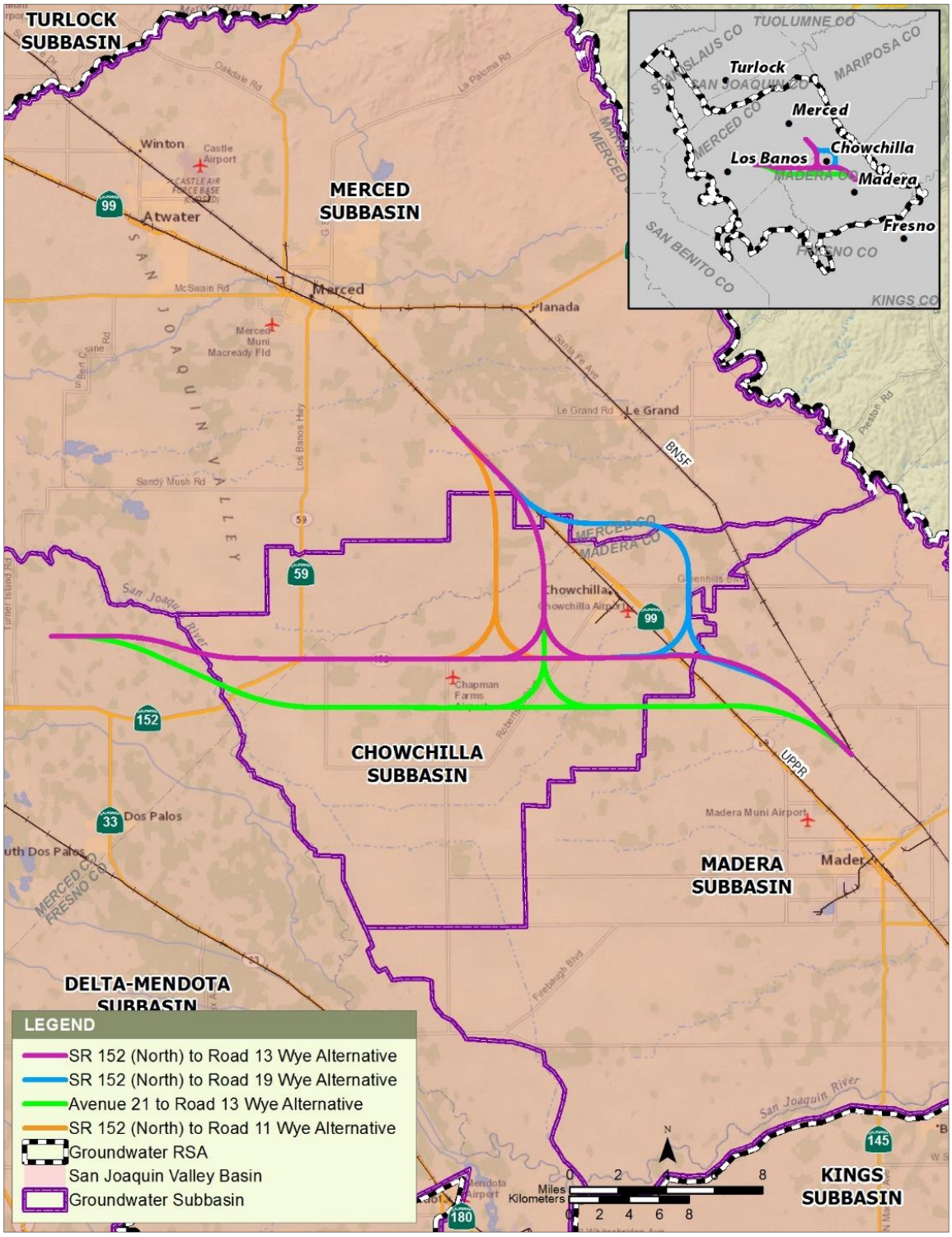
Figure 4-1 San Joaquin River Basin Subwatersheds within the Surface Water Resource Study Area



Source: DWR, 2003

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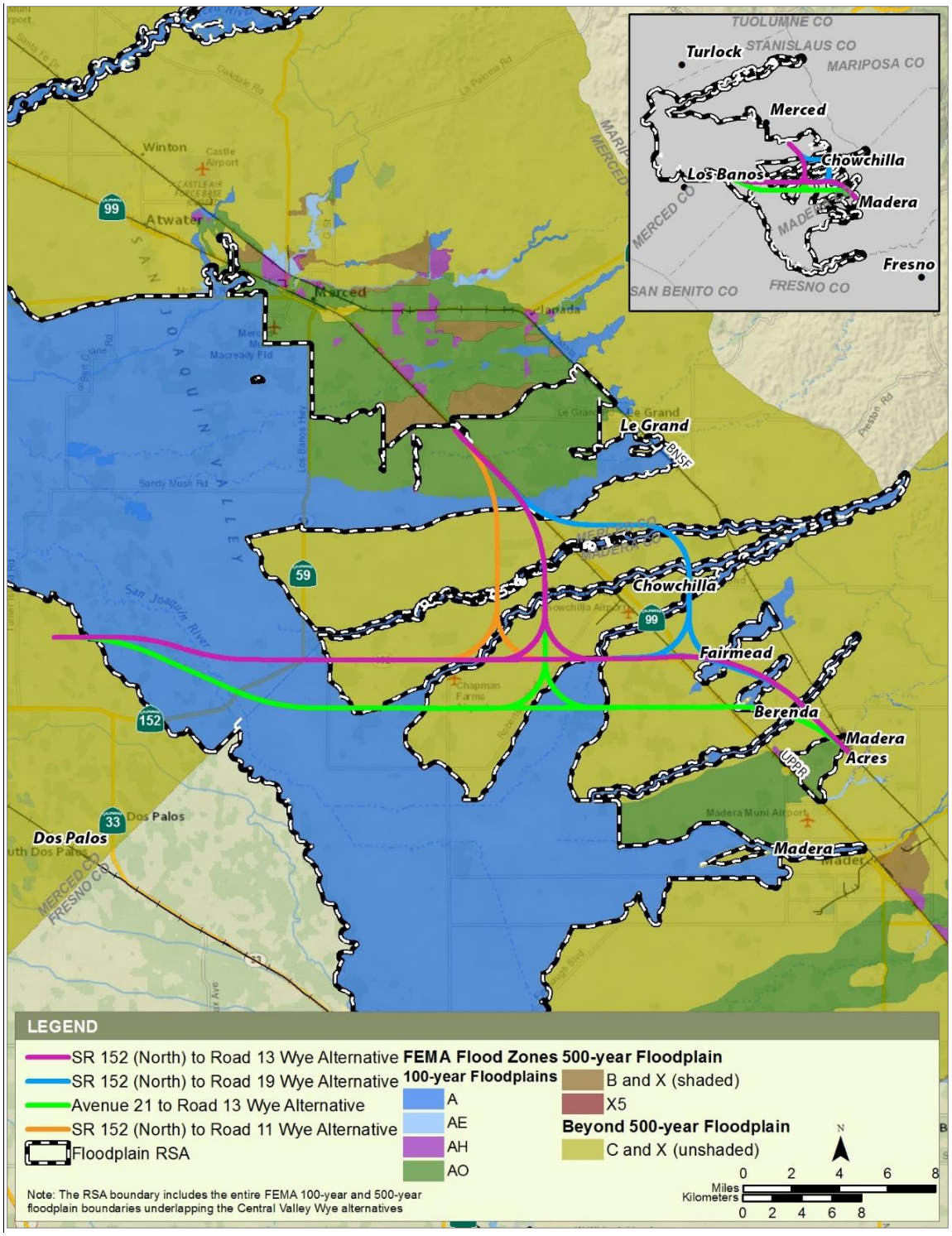
Figure 4-2 San Joaquin Valley Groundwater Subbasins within the Groundwater Resource Study Area



Source: FEMA, 2008a, 2008b

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Figure 4-3 Federal Emergency Management Agency Flood Zones in the Floodplain Resource Study Area

4.2 Methodology for Effects Analysis

Analysts used the following information sources (and associated geographic information system [GIS] data) to describe the affected environment:

- **Climate, Precipitation, and Topography**—Sources of information for these elements included the Statewide Program EIR/EIS (Authority and FRA 2005), California Data Exchange Center (CDEC) (CDEC 2012a, 2012b, 2012c); Western Regional Climate Center (WRCC) (WRCC 2016a, 2016b); U.S. Geological Survey (USGS) topographic maps; National Elevation Dataset (USGS 2013); description of the Central Valley Wye alternatives; and conceptual design, plans, and profiles.
- **Regional and Local Hydrology and Water Quality**—The following hydrology and water quality features exist in the regional and local vicinity: major surface water features, including lakes, reservoirs, rivers, streams, canals, and floodplains; major water quality impairments; and major groundwater aquifers. Information regarding these features and their conditions originates in the following sources: the Statewide Program EIR/EIS (Authority and FRA 2005), U.S. Geological Survey topographic maps, aerial imagery, FEMA Flood Insurance Rate Maps (FIRM) (FEMA 2008a, 2008b, 2009), CVFPB floodway maps (CVFPB 1973a, 1973b, 2011), CWA section 303(d) lists of water quality–impaired reaches (SWRCB 2015), *U.S. Geological Survey Ground Water Atlas of the United States* (Planert and Williams 1995), and the Natural Resources Conservation Service Web Soil Survey (USDOA-NRCS 2010).

To evaluate potential effects on hydrology and water resources, the analysts performed the following quantitative and qualitative analyses:

- Reviewed conceptual-level plans (15 percent design) for each of the Central Valley Wye alternatives and compared the plans with information on existing floodplains, surface water features, and groundwater basins. In addition, data from preparation of the *Merced to Fresno Section: Central Valley Wye Hydrology and Hydraulics Engineering Report* (Authority and FRA 2016a) were used.
- Identified and considered federal and state statutes regulating water resources as part of the analysis of potential flooding, hydrology, and water quality effects. The applicable statutes establish water quality standards; regulate discharges and pollution sources; and protect drinking water systems, aquifers, and floodplain and floodway values. Analysts also reviewed county and city general plans and ordinances for applicable policies and regulations to determine if implementation of the Central Valley Wye would result in potential effects.
- Researched available documents from various agencies, including the USGS, FEMA, CVFPB, and the Central Valley RWQCB, to determine whether the Central Valley Wye alternatives would affect water quality and water resources. These documents included floodplain and floodway maps from FEMA and CVFPB. Analysts identified and mapped FEMA-designated 100-year floodplain boundaries and areas and base flood elevations (BFE) using GIS and FEMA's FIRMs for Merced and Madera Counties (FEMA 2008a, 2008b). The FIRMs have effective dates of December 2, 2008, for Merced County and September 26, 2008, for Madera County (FEMA 2008a, 2008b). Peak flows in major rivers were found in FEMA flood insurance studies for Merced and Madera Counties (FEMA 2008c, 2008d).

The evaluation considered both direct and indirect effects. For example, a direct effect occurs through increased turbidity and erosion during construction and increased runoff, or an increase in the BFE. An example of an indirect effect is when changes in the planned development of an area result in increased groundwater supply needs or reduced water quality. Indirect effects on hydrology and water quality resources also consist of those that may occur through a change to land use or through economic or social effects. For example, new development could result in adding sources of pollutants to stormwater runoff, and development within FEMA floodplains could result in increased costs for flood protection facilities. Some economic or social effects may result from indirect effects on hydrology and water quality—specifically effects on capital improvements in stormwater infrastructure and water supply sources (i.e., groundwater to surface

water supplies) as a result of the conversion of agricultural land to urban or suburban land uses. Construction and operations of the Central Valley Wye would not trigger a large-scale conversion of agricultural land to urban or suburban uses and would not result in large-scale development within FEMA floodplains that could result in increased costs for flood protection facilities.

Therefore, the Central Valley Wye would have no indirect effects on hydrology and water resources, and indirect effects were not evaluated further. The following sections discuss topic-specific evaluation methods for surface water hydrology, surface water quality, groundwater, and floodplains.

4.2.1 Surface Water Hydrology

Construction activities with potential for effects on surface water hydrology include:

- Temporary changes in drainage infrastructure (e.g., replacement or removal of storm drains or drainage ditches, temporary diversion structures).
- Temporary changes in topography or waterbody channel geometry resulting from grading, dredging, or fill activities.
- Temporary or permanent changes to waterbodies associated with construction of piers, bridge abutments, and culverts.
- Increases in impervious surfaces as a result of the Central Valley Wye alternatives, leading to increases in the timing and volume of runoff.
- Changes to or disruption of the local drainage infrastructure and site topography as a result of the proposed Central Valley Wye design, potentially leading to localized or regional drainage effects.

Effects resulting from ongoing operations and maintenance activities of the HSR system include:

- Intermittent or permanent effects on hydraulic capacity and connectivity of natural waterbodies during in-water bridge maintenance activities or other activities conducted in or near waters.

Analysts performed the following analyses to evaluate potential effects the Central Valley Wye alternatives could have on surface waters:

- Overlaid GIS layers for the proposed Central Valley Wye alternatives on the GIS layers for surface waters and flood-prone areas, USGS topographic maps, and aerial photography from web mapping services to identify the potential effects on surface waters. Analysts then used these GIS layers to identify where the Central Valley Wye alternatives would cross streams and irrigation canals.
- Used GIS to estimate the locations and lengths of rivers, creeks, and canals crossed by the Central Valley Wye alternatives.
- Estimated the areas of temporary and permanent disturbances and identified locations of stream segments with impaired water quality.
- Qualitatively assessed how stream crossings could impede flood flows and affect downstream hydrology of rivers and creeks resulting in erosion and sedimentation, runoff, and drainage patterns.
- Qualitatively assessed potential changes in drainage infrastructure within the Central Valley Wye alignment based on existing land uses, such as agricultural areas (i.e., open irrigation ditches) and urban areas (i.e., storm drain pipes and roadside ditches).

4.2.1.1 San Joaquin River Restoration Program

Analysts also considered activities and plans of the SJRRP in relation to the Central Valley Wye. The SJRRP divides the San Joaquin River into multiple segments, and segment 4A of the river

restoration area crosses the project footprint of the Central Valley Wye alternatives in a general north-south direction south of the City of Merced (DWR 2008a).

The USBR initiated interim flows in 2009. Interim flows are experimental flows and assist in obtaining data concerning flows, temperatures, fish needs, seepage losses, recirculation, recapture, and reuse. Prior to interim flows, the reach between Friant Dam and the Mendota Pool rarely had sustained river flows that could support the Chinook salmon life cycle (USBR and DWR 2012). Beginning in 2014, the SJRRP initiated full restoration flows to support this species and these flows have continued in 2016.

During the initial design of the Merced to Fresno section of the California High-Speed Rail, the Authority took part in a coordination meeting on June 6, 2011 with the USBR and the DWR. During this meeting, it was determined that the project design would not conflict with the SJRRP. As the design has progressed, the Authority has continued working with the implementing agencies of the SJRRP to avoid any project-related impacts to the goals of the SJRRP or impacts from the interim flows provided by the SJRRP on the HSR crossings of the San Joaquin River. Therefore, while the SJRRP is not discussed further in this analysis in terms of conflicts that may arise as a result of the Central Valley Wye, activities of the SJRRP are described, where applicable, to provide information for the surface water affected environment.

4.2.2 Surface Water Quality

Construction activities with potential for effects on water quality include:

- Soil-disturbing activities (e.g., excavation and grading) that can lead to erosion and sedimentation
- Construction in areas of high groundwater that could result in pollutants discharging to surface water that would affect water quality
- Construction of HSR tracks, relocated roads, and grade-separated roads that would result in permanent changes to runoff patterns and potential release pollutants or sediment, which could permanently degrade water quality or violate water quality standards

Effects resulting from ongoing operations and maintenance activities of the HSR system include:

- Routine vegetation removal along the tracks and associated infrastructure may require the use of herbicides or pesticides that may affect water quality
- Increases in the amount of the pollutants associated with rail operations that may already exist in the watershed because of increased rail service, and introduction of new pollutant types in those areas not parallel to the existing BNSF

Analysts performed the following analyses to evaluate potential effects the Central Valley Wye alternatives could have on surface water quality:

- Using GIS and CWA section 303(d) lists of water quality–impaired reaches (SWRCB 2015), identified and considered the location of stream segments with impaired water quality in relation to the proposed Central Valley Wye alternative footprints
- Evaluated construction activities for the potential to affect surface water quality as a result of runoff and discharges. These activities include accidental releases of construction-related hazardous materials, ground disturbance and associated erosion and sedimentation, stormwater discharges, particularly in locations within or close to a surface waterbody[66]
- Reviewed operations activities for the potential to introduce pollutants into the environment, with a particular focus on stormwater runoff from Central Valley Wye facilities

[6] An approved SWPPP, when properly implemented, would reduce the potential adverse water quality effects from construction.

4.2.3 Groundwater

Analysts evaluated the following potential construction effects:

- Potential for contaminated site runoff to percolate to groundwater
- Excavation activities that could intersect the groundwater table and provide a direct mechanism for contaminants to enter groundwater
- Increases in impervious surfaces as a result of the Central Valley Wye alternatives, potentially reducing groundwater recharge

The potential for underground Central Valley Wye facilities, such as piped systems or embedded utility poles, to be located below the naturally occurring water table, which could result in potential effects on groundwater quality or quantity.

Analysts evaluated the following potential operations effects:

- Creation of substantial new sources of pollutants, such as train operations and maintenance activities, leading to new sources of contaminated runoff that could percolate to the aquifer

Analysts evaluated potential effects on groundwater resources using documents available from DWR, Central Valley RWQCB, Merced and Madera Counties, and other agencies. During construction, excavation in areas of high groundwater could potentially affect groundwater quality. In general, depth to groundwater within the groundwater RSA is greater than 50 feet.

Analysts performed the following analyses to evaluate potential effects the Central Valley Wye could have on groundwater:

- Used GIS to estimate the length and acreage of groundwater basins beneath the Central Valley Wye alternatives' footprints.
- Reviewed available documentation from DWR (e.g., DWR Bulletin 118) to obtain estimates of the depth to groundwater within the groundwater RSA.
- Identified known groundwater depths and agricultural well locations to evaluate how construction and operations could affect groundwater quality and quantity.

4.2.4 Floodplains

The location of facilities, such as utility poles or tracks, within a designated floodplain could expose the Central Valley Wye to risks related to flooding, as well as subject other areas to effects resulting from changes in the location or direction of flood flows. Railroad track, bridges, and culverts that cross a designated floodplain may encroach into the floodplain and affect the hydraulics of the creek and its associated floodplain. Analysts reviewed conceptual-level plans (15 percent design) for each of the Central Valley Wye alternatives and compared with information on existing floodplains. The Authority would construct portions of the HSR on grade, fill, open cut, trench, bridges, or aerial structures. The type of crossing and the estimated amount of floodplain that may be affected by each of the Central Valley Wye alternatives provides an indication of the potential magnitude of the encroachment for comparing the Central Valley Wye alternatives.

The channel of a watercourse designated as a floodway by a public agency (e.g., FEMA or CVFPB) must be kept free of encroachment so that the 100-year flood flow can be conveyed without increasing the water surface elevation. Within the portion of the floodplain outside the floodway, referred to as the floodway fringe, development and other forms of encroachment are permitted and small increases in water surface elevation may result. A substantial encroachment on the 100-year floodplain would be one that increases the BFE by 1 foot, consistent with FEMA guidance.

Analysts evaluated the potential Central Valley Wye effects on floodplains using the following sources and approach:

- Reviewed GIS information sources and the proposed Central Valley Wye alternative conceptual-level designs to estimate the length and acreage of floodplains defined as SFHAs within the Central Valley Wye area.
- Used GIS information sources to estimate the length and acreage of regulatory floodways within the Central Valley Wye area.
- Used GIS information sources to estimate the distance of the nearest upstream community that could be affected by backwater effects from floodplain encroachment.
- Reviewed Flood information from the FEMA FIRMS and FEMA flood insurance studies for Merced and Madera Counties (FEMA 2008a, 2008b, 2008c, and 2008d) and available topographic data to evaluate the potential for each Central Valley Wye alternative to increase flood height or divert flood flows.

Table 4-2 shows river and stream peak flow data available from the FEMA flood insurance studies. Relevant rivers and streams were all found in the Madera County FIRM (FEMA 2008d).

Table 4-2 Flow Data from the Federal Emergency Management Agency Flood Insurance Study for Madera County

Location	Flow (1% annual chance) (cfs)	Flood Insurance Study
Dry Creek—At a point upstream of AT&SF Railroad	2,830	Madera County
San Joaquin River—Below Little Dry Creek	74,300	Madera County
Schmidt Creek—At SR 99/At Avenue 18	1,270/650	Madera County
Schmidt Creek Tributary—At confluence with Schmidt Creek	600	Madera County

Source: FEMA, 2008d

5 AFFECTED ENVIRONMENT

This section describes the affected environment for hydrology and water resources in the Central Valley Wye study area, including climate, precipitation, and topography, surface water hydrology, surface water quality, groundwater hydrology and quality, and floodplains.

5.1 Surface Water Hydrology

5.1.1 Surface Water Hydrology Conditions in the Study Area

The surface water RSA is within the San Joaquin River Hydrologic Region. Within that region, the surface water RSA is within the San Joaquin Valley floor, Delta-Mendota Canal, Mariposa, and Ahwanee hydrologic units (HU). The RSA encompasses the entire area of potential effects within the associated watersheds for the Central Valley Wye because of its hydrological connection to the network of surface waters within the watershed. The Central Valley Wye alternatives are within the San Joaquin Valley floor and Delta-Mendota Canal HUs. The San Joaquin River Basin drains to the Sacramento–San Joaquin Delta via the San Joaquin River and its major tributaries, the Fresno, Merced, Tuolumne, and Stanislaus Rivers (DWR 2004a, 2004b, 2004c). Most watercourses in the San Joaquin Valley drain from east to west and eventually join the San Joaquin River. They include improved flood-control or drainage channels, river and stream channels, and sloughs. The U.S. Bureau of Reclamation's Friant Dam, which forms Millerton Lake, controls the San Joaquin River. Millerton Lake provides irrigation for the San Joaquin Valley, distributed by the Madera and Friant-Kern-Canals, as well as power generation, flood control, and recreation.

Stream flow consists of natural flows, irrigation runoff, and other point- and nonpoint-source discharges. Natural flows depend on precipitation, snowmelt runoff, and the slow discharge of groundwater through surface seeps and springs. Natural or built impoundments, water diversions, dams, levees, and channel straightening or realignment regulate stream flows. Much of the region is in a floodplain, which has a relatively flat gradient that generally slopes slowly to the west or southwest. When the stream channels overflow, shallow, 1- to 3-foot-deep overland flooding occurs that tends to pond against linear obstacles, such as canal levees and road and railroad embankments lying perpendicular to the land gradient. If these facilities lack sufficient culverts or other means of cross drainage, that shortcoming could divert overland flows for long distances before finally overflowing the linear obstacles and continuing west.

A number of water and irrigation districts provide water supply within the surface water RSA and own facilities, such as canals, in the Central Valley Wye vicinity (Table 5-1). These water districts pump surface water and groundwater to and from rivers, creeks, and the numerous canals that deliver municipal water to individual water users and irrigation water to and from agricultural fields throughout the region. The Authority and FRA are required to coordinate with these water and irrigation districts if there is potential for a proposed project to affect any of their facilities. Other districts, such as the El Nido Irrigation District, Le Grand Athlone Water District, Madera Irrigation District, San Luis Canal Company, and Sierra Water District may use water from these facilities for their deliveries.

Table 5-1 Water Suppliers that Potentially Own Infrastructure Crossing the Central Valley Wye Alternative Alignments

Water Districts
Central California Irrigation District Section 2
San Luis Canal Company–Henry Miller Reclamation District #2131
Chowchilla Water District
Delta Mendota Water Authority
Merced Irrigation District
Santa Rita Water District

Source: Authority and FRA, 2016a

5.1.2 Climate

The climate in the surface water RSA is semi-arid, with the valley experiencing long, hot, dry summers and relatively mild winters and intermittent wet periods. Table 5-2 presents monthly average, maximum, and minimum temperature data and daily maximum and minimum temperature data based on long-term records for the Merced and Madera weather stations. The average annual temperature for the surface water RSA ranges from 61.7 to 62.1 degrees Fahrenheit (°F); the minimum daily temperature ranges from 13 to 15 °F; and the maximum daily temperature ranges from 114 to 116 °F (WRCC 2016a, 2016b).

Table 5-2 Temperature Summary

Temperature (°F)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Merced, California (1899–2016)													
Mean	45.5	50.2	54.2	59.6	66.6	73.6	79.0	77.2	72.4	63.5	52.9	45.7	61.8
Average Max.	54.9	61.6	67.2	74.3	82.6	90.8	97.1	95.3	90.0	79.8	66.2	55.7	76.3
Average Min.	36.0	38.7	41.2	44.9	50.6	56.4	60.9	58.9	54.8	47.2	39.6	35.6	47.1
Daily Max. Extreme	75.0	84.0	88.0	98.0	109.0	111.0	114.0	114.0	110.0	102.0	91.0	76.0	114.0
Daily Min. Extreme	13.0	20.0	20.0	22.0	30.0	37.0	40.0	36.0	32.0	28.0	21.0	15.0	15.0
Madera, California (1928–2016)													
Mean	44.9	50.1	54.5	60.1	67.6	74.2	79.8	78.2	73.1	64.0	52.8	45.4	62.1
Average Max.	54.0	61.2	67.2	74.8	83.9	91.6	98.2	96.4	90.9	80.3	66.1	55.2	76.6
Average Min.	35.9	39.1	41.8	45.5	51.3	56.7	61.4	59.9	55.3	47.8	39.6	35.7	47.5
Daily Max. Extreme	75.0	83.0	90.0	99.0	107.0	115.0	116.0	113.0	115.0	101.0	92.0	75.0	116.0
Daily Min. Extreme	15.0	21.0	24.0	29.0	32.0	38.0	42.0	41.0	34.0	24.0	22.0	16.0	15.0

Source: WRCC, 2016a, 2016b
°F = degree(s) Fahrenheit max. = maximum
min. = minimum

Annual precipitation in the San Joaquin Valley is highly variable and as a result, water availability is also highly variable. Precipitation occurring both as rainfall and snow on the western slope of the Sierra Nevada is the major source of water in the San Joaquin Valley. While light to moderate precipitation events may contribute water to the San Joaquin Valley, the amounts reaching the valley are reduced by evapotranspiration in the area (Gronberg et al. 1998). Based on the long-term records of precipitation, the average annual precipitation in the surface water RSA ranges from approximately 10.99 to 12.27 inches (Table 5-3), while the 1-day maximum ranges from 2.2 to 2.6 inches. Almost 90 percent of precipitation in the surface water RSA occurs from November through April (WRCC 2016a, 2016b). In the Sierra Nevada, the majority of the mean annual precipitation falls as snow and ranges from 20 inches in the foothills to more than 80 inches at higher elevations. The Coast Ranges west of the valley floor have annual precipitation ranging from 10 to more than 20 inches (Gronberg et al. 1998).

Table 5-3 Average Monthly Precipitation (inches)

Station	Period of Record	Elevation (feet)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Merced	1899–2016	150	2.46	2.17	1.96	1.09	0.44	0.10	0.01	0.02	0.15	0.6	1.37	1.89	12.27
Madera	1928–2016	270	1.98	1.92	1.81	1.08	0.39	0.09	0.01	0.02	0.14	0.58	1.18	1.78	10.99

Source: WRCC, 2016a, 2016b
Precipitation measured in inches.

The soils underlying the surface water RSA consist primarily of alluvial deposits of clay, silt, sand, and gravel with varying grain sizes and content. The soil types and consistencies of these deposits vary by location, depending on how they were deposited. The surface soils in the surface water RSA generally have high permeability and infiltrate runoff relatively quickly.

Climate change has the potential to increase air temperatures and modify precipitation patterns in ways that would affect snowpack and runoff. Changes in the timing and amount of flow in streams could affect flooding and water supplies. As air temperatures increase, precipitation may fall as rain instead of snow in lower altitudes of the Sierras. Heavier rains and rain or snow events may increase peak runoff during the rainy season leading to increased strength and frequency of floods, which could damage housing, transportation, and other infrastructure. The warmer temperatures may also cause the snow that does fall and accumulate to melt faster and earlier, making it more difficult to store and use runoff in upstream reservoirs of the surface water RSA during the dry months in California. Projections indicate that temperatures could increase by 3 to 9°F (CNRA 2009) and the snowpack in the Sierra Nevada range could be reduced by at least 25 percent by 2050 (Luers and Mastrandrea 2008). A recent study conducted by DWR concluded that groundwater pumping would likely increase under climate change to augment reduced surface water supplies (DWR 2009). Because of the inland location of the surface water RSA and its elevation, the level of sea level rise caused by climate change would not be expected to affect the Central Valley Wye.

DWR addresses climate change in its *California Water Plan, Update 2013* (Water Plan) (DWR 2014). The Water Plan, which is updated every 5 years, provides a framework for water managers, legislators, and the public to consider options, make decisions, and implement adaptation strategies (e.g., operational changes for reservoirs) to provide Californians with an adequate water supply, reliable flood control, and healthy ecosystems. Since the most recent plan update in 2009, DWR completed the *Climate Change Handbook for Regional Water Planning* in 2010 with USEPA and USACE, adopted an Environmental Stewardship Policy in 2010, and adopted the first phase of its *Climate Action Plan* in 2012 (DWR 2013).

5.1.3 Surface Water Hydrology for the Central Valley Wye

5.1.3.1 Surface Water Features

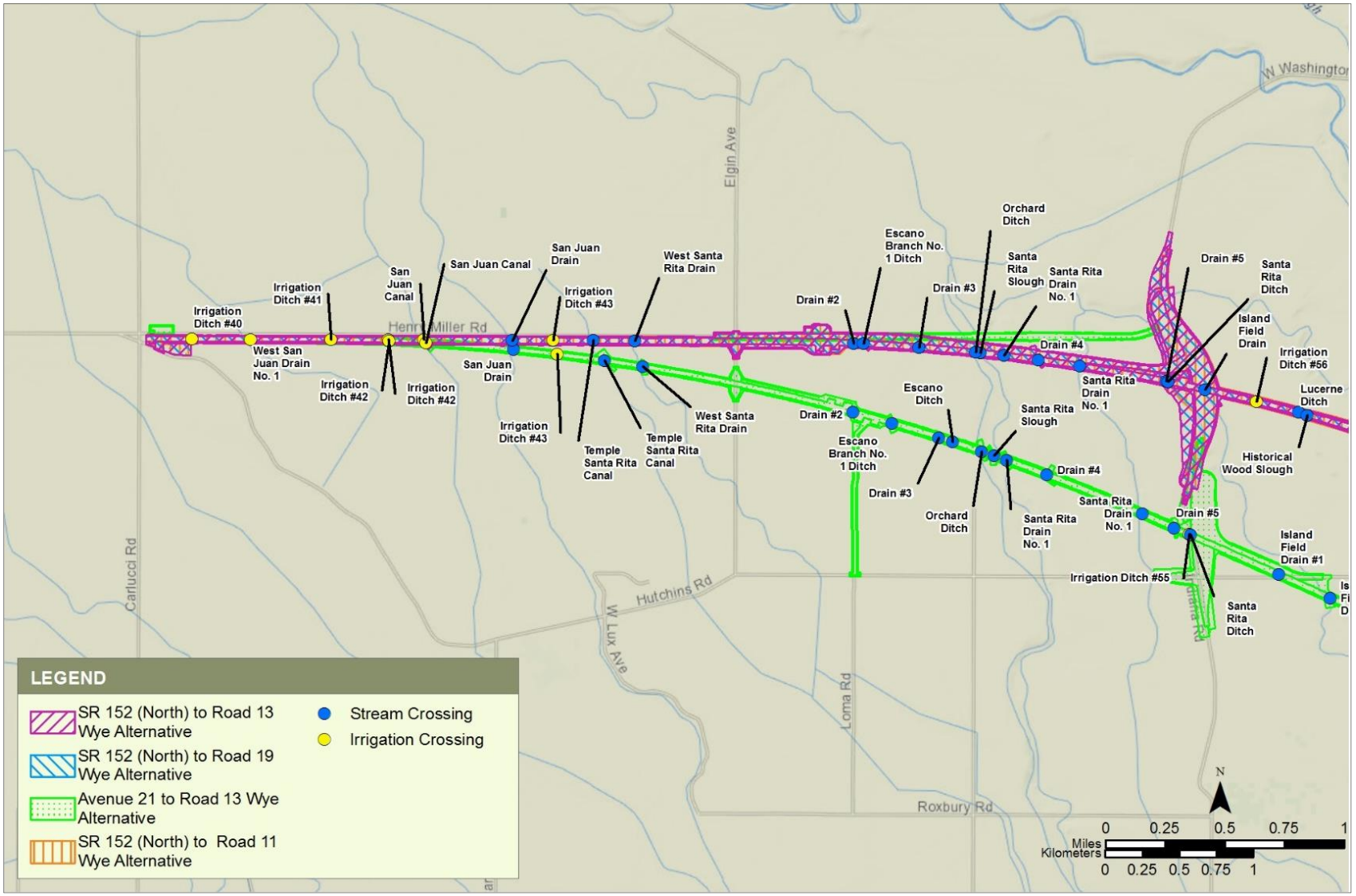
The surface water RSA is entirely within the lower San Joaquin River Basin (Figure 4-1). There are several natural waterbodies and irrigation canals located within the surface water RSA. The San Joaquin River is the largest waterbody crossing. The San Joaquin River originates in the Sierra Nevada range, and flows through the agricultural region of the San Joaquin Valley before reaching the Suisun Bay, San Francisco Bay, and the Pacific Ocean. Smaller streams, creeks, and canals are also present on the valley floor, some of which cross the Central Valley Wye alternative alignments. Existing water districts and individual users pump surface water and groundwater to and from rivers, creeks, and the numerous canals that deliver irrigation water to and from agricultural fields throughout the region. The canals are generally made of packed earth

or concrete-lined. No significant lakes or reservoirs are adjacent to or within the surface water study area, although small farm ponds are relatively common. The U.S. Bureau of Reclamation controls San Joaquin River flows through operation of the Friant Dam, upstream of the Central Valley Wye study area. Natural flows in other rivers and creeks depend on precipitation, snowmelt runoff, and the slow discharge of groundwater through surface seeps and springs.

Natural or engineered impoundments, water diversions, levees, and straightened or realigned channels regulate stream flows in the study area. Because there are significant diversions upstream of the Central Valley Wye alternatives, flows in the San Joaquin and Chowchilla Rivers during the irrigation season are largely groundwater accretions between Mendota Pool and Salt Slough. The Central Valley Wye alternative alignments would run parallel to and cross numerous canals and drainages, including the Outside Canal, Main Canal, Los Banos Creek, Mud Slough, Salt Slough, San Joaquin River, Eastside Bypass, Ash Slough, and Berenda Slough.

Figures 5-1a through 5-1l show and Table 5-4 lists the major waterbodies and canals the Central Valley Wye alternatives would cross in the surface water RSA. Crossings of waterbodies would primarily be by aerial structures, bridges, or culverts. Most waterbodies within the surface water RSA are of two major types:

- Type I: stream or other intermittent natural waterbody. This type includes natural sloughs, rivers, and creeks.
- Type C: irrigation or flood control canal or ditch. This type includes channelized sloughs, rivers, and creeks.



Source: Authority, 2016

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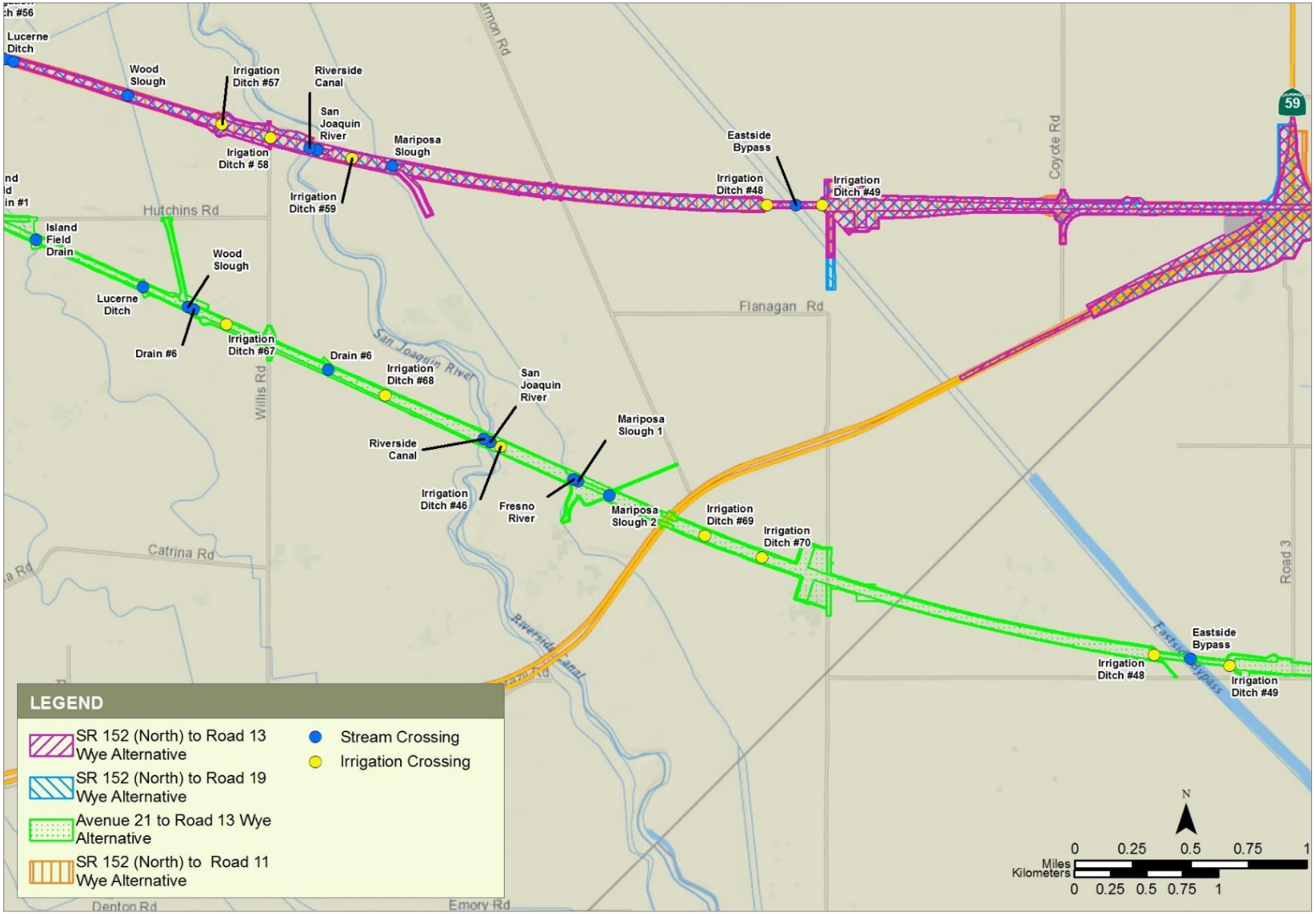
Figure 5-1a Waterbody Crossings along the Central Valley Wye Alternative Alignments



Source: Authority, 2016

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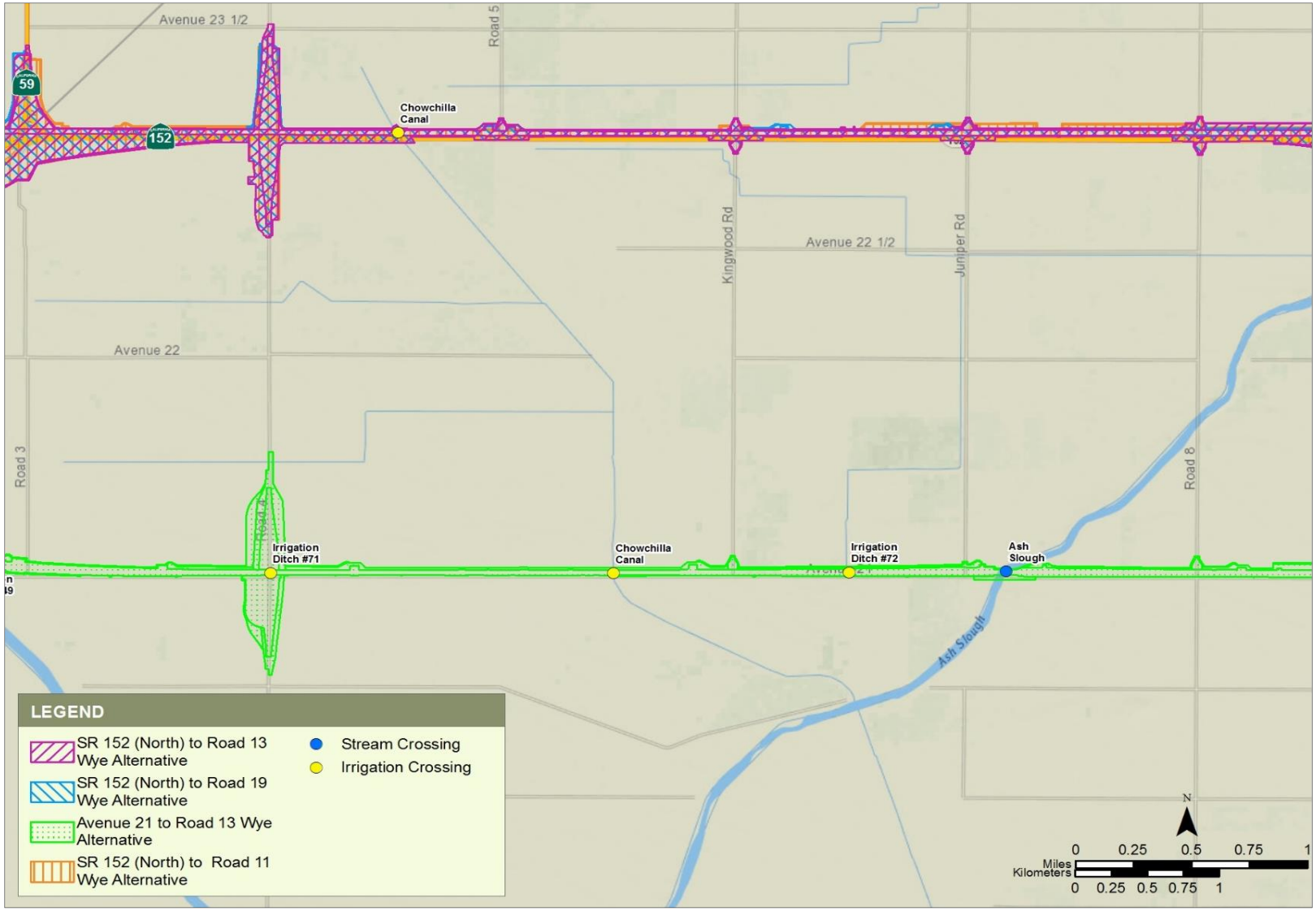
Figure 5-1b Waterbody Crossings along the Central Valley Wye Alternative Alignments (cont.)



Source: Authority, 2016

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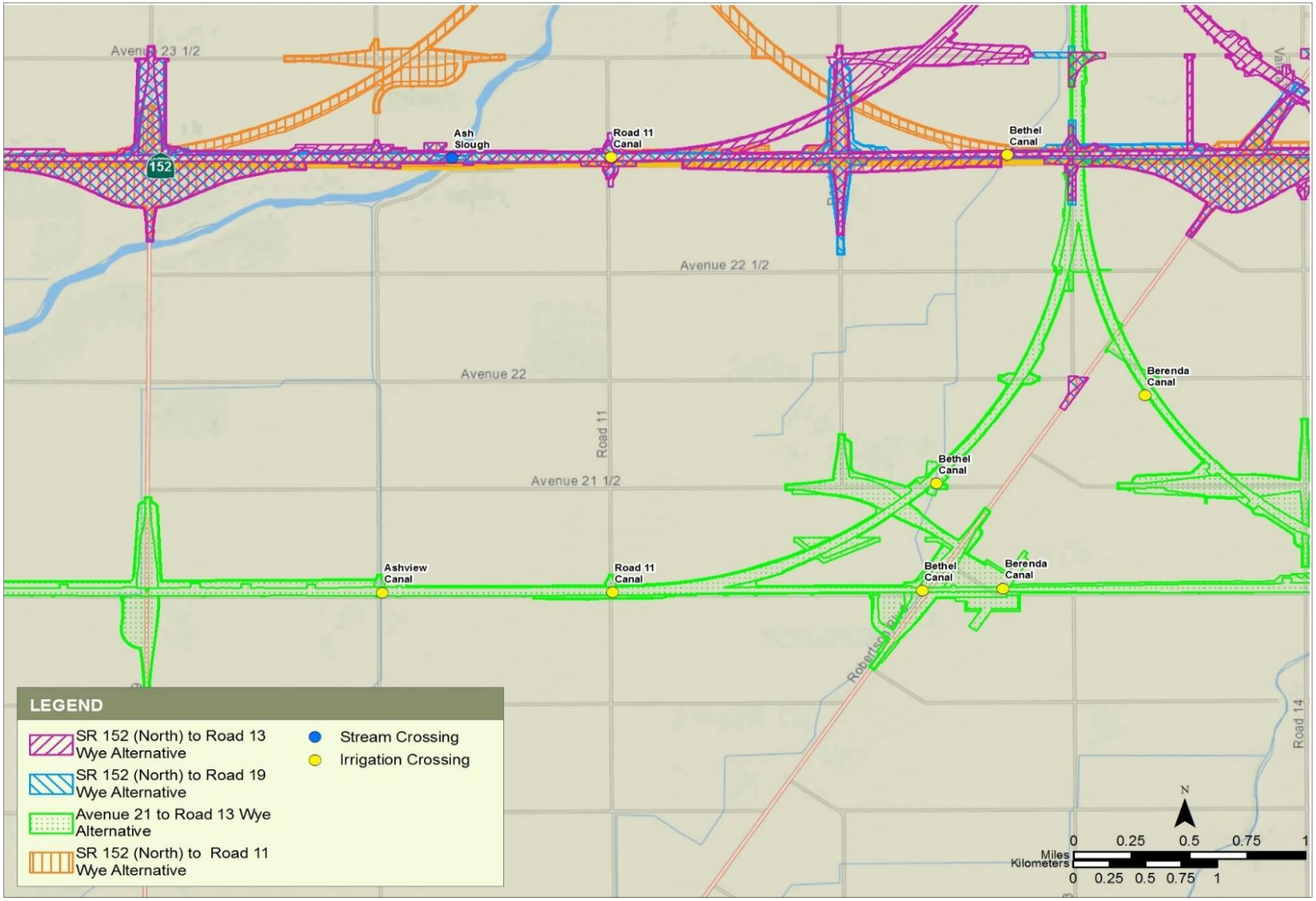
Figure 5-1c Waterbody Crossings along the Central Valley Wye Alternative Alignments (cont.)



Source: Authority, 2016

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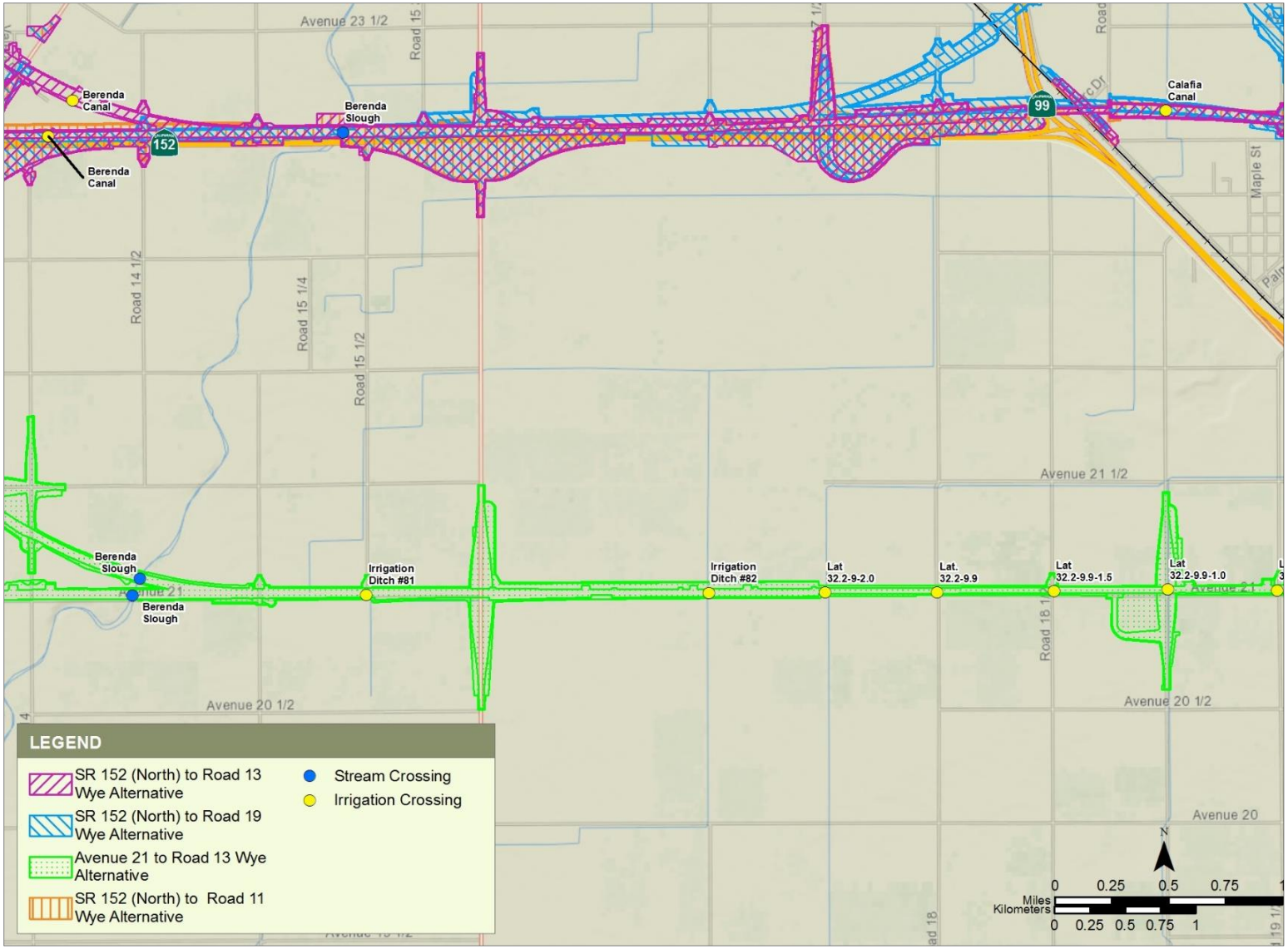
Figure 5-1d Waterbody Crossings along the Central Valley Wye Alternative Alignments (cont.)



Source: Authority, 2016

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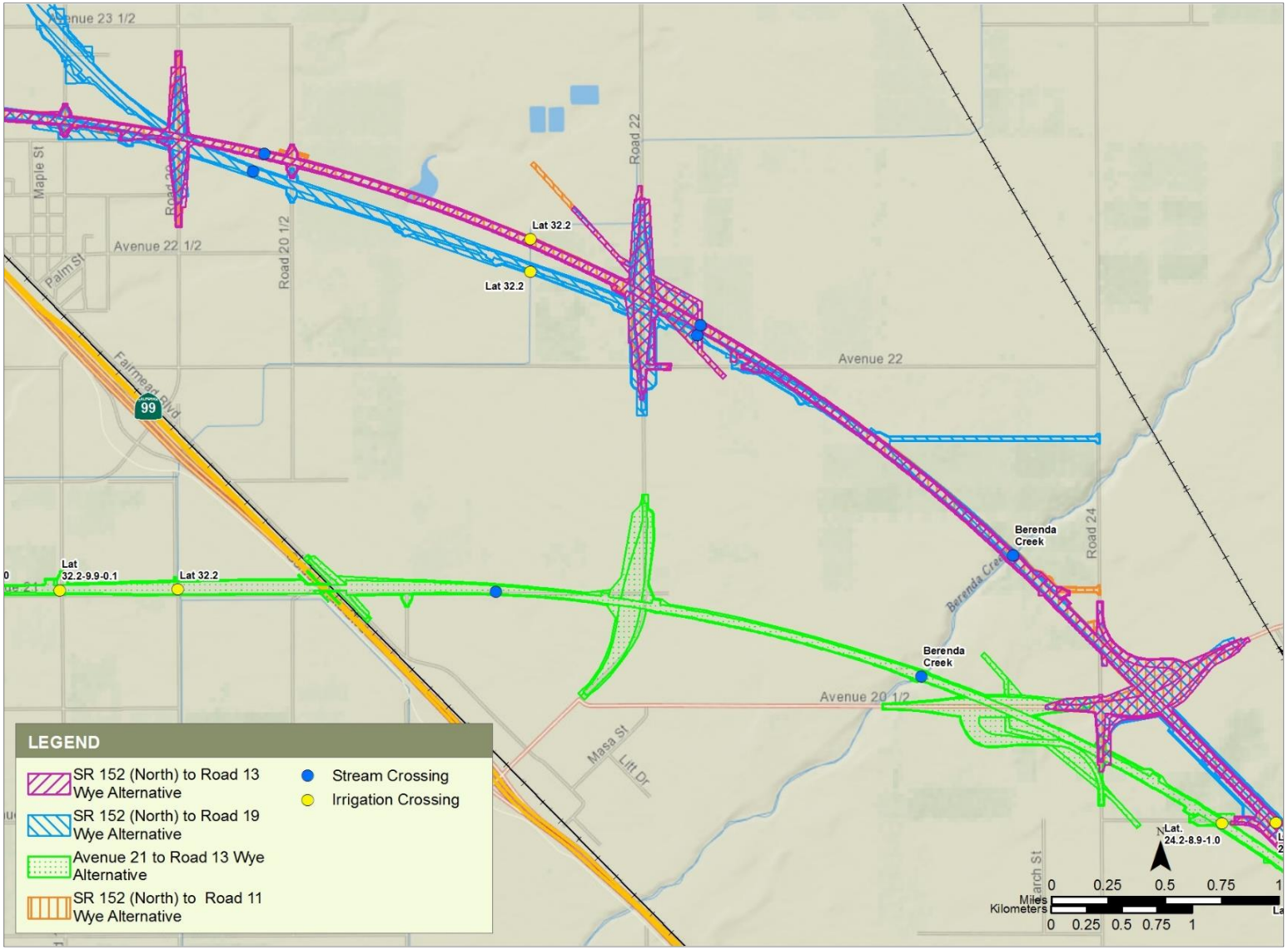
Figure 5-1e Waterbody Crossings along the Central Valley Wye Alternative Alignments (cont.)



Source: Authority, 2016

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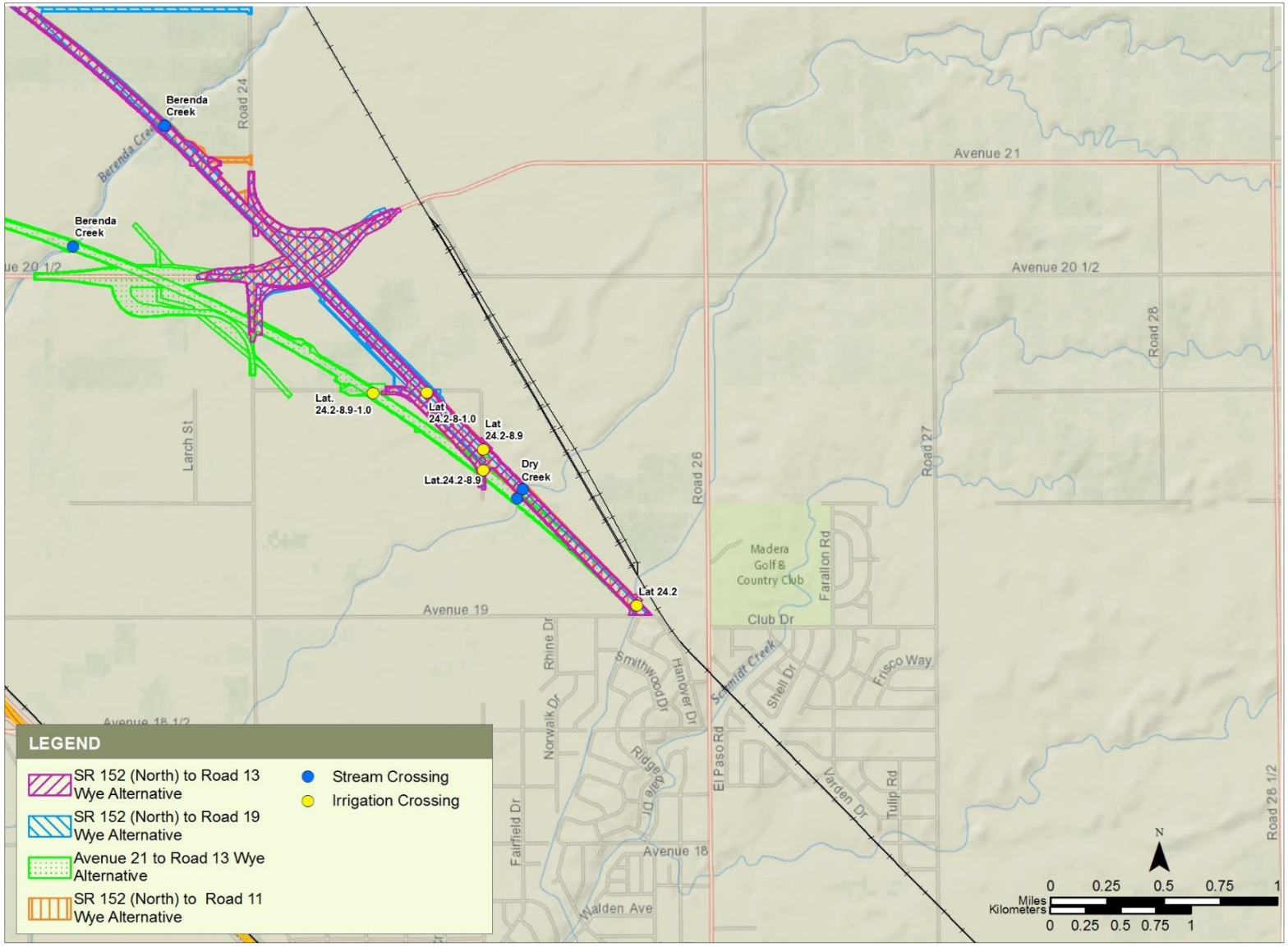
Figure 5-1f Waterbody Crossings along the Central Valley Wye Alternative Alignments (cont.)



Source: Authority, 2016

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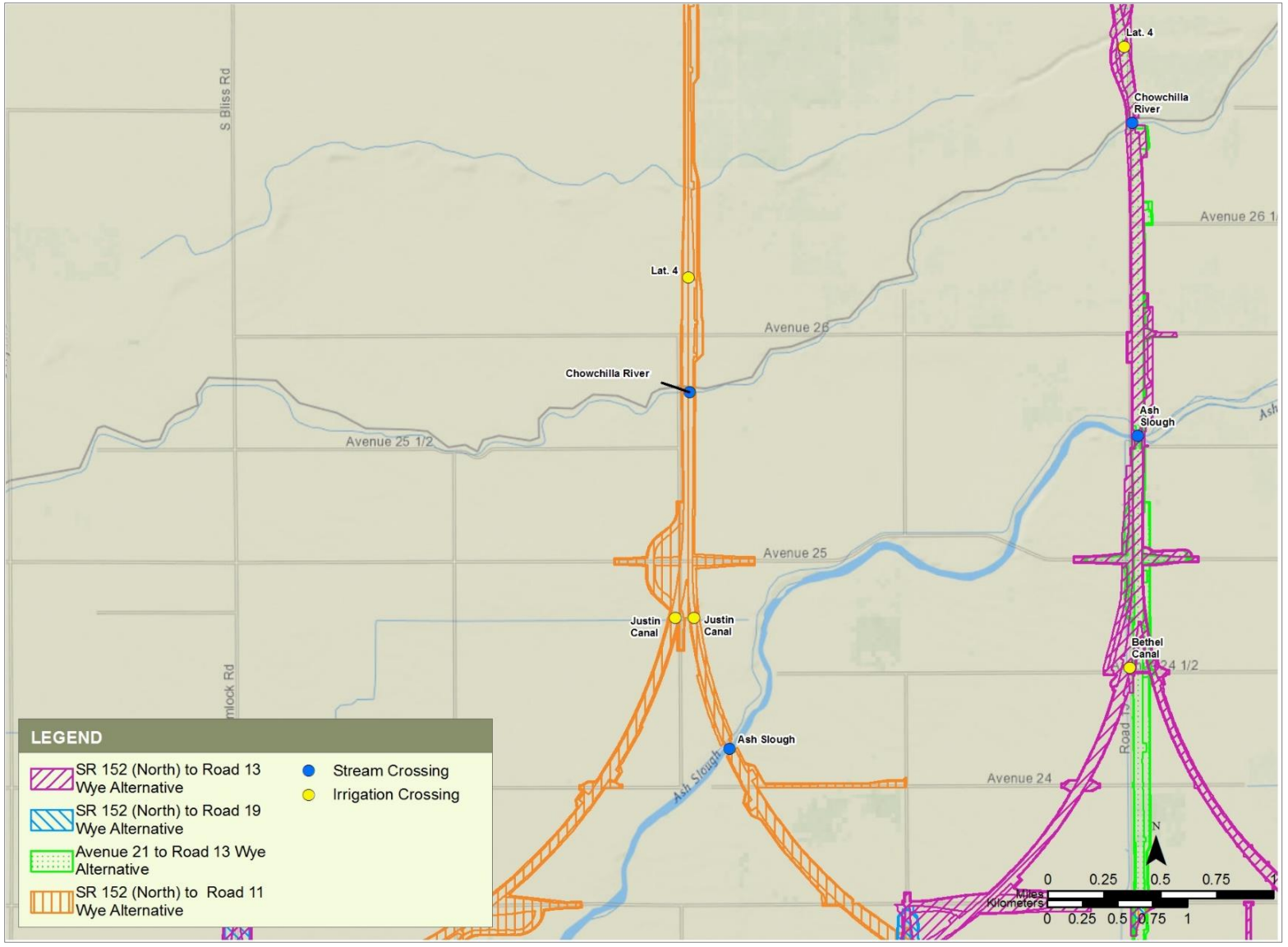
Figure 5-1g Waterbody Crossings along the Central Valley Wye Alternative Alignments (cont.)



Source: Authority, 2016

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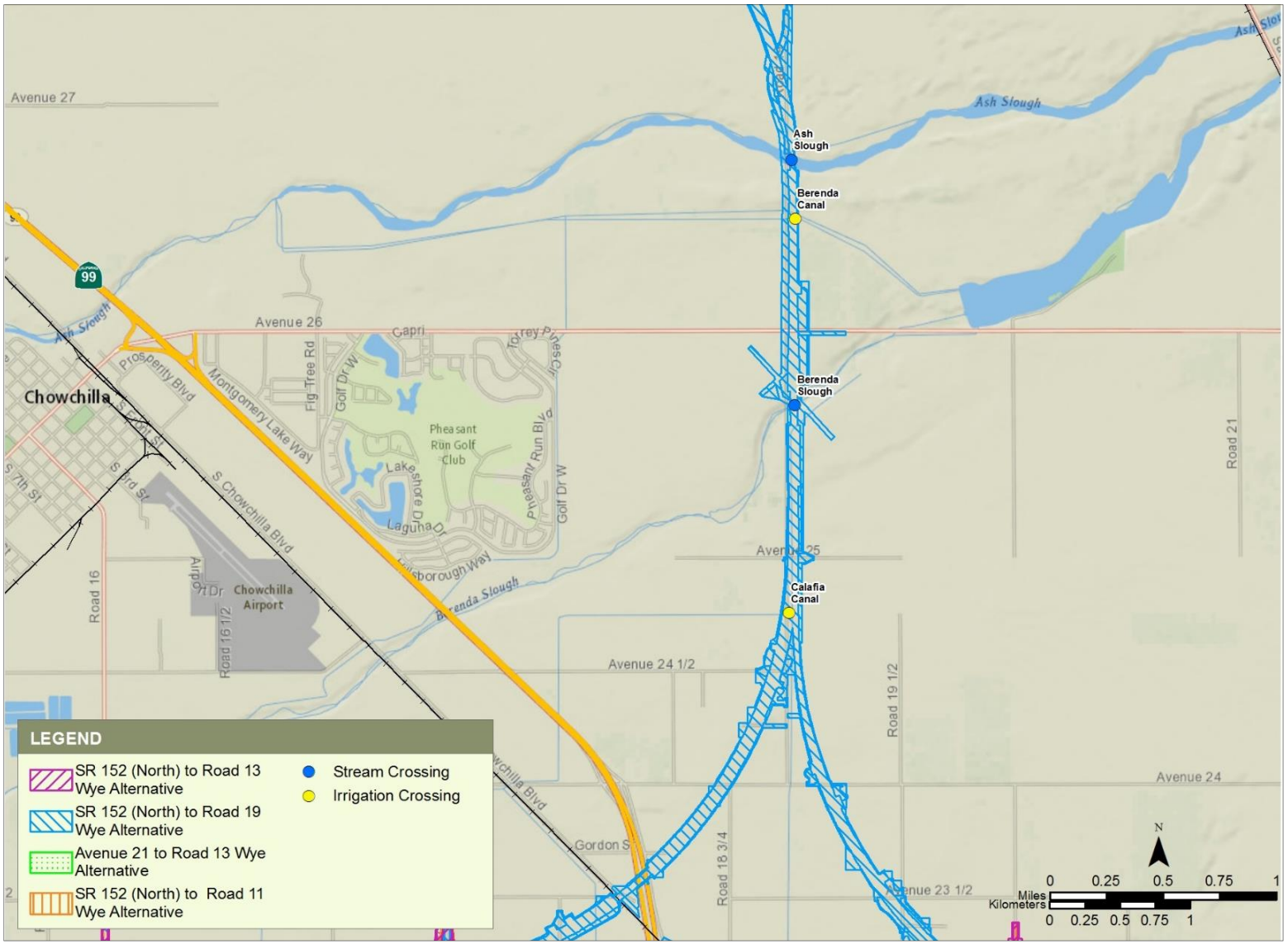
Figure 5-1h Waterbody Crossings along the Central Valley Wye Alternative Alignments (cont.)



Source: Authority and FRA, 2016a

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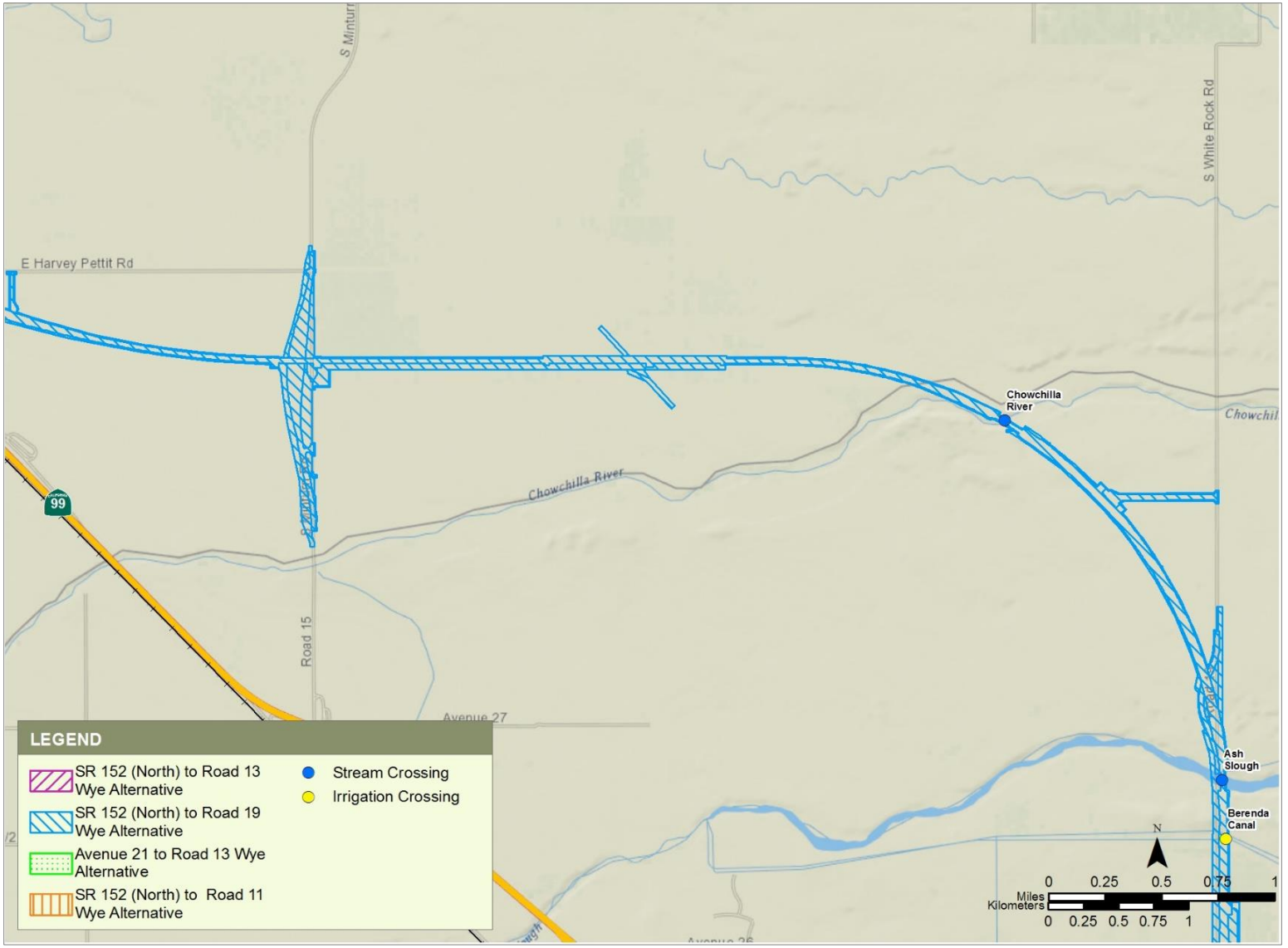
Figure 5-1i Waterbody Crossings along the Central Valley Wye Alternative Alignments (cont.)



Source: Authority and FRA, 2016a

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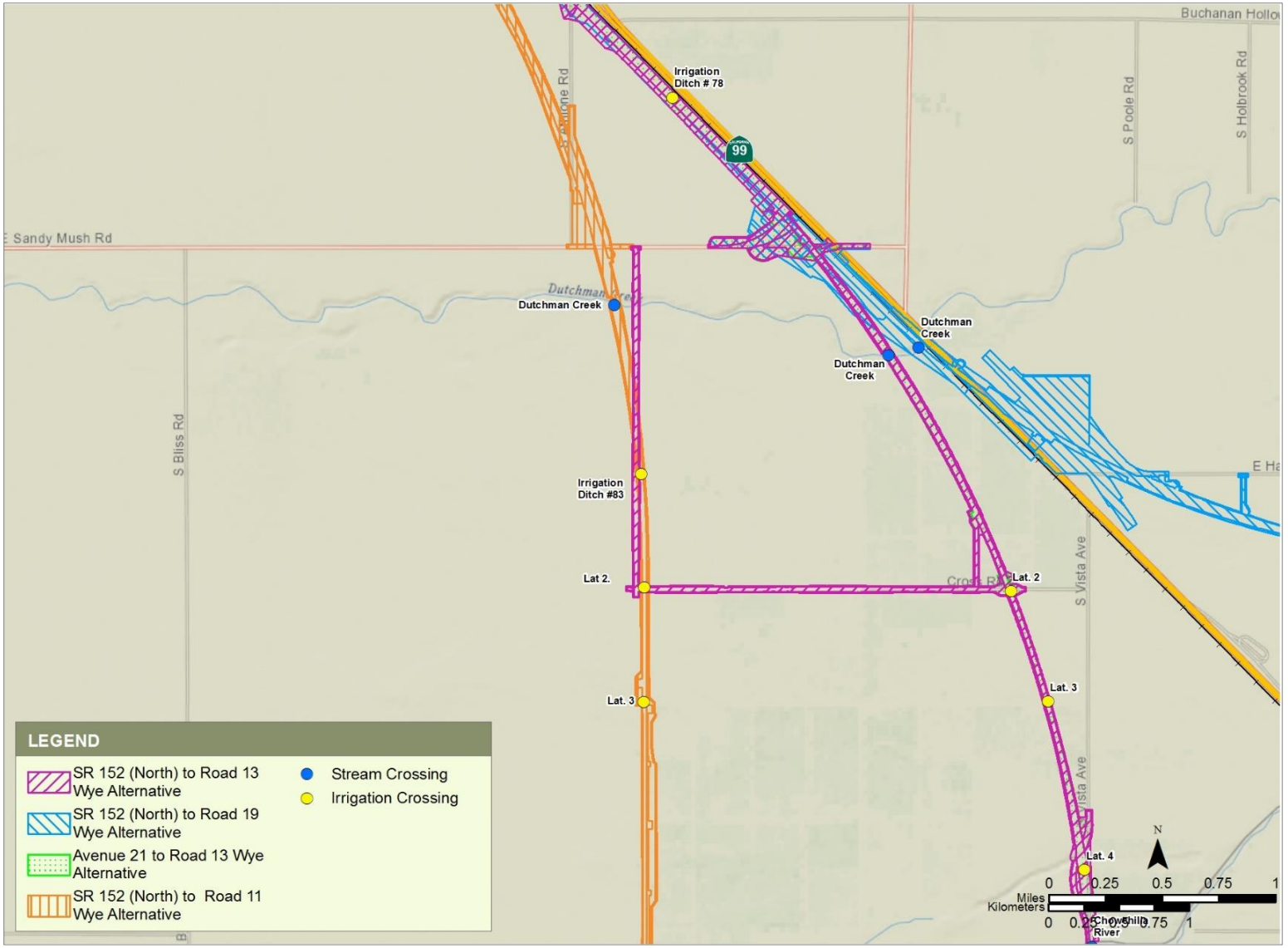
Figure 5-1j Waterbody Crossings along the Central Valley Wye Alternative Alignments (cont.)



Source: Authority and FRA, 2016a

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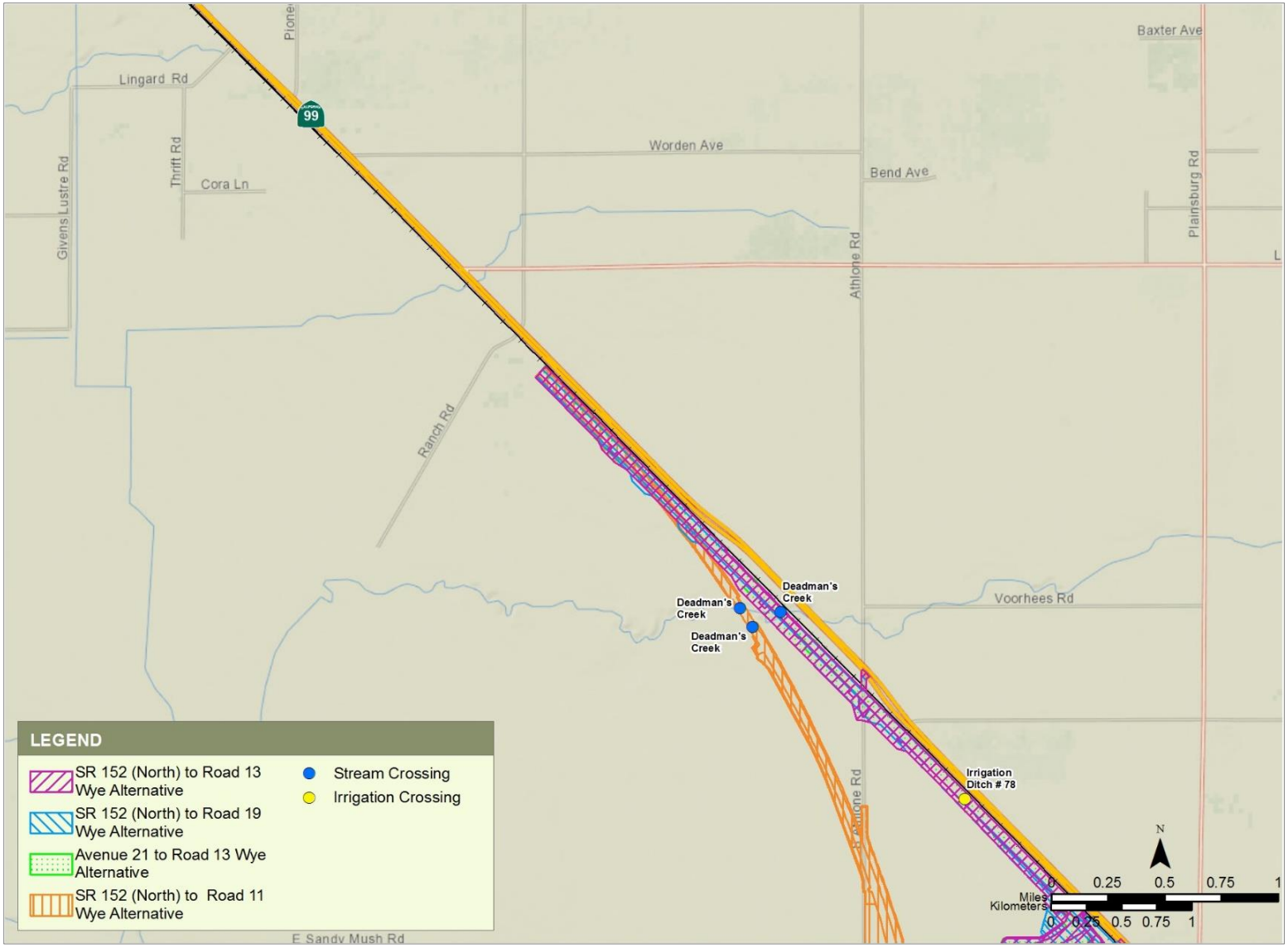
Figure 5-1k Waterbody Crossings along the Central Valley Wye Alternative Alignments (cont.)



Source: Authority and FRA, 2016a

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Figure 5-1l Waterbody Crossings along the Central Valley Wye Alternative Alignments (cont.)

Table 5-4 Major Waterbodies Crossed by the Central Valley Wye Alternatives

Waterbody[1]	Alternative(s)	Type[2]	Approximate Crossing Width (feet)[3]
San Juan Drain	SR 152 (North) to Road 13 Wye	C	45
	SR 152 (North) to Road 19 Wye		45
	Avenue 21 to Road 13 Wye		55
	SR 152 (North) to Road 11 Wye		45
Temple Santa Rita Canal	SR 152 (North) to Road 13 Wye	C	40
	SR 152 (North) to Road 19 Wye		40
	Avenue 21 to Road 13 Wye		55
	SR 152 (North) to Road 11 Wye		40
West Santa Rita Drain	SR 152 (North) to Road 13 Wye	C	88
	SR 152 (North) to Road 19 Wye		88
	Avenue 21 to Road 13 Wye		110
	SR 152 (North) to Road 11 Wye		88
Drain #2	SR 152 (North) to Road 13 Wye	C	40
	SR 152 (North) to Road 19 Wye		40
	Avenue 21 to Road 13 Wye		40
	SR 152 (North) to Road 11 Wye		40
Escano Branch No. 1 Ditch	SR 152 (North) to Road 13 Wye	C	35
	SR 152 (North) to Road 19 Wye		35
	Avenue 21 to Road 13 Wye		35
	SR 152 (North) to Road 11 Wye		35
Drain #3	SR 152 (North) to Road 13 Wye	C	30
	SR 152 (North) to Road 19 Wye		30
	Avenue 21 to Road 13 Wye		30
	SR 152 (North) to Road 11 Wye		30
Escano Ditch	Avenue 21 to Road 13 Wye	C	40
Orchard Ditch	SR 152 (North) to Road 13 Wye	C	65
	SR 152 (North) to Road 19 Wye		65
	Avenue 21 to Road 13 Wye		50
	SR 152 (North) to Road 11 Wye		65
Santa Rita Slough	SR 152 (North) to Road 13 Wye	C	60
	SR 152 (North) to Road 19 Wye		60
	Avenue 21 to Road 13 Wye		55
	SR 152 (North) to Road 11 Wye		60
Santa Rita Drain No. 1	SR 152 (North) to Road 13 Wye	C	60
	SR 152 (North) to Road 19 Wye		60
	Avenue 21 to Road 13 Wye		55
	SR 152 (North) to Road 11 Wye		60

Waterbody[1]	Alternative(s)	Type[2]	Approximate Crossing Width (feet)[3]
Drain #4	SR 152 (North) to Road 13 Wye	C	85
	SR 152 (North) to Road 19 Wye		85
	Avenue 21 to Road 13 Wye		60
	SR 152 (North) to Road 11 Wye		85
Santa Rita Drain No. 1a	SR 152 (North) to Road 13 Wye	C	50
	SR 152 (North) to Road 19 Wye		50
	Avenue 21 to Road 13 Wye		50
Drain #5	SR 152 (North) to Road 13 Wye	C	55
	SR 152 (North) to Road 19 Wye		55
	Avenue 21 to Road 13 Wye		65
	SR 152 (North) to Road 11 Wye		55
Santa Rita Ditch	SR 152 (North) to Road 13 Wye	C	100
	SR 152 (North) to Road 19 Wye		100
	Avenue 21 to Road 13 Wye		100
	SR 152 (North) to Road 11 Wye		100
Island Field Drain #1	Avenue 21 to Road 13 Wye	C	90
Island Field Drain	SR 152 (North) to Road 13 Wye	C	155
	SR 152 (North) to Road 19 Wye		155
	Avenue 21 to Road 13 Wye		140
	SR 152 (North) to Road 11 Wye		155
Lucerne Ditch	SR 152 (North) to Road 13 Wye	C	60
	SR 152 (North) to Road 19 Wye		60
	Avenue 21 to Road 13 Wye		120
	SR 152 (North) to Road 11 Wye		60
Historical Wood Slough	SR 152 (North) to Road 13 Wye	C	90
	SR 152 (North) to Road 19 Wye		90
	SR 152 (North) to Road 11 Wye		90
Wood Slough	SR 152 (North) to Road 13 Wye	I	80
	SR 152 (North) to Road 19 Wye		80
	Avenue 21 to Road 13 Wye		80
	SR 152 (North) to Road 13 Wye		80
Drain #6	Avenue 21 to Road 13 Wye	C	80
Drain #6	Avenue 21 to Road 13 Wye	C	60
Riverside Canal	SR 152 (North) to Road 13 Wye	C	230
	SR 152 (North) to Road 19 Wye		230
	Avenue 21 to Road 13 Wye		230
	SR 152 (North) to Road 11 Wye		230

Waterbody[1]	Alternative(s)	Type[2]	Approximate Crossing Width (feet)[3]
San Joaquin River	SR 152 (North) to Road 13 Wye	I	530
	SR 152 (North) to Road 19 Wye		530
	Avenue 21 to Road 13 Wye		575
	SR 152 (North) to Road 11 Wye		530
Fresno River	Avenue 21 to Road 13 Wye	C	250
Mariposa Slough 1	SR 152 (North) to Road 13 Wye	C	300
	SR 152 (North) to Road 19 Wye		300
	Avenue 21 to Road 13 Wye		90
	SR 152 (North) to Road 11 Wye		300
Mariposa Slough 2	Avenue 21 to Road 13 Wye	C	120
Eastside Bypass	SR 152 (North) to Road 13 Wye	I	1375
	SR 152 (North) to Road 19 Wye		1375
	Avenue 21 to Road 13 Wye		1950
	SR 152 (North) to Road 11 Wye		1375
Ash Slough	SR 152 (North) to Road 13 Wye	I	700
	SR 152 (North) to Road 19 Wye		700
	Avenue 21 to Road 13 Wye		400
	SR 152 (North) to Road 11 Wye		700
Berenda Slough	SR 152 (North) to Road 13 Wye	I	350
	SR 152 (North) to Road 19 Wye		350
	Avenue 21 to Road 13 Wye		180
	SR 152 (North) to Road 11 Wye		350
Berenda Creek	SR 152 (North) to Road 13 Wye	I	170
	SR 152 (North) to Road 19 Wye		170
	Avenue 21 to Road 13 Wye		130
	SR 152 (North) to Road 11 Wye		170
Berenda Slough	SR 152 (North) to Road 19 Wye	I	350
	Avenue 21 to Road 13 Wye		190
Dry Creek	SR 152 (North) to Road 13 Wye	I	105
	Avenue 21 to Road 13 Wye		130
	SR 152 (North) to Road 11 Wye		105
Schmidt Creek	SR 152 (North) to Road 13 Wye	I	150
	Avenue 21 to Road 13 Wye		150
Schmidt Creek Tributary	SR 152 (North) to Road 13 Wye	I	50
	Avenue 21 to Road 13 Wye		50
Ash Slough	SR 152 (North) to Road 13 Wye	I	450
	SR 152 (North) to Road 19 Wye		450
	Avenue 21 to Road 13 Wye		450

Waterbody[1]	Alternative(s)	Type[2]	Approximate Crossing Width (feet)[3]
Chowchilla River	SR 152 (North) to Road 13 Wye	I	270
	SR 152 (North) to Road 19 Wye		530
	Avenue 21 to Road 13 Wye		270
	SR 152 (North) to Road 11 Wye		155
Dutchman Creek	SR 152 (North) to Road 13 Wye	I	55
	SR 152 (North) to Road 19 Wye		100
	Avenue 21 to Road 13 Wye		55
	SR 152 (North) to Road 11 Wye		65
Deadman Creek	SR 152 (North) to Road 13 Wye	I	110
	SR 152 (North) to Road 19 Wye		110
	Avenue 21 to Road 13 Wye		110
	SR 152 (North) to Road 13 Wye		50

Source: Evaluated using ESRI ArcGIS versions 10.1, 10.2, and 10.3; Authority and FRA, 2016a, Tables 7-1 and 8-1
[1] The Central Valley Wye alternatives also cross unnamed irrigation canals and distribution pipelines; the Waterbody column in the table lists these features as the feature type with a number (e.g., "Drain #1").
[2] Type: C = irrigation or flood control canal or ditch, I = intermittent.
[3] Crossing widths subject to change once the Authority finalizes the Central Valley Wye alternative designs. SR = State Route

Numerous natural waterbodies flow through Merced and Madera Counties. Table 5-5 summarizes the number of times each of the Central Valley Wye alternatives would cross the natural waterbodies in the surface water RSA. In some cases, one or more of the Central Valley Wye alternatives cross the same waterbody more than once.

Table 5-5 Natural Waterbodies Crossed by the Central Valley Wye Alternatives and the associated Number of Waterbody Crossings[1]

Natural Waterbody	Alternative			
	SR 152 (North) to Road 13 Wye	SR 152 (North) to Road 19 Wye	Avenue 21 to Road 13 Wye	SR 152 (North) to Road 11 Wye
Ash Slough	2	2	2	2
Berenda Creek	1	1	1	1
Berenda Slough	1	2	2	1
Chowchilla River	1	1	1	1
Deadman Creek	1	1	1	2
Drain #2	1	1	1	1
Drain #3	1	1	1	1
Drain #4	1	1	1	1
Drain #5	1	1	1	1
Drain #6	0	0	2	0
Dry Creek	1	1	0	1
Dutchman Creek	1	1	1	1
Eastside Bypass	1	1	1	1

Natural Waterbody	Alternative			
	SR 152 (North) to Road 13 Wye	SR 152 (North) to Road 19 Wye	Avenue 21 to Road 13 Wye	SR 152 (North) to Road 11 Wye
Escano Branch No. 1 Ditch	1	1	1	1
Escano Ditch	0	0	1	0
Fresno River	0	0	1	0
Historical Wood Slough	1	1	0	1
Island Field Drain	1	1	1	1
Island Field Drain #1	0	0	1	0
Lucerne Ditch	1	1	1	1
Mariposa Slough 1	1	1	1	1
Mariposa Slough 2	0	0	1	0
Orchard Ditch	1	1	1	1
Riverside Canal	1	1	1	1
San Joaquin River	1	1	1	1
San Juan Drain	1	1	2	1
Santa Rita Ditch	1	1	1	1
Santa Rita Drain No. 1	2	2	2	2
Santa Rita Slough	1	1	2	1
Schmidt Creek	1	1	1	0
Schmidt Creek Tributary	1	1	1	0
Temple Santa Rita Canal	1	1	1	1
West Santa Rita Drain	1	1	2	1
Wood Slough	1	1	1	1
Total	**31**	**32**	**39**	**30**

Source: Determined using ESRI ArcGIS versions 10.1, 10.2, and 10.3; Authority and FRA, 2016a
[1] These values represent the number of times the Central Valley Wye alternative would cross the waterbody. Some of the Central Valley Wye alternatives would cross the waterbodies multiple times.
SR = State Route

Canals typically provide irrigation water from riverine diversions and convey agricultural drainage. Such channels often have little to no slope so that water can be moved in either direction by the responsible water or irrigation district. Table 5-6 summarizes the number of times that the Central Valley Wye alternatives would cross irrigation canals and ditches. In some cases, one or more of the Central Valley Wye alternatives cross the same canal or ditch more than once.

Table 5-6 Irrigation Canals and Ditches Crossed by the Central Valley Wye Alternatives and the associated Number of Canal Crossings[1]

Irrigation Canal or Ditch	Alternative			
	SR 152 (North) to Road 13 Wye	SR 152 (North) to Road 19 Wye	Avenue 21 to Road 13 Wye	SR 152 (North) to Road 11 Wye
Ashview Canal	0	0	1	0
Berenda Canal	2	2	2	1
Bethel Canal	2	1	2	1
Calafia Canal	1	2	0	1
Chowchilla Canal	1	1	1	1
Irrigation Ditch #40	1	1	1	1
Irrigation Ditch #41	1	1	1	1
Irrigation Ditch #42	2	2	2	2
Irrigation Ditch #43	2	2	2	1
Irrigation Ditch #46	0	0	1	0
Irrigation Ditch #48	1	1	1	1
Irrigation Ditch #49	1	1	1	1
Irrigation Ditch #55	0	0	1	0
Irrigation Ditch #56	1	1	0	1
Irrigation Ditch #57	1	1	0	1
Irrigation Ditch #58	1	1	0	1
Irrigation Ditch #59	1	1	0	1
Irrigation Ditch #67	0	0	1	0
Irrigation Ditch #68	0	0	1	0
Irrigation Ditch #69	0	0	1	0
Irrigation Ditch #70	0	0	1	0
Irrigation Ditch #71	0	0	1	0
Irrigation Ditch #72	0	0	1	0
Irrigation Ditch #78	1	1	1	0
Irrigation Ditch #81	0	0	1	0
Irrigation Ditch #82	0	0	1	0
Irrigation Ditch #83	0	0	0	1
Justin Canal	0	0	0	2
Lat 2	1	0	1	1
Lat 24.2	1	1	1	1
Lat 24.2-8-1.0	1	1	0	1

Irrigation Canal or Ditch	Alternative			
	SR 152 (North) to Road 13 Wye	SR 152 (North) to Road 19 Wye	Avenue 21 to Road 13 Wye	SR 152 (North) to Road 11 Wye
Lat 24.2-8.9	2	2	1	2
Lat 24.2-8.9-1.0	0	0	1	0
Lat 3	1	0	1	1
Lat 32.2	1	1	1	1
Lat 32.2-9.9	0	0	1	0
Lat 32.2-9.9-0.1	0	0	1	0
Lat 32.2-9.9-1.0	0	0	1	0
Lat 32.2-9.9-1.5	0	0	1	0
Lat 32.2-9-2.0	0	0	1	0
Lat 4	1	0	1	1
Road 11 Canal	1	1	1	1
San Juan Canal	2	2	2	2
West San Juan Drain No. 1	1	1	1	1
Total	**31**	**28**	**41**	**30**

Source: Determined using ESRI ArcGIS versions 10.1, 10.2, and 10.3; Authority and FRA, 2016a
[1] These values represent the number of times the Central Valley Wye alternative would cross the irrigation canal or ditch. Some of the Central Valley Wye alternatives would cross the canals multiple times.
SR = State Route Lat = lateral

5.1.3.2 Hydrologic Area

A hydrologic area is a drainage basin or subwatershed within a larger HU and even larger hydrologic region. The surface water RSA is within four watersheds within the San Joaquin River Basin the San Joaquin Valley floor, Delta Mendota Canal, Mariposa, and Ahwanee HUs. The Central Valley Wye alternatives are within the San Joaquin Valley floor and Delta-Mendota Canal HUs. The Central Valley Wye alternatives cross the Berenda Creek, Madera, Gravelly Fork, El Nido-Stevinson, and Merced Hydrologic Areas. The Central Valley Wye alternatives also cross the Los Banos Hydrologic Area of the Delta-Mendota HU. The following discussion presents primary hydrologic areas within the surface water RSA, and includes sloughs, rivers, creeks, channels, and bypasses. Figure 4-1 shows the hydrologic areas (subwatersheds) within the surface water RSA.

5.1.3.3 Sloughs

A slough is a wetland, usually a swamp or shallow lake, often a backwater to a larger body of water. Water tends to be stagnant or may flow slowly on a seasonal basis. Some sloughs are channelized for the purposes of flood protection or water distribution.

Ash Slough

Ash Slough is a distributary channel of the Chowchilla River that enters the Eastside Bypass system. Ash Slough includes levees on both banks of the channel, diversion structures, and drop structures.

Berenda Slough

Berenda Slough is a distributary channel of the Chowchilla River that enters the Eastside Bypass system. A diversion dam on Berenda Slough sends excess flows through a diversion channel to Ash Slough. Several other flow diversions move water between streams. Madera County maintains and operates Berenda Slough.

5.1.3.4 Rivers

A river is a natural flowing watercourse, usually freshwater, flowing towards an ocean, a lake, a sea, or another river. In some rare cases a river could flow into the ground and dry up completely at the end of its course, without reaching another body of water. Some rivers are artificially channelized for the purposes of water conveyance or flood control.

San Joaquin River

The San Joaquin River originates in the Sierra Nevada as three branches. The South Fork begins at Martha Lake at an elevation of 11,004 feet. The Middle Fork begins at Thousand Island Lake and joins the South Fork north of Balloon Dome in the Ansel Adams Wilderness. The river flows west to the Central Valley, where it is joined by the Sierra Nevada's other great rivers, such as the Kern, Fresno, Chowchilla, and Merced. At Mendota Pool, the San Joaquin River flows north to the Sacramento–San Joaquin Delta and then ultimately to the San Francisco Bay. With the exception of overflow and drain water along the North Fork of the Kings River, which meets the San Joaquin River at Mendota Pool, the San Joaquin River itself is the southernmost river of the greater San Joaquin River Watershed.

During some years, portions of the San Joaquin River (and some of its tributaries) run dry as water urban or agricultural users divert water from the river. Though these users return agricultural drain water or urban wastewater to the original channel downstream of the point of diversion, the water returned to the river is not of the same quality as the water found in the upper watersheds. In other places, such as at the confluence of the San Joaquin and Chowchilla Rivers near Dos Palos, bypass channels, such as the Eastside Bypass, divert the river flow for other uses.

The following rivers, creeks, and sloughs, shown on Figures 5-1a through 5-1l, are tributaries of the San Joaquin River: Mokelumne River, Cosumnes River, Calaveras River, Stanislaus River, Tuolumne River, Merced River, Bear Creek, Hospital Creek, Ingram Creek, Chowchilla River, Ash Slough, Berenda Slough, and Fresno River. Figures 5-1a through 5-1l also show irrigation crossings. The Central Valley Wye is within Reach 4 of the SJRRP which has a levee- to-levee channel width that varies between 200- and 700-feet wide (USBR and DWR 2012).

Dams and water diversions regulate the San Joaquin River flows. The SJRRP is a comprehensive long-term effort to restore flows to the San Joaquin River from Friant Dam to the confluence with the Merced River to allow for fish passage. The stated objective of the program is to restore a self-sustaining Chinook salmon fishery in the river while reducing or avoiding adverse water supply effects from restoration flow releases.

The SJRRP flow releases began in 2009. Base flows of 350 cubic feet per second (cfs) from Friant Dam result in about 45–175 cfs[7] remaining in the channel 60 miles downstream, below Sack Dam. The highest flows, up to around 4,000 cfs, are released by the U.S. Bureau of Reclamation in the spring over a few-month period (depending on water year type[8]). The program includes a 10-day 700 cfs fall pulse in most water year types. The U.S. Bureau of Reclamation is scheduled to receive an allocation of water that could release up to 70 cfs into the Eastside Bypass. At 70 cfs, the U.S. Bureau of Reclamation expects that a groundwater level threshold

[7] This is the most common year-round flow range in the river channel below Sack Dam.

[8] The DWR categorizes water years into five types: Wet, Normal, Below Normal, Dry, and Critical. Volume of planned water releases depends on the water year type.

would be reached. The *Draft Seepage Management Plan* indicates that this allocation would help address groundwater seepage issues (USBR 2014).

Chowchilla River

The Chowchilla River flows for 65 miles from the western side of the Sierra Nevada range toward the San Joaquin River system. Most of the lower half of the river forms the border between Merced and Madera Counties. The last 2 miles of the river also serve as an irrigation canal for farms located along its banks. The main river channel ends abruptly about 3 miles east of the San Joaquin River and discharges into the Eastside Bypass. The river has never had a defined natural outlet to the San Joaquin River, as evidenced by the fact that the riverbed shrinks considerably in size as it travels west. A natural outlet never existed because the river has only a seasonal flow, and the natural water flow would normally seep into the ground, dry up, or be absorbed by natural wetlands before it had a chance to reach the San Joaquin River (DWR 2010).

Fresno River

The Fresno River is a major tributary of the San Joaquin River. It runs approximately 68 miles from the Sierra Nevada range to the San Joaquin River. The Eastside Bypass intercepts the river at the downstream end of the Chowchilla Bypass. The river exits the bypass then flows generally northwest to its confluence with the San Joaquin River, just north of SR 152. The DWR's *State Plan for Flood Control Facilities* on the river includes an excavated trapezoidal channel with levees on both banks for a realigned Fresno River and a diversion weir intended to reduce flood risk to adjacent agricultural land and the city of Madera. The Lower San Joaquin Levee District maintains the Chowchilla and Eastside bypasses (DWR 2010).

5.1.3.5 Creeks

A creek is a natural stream of water normally smaller than and often tributary to a river. Some creeks are channelized for the purposes of water distribution or flood control.

Berenda Creek

Berenda Creek is a tributary channel of the Fresno River that enters the holding ponds near the boundary of the Madera Irrigation District. Madera County maintains the creek for flood control. The channel delivers water to the Madera Irrigation District for agricultural use, and much of the flow along the creek is from irrigation flows.

Dry Creek

Dry Creek is a tributary channel of the Fresno River that enters the Eastside Bypass system.

Schmidt Creek

Schmidt Creek is a tributary channel of Dry Creek.

Schmidt Creek Tributary

Schmidt Creek Tributary is a tributary channel of Dry Creek.

Dutchman Creek

Dutchman Creek originates from the foothills of the Sierra Nevada range and drains to the San Joaquin River. Dutchman Creek has a watershed area of 84.11 square miles.

Deadman Creek

Deadman Creek originates from the foothills of the Sierra Nevada range and drains to the San Joaquin river.

5.1.3.6 Bypass Channels

The Mariposa, Eastside, and Chowchilla bypass canals are components of the San Joaquin River bypass system. The bypass system was constructed with the objective to divert and carry flood

flows from the San Joaquin River at the Chowchilla bifurcation structure, along with flows from the eastside tributaries, downstream to the mainstem San Joaquin River upstream of the Merced River confluence (DWR 2010).

Chowchilla Bypass

As a component of the Lower San Joaquin River and Tributaries Project, the Chowchilla Bypass begins at the Chowchilla Bypass Bifurcation Structure (River Mile 216.1) in the San Joaquin River and runs northwest, parallel to the San Joaquin River, to the confluence of the Fresno River, where the Chowchilla Bypass ends and becomes the Eastside Bypass. The design channel capacity of the Chowchilla Bypass is 5,500 cfs. Highly permeable soils form the bottom of the bypass channel, and much of the initial flood flows infiltrate and recharge groundwater.

The Chowchilla Bypass Bifurcation Structure is a gated structure that controls the proportion of flood flows between the Chowchilla Bypass and Reach 2B of the San Joaquin River. The Lower San Joaquin Levee District maintains the Lower San Joaquin Levee District to keep flows in Reach 2B at a level less than 2,500 cfs because of channel capacity limitations, though significant seepage has been observed at flows above 1,300 cfs.

Eastside Bypass

The Eastside Bypass is a constructed channel which extends from the confluence of the Fresno River and the Chowchilla Bypass to its confluence with the San Joaquin River at the head of Reach 5. The bypass conveys water from the Chowchilla Bypass to the Mariposa Bypass Bifurcation Structure and back to the San Joaquin River. There are three reaches:

- **Eastside Bypass Reach 1**—Gradually increases in design channel capacity from 10,000 cfs to 17,000 cfs as it receives flows from the Fresno River, Berenda Slough, and Ash Slough, and ends at the downstream end of the Sand Slough Bypass, where it intercepts flows from the Chowchilla River.
- **Eastside Bypass Reach 2**—This reach has a design channel capacity of 16,500 cfs; it extends from the Sand Slough Bypass confluence to the Mariposa Bypass Bifurcation Structure at the head of the Mariposa Bypass and the Eastside Bypass Control Structure.
- **Eastside Bypass Reach 3**—This reach has a design channel capacity of 13,500 cfs at the Eastside Bypass Control Structure, and a design channel capacity of 18,500 cfs at its confluence with Bear Creek, extends from the Eastside Bypass Control Structure to the head of Reach 5 of the San Joaquin River, and receive flows from Deadman, Owens, and Bear Creeks. The gated Eastside Bypass Control Structure works in coordination with the Mariposa Bypass Bifurcation Structure to direct flows to either Eastside Bypass Reach 3 or to the Mariposa Bypass. The channel capacities are design capacities; subsidence of the land underlying the Eastside Bypass levees could reduce current capacities[9]. This reach ultimately joins with Bear Creek to return flows to the San Joaquin River.

At the HSR alignment crossing, the Eastside Bypass includes levees on both banks of the channel. Based on the DWR's Operations and Maintenance Manual, the channel has a design capacity of 17,000 cfs (USBR 2011). The Lower San Joaquin Levee District maintains the levees.

Mariposa Bypass

The Mariposa Bypass (River Mile 148) conveys water from the Eastside Bypass back to the San Joaquin River. The Mariposa Bypass Bifurcation Structure controls the proportion of flood flows that continue down the Eastside Bypass or return the San Joaquin River through the Mariposa Bypass to Reach 4B2. The Mariposa Bypass delivers flow back into the San Joaquin River from the Eastside Bypass at the head of Reach 4B2. There are gates on 8 of the 14 bays on the Mariposa Bypass Bifurcation Structure. The operating rule for the Mariposa Bypass is to divert all

[9] Subsidence conditions and potential effects are described in the *Central Valley Wye Geology, Soils, and Seismicity Technical Report* (Authority and FRA 2016b).

flows to the San Joaquin River when flows in the Eastside Bypass above the Mariposa Bypass are less than 8,500 cfs, with flows greater than 8,500 cfs remaining in the Eastside Bypass, eventually discharging back into the San Joaquin River at the Bear Creek Confluence at the end of Reach 4B2 of the San Joaquin River. However, actual operations have deviated from this rule, flows of up to 2,000 to 3,000 cfs have historically remained in the Eastside Bypass, and approximately one-quarter to one-third of the additional flows are released to the Mariposa Bypass (McBain and Trush 2002).

Flood flows not diverted to the San Joaquin River via the Mariposa Bypass continue down the Eastside Bypass and are returned to the San Joaquin River via Bravel Slough and Bear Creek. Bravel Slough reenters the San Joaquin River at mile post 136 and is the ending point of the bypass system.

5.2 Surface Water Quality

5.2.1 Surface Water Quality Conditions in the Study Area

Regional and local agricultural practices influence the surface water quality of the lower San Joaquin River watershed. Agricultural operations have the potential for pesticide application between November and January that can be conveyed to waterbodies through stormwater runoff and agricultural return flows. The Central Valley RWQCB detected pesticides known to be associated with agricultural operations in at least one of the lower San Joaquin River waterbodies that have been monitored. The Central Valley RWQCB detected elevated levels of arsenic, boron, cadmium, copper, iron, lead, manganese, molybdenum, selenium, and zinc at multiple locations within the lower San Joaquin River watershed (ICF Jones & Stokes 2008). These metals are all naturally occurring and are partially mobilized and concentrated by irrigated agriculture and mobilized by agricultural runoff. Pesticides may also include copper and molybdenum.

To convey water for agricultural purposes, the San Joaquin Valley's many watercourses are highly altered from their natural state. Small farm ponds are relatively common. Farmers and other agricultural producers pump groundwater and surface water to and from numerous canals and drains delivering irrigation water to and from agricultural fields. Irrigation canals generally lack the meanders, vegetation, biota, and other features of natural streams. Central California Irrigation District, Chowchilla Water District, El Nido Irrigation District, Le Grand Athlone Water District, Madera Irrigation District, San Luis Canal Company, and Sierra Water District act as purveyors of irrigation water in the Central Valley Wye vicinity.

Natural flow in river headwaters in the Sierra Nevada starts out generally free of pollutants. As natural flows decrease seasonally, concentrations of pollutants increase. Stormwater and irrigation runoff enters streams directly as overland flow and, therefore, surrounding land uses affect surface water quality. Urban and agricultural runoff can carry the dissolved or suspended residue of both natural and human land use practices within the watershed. Pollutant sources in urban areas include parking lots and streets; residential, commercial, and industrial development; rooftops; exposed earth at construction sites; and un-landscaped, undeveloped areas. Pollutant sources in rural and agricultural areas primarily include agricultural fields and operations.

Pollutants in runoff can include sediment, oil and grease, hydrocarbons (e.g., fuels, solvents), heavy metals, organic fertilizers and pesticides, pathogens, nutrients, and debris. Construction activities, such as grading that remove vegetation and expose soil to erosion, can contribute to accelerated erosion rates, which can result in runoff containing sediment that ultimately flows into surface waters. In addition, potentially erosive conditions occur in areas that have a combination of erosive soil types and steep slopes. The *Merced to Fresno Section: Central Valley Wye Geology, Soils, and Seismicity Technical Report* (Central Valley Wye Geology, Soils, and Seismicity Technical Report) (Authority and FRA 2016a), provides more details regarding soil erosion.

5.2.2 Surface Water Quality for the Central Valley Wye

The Basin Plan (Central Valley RWQCB 2016) designates beneficial uses for specific surface water and groundwater resources, establishes water quality objectives to protect those uses, and sets forth policies to guide the implementation of programs to attain the objectives. Table 5-7 summarizes the beneficial uses of waterbodies in the surface water RSA.

Table 5-7 Beneficial Uses of Surface Water in the Resource Study Area

Surface Waterbody	HUC Watershed	Beneficial Uses[1]
Chowchilla River (Buchanan Dam to San Joaquin River)	Upper Chowchilla – Upper Fresno (HUC # 18040007); Middle San Joaquin – Lower Chowchilla (HUC # 18040001)	Municipal and Domestic Supply (potential); Agricultural Irrigation; Industrial Processes; Water Contact Recreation; Canoeing and Rafting (potential); Other Non-contact Water Recreation; Warm Freshwater Habitat; Wildlife Habitat
San Joaquin River (Sack Dam to Mouth of Merced River)	Upper San Joaquin (HUC # 18040006); Middle San Joaquin – Lower Chowchilla (HUC # 18040001)	Municipal and Domestic Supply (potential); Agricultural Irrigation; Agricultural Stock Watering; Industrial Processes; Water Contact Recreation; Canoeing and Rafting; Other Non-contact Water Recreation; Warm Freshwater Habitat; Warm Migration; Cold Migration; Warm Spawning; Cold Spawning (potential); Wildlife Habitat

Source: Central Valley RWQCB, 2016
[1] Beneficial use is existing unless noted as "potential."

The SWRCB developed a list of waterbodies (known as 303(d) water quality limited waterbodies) that are impaired and do not meet water quality objectives (CWA § 303(d) specifies the requirements for listing impaired waterbodies). The SWRCB develops TMDLs over several years for constituents on the list to restore the quality of the waterbody. A few of the waterbodies crossed by the Central Valley Wye alternatives are on the Section 303(d) list and require TMDL limits (SWRCB 2015) (Table 5-8).

Table 5-8 Section 303(d) List of Impaired Waters in the Resource Study Area

Waterbody	Impairment	Source of Impairment	TMDL Completion Date
2012 Integrated Report 303(d) Listings			
Ash Slough (Madera County)	Chlorpyrifos	Unknown	2021
Berenda Slough (Madera County)	Chlorpyrifos	Agriculture	2021
Berenda Creek (Madera County)	Chlorpyrifos Unknown toxicity	Agriculture Unknown	2021 2021
San Joaquin River (Mendota Pool to Bear Creek)	Boron Chlorpyrifos DDT Diazinon Group A Pesticides Unknown toxicity	Agriculture Agriculture Agriculture Agriculture Agriculture Unknown	2019 2007 2011 2007 2011 2019
Deadman Creek (Merced County)	Chlorpyrifos	Unknown	2021
	Escherichia coli *(E. coli)*	Unknown	2021

Source: SWRCB, 2015
TMDL = total maximum daily load DDT = dichlorodiphenyltrichloroethane

Table 5-7 lists the beneficial uses and Table 5-8 lists 303(d)-listed impairments of waterbodies in the Central Valley Wye vicinity. Currently, five waterbodies are impaired—the San Joaquin River (Mendota Pool to Bear Creek), Ash Slough, Berenda Slough, Berenda Creek, and Deadman Creek—meaning these waters do not meet water quality standards for one or more constituents (Central Valley RWQCB 2016). The impairments are attributed to chlorpyrifos, boron, dichlorodiphenyltrichloroethane, diazinon, Group A Pesticides, *E. coli*, and unknown toxicity from agricultural and unknown sources. The SWRCB expects to complete or has completed TMDLs for chlorpyrifos in the San Joaquin River (Mendota Pool to Bear Creek), Ash Slough, Berenda Slough, Berenda Creek, and Deadman Creek in 2007, 2021, 2021, 2021, and 2021, respectively. The SWRCB expects to complete the TMDL for unknown toxicity in Berenda Creek in 2021, as well as the TMDL for *E. coli* in Deadman Creek in 2021.

The SWRCB expects to or completed TMDLs for boron, chlorpyrifos, dichlorodiphenyl-trichloroethane, diazinon, Group A Pesticides, and the unknown pollutant in the San Joaquin River (Mendota Pool to Bear Creek) in 2019, 2007, 2011, 2007, 2011, and 2019, respectively. The Central Valley Wye alternatives are in areas where the majority of the soils have a high to moderate degree of water erosion potential. However, the low gradient of the surface water RSA reduces the overall erosion risk to low (refer to Table 5-2 in the Central Valley Wye Geology, Soils, and Seismicity Technical Report [Authority and FRA 2016b: page 5-7]). The *Central Valley Wye Geology, Soils, and Seismicity Technical Report* (Authority and FRA 2016b) provides more details regarding soil erosion.

The Basin Plan specifies the water quality objectives for the San Joaquin River (Central Valley RWQCB 2016). Table 5-9 lists the water quality constituents described in the Basin Plan and their objectives.

Table 5-9 Water Quality Objectives Provided in the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins

Water Quality Constituent	Water Quality Objective
Bacteria[1]	In waters designated REC-1 the fecal coliform concentration based on a minimum of not less than five samples for any 30-day period shall not exceed a geometric mean of 200/100 ml, nor shall more than 10 percent of the total number of samples taken during any 30-day period exceed 400/100 ml.
Biostimulatory Substances	Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths in concentrations that cause nuisance or negatively affect beneficial uses.
Chemical Constituents[2]	Waters shall not contain chemical constituents in concentrations that negatively affect beneficial uses. At a minimum, water designated MUN[2] shall not contain concentrations of chemical constituents in excess of the MCLs specified in the following provisions of Title 22 of the California Code of Regulations.
Color	Waters shall be free of discoloration that causes nuisance or negatively affects beneficial uses.
Dissolved Oxygen	Within the legal boundaries of the Delta, the DO concentration shall not be reduced by the amounts specified in the Basin Plan. For surface waterbodies outside the legal boundaries of the Delta, the monthly median DO concentrations shall not fall below 85 percent of saturation in the main water mass, and the 95 percentile concentration shall not fall below 75 percent of saturation. The DO concentrations shall not be reduced below the minimum levels specified in the Basin Plan.
Floating Material	Waters shall not contain floating material in amounts that cause nuisance or negatively affect beneficial uses.

Water Quality Constituent	Water Quality Objective
Methylmercury	For the Delta and Yolo Bypass waterways listed in Appendix 43 of the Basin Plan, the average methylmercury concentrations shall not exceed 0.08 and 0.24 mg methylmercury/kg, wet weight, in muscle tissue of trophic level 3 and 4 fish, respectively (150–500 mm total length). The average methylmercury concentrations shall not exceed 0.03 mg methylmercury/kg, wet weight, in whole fish less than 50 mm in length.
Oil and Grease	Waters shall not contain oils, greases, waxes, or other materials in concentrations that cause nuisance, result in a visible film or coating on the surface of the water or on objects in the water, or otherwise negatively affect beneficial uses.
pH	The pH of water shall not be depressed below 6.5, raised above 8.5, or changed at any time more than 0.3 unit from normal ambient pH.
Pesticides[2]	Pesticide concentrations shall not exceed the levels identified in Table III-2A of the Basin Plan and shall meet all other objectives listed in the Basin Plan pertaining to concentrations, discharges, total identifiable persistent chlorinated hydrocarbon pesticides, antidegradation policies, municipal supply, and thiobencarb.
Radioactivity	Radionuclides shall not be present in concentrations that are deleterious to human, plant, animal, or aquatic life nor that result in the accumulation of radionuclides in the food web to an extent that presents a hazard to human, plant, animal, or aquatic life.
Salinity	The objectives in Table III-3 of the Basin Plan shall be met for the specified waterbodies. Salinity objectives applicable in the Delta can be found in the *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary*.
Sediment	The suspended sediment load and suspended sediment discharge rate of waters shall not be altered in such a manner as to cause nuisance or negatively affect beneficial uses.
Settable Material	Waters shall not contain substances in concentrations that result in the deposition of material that causes nuisance or negatively affects beneficial uses.
Suspended Material	Waters shall not contain suspended material in concentrations that cause nuisance or negatively affect beneficial uses.
Taste and Odors	Waters shall not contain taste- or odor-producing substances in concentrations that impart undesirable tastes or odors to fish flesh or other edible products of aquatic origin, or that cause nuisance, or otherwise negatively affect beneficial uses.
Temperature	Natural receiving water temperatures of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the RWQCB that such alteration in temperature does not negatively affect beneficial uses.
Toxicity	All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life.
Turbidity	Waters shall be free of changes in turbidity that cause nuisance or negatively affect beneficial uses. Increases in turbidity attributable to controllable water quality factors shall not exceed limits provided in the Basin Plan.

Source: Central Valley RWQCB, 2016
[1] Water Quality Objective based on REC-1 beneficial use.
[2] MUN beneficial use designation triggers maximum contaminant levels for specific constituents.
REC-1 = water contact recreation ml = milliliter
MUN = municipal and domestic water supply MCL = maximum contaminant level
Delta = Sacramento–San Joaquin River Delta DO = dissolved oxygen
Basin Plan = *Water Quality Control Plan for the Sacramento River and San Joaquin River Basins* (Central Valley RWQCB 2016)
mg = milligrams
kg = kilograms mm = millimeters
RWQCB = Regional Water Quality Control Board

5.2.3 Erosion

Erosion is a major contributing factor to the degradation of surface water quality in the Central Valley. Silt and sand carried by stormwater runoff are the products of continuing soil erosion within the Sierra Nevada watersheds. As the topography flattens across the valley floor, runoff deposits soil and that soil accumulates slowly in the channels. The accumulated material gradually decreases channel capacity, which forces floodwaters to move into the surrounding floodplain. Additionally, urbanization and suburbanization create impervious surfaces that result in increased stormwater runoff volumes and flow velocities that can cause scour and erosion of natural stream channels. Upland erosion also causes sedimentation in the floodplains adjacent to the smaller streams and creeks, slowly decreasing their capacity to alleviate downstream flooding. As documented in the *Central Valley Wye Geology, Soils, and Seismicity Technical Report* (Authority and FRA 2016b), most of the Central Valley Wye would not run through areas that are particularly susceptible to erosion, with the exception of the following reaches which have relatively high erosion potential:

- Along the San Joaquin River
- Intermittently along SR 152 surrounding the SR 152 (North) to Road 13 Wye and SR 152 (North) to Road 11 Wye Alternatives
- Northern portion of the surface water RSA along SR 99, Road 13, Road 19, and Road 11
- Along Avenue 21 between approximately Road 15 and Road 19

5.3 Groundwater

5.3.1 Groundwater Conditions in the Study Area

Groundwater in the region is present in unconfined or semi-confined conditions as a part of the San Joaquin Valley groundwater basin. Most of the San Joaquin Valley floor is underlain by several thousand feet of Tertiary, or older, sediments, which were deposited on a basement complex of granitic and metamorphic rocks. Water is stored in relatively coarse-grained geologic units, such as the Mehrten Formation, which have sand and gravel zones.

Groundwater is a major water supply source for agricultural and urban uses in the region (Table 5-10). Table 5-11 identifies the groundwater subbasins crossed by the Central Valley Wye alternatives. Numerous large- and small-scale districts provide domestic water service to the communities, and in some areas municipal supply consists entirely of groundwater. Beneficial uses of groundwater in these subbasins include municipal, industrial, and agricultural supply.

Agricultural irrigation depends heavily on groundwater recharge in the vicinity of Chowchilla, as do surface water flows in the Chowchilla River, Ash Slough, and Berenda Slough especially during dry years or when surface water irrigation supplies are unavailable. However, the area does not have high groundwater recharge potential in general (Boyle Engineering Corporation 2008).

Table 5-10 Groundwater Extraction in the San Joaquin River Hydrologic Region

Use of Groundwater for Water Supply	Groundwater Pumping (AF/year)
Regional Groundwater Demand (San Joaquin River Hydrologic Region)	
Agricultural and municipal groundwater use	2,195,000
Local Municipal Supply	
City of Chowchilla	2,852–4,189
City of Madera	9,849–13,114
City of Merced	22,171–24,397

Source: DWR, 2003; City of Chowchilla, 2010; City of Madera, 2011; page 4-6; City of Merced, 2011: page 4-11
AF/year = acre-feet per year

Groundwater pumping greatly exceeds natural recharge, a condition known as overdraft. The overdraft estimate in the Chowchilla Water District and Madera Irrigation District is approximately 20,000 acre-feet per year (AF/year) (City of Chowchilla et al. 2014). DWR considers all of the subbasins in the groundwater RSA to be in critical overdraft (DWR 2016). As a result, groundwater levels in the Chowchilla Water District have fallen at a rate of 1.5 feet per year over the last 25-year period (USBR 2008). Water levels in the Chowchilla and Madera Subbasins declined approximately 30 feet between 1970 and 1978, stabilized and rebounded 25 feet between 1978 and 1987, declined between 1987 and 1996, and rose 8 feet from 1996 to 2000 with a total decrease of nearly 40 feet between 1970 and 2000 (DWR 2004a, 2004b). Groundwater levels in the Merced Subbasin declined nearly 30 feet from 1970 to 2000, with groundwater levels fluctuating over the 30-year period (DWR 2004c). Groundwater levels in the Delta-Mendota Subbasin fluctuated more than 17 feet from 1970 to 2000, but water levels in 2000 were approximately 2 feet above 1970 levels (DWR 2006). Groundwater level data for the Chowchilla, Delta-Mendota, Merced, and Madera subbasins was most recently updated by the DRW between 2004 and 2006; however, more recent data show that declines have continued in recent years. Wells monitored in the Madera Regional Groundwater Management Plan area, which include the Chowchilla, Delta-Mendota, and Madera subbasins, have decline on average between 31 and 155 feet from 1980 to 2011 (City of Chowchilla et al. 2014). The current average annual overdraft in the valley floor portion of Madera County, which includes the groundwater RSA, is approximately 100,000 AF/year (Boyle Engineering Corporation 2008). This area includes the Madera, Chowchilla, and Delta-Mendota subbasins.

Groundwater in the San Joaquin Groundwater Basin tends to have sodium bicarbonate alkalinity with low total dissolved solids, hardness, iron, and manganese. However, localized areas of high hardness, iron, nitrate, chloride, fluoride, and boron exist in the subbasins (DWR 2004a, 2004b, 2004c, 2006). Septic disposal leach fields, fertilizers, stockpiled animal manure or plant residues, and unusual geologic conditions are potential sources of nitrate contamination in groundwater (Merced County 1990). Local agencies generally are responsible for approval of septic disposal fields and confined animal operations, based on site-specific soil conditions and the potential for contamination.

Table 5-11 Groundwater Subbasins Crossed by the Central Valley Wye Alternatives

Groundwater Basin (name)	Total Groundwater Basin Area (acres)[1]	Groundwater Storage (AF)[1]	Typical Well Depths (feet)[1]	Approximate Length of Groundwater Basin Crossed (miles)[2]	Approximate Area of Groundwater Basin Crossed by HSR (acres)[3]	Designated Sole-Source Aquifer[4]
Chowchilla Subbasin	159,000	5,500,000	100–800	29.6–30.4	1,358–1,680	No
Delta-Mendota Subbasin	747,000	26,600,000	50–800	6.3–7.4	238–292	No
Merced Subbasin	491,000	15,700,000	100–800	5.4–9.2	115–458	No
Madera Subbasin	394,000	12,600,000	100–600	10.8–12.0	396–430	No

Source: Calculated using ESRI ArcGIS versions 10.1, 10.2, and 10.3 (DWR, 2004a, 2004b, 2004c, 2006)
[1] Basin areas, storage, and well depths are from Bulletin 118 (DWR 2004a, 2004b, 2004c, 2006).
[2] Length calculated by overlaying geographic information system (GIS) layers for the proposed Central Valley Wye alternatives on the GIS layer for the groundwater basin.
[3] Area calculated by overlaying GIS layers for the proposed permanent Central Valley Wye alternatives' footprints on the GIS layer for the groundwater basin.
[4] The U.S. Environmental Protection Agency defines a sole- or principal-source aquifer as an aquifer that supplies at least 50 percent of the drinking water consumed in the area overlying the aquifer. These areas may have no alternative drinking water source(s) that could physically, legally, and economically supply all those who depend on the aquifer for drinking water. For convenience, all designated sole- or principal-source aquifers are referred to as "sole-source aquifers."
AF = acre-feet
HSR = high-speed rail

Most of Merced County lies within the Merced Subbasin (Figure 4-2). The Central Valley Wye alternatives in Merced County are within an area of high groundwater tables, with groundwater within 0–10 feet of the ground surface in some areas. The Central Valley Wyes are within a groundwater recharge area for the San Joaquin River and its tributaries. Surface water diversions for irrigation, municipal, and industrial water supplies have reduced stream flows, resulting in less-than-historic percolation recharge in streambeds. Currently, groundwater withdrawals exceed recharge levels (Merced County 1990).

5.3.2 Chowchilla Subbasin

The Chowchilla Subbasin, which covers approximately 159,000 acres in Merced and Madera Counties, is bounded on the west by the Delta-Mendota Subbasin, on the north by the Merced Subbasin and on the south and the east by the Madera Subbasin (DWR 2003). Groundwater within the Chowchilla Subbasin flows generally to the southwest (DWR 2004a). Depth to groundwater ranges from approximately 100 to 250 feet below ground surface in the Central Valley Wye vicinity (DWR 2012b).

Groundwater recharge in the Chowchilla Subbasin is primarily from percolation of applied irrigation water. Approximately 179,000 AF/year of applied water enters the subbasin. Annual natural recharge is approximately 87,000 acre-feet. DWR has estimated urban and agricultural groundwater extractions to be 6,000 and 249,000 AF/year, respectively (DWR 2004a).

Groundwater levels in the Chowchilla Subbasin decreased by approximately 40 feet from 1970 to 2000, with the most severe water level declines occurring in the eastern portion of the subbasin (DWR 2004a). Storage capacity in the subbasin is estimated at approximately 8,000,000 acre-feet to a depth of 300 feet and 13,900,000 acre-feet to the base of fresh groundwater (DWR 2004a).

The Chowchilla Subbasin is not a USEPA-designated or state-designated sole source aquifer (USEPA 2009). Within the groundwater RSA, the state has identified the following beneficial uses for groundwater in the subbasin: municipal and domestic supply, agricultural supply, industrial service supply, and industrial process supply. Within the subbasin, there are localized areas of high nitrate, hardness, iron, and chloride (DWR 2004a).

5.3.3 Delta-Mendota Subbasin

The Delta-Mendota Subbasin covers approximately 747,000 acres in Fresno, Madera, Merced, and Stanislaus Counties. The Delta-Mendota Subbasin is bounded on the west by the Los Banos Creek Valley, on the south by the Tulare Lake Basin, on the east by the Modesto, Turlock, Merced, Chowchilla, and Madera subbasins, and on the north by the Tracy Subbasin (DWR 2003). Groundwater within the Delta-Mendota Subbasin flows generally to the northeast, toward the San Joaquin River (DWR 2006).

Groundwater recharge in the Delta-Mendota Subbasin is primarily from percolation of applied irrigation water. Approximately 74,000 AF/year of applied irrigation water enters the subbasin. Annual natural recharge is approximately 8,000 acre-feet. DWR has estimated urban and agricultural groundwater extractions to be 17,000 and 491,000 AF/year, respectively, with other extraction equaling 3,000 acre-feet (DWR 2006). Groundwater levels in the Delta-Mendota Subbasin increased by over 2 feet from 1970 to 2000 (DWR 2006). Storage capacity in the subbasin is estimated by DWR at approximately 30,400,000 acre-feet to a depth of 300 feet and 81,800,000 acre-feet to the base of fresh groundwater (DWR 2006).

The Delta-Mendota Subbasin is not a USEPA-designated or state-designated sole source aquifer (USEPA 2009). Within the groundwater RSA, the state has identified the following beneficial uses for groundwater in the subbasin: municipal and domestic supply, agricultural supply, industrial service supply, and industrial process supply. A large portion of the subbasin has shallow, saline groundwater, with localized areas of high iron, fluoride, nitrate, and boron (DWR 2006).

5.3.4 Merced Subbasin

The Merced Subbasin covers approximately 491,000 acres in Merced County. The Merced Subbasin is bounded on the west by the Delta-Mendota Subbasin, on the east by the Yosemite Valley, on the north by the Turlock Subbasin, and on the south by the Chowchilla and Merced Subbasins (DWR 2003). Groundwater within the Merced Subbasin flows to the southwest (DWR 2004c). Depth to groundwater ranges from approximately 150 to 230 feet below ground surface in the Central Valley Wye vicinity (DWR 2012b).

Groundwater recharge in the Merced Subbasin is primarily from percolation of applied irrigation water. Approximately 243,000 AF/year of applied water enters the subbasin. Annual natural recharge is approximately 47,000 acre-feet. DWR has estimated urban and agricultural groundwater extractions to be 54,000 and 492,000 AF/year, respectively, with other extractions equaling 9,000 acre-feet (DWR 2004c). Groundwater levels in the Merced Subbasin decreased by approximately 30 feet from 1970 to 2000, with the most severe water level declines occurring in the eastern portion of the subbasin (DWR 2004c). Storage capacity in the subbasin is estimated at approximately 15,700,000 acre-feet to a depth of 300 feet, and 47,600,000 acre-feet to the base of fresh groundwater (DWR 2004c).

The Merced Subbasin is not a USEPA-designated or state-designated sole source aquifer (USEPA 2009). Within the groundwater RSA, the state has identified the following beneficial uses for groundwater in the subbasin: municipal and domestic supply, agricultural supply, industrial service supply, and industrial process supply. Within the subbasin, there are localized areas of high hardness, iron, nitrate, and chloride (DWR 2004b).

5.3.5 Madera Subbasin

The Madera Subbasin covers approximately 394,000 acres in Madera County. The Madera Subbasin is bounded on the west by the Delta-Mendota Subbasin, on the east by the Yosemite Valley, on the north by the Chowchilla and Merced subbasins, and on the south by the Tulare Lake Basin (DWR 2003). Groundwater within the Chowchilla Subbasin flows to the southwest and northwest in the eastern and southern portions of the subbasin, respectively (DWR 2004b). Depth to groundwater ranges from approximately 180 to 260 feet below ground surface in the Central Valley Wye vicinity (DWR 2012b).

Groundwater recharge in the Madera Subbasin is primarily from percolation of applied irrigation water. Approximately 404,000 AF/year of applied water enters the subbasin. DWR has estimated annual natural recharge to be approximately 21,000 acre-feet. Urban and agricultural groundwater extractions are estimated at 15,000 and 551,000 AF/year, respectively (DWR 2004b). Groundwater levels in the Madera Subbasin decreased by approximately 40 feet from 1970 to 2000, with the most severe water level declines occurring in the eastern portion of the subbasin (DWR 2004b). DWR has estimated storage capacity in the subbasin is estimated to be approximately 12,600,000 acre-feet to a depth of 300 feet in 1995 and 24,000,000 acre-feet to depths up to 1,000 feet in 1961 (DWR 2004b).

The Madera Subbasin is not a USEPA-designated or state-designated sole source aquifer (USEPA 2009). Within the groundwater RSA, the state has identified the following beneficial uses for groundwater in the subbasin: municipal and domestic supply, agricultural supply, industrial service supply, and industrial process supply. Within the subbasin, there are localized areas of high hardness, iron, nitrate, and chloride (DWR 2004b).

5.3.6 Groundwater for the Central Valley Wye

The Central Valley Wye alternatives lie within the San Joaquin Valley groundwater basin and cross through four of its nine subbasins: Chowchilla, Delta-Mendota, Merced, and Madera. Table 5-11 summarizes the groundwater subbasins crossed by the Central Valley Wye alternatives, and Figure 4-2 shows where the Central Valley Wye alternatives pass through those subbasins. The aquifers in these subbasins are generally thick, with wells often extending to 800-foot depths (DWR 2003). Freshwater-bearing deposits reach their maximum thickness of 4,400 feet at the southern end of the San Joaquin Valley (DWR 2003).

Groundwater levels fluctuate with seasonal rainfall, withdrawal, and recharge.[10] Depth to groundwater in the San Joaquin Valley ranges from a few inches to more than 100 feet. Groundwater levels in the groundwater RSA are generally deep; most of the water depths are greater than 50 feet (Table 5-12). Depth to groundwater ranges from less than 50 feet in the Merced Subbasin to more than 250 feet in the Madera Subbasin, fluctuating with seasonal rainfall, recharge, and pumping (DWR 2012b). Recharge occurs naturally (e.g., from rainfall) but also results from importing surface water for irrigation. Extensive clay and hardpan layers generally limit infiltration throughout the basin, but recharge areas exist along active stream channels that contain substantial amounts of sand and gravel.

Table 5-12 Depth to Groundwater in the Vicinity of the Central Valley Wye Alternatives

Groundwater Subbasin	Location	Approximate Depth to Groundwater (feet bgs)
Chowchilla Subbasin	Chowchilla	180–190
Delta-Mendota Subbasin	Mendota	50
Merced Subbasin	Merced	40–80
Madera Subbasin	Madera	150–260

Source: DWR, 2012b
bgs = below ground surface

5.4 Floodplains

5.4.1 Floodplain Conditions in the Study Area

Historically, flooding has been a natural occurrence in the San Joaquin Valley because it is a natural drainage basin for thousands of watershed acres of the Sierra Nevada (on the east) and Coast range (on the west) foothills and mountains. The construction of dams, levees, and canals in the valley has changed the pattern of flooding, restricting it mainly to rivers and creeks and their adjacent floodplains. The two types of flooding that can occur in the valley are general rainfall floods occurring in the late fall and winter in the foothills and on the valley floor and snowmelt floods occurring in the late spring and early summer.

Figure 4-3 shows the FEMA flood zones within the vicinity of the floodplain RSA. Figures 5-2a through 5-2l show more details of FEMA flood zones within the floodplain RSA.

Floodplains provide floodwater storage (which reduces the risk of downstream flooding), provide habitat for native species, improve water quality by allowing sediments and other contaminants to filtrate, and can provide locations for groundwater recharge. Within most urban areas, levees and upstream dams control floods. Conversely, many rural areas are subject to shallow flow or ponding, which spreads out over extensive areas. Shallow flooding occurs primarily from overflows of stream channels when flows exceed the capacity of the channels.

Although there is an extensive flood control system in the region, large portions of the San Joaquin River Basin are considered to be flood-hazard areas by FEMA and DWR.

Two types of events trigger floods in the San Joaquin Valley: rainfall occurring in the late fall and winter in the foothills and on the valley floor, and snowmelt from the Sierra Nevada range occurring in the late spring and early summer (Merced County 1990). Existing flood control in the Central Valley includes levees at the major rivers, bypass segments along the San Joaquin River, and at Millerton Lake, which moderates flood inflows into the Central Valley (DWR 2011). Over the past 55 years several record flood events have occurred within the floodplain RSA. The most recent major flood events occurred in the floodplain RSA along the Lower San Joaquin River in 1955, 1983, 1986, 1995 and 1997. While the distribution of flood damage in the region has varied

[10] *Recharge* is the natural replenishment of groundwater from rain or other surface water.

considerably with each storm event, the highest magnitude of damage occurred to agricultural crops and developments.

The San Joaquin Area Flood Control Agency has partnered with local agencies to develop regional flood management plans for flood management planning regions within the Central Valley. The floodplain RSA is within the Upper San Joaquin River Region and Delta South Region (DWR 2012a). FEMA has identified SFHAs on FIRMs for all communities that participate in the National Flood Insurance Program. State and local governments use these FIRMs for administering floodplain management programs, enforcing building codes, and mitigating flooding losses. Merced and Madera Counties participate in this program. FEMA develops the floodplain information on the FIRM based on historical data and hydrologic and hydraulic computations.

5.4.2 Floodplain Crossings for the Central Valley Wye

The 100-year floodplain, or the areas inundated by a storm having a 1 percent annual chance of occurrence (known as the *base flood*) is designated as an SFHA.[11] SFHAs represent high-risk areas, which are 100-year flood zones (FEMA flood zones A or V). The SFHA is the land area covered by the base flood to which the FEMA floodplain management regulations apply (FEMA 2015). Federal, state, and local agencies restrict and regulate development in an SFHA. Table 5-13 defines the SFHAs in the floodplain RSA—FEMA flood zones A, AE, AH, and AO. Table 5-13 also defines the 100-year to 500-year flood Zone X (shaded) or Zone B and Zone X (unshaded) or Zone C. These flood zone designations apply to areas of minimal to moderate flood hazard and are not designated SFHAs.

Table 5-13 Federal Emergency Management Agency Flood Zone Designations in the Floodplain Resource Study Area

Zone[1]	Zone Description
A	Areas with a 1 percent annual chance of flooding (i.e., within 100-year floodplain). Because FEMA did not perform detailed analyses for such areas, no depths or BFEs are shown within these zones.
AE	Areas with a 1 percent annual chance of flooding. BFEs are determined and shown on FEMA flood maps.[2]
AH	Areas with a 1 percent annual chance of shallow flooding, usually areas of ponding, with an average depth ranging from 1 to 3 feet. FEMA determined the BFEs and are shown on FEMA flood maps.
AO	River or stream flood-hazard areas and areas with a 1 percent or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from 1 to 3 feet. These zones show average flood depths derived from detailed analyses.
X (shaded) or B	Areas of 0.2 percent annual chance flood; areas of 1 percent annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1 percent annual chance flood. Areas of minimal to moderate flood hazard and therefore, not a designated SFHA.
X (unshaded) or C	Low lying areas of minimal flood hazard outside the 100-year and 500-year floodplains. Areas of minimal to moderate flood hazard and therefore, not a designated SFHA.

[11] The land area covered by the floodwaters of the base flood is the special flood-hazard area (SFHA) on National Flood Insurance Program maps. The SFHA is the area where the National Flood Insurance Program's floodplain management regulations must be enforced by the enrolled city or county and the area where the mandatory purchase of flood insurance applies. The SFHA includes Zones A, AO, AH, A1-30, AE, A99, AR, AR/A1-30, AR/AE, AR/AO, AR/AH, AR/A, VO, V1-30, VE, and V (FEMA 2015).

Zone[1]	Zone Description
X5	An area inundated by 500-year flooding; an area inundated by 100-year flooding with average depths of less than 1 foot or with drainage areas less than 1 square mile; or an area protected by levees from 100-year flooding.

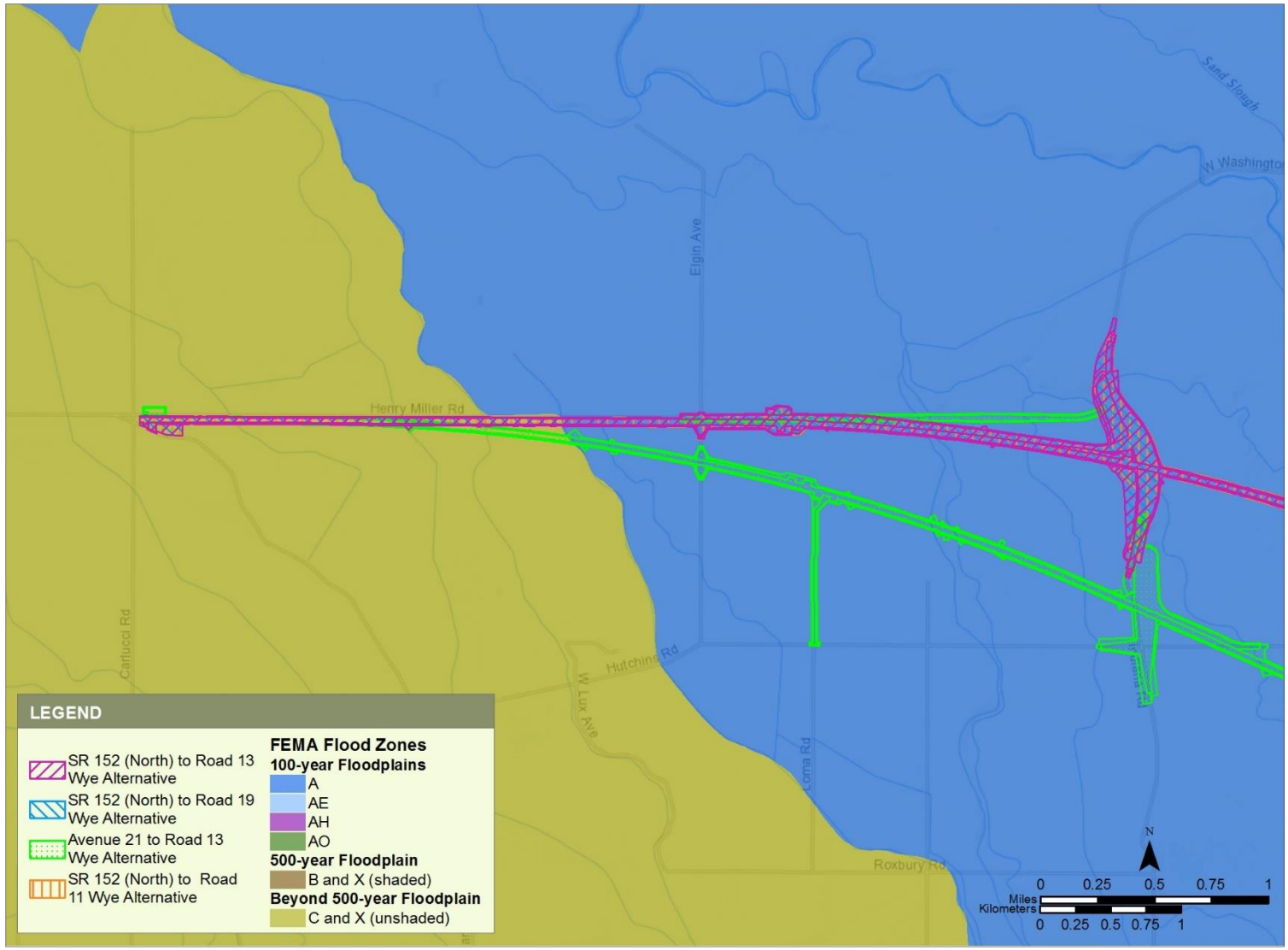
Source: FEMA, 2015
[1] Zones beginning with A are known as high-risk areas and are known as special flood-hazard areas
[2] AE Zones should have BFEs, but they were not available from dataset for the floodplain resource study area. FEMA = Federal Emergency Management Agency
BFE = base flood elevation
SFHA = special flood-hazard area

The FEMA-delineated 100-year floodplains exist along most of the minor creeks and streams in the floodplain RSA. In urban areas and along most of the reaches of the major rivers, the 100-year floodplains are generally contained within the riverbanks. As shown on Figure 4-3, portions of the western, northern, and central segments of the floodplain RSA are in an SFHA (within the 100-year floodplain) or within the 500-year floodplain associated with the San Joaquin River and its tributaries. However, much of the central and eastern portions of the Central Valley Wye alternatives' permanent effect areas lie outside of the 100-year floodplain (Zone C and X [unshaded]) and are not considered an SFHA.

The waterbodies, Chowchilla River, Ash Slough, Berenda Slough, Berenda Creek, Dry Creek, Schmidt Creek, Schmidt Creek Tributary, Dutchman Creek, and Deadman Creek, are all within 100-year floodplains. FEMA generally designates these flood-prone areas as Zone A, indicating a 100-year floodplain for which FEMA has determined approximate inundation area(s), but without detailed flow or water surface elevation information. Zone A areas are identified as within a SFHA.

The existing conditions with respect to floodplains are based on available data, reports, studies, and topographic and floodplain mapping. The FEMA-designated 100-year floodplain areas, which for the purposes of this analysis, are also designated SFHAs, are identified and mapped using GIS data and are based on FEMA's FIRMs for Merced and Madera Counties. Where available, analysts obtained the SFHA designations and BFE information from the FIRMs. The FIRMs have effective dates of December 2, 2008 for Merced County and September 26, 2008, for Madera County (FEMA 2008a, 2008b).

Flood control agencies have constructed levees and floodwalls in urban areas, restricting the rivers' flows, many of which also are controlled by upstream dams. Throughout the rural portion of the region, the land is low-lying and subject to frequent shallow flooding. Levees can fail because of earthquakes or storm events, if not properly maintained or reinforced to withstand potential stresses. In the event of levee failure, there could be flooding of several areas within the floodplain RSA beyond those identified in the current 100-year floodplain (i.e., Zones A, AE, AH, and AO). The Central Valley Wye corridor would pass through levee-protected flood zones. DWR has estimated that if a levee fails when the water surface elevation is at the top of a levee, between 3 feet and 9 feet of flooding depths would occur adjacent to the Eastside Bypass and the San Joaquin River (Authority and FRA 2016b).



Sources: FEMA, 2008a, 2008b

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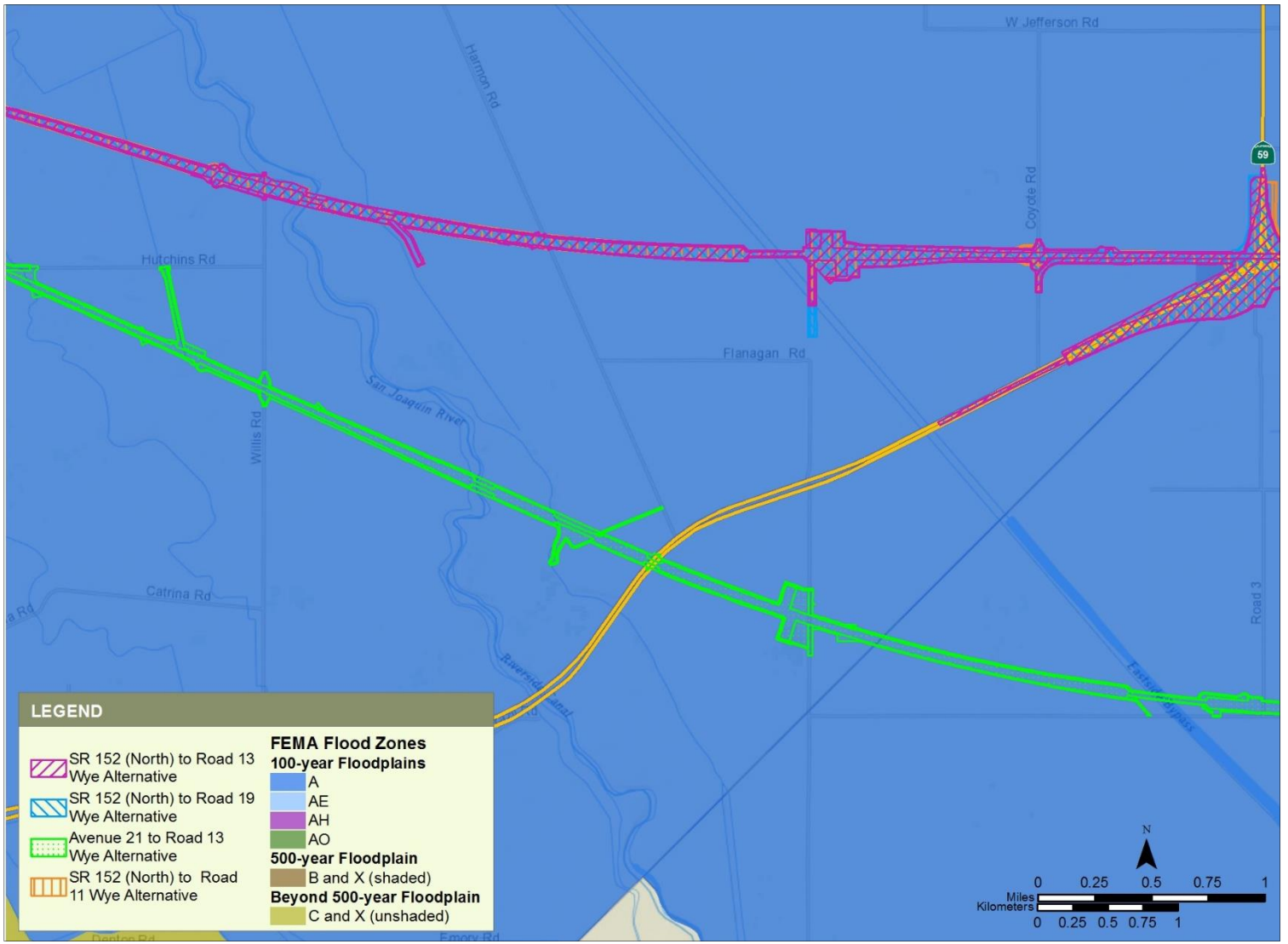
Figure 5-2a Federal Emergency Management Agency Flood Zones along the Central Valley Wye Alternative Alignments



Sources: FEMA, 2008a, 2008b

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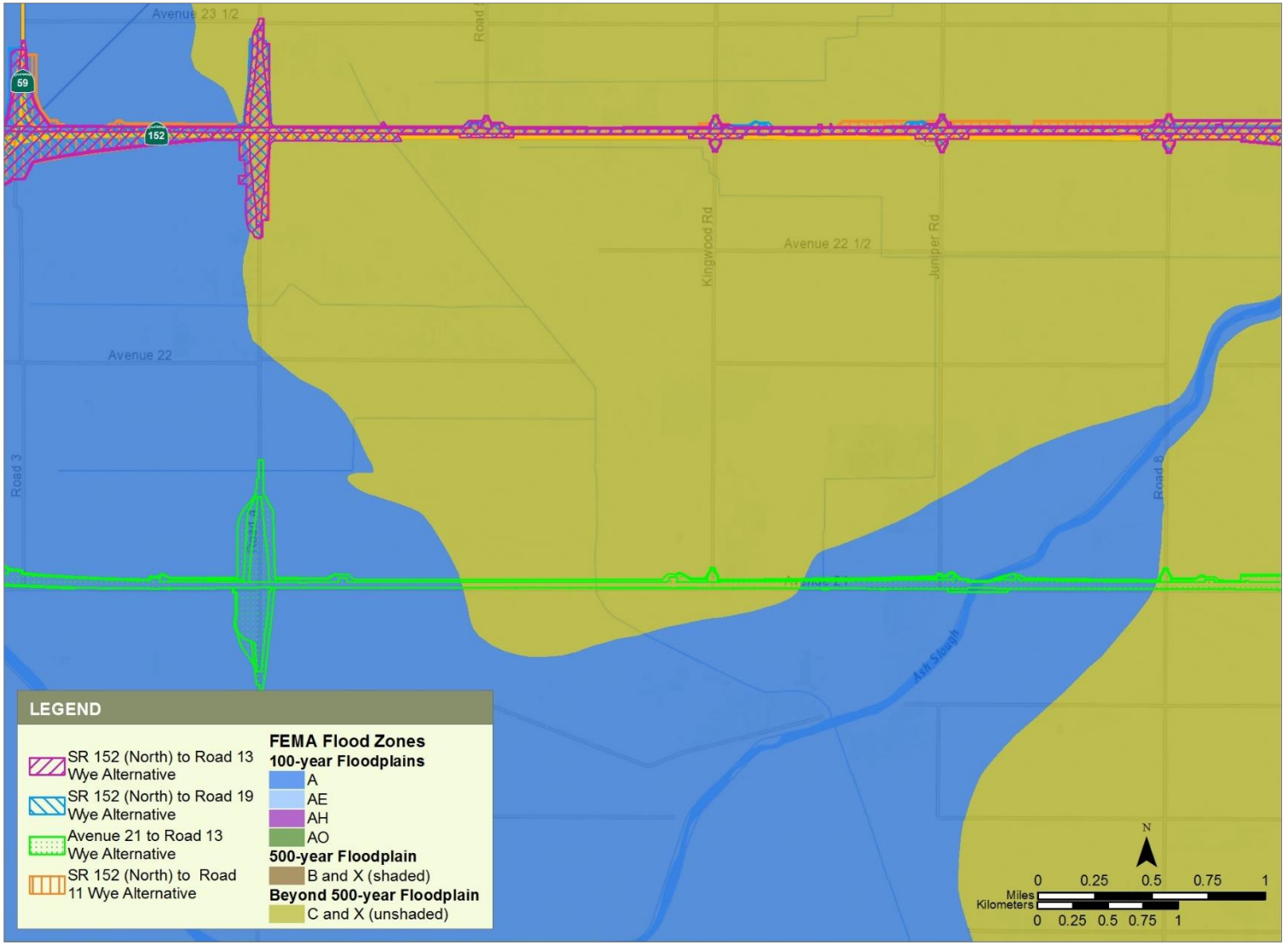
Figure 5-2b Federal Emergency Management Agency Flood Zones along the Central Valley Wye Alternative Alignments (cont.)



Sources: FEMA, 2008a, 2008b

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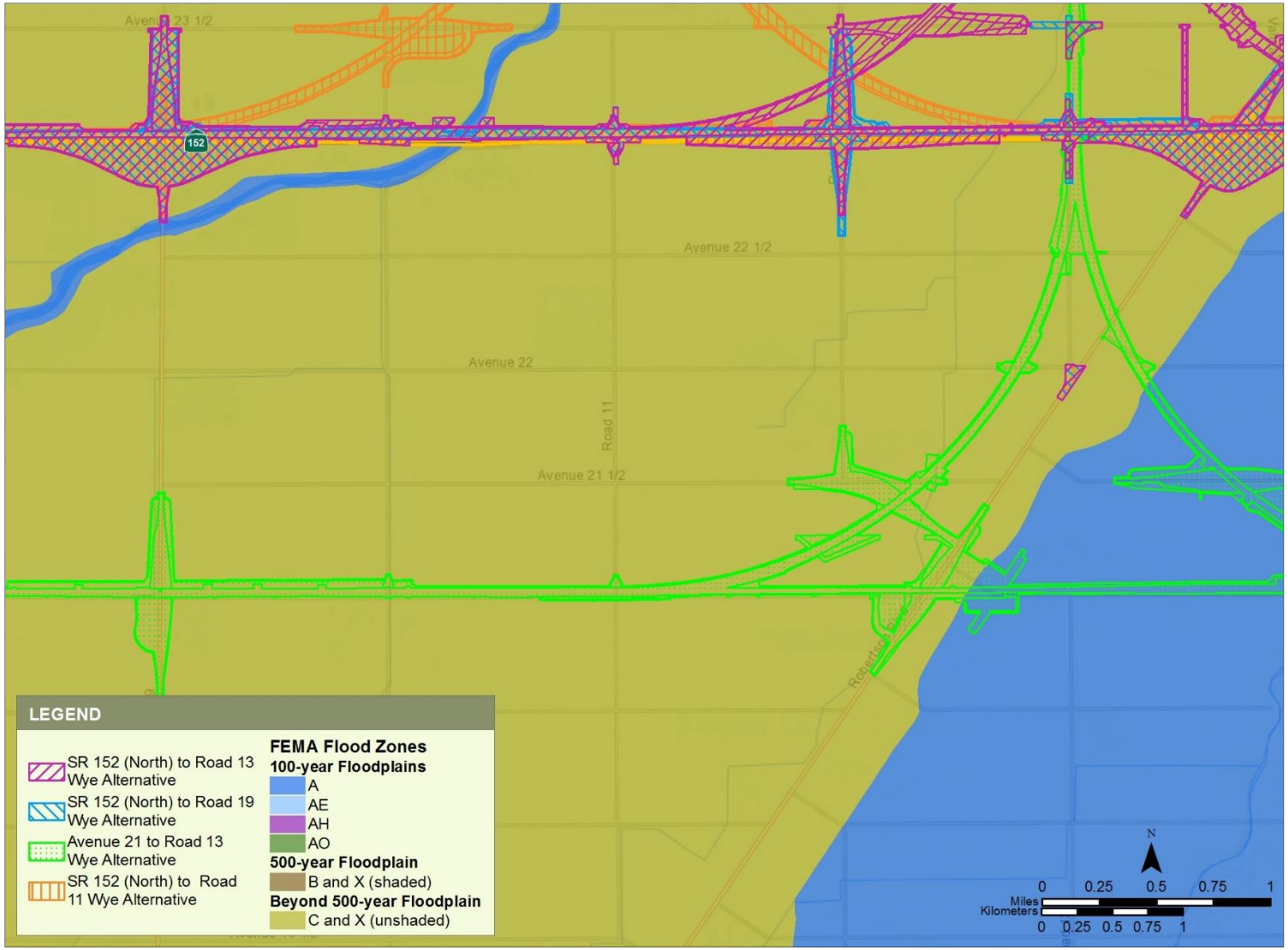
Figure 5-2c Federal Emergency Management Agency Flood Zones along the Central Valley Wye Alternative Alignments (cont.)



Sources: FEMA, 2008a, 2008b

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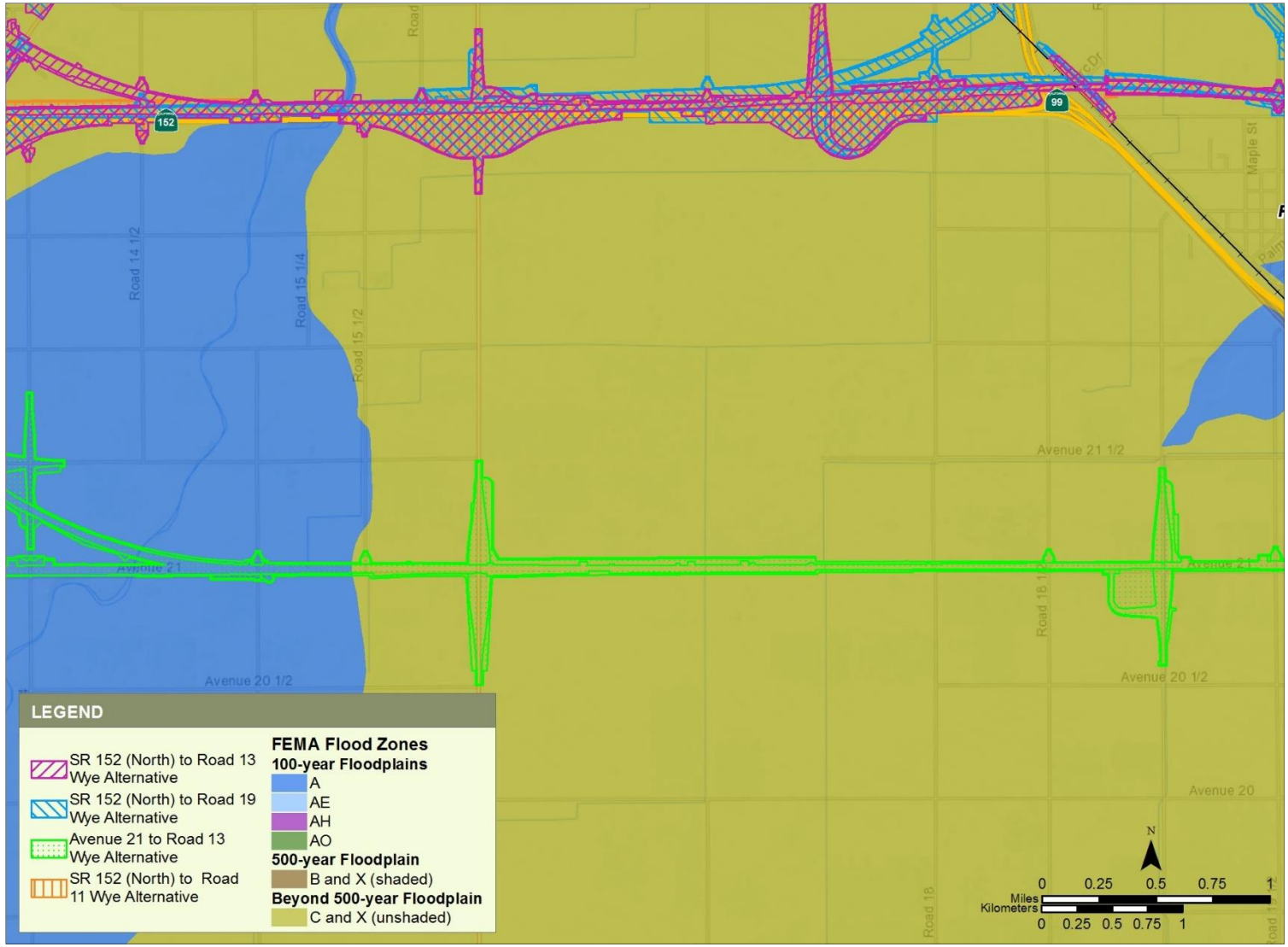
Figure 5-2d Federal Emergency Management Agency Flood Zones along the Central Valley Wye Alternative Alignments (cont.)



Sources: FEMA, 2008a, 2008b

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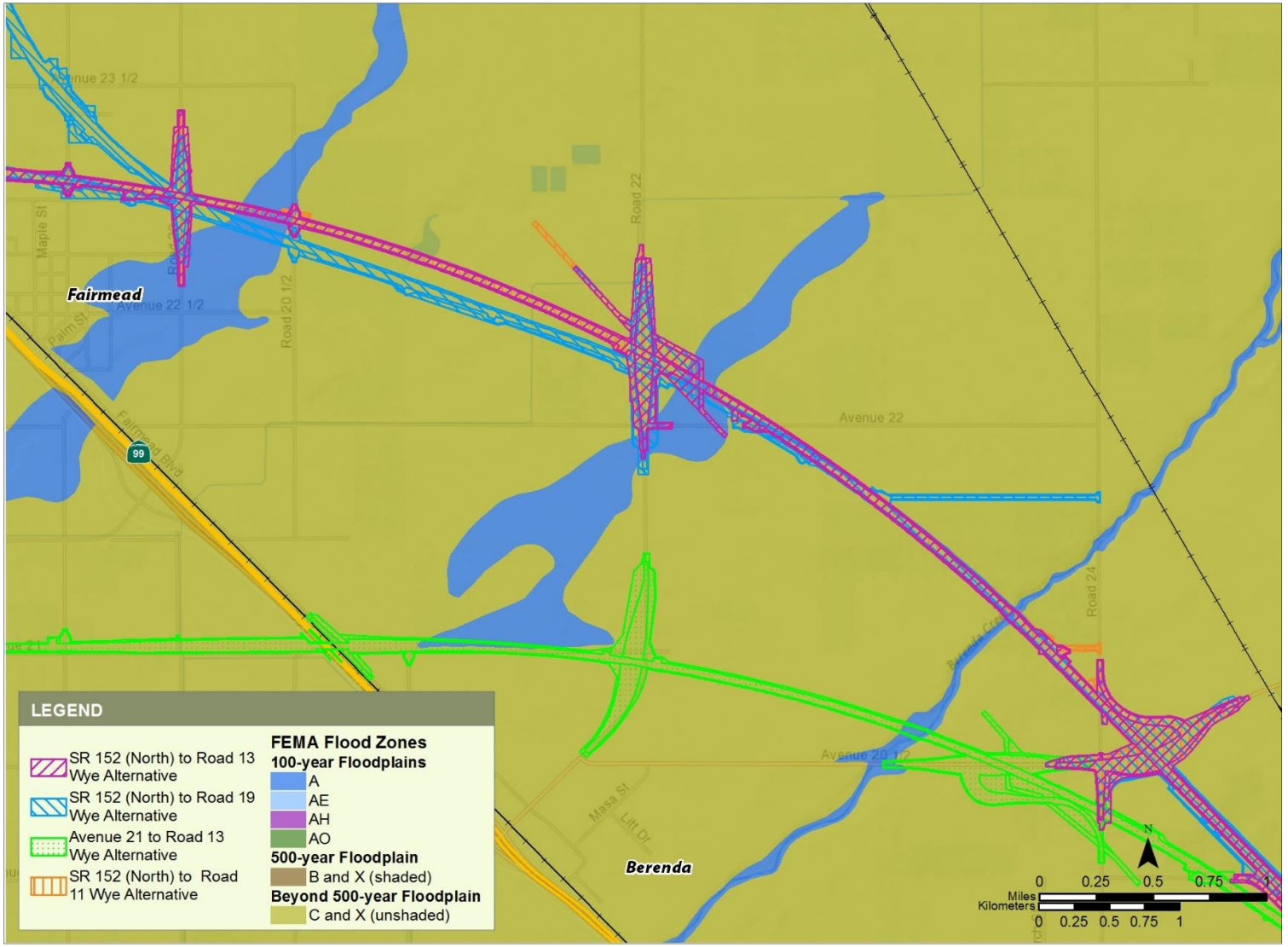
Figure 5-2e Federal Emergency Management Agency Flood Zones along the Central Valley Wye Alternative Alignments (cont.)



Sources: FEMA, 2008a, 2008b

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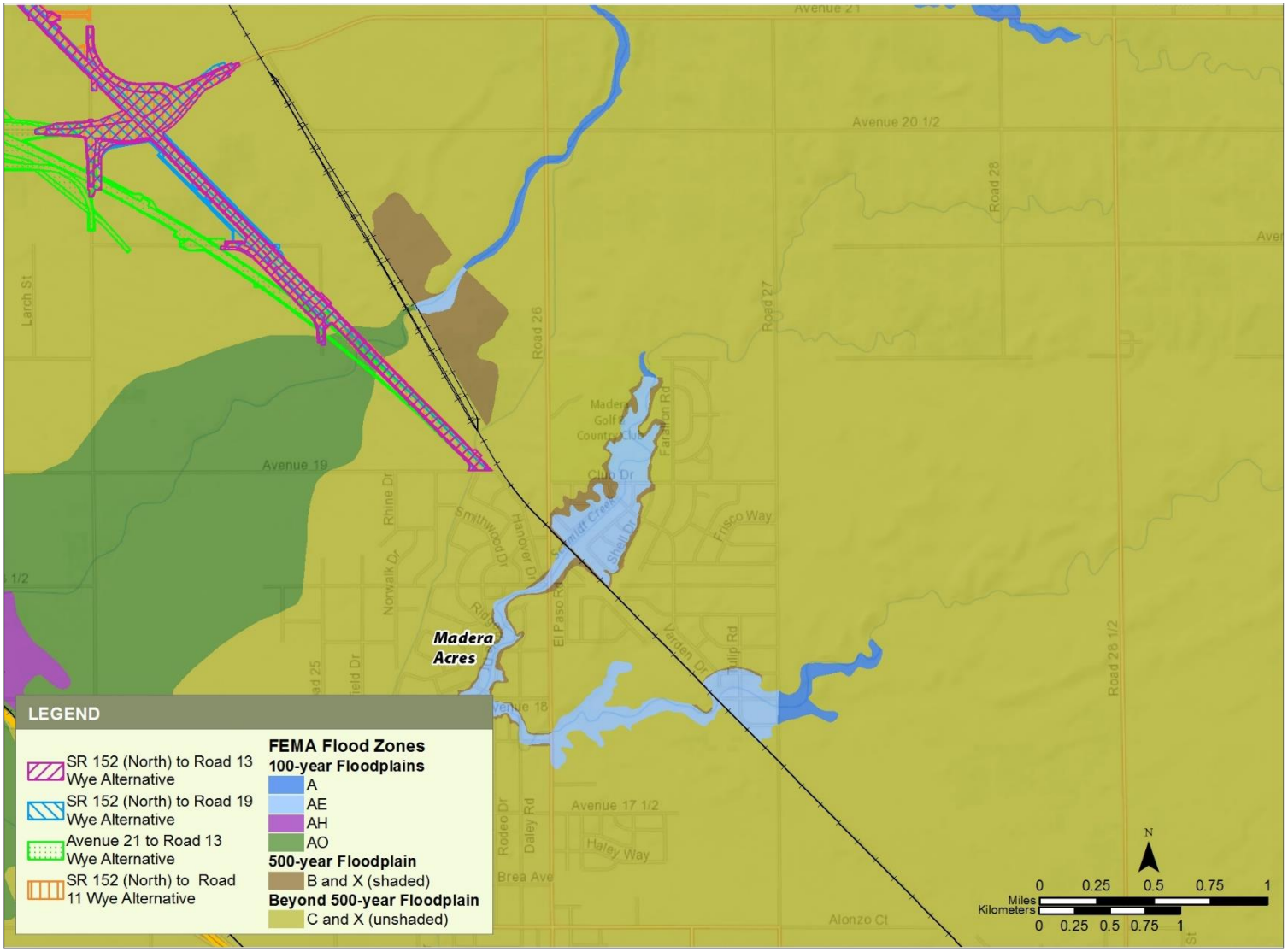
Figure 5-2f Federal Emergency Management Agency Flood Zones along the Central Valley Wye Alternative Alignments (cont.)



Sources: FEMA, 2008a, 2008b

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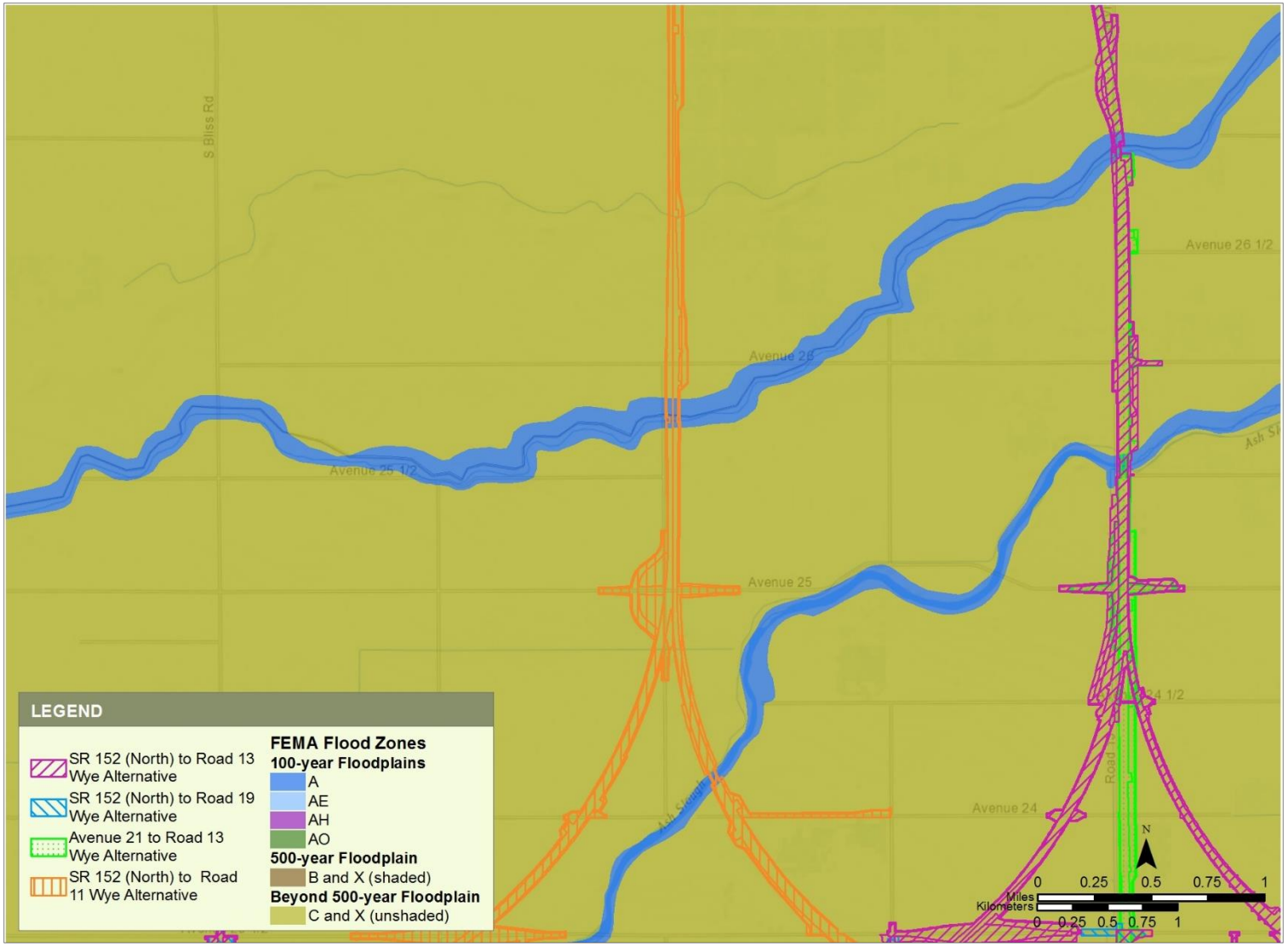
Figure 5-2g Federal Emergency Management Agency Flood Zones along the Central Valley Wye Alternative Alignments (cont.)



Sources: FEMA, 2008a, 2008b

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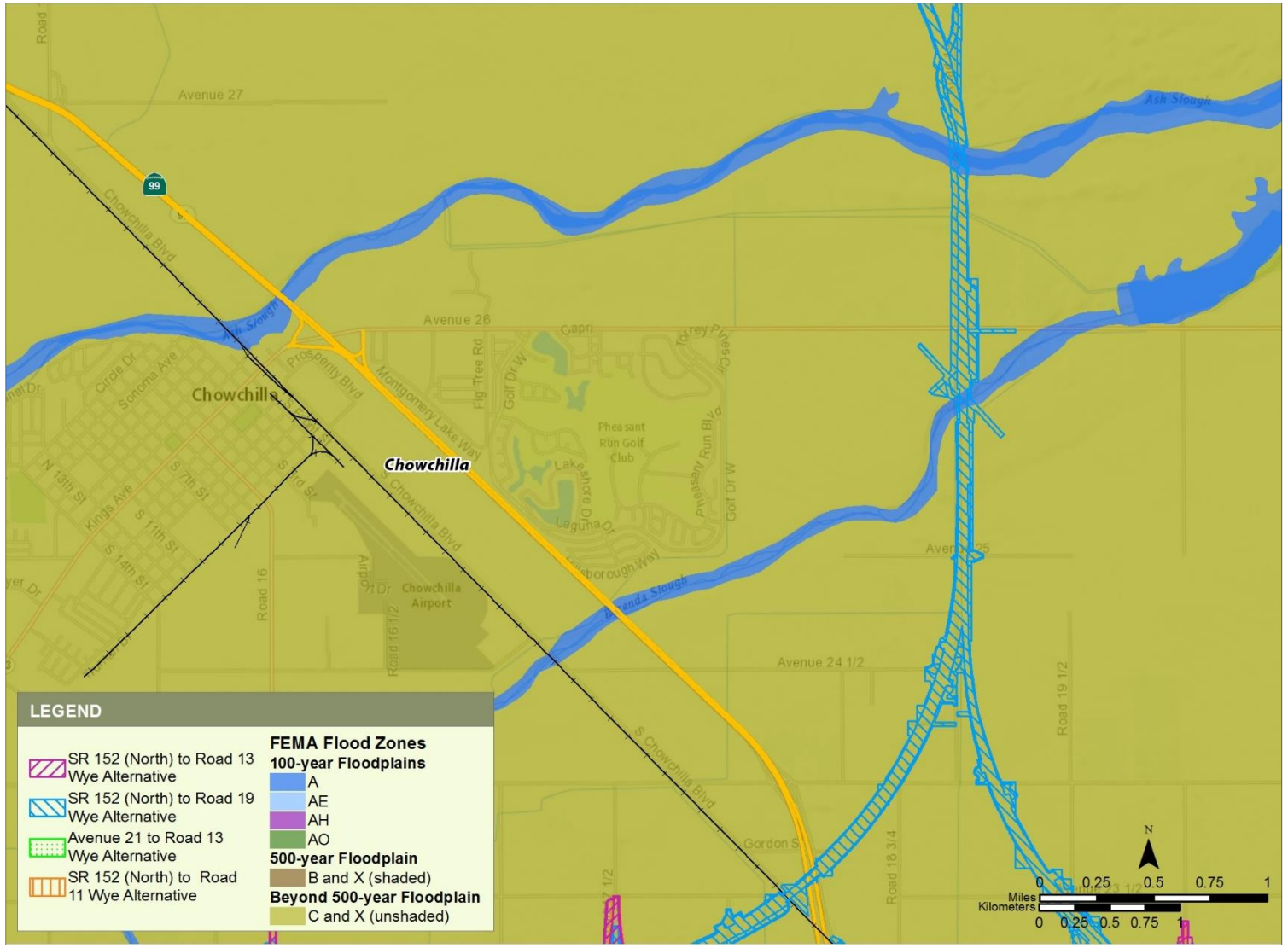
Figure 5-2h Federal Emergency Management Agency Flood Zones along the Central Valley Wye Alternative Alignments (cont.)



Sources: FEMA, 2008a, 2008b

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Figure 5-2i Federal Emergency Management Agency Flood Zones along the Central Valley Wye Alternative Alignments (cont.)

Sources: FEMA, 2008a, 2008b

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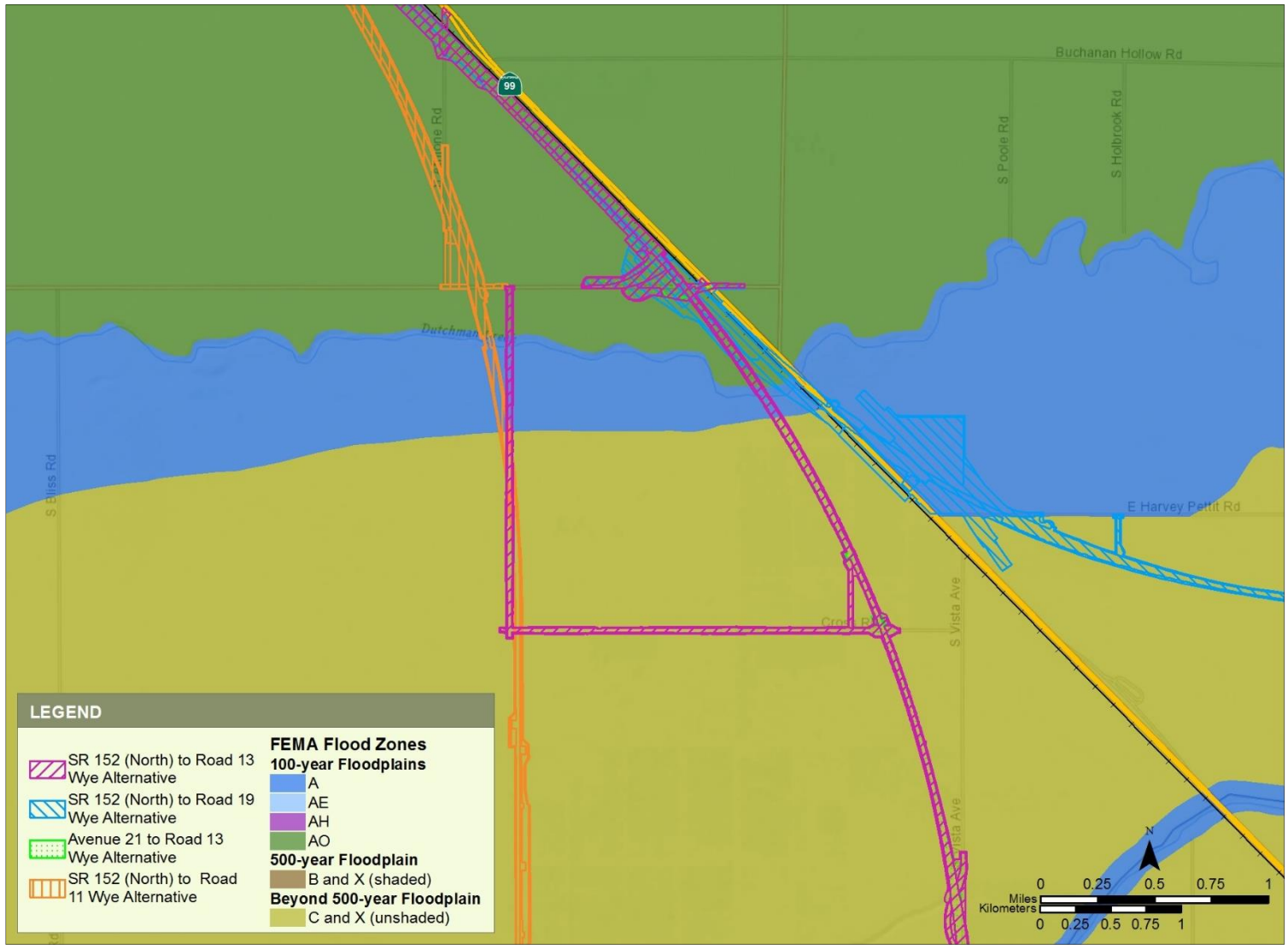
Figure 5-2j Federal Emergency Management Agency Flood Zones along the Central Valley Wye Alternative Alignments (cont.)



Sources: FEMA, 2008a, 2008b

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Figure 5-2k Federal Emergency Management Agency Flood Zones along the Central Valley Wye Alternative Alignments (cont.)

Sources: FEMA, 2008a, 2008b

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Figure 5-2l Federal Emergency Management Agency Flood Zones along the Central Valley Wye Alternative Alignments (cont.)

Figure 4-3 shows the flood zones within the floodplain RSA. Figures 5-2a through 5-2l provide greater flood zone detail for the Central Valley Wye alternatives. Table 5-14 lists the floodplains and floodways crossed by the Central Valley Wye alternatives. FEMA flood zones designating areas within the 100-year floodplain (i.e., the area that would be covered by the base flood—an event with a 1 percent or greater chance of occurring in any given year) have been designated for the San Joaquin River, Eastside Bypass, Chowchilla River, Ash Slough, Berenda Slough, Berenda Creek, Dry Creek, Schmidt Creek, Schmidt Creek Tributary, Dutchman Creek, Deadman Creek, as well as two unnamed floodplains (Floodplain #1 and Floodplain #2). As identified in Table 5-13, many of these flood-prone areas are designated as Zone A, indicating a floodplain for which FEMA has determined approximate inundation area(s), but without detailed flow or water surface elevation information. Dry Creek and Deadman Creek are designated Zone AO, indicating an average flood depth ranging from 1 to 3 feet, and Schmidt Creek and Schmidt Creek Tributary are designated Zone AE, indicating FEMA has determined BFEs.

FEMA defines a floodway as the channel of a stream plus any adjacent floodplain area that must be kept free of encroachment so that the 100-year flood can be conveyed without a substantial increase in the BFE (e.g., less than 1 foot) (FEMA 2009). FEMA has delineated the designated floodway for the San Joaquin River, Chowchilla River, Fresno River, Ash Slough, and Berenda Slough. Table 5-14 summarizes information (e.g., length, type, and depth) about the floodways and floodplains crossed by the Central Valley Wye alternatives.

The CVFPB defines the floodway as the stream channel and as that portion of the adjoining floodplain reasonably required to provide for passage of a design flood. The CVFPB further defines a designated floodway as that area between existing levees, as adopted by the CVFPB or the legislature (CVFPB 2011). CVFPB-designated floodways within the floodplain RSA include the San Joaquin River, Eastside Bypass, Fresno River, Chowchilla River, Ash Slough, and Berenda Slough. Analysts identified CVFPB-designated floodways using designated floodway maps, which are available on the CVFPB web site but are not digitized.

DWR manages FloodSAFE California, a program to improve flood management in California, particularly as it relates to the state/federal flood protection system in the Central Valley (DWR 2008b). One of the foundational objectives of the FloodSAFE program is to provide 200-year level (or greater) flood protection to all urban and urbanizing areas in the Sacramento–San Joaquin Valley by the end of 2025. Currently, the FloodSAFE program's southernmost boundary is located at the San Joaquin River (DWR 2012a).

Table 5-14 Floodplains and Floodways Crossed by the Central Valley Wye Alternatives

Floodplain Name or Flooding Source	County	Alternatives	FEMA SFHA[1]	Approximate Length of Floodplain Crossed (miles)	Floodplain Crossing Type and Length (miles)	FEMA BFE or Depth near Crossing (feet)[2]	FEMA Designated Floodway[3,4]	CVFPB Designated Floodway[4]	FEMA FIRM Panel
San Joaquin River[5]	Merced Madera	SR 152 (North) to Road 13	Zone A	9.58	Elevated, 9.58	N/A	X	X	06047C0875G 06019C0625H 06047C0925G 06047C0900G 06039C0825E 06039C0850E
		SR 152 (North) to Road 19	Zone A	9.58	Elevated, 9.58				
		Avenue 21 to Road 13	Zone A	10.94	Elevated, 10.94				
		SR 152 (North) to Road 11	Zone A	0.63	Elevated, 0.63				
		SR 152 (North) to Road 11	Zone A	8.96	At-grade, 8.96				
Eastside Bypass	Merced Madera	SR 152 (North) to Road 13 SR 152 (North) to Road 19 Avenue 21 to Road 13	Zone A	N/A	N/A	N/A	N/A	X	N/A
Chowchilla River	Merced Madera	SR 152 (North) to Road 13	Zone A	0.11	Elevated, 0.11	N/A	X	X	06047C0700G 06043C0975C 06047C0950G 06039C0875E
		SR 152 (North) to Road 19	Zone A	0.10	Elevated, 0.10				
		Avenue 21 to Road 13	Zone A	0.12	Elevated, 0.12				
		SR 152 (North) to Road 11	Zone A	0.07	Elevated, 0.07				
		SR 152 (North) to Road 11	Zone A	0.06	At-grade, 0.06				
Ash Slough	Madera	SR 152 (North) to Road 13	Zone A	0.17	Elevated, 0.17	N/A	X	X	06043C0975C 06047C0950G 06047C0925G 06039C0875E
		SR 152 (North) to Road 19	Zone A	0.23	Elevated, 0.23				
		Avenue 21 to Road 13	Zone A	1.63	Elevated, 1.63				
		SR 152 (North) to Road 11	Zone A	0.16	Elevated, 0.16				
Berenda Slough	Madera	SR 152 (North) to Road 13	Zone A	0.08	Elevated, 0.08	N/A	X	X	06039C0900E 06039C0875E 06047C0950G
		SR 152 (North) to Road 19	Zone A	0.16	Elevated, 0.16				
		Avenue 21 to Road 13	Zone A	4.85	Elevated, 4.85				
		SR 152 (North) to Road 11	Zone A	0.08	Elevated, 0.08				

Floodplain Name or Flooding Source	County	Alternatives	FEMA SFHA[1]	Approximate Length of Floodplain Crossed (miles)	Floodplain Crossing Type and Length (miles)	FEMA BFE or Depth near Crossing (feet)[2]	FEMA Designated Floodway[3,4]	CVFPB Designated Floodway[4]	FEMA FIRM Panel
Floodplain #1	Madera	SR 152 (North) to Road 13	Zone A	0.17	At-grade, 0.17	N/A	N/A	N/A	06039C0900E
		SR 152 (North) to Road 19	Zone A	0.22	At-grade, 0.22				
		Avenue 21 to Road 13	Zone A	0.09	At-grade, 0.09				
		SR 152 (North) to Road 11	Zone A	0.17	At-grade, 0.17				
Floodplain #2	Madera	SR 152 (North) to Road 13	Zone A	0.24	At-grade, 0.24	N/A	N/A	N/A	06039C0900E
		SR 152 (North) to Road 19	Zone A	0.49	Aerial, 0.49				
		SR 152 (North) to Road 11	Zone A	0.24	At-grade, 0.24				
Berenda Creek	Madera	SR 152 (North) to Road 13	Zone A	0.04	Elevated, 0.04	N/A	N/A	N/A	06039C0915E 06039C0900E
		SR 152 (North) to Road 19	Zone A	0.04	At-grade, 0.04				
		Avenue 21 to Road 13	Zone A	0.11	At-grade, 0.11				
		SR 152 (North) to Road 11	Zone A	0.04	Elevated, 0.04				
Dry Creek	Madera	SR 152 (North) to Road 13	Zone AO	0.21	Elevated, 0.21	Depth = 1	N/A	N/A	06039C0915E
		SR 152 (North) to Road 19	Zone AO	0.21	Elevated, 0.21	Depth = 1			
		Avenue 21 to Road 13	Zone AO	0.25	Elevated, 0.25	Depth = 1			
		SR 152 (North) to Road 11	Zone AO	0.05	Elevated, 0.05	N/A			
		SR 152 (North) to Road 11	Zone AO	0.17	At-grade, 0.17	N/A			
Schmidt Creek	Madera	SR 152 (North) to Road 13	Zone AE	0.07	Elevated, 0.07	N/A	N/A	N/A	06039C0915E
		SR 152 (North) to Road 19	Zone AE	0.07	Elevated, 0.07				
		Avenue 21 to Road 13	Zone AE	0.07	Elevated, 0.07				
Schmidt Creek Tributary	Madera	SR 152 (North) to Road 13	Zone AE	0.05	At-grade, 0.05	N/A	N/A	N/A	06039C0920E
		SR 152 (North) to Road 19	Zone AE	0.05	At-grade, 0.05				
		Avenue 21 to Road 13	Zone AE	0.05	At-grade, 0.05				

Floodplain Name or Flooding Source	County	Alternatives	FEMA SFHA[1]	Approximate Length of Floodplain Crossed (miles)	Floodplain Crossing Type and Length (miles)	FEMA BFE or Depth near Crossing (feet)[2]	FEMA Designated Floodway[3,4]	CVFPB Designated Floodway[4]	FEMA FIRM Panel
Dutchman Creek	Merced	SR 152 (North) to Road 13	Zone A	0.16	Elevated, 0.16	N/A	N/A	N/A	06047C0700G 06039C0600E
		SR 152 (North) to Road 19	Zone A	1.05	Trench, 1.05				
		Avenue 21 to Road 13	Zone A	0.16	Elevated, 0.16				
		SR 152 (North) to Road 11	Zone A	0.07	Elevated, 0.07				
		SR 152 (North) to Road 11	Zone A	0.36	At-grade, 0.36				
Deadman Creek	Merced	SR 152 (North) to Road 13	Zone AO	4.10	At-grade, 4.10	Depth = 1	N/A	N/A	06047C0700G 06047C0675G 06039C0600E
		SR 152 (North) to Road 19	Zone AO	4.16	At-grade, 4.16	Depth = 1			
		Avenue 21 to Road 13	Zone AO	4.10	At-grade, 4.10	Depth = 1			
		SR 152 (North) to Road 11	Zone AO	0.12	Elevated, 0.12	N/A			
		SR 152 (North) to Road 11	Zone AO	3.12	At-grade, 3.12	N/A			

Source: FEMA, 2008a; FEMA, 2008b; Authority and FRA, 2016a

[1] Special flood-hazard areas or the100-year floodplain designated by FEMA. In the floodplain resource study area, these include: Zone A–no base-flood elevation (BFE) determined
Zone AE– Although this zone is said to have BFEs determined, BFEs could not be found for these areas. Zone AO–flood depth of 1 to 3 feet and average depth determined

[2] FEMA floodplains with Zone A designation do not have BFEs determined and are indicated with N/A. AE Zones should have BFEs, but they were not available from dataset, and therefore are also indicated with N/A. For Zone AO, average depth is shown. The Central Valley Wye alternatives do not cross Zone AH.

[3] A "Regulatory Floodway" means the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height. Communities must regulate development in these floodways to prevent increases in upstream flood elevations. For streams and other watercourses where FEMA has provided BFEs, but no floodway has been designated, the community must review floodplain development on a case-by-case basis to prevent increases in water surface elevations, or identify the need to adopt a floodway if adequate information is available.

[4] An X indicates the floodplain or flooding source is a FEMA or CVFPB designated floodway.

[5] According to the FEMA data, the flood zone for the Fresno River and Eastside Bypass are combined with the San Joaquin River into one large floodplain, and therefore, they are incorporated into the area of San Joaquin River floodplain.

FEMA = Federal Emergency Management Agency
BFE = base flood elevation
FIRM = Flood Insurance Rate Map
SFHA = special flood-hazard area
CVFPB = Central Valley Flood Protection Board
SR = State Route N/A = not applicable

6 EFFECTS ANALYSIS

This section describes the potential effects of Central Valley Wye construction and operations on hydrology and water resources in the Central Valley Wye study area. The analysis describes temporary and permanent construction effects as well as intermittent permanent and continuous operations effects on surface water hydrology, surface water quality, groundwater hydrology and quality, and floodplains.

6.1 Surface Water Hydrology Effects

6.1.1 Overview

Construction and operations of the Central Valley Wye alternatives could affect existing drainage patterns, and irrigation and stormwater distribution systems. Construction of new impervious surfaces would increase runoff without implementation of stormwater management and treatment measures (HYD-IAMF#1, Stormwater Management). The Central Valley Wye alternatives could redirect and increase the volume and rate of shallow overland flows, increasing the potential for erosion and siltation in areas of exposed soils and along channel banks, unless SWPPP BMPs (HYD-IAMF#3, Prepare and Implement a Construction Stormwater Pollution Prevention Plan) and stormwater management and treatment measures (HYD-IAMF#1) are implemented to avoid or minimize potential erosion and sedimentation from increased rates and volumes of flows. The Central Valley Wye alternatives could affect drainage and hydrology by altering the course of a river or stream unless they are designed to maintain pre-project hydrology and to not impede flood flows (HYD-IAMF#2, Flood Protection). As Section 2.6 describes, the Authority will incorporate IAMFs as part of the Central Valley Wye design to minimize effects on hydrology and water resources. Appendix A provides detailed descriptions of the IAMFs relevant to hydrology and water resources.

The contractor would prepare and implement an SWPPP (HYD-IAMF#3), that would involve implementing BMPs. Standard BMPs used during construction include measures to provide permeable surfaces or vegetated areas, where feasible, to retain or detain stormwater on-site; flow dissipation measures to reduce the rates of stormwater runoff along steep slopes and prevent erosion and sedimentation; and measures for in-water work at stream crossings to minimize temporary changes to river and stream hydrology potentially resulting in erosion or siltation.

The Authority will require the contractor to reduce effects on surface water hydrology during design by implementing stormwater management and treatment measures (HYD-IAMF#1) such as stormwater infiltration or detention facilities. Other measures would include incorporating low impact development measures within areas of new impervious surfaces to prevent stormwater runoff rates and volumes exceeding the receiving stormwater system's capacity.

The contractor would maintain pre-project hydrology by a number of measures. Examples include incorporating permeable surfaces and vegetated areas designed to capture and infiltrate flows, drainage ditches to mimic the direction of existing surface flows, and on-site detention basins to capture flows and allow for soil infiltration or evaporation of runoff, where feasible. As required by the Construction General Permit and administered by the SWRCB, the Central Valley Wye design would maintain pre-project hydrology (HYD-IAMF#3). This design feature would avoid or minimize increases in stormwater runoff rates and volumes, minimize alterations to existing drainage patterns, and limit off-site flows of drainage waters, thereby reducing potential effects on neighboring properties. Complying with Central Valley RWQCB orders and requirements and CVFPB requirements for river, creek, and slough crossings would minimize the extent of alterations by designing bridges to allow for existing design flows to pass at stream crossings and to protect against downstream streambank and channel erosion. Additional flow control measures would be implemented as needed where local regulations or drainage requirements dictate. Through design features, runoff is expected to enter the same waterbodies as existing conditions, and effects on runoff and drainage patterns would be minimized.

Implementing measures, design features, and BMPs as part of IAMFs for the Central Valley Wye would minimize changes in surface water hydrology and would prevent any exceedances in the capacity of existing drainage infrastructure or erosion or siltation on-site or off-site.

Table 6-1 identifies the total number of water crossings by each Central Valley Wye alternative.

Table 6-1 Total Number of Water Crossings by Central Valley Wye Alternative

Alternative	Natural Waterbodies	Canals and Ditches	Total
SR 152 (North) to Road 13 Wye	31	31	62
SR 152 (North) to Road 19 Wye	32	28	60
Avenue 21 to Road 13 Wye	39	41	80
SR 152 (North) to Road 11 Wye	30	30	60

Source: Determined using ESRI ArcGIS versions 10.1, 10.2, and 10.3; Authority and FRA, 2016a
SR = State Route

Table 6-2 lists the temporary and permanent construction area disturbance for each Central Valley Wye alternative. Construction would clear these areas of vegetation or otherwise physically disturb them.

Table 6-2 Acres of Land Disturbed During Construction by Central Valley Wye Alternative

Alternative	Temporary Effects Area (acres)[1]	Permanent Effects Area (acres)[1]
SR 152 (North) to Road 13 Wye	532	2,510
SR 152 (North) to Road 19 Wye	674	2,752
Avenue 21 to Road 13 Wye	361	2,309
SR 152 (North) to Road 11 Wye	411	2,460

Source: Calculated using ESRI ArcGIS versions 10.1, 10.2, and 10.3 using area of footprint in computer-aided design plans for the Central Valley Wye Alignment; Authority and FRA, 2016a
[1] Acreages are rounded to the nearest whole number.
SR = State Route

6.1.1.1 SR 152 (North) to Road 13 Wye Alternative

Construction

Temporary Construction Effects

The SR 152 (North) to Road 13 Wye Alternative would entail a total of 62 waterbody crossings, of which 31 are natural waterbody crossings and 31 are canal and ditch crossings (Table 6-2). The alternative would cross two natural waterbodies twice[12] Ash Slough and Santa Rita Drain #1 (Table 5-5). In addition, this Central Valley Wye alternative would cross six canals and ditches twice: Berenda Canal, Bethel Canal, Irrigation Ditches #42 and #43, Lat 24.2-8.9, and the San Juan Canal (Table 5-6). This Central Valley Wye alternative would have the second lowest number of total waterbody crossings.

[12] A total of 38 different waterbodies are crossed by the Central Valley Wye alternatives. While not all Central Valley Wye alternatives cross every waterbody, some cross the same waterbody twice. As a result, the SR 152 (North) to Road 13 Wye, the SR 152 (North) to Road 19 Wye, the Avenue 21 to Road 13 Wye, and the SR 152 (North) to Road 13 Wye cross a total of 31, 32, 39, and 30 waterbodies, respectively. The number of waterbody crossings is related to severity of the effect on surface water hydrology and water quality, as multiple crossings of a single waterbody result in a corresponding increase in the potential effect on that waterbody.

Within the surface water RSA, changes in runoff patterns or volume from Central Valley Wye construction could temporarily affect several waterbodies (Table 5-4). Because some waterbodies are intermittent streams, and not continuous flowing, changes in drainage patterns from construction would not affect all waterbodies. Construction activities, such as grading and establishing construction staging areas, could alter existing drainage patterns and redirect stormwater runoff. In addition, the amount of stormwater runoff would increase if construction activities include removal of natural vegetation or other barriers to runoff such as soil berms, or if the activities result in an increase in impervious surface area, including new paved roads constructed as part of the Central Valley Wye. Temporary diversions of stream flows may be necessary during the installation of support piers and bridge abutments in stream channels. This could temporarily reduce channel capacity and cause erosion or sedimentation. The Central Valley Wye design includes stormwater management measures (HYD-IAMF#1) to detain on-site stormwater runoff, increase infiltration rates, minimize disruptions to the movement of water, and maintain stream flows through the surface water RSA.

The SR 152 (North) to Road 13 Wye Alternative would require grading, as well as construction laydown and staging areas. This Central Valley Wye alternative would disturb areas during construction and result in the potential for changes in stormwater runoff patterns. The amount of ground disturbance required for this Central Valley Wye alternative is relatively small compared to the overall surface water RSA. Table 6-2 shows that this Central Valley Wye alternative would temporarily disturb approximately 532 acres during construction. The Authority and FRA would be required to obtain coverage under the Construction General Permit because construction would disturb more than 1 acre of soil (Section 3.1.1.5).

The Authority will maintain drainage patterns to the extent possible during construction activities (HYD-IAMF#3). The contractor would prepare an SWPPP prior to construction and identify construction-related BMPs to prevent and minimize short-term increases in sediment transport caused by construction, including erosion and sedimentation control, and stormwater treatment and management (or flow diversions). Erosion and sedimentation control BMPs would include measures to stabilize exposed soils, and to retain new stormwater flows on-site using flow dispersion, infiltration, and evaporation supplemented by detention and treatment. Other construction BMPs include standard practices to protect water quality such as siltation fences, inlet protection, and sediment traps to prevent substantial siltation or erosion effects from occurring in potentially affected surface waters. The SWPPP would also indicate that construction would not occur in stream or river channels during a storm event and would describe temporary drainage patterns within the area affected by construction activities and stormwater discharge locations from the affected area. Implementation of the SWPPP reduces effects due to changes in drainage patterns or volume by providing BMPs, which include measures to provide permeable surfaces where feasible and to retain or detain and treat stormwater on-site. The description of HYD-IAMF#3 (Appendix A) provides additional information on Construction General Permit requirements. The Authority has also established design standards and features, such as use of elevated track, bridges, or culverts at all water crossings to retain

On-site stormwater runoff and minimize disruptions to the movement of water through the surface water RSA. The Central Valley Wye design includes design standards and features such as elevated sections of track (HYD-IAMF#2) to prevent saturation, increase infiltration, and stabilize soils where stream-flow velocities are increased to minimize potential effects related to erosion and surface water hydrology in the surface water RSA.

Central Valley Wye temporary construction activities could result in a short-term change in drainage patterns or an increase in sediment loads in surface waters for a minimum of 1–3 days after land disturbance or other construction activities to allow for the erosion to stabilize or siltation to settle. Temporary changes in drainage patterns may result in redirecting stormwater runoff, changes in runoff volume, and rates of pollutant loading compared to existing conditions. Effects on surface water hydrology would be reduced because the contractor would maintain pre-project runoff volume and rates (as required by the Construction General Permit), and implement measures to minimize associated erosion and sedimentation through soil stabilization, siltation fences, or sediment catchment basins (HYD-IAMF#3). With implementation of erosion and

sedimentation measures, the Central Valley Wye alternatives would not be expected to contribute to a violation of regulatory standards related to siltation, or result in a substantial change in existing on-site or off-site drainage patterns. Conditions would not exceed the capacity of drainage infrastructure and would not result in substantial erosion or siltation in on-site or off-site waterbodies.

Changes in drainage patterns resulting from Central Valley Wye construction would temporarily affect several waterbodies. Because some waterbodies are intermittent streams, and not continuous flowing, temporary changes in drainage patterns from construction would not affect all waterbodies. Temporary diversion of stream flow may be necessary during the installation of support piers and bridge abutments in stream channels. This work could temporarily reduce channel capacity. The Authority has established HYD-IAMF#3, which includes implementation of drainage BMPs included in the SWPPP to temporarily divert channel flows and avoid the discharge of sediment from within the project footprint. In addition, HYD-IAMF#3 requires bridge maintenance activities that involve in-water work be limited to dry periods when flows in waterbodies are low or absent.

Permanent Construction Effects

Elevated crossings could require support piers in the water channel. At-grade crossings of stream channels would require bridge abutments on banks and support piers in the water channel or, in some locations, the alignment would cross natural waterbodies using box culverts. Bridge components could obstruct the ability of the waterbody to convey peak flows by reducing its channel capacity and possibly by raising flood elevations locally. The Authority has designed each crossing in a manner that would maintain the existing hydraulic capacity and, as required by the Construction General Permit, maintain pre-project hydrology through on-site stormwater management measures, such as infiltration and retention of stormwater runoff, where appropriate, and would capture runoff and provide treatment prior to discharge of pollutant-generating surfaces, including access roads, new overpasses and underpasses, and new roads (HYD-IAMF#1). Low-impact development techniques would be used to detain runoff on-site and to reduce off-site runoff such as biofiltration and bioretention systems, wet ponds, organic mulch layers, planting soil beds, and vegetated systems (biofilters), such as vegetated swales and grass filter strips, would be used where appropriate. Further, with Authority approval, the contractor would design and place piers to minimize backwater effects and local scouring and design the shape and alignment of the piers to minimize negative hydraulic effects.

Irrigation canal culverts would include pipes, box structures, or inverted siphons that pass water from an open canal headwork under the HSR embankment and adjacent embankments. Where possible, the Authority would use a straight culvert rather than a U-shaped siphon because the straight culvert can flush out sediment and debris more easily. Inverted siphons require regular inspection and maintenance.

Introducing impervious surfaces where they currently do not exist would have the potential to increase the rate and amount of stormwater runoff and cause erosion in areas adjacent to the new impervious surface and in new or existing drainage channels. Soils beneath the track would be compacted with a gravel surface layer, which would result in slightly reduced infiltration relative to existing soil conditions. Stormwater would drain toward swales running parallel to at-grade track within the HSR right-of-way. The contractor would implement stormwater management and treatment plans to manage and treat stormwater flows (HYD-IAMF#1) as required by the MS4 permit, and maintain pre-project hydrology. In areas where the right-of-way is constrained, drainage pipes or lined channels leading to established discharge locations would replace swales. Tracks placed on embankments with retaining walls would feature weep holes near the base of the wall to prevent the buildup of stormwater in the embankment. Drainage systems for tracks set below grade would collect stormwater in trenches and pump it out into a drainage facility designed to accommodate the volume of runoff. Drainage systems within the portions of elevated track would collect and drain stormwater to the ground through downspouts at the columns. Depending on location, drainage from the downspouts from elevated tracks would be retained on-site, discharged to a detention basin, conveyed to a nearby stormwater collection system, or dispersed

in a non-erosive fashion. Where the alignment travels through urban areas, impermeable surfaces are common because of past land development, so in most cases, existing stormwater systems would convey track runoff. In areas with infiltrative soils, runoff would likely infiltrate within the HSR right-of-way. In other areas, to maintain pre-project hydrology, the contractor would incorporate on-site retention of stormwater using measures such as flow dispersion, infiltration, and evaporation, supplemented by detention, into the design. To avoid potential effects related to maintenance facilities associated with transportation operations, a stormwater pollution prevention plan would be prepared and implemented (HYD-IAMF#4, Prepare and Implement an Industrial Stormwater Pollution Prevention Plan). The stormwater general permit requires preparation of a SWPPP and a monitoring plan for industrial facilities that discharge stormwater from the site, and includes performance standards for pollution control. As a result, industrial facilities would comply with existing water quality regulations.

The construction of overheads would slightly increase impervious area because of the lengthening of paved surfaces, compared to the existing at-grade roadway. Stormwater would be collected at the toe of embankments, and directed to detention basins. Underpasses would require pump stations that would pump runoff from the low point of the road to either a municipal drainage system or a detention basin. Several rail crossing improvements would require new paved access or frontage roads. In most locations, proposed new roads are in rural areas, and stormwater would run off into unlined roadside ditches to convey stormwater flows and typically infiltrate. In more urban locations, runoff would flow to an existing storm drain system. New paved roads constructed as part of the Central Valley Wye would result in increased impervious surfaces, and could increase runoff. The contractor, in coordination with the local government with jurisdiction, would design roads with drainage infrastructure that would minimize changes to pre-project runoff volumes and rates.

Effects on hydraulic capacity as it relates to drainage patterns and surface water flows and connectivity of natural waterbodies would be similar for all Central Valley Wye alternatives. Increases in impervious surfaces along the Central Valley Wye would be small compared to the size of the drainage basins in which they are located. In addition, the stormwater drainage system or stormwater basin and culverts that would be installed by the contractor as part of the Central Valley Wye would accommodate any increased rates and amounts of runoff from the Central Valley Wye. The contractor would also comply with the Caltrans NPDES Permit, California HSR MS4 Permit, local stormwater requirements, and would implement measures to manage and treat for stormwater. The design of the Central Valley Wye includes the installation of infiltration or detention facilities and incorporation of permeable vegetated surfaces to accommodate increased rates and amounts of runoff (HYD-IAMF#1 and HYD-IAMF#3). The Authority will implement additional flow control measures where local regulations or drainage requirements dictate.

Central Valley Wye construction could result in permanent changes to runoff and drainage patterns within the surface water RSA. The contractor would implement design standards (HYD-IAMF#1) to manage stormwater and to maintain pre-project hydrology through on-site stormwater management measures, such as infiltration and retention of stormwater runoff, where appropriate, the Central Valley would not be expected to contribute to a violation of regulatory standards or result in a substantial change in on-site or off-site drainage capacity. In addition, detention or selected upgrades to the receiving system would be implemented to provide on-site stormwater management measures. These features would comply with the design standards in Appendix B and the latest version of Authority Technical Memorandum 2.6.5 Hydraulics and Hydrology Guidelines, and the design for each crossing would maintain the existing conditions and provide adequate capacity. The Central Valley Wye alternatives would not result in substantial erosion or siltation on-site or off-site.

All of the Central Valley Wye alternatives would result in multiple stream crossings, which could affect sedimentation, obstruct the ability of the waterbody to convey peak flows, and locally raise flood elevations, leading to effects on drainage patterns and stormwater runoff. Crossing the same waterbody multiple times could compound the effects on the waterbody depending on the proximity of the crossings. The Authority will develop and implement a stormwater management and treatment plan (HYD-IAMF#1) that includes detention to disperse flows and increase

infiltration, and LID design standards to detain runoff on-site and reduce off-site runoff. The Central Valley Wye includes a requirement to maintain pre-project hydrology (HYD-IAMF#3) and would develop and implement design standards to prevent saturation, and minimize potential effects related to erosion and surface water hydrology (HYD-IAMF#2). The construction SWPPP (HYD-IAMF#3) provides BMPs to minimize potential short-term increases in sediment transport caused by construction, including erosion control requirements, stormwater management, and channel dewatering for affected stream crossings. These BMPs would include measures to provide permeable surfaces where feasible and to retain or detain and treat stormwater on-site.

Operations

Intermittent Permanent Effects

Central Valley Wye operations could result in an intermittent change in hydraulic capacity and connectivity of natural waterbodies which would be approximately the same for all alternatives. Intermittent effects on existing drainage patterns or the course of a stream or river could occur and cause temporary siltation and turbidity within the water column during in-water bridge maintenance activities, such as those requiring barge or dredge equipment, temporary coffer dams, or other activities conducted in or near waters during maintenance activities. The Central Valley Wye design includes implementation of drainage BMPs included in the SWPPP to temporarily divert channel flows and minimize or avoid discharge of sediment from the areas of land disturbance (HYD-IAMF#3). In addition, the Central Valley Wye requires bridge maintenance activities that involve in-water work to be limited, where feasible, to dry periods when flows in waterbodies are low or absent to manage the overall amount and quality of stormwater runoff potentially affecting receiving waterbodies.

Maintenance and repair of drainages or drainage infrastructure could temporarily affect existing drainage patterns, resulting in a short-term increase in localized erosion or siltation. Maintenance or repair crews would temporarily divert surface flows, if necessary, to a nearby storm drain(s) to maintain proper drainage, and would implement BMPs to minimize the potential for erosion and siltation (HYD-IAMF#3). If the maintenance activity requires land disturbance of 1 acre or more, the contractor would obtain a Construction General Permit and prepare and implement an SWPPP (HYD-IAMF#3 and HYD-IAMF#4), which would provide BMPs to minimize potential short-term increases in sediment transport caused by construction, including erosion control requirements, stormwater management, and management of the amount and quality of stormwater runoff. If the activity would disturb less than 1 acre of land, then typically local grading and drainage requirements may trigger the need to develop an erosion control plan or similar plan as required by local ordinances, as described in Section 3.3.2, General Plan Policies and Ordinances. Although not required to comply with local requirements, the Authority, through the IAMFs, has committed to coordinate with local agencies and to adhere to the local drainage requirements to the maximum extent practicable (HYD-IAMF#3 and HYD-IAMF#2) for flood protection, stormwater runoff management, sediment transport minimization, and on-site stormwater detainment and treatment.

Operations could result in an intermittent change an increase sediment loads in surface waters. The Authority would implement design features and measures, such as stormwater management and treatment including detention or LID features to prevent or minimize these effects (HYD-IAMF#1). Stormwater management measures would be designed and constructed to capture runoff and provide treatment prior to discharge of pollutant-generating surfaces, including access roads, and new over- and underpasses. Stormwater management measures may include infiltration and retention of stormwater runoff, where appropriate, or selected upgrades to the receiving system, to provide adequate capacity and to comply with the design standards in Appendix B and the latest version of Authority Technical Memorandum *2.6.5 Hydraulics and Hydrology Guidelines* (HYD-IAMF#1). The Central Valley Wye alternatives would not be expected to contribute to a violation of regulatory standards or result in a substantial change in on-site or off-site drainage capacity.

6.1.1.2 SR 152 (North) to Road 19 Wye Alternative

Under the SR 152 (North) to Road 19 Wye Alternative, construction and operations effects on drainage patterns would be similar to those described under the SR 152 (North) to Road 13 Wye Alternative because it would cross areas with similar topography, stormwater infrastructure, waterbodies, and land uses.

Construction

Temporary Construction Effects

Temporary construction effects of this Central Valley Wye alternative on drainage patterns would differ from those of the SR 152 (North) to Road 13 Wye Alternative slightly in the total waterbody crossings required (Table 6-1) and total acres disturbed during construction (Table 6-2). This Central Valley Wye alternative would have a total of 60 waterbody crossings, of which 32 are natural waterbody crossings and 28 are canal and ditch crossings (Table 6-2). The SR 152 (North) to Road 19 Wye Alternative would cross three natural waterbodies twice: Ash Slough, Berenda Slough, and Santa Rita Drain No. 1 (Table 5-5). In addition, the SR 152 (North) to Road 19 Wye Alternative would cross six canals and ditches twice: Berenda Canal, Califia Canal, Irrigation Ditches #42 and #43, Lat 24.2-8.9, and the San Juan Canal (Table 5-6). This Central Valley Wye alternative would have the fewest total waterbody crossings, and the same number of total waterbody crossings as the SR 152 (North) to Road 11 Wye Alternative.

Temporary disturbance could result in potential changes in stormwater runoff patterns. Design features and measures to maintain pre-project runoff volume and rates, and minimize associated erosion and siltation would minimize temporary construction effects on surface water hydrology. The SR 152 (North) to Road 19 Wye Alternative would not be expected to contribute to a violation of regulatory standards or result in a substantial change in existing on-site or off-site drainage patterns and conditions would not exceed the capacity of drainage infrastructure.

Permanent Construction Effects

Permanent construction effects of the SR 152 (North) to Road 19 Wye Alternative on drainage patterns would differ from those of the SR 152 (North) to Road 13 Wye Alternative slightly in the amount of new impervious area that would result. Construction of this Central Valley Wye alternative would not result in substantial erosion or siltation on-site or off-site, contribute to a violation of regulatory standards, or result in a substantial change in drainage that would exceed capacity of drainage infrastructure.

Operations

Intermittent Permanent Effects

Intermittent operation effects of the SR 152 (North) to Road 19 Wye Alternative on drainage patterns would differ from those of the SR 152 (North) to Road 13 Wye Alternative and the Avenue 21 to Road 13 Wye Alternatives slightly in the number of bridge crossings that may require maintenance activities (Table 6-1). The SR 152 (North) to Road 19 Wye Alternative would have a total of 60 waterbody crossings, of which 32 are natural waterbody crossings and 28 are canal and ditch crossings. The SR 152 (North) to Road 19 Wye Alternative would have the fewest total waterbody crossings. Despite this difference, the contractor would implement the same measures to reduce potential effects on surface water hydrology and drainage that could result from in-water bridge maintenance activities, or other maintenance and repair of drainages or drainage infrastructure (see the discussion under Operations in Section 6.1.1.1, SR 152 [North] to Road 13 Wye Alternative).

6.1.1.3 Avenue 21 to Road 13 Wye Alternative

Under the Avenue 21 to Road 13 Wye Alternative, construction and operation effects on drainage patterns would be similar to those described under Section 6.1.1.2, SR 152 (North) to Road 13 Wye Alternative because it would cross areas with similar topography, stormwater infrastructure, waterbodies, and land uses.

Construction

Temporary Construction Effects

Temporary construction effects of the Avenue 21 to Road 13 Wye Alternative on drainage patterns would differ from those of the SR 152 (North) to Road 13 Wye Alternative slightly in the total waterbody crossings required (Table 6-1) and total acres disturbed during construction (Table 6-2). The Avenue 21 to Road 13 Wye Alternative would have a total of 80 waterbody crossings, of which 39 are natural waterbody crossings and 41 are canal and ditch crossings (Table 6-1). This alternative would cross seven natural waterbodies twice: Ash Slough, Berenda Slough, Drain #6, San Juan Drain, Santa Rita Drain No. 1, Santa Rita Slough, and the West Santa Rita Drain (Table 5-5). In addition, the Avenue 21 to Road 13 Wye Alternative would cross six canals and ditches twice: Berenda Canal, Bethel Canal, Irrigation Ditches #42 and #43, Lat 24.2-8.9, and the San Juan Canal (Table 5-6). This alternative would have the highest number of total waterbody crossings. The Authority and FRA would be required to obtain coverage under the Construction General Permit because construction would disturb more than 1 acre of soil (Section 3.1.1.5).

The Avenue 21 to Road 13 Wye Alternative would not be expected to contribute to a violation of regulatory standards or result in a substantial change in existing on-site or off-site drainage patterns and conditions would not exceed the capacity of drainage infrastructure.

Permanent Construction Effects

Permanent construction effects of the Avenue 21 to Road 13 Wye Alternative on drainage patterns would differ from those of the SR 152 (North) to Road 13 Wye Alternative slightly in the amount of new impervious area that would result. Construction of this Central Valley Wye alternative could result in a change in drainage patterns or an increase in sediment loads in surface waters from land disturbance or other construction activities. This Central Valley Wye alternatives would not result in substantial erosion or siltation on-site or off-site, be expected to contribute to a violation of regulatory standards, or result in a substantial change in on-site or off-site drainage that would exceed capacity of drainage infrastructure.

Operations

Intermittent Permanent Effects

Intermittent operations effects of the Avenue 21 to Road 13 Wye Alternative on drainage patterns would differ from those of the SR 152 (North) to Road 13 Wye Alternative and the SR 152 (north) to Road 19 Wye Alternative slightly in the number of bridge crossings that may require maintenance activities. The Avenue 21 to Road 13 Wye Alternative would have a total of 80 waterbody crossings, of which 39 are natural waterbody crossings and 41 are canal and ditch crossings (Table 6-1). This alternative would have the highest number of total waterbody crossings. Despite this difference, the contractor would implement the same measures to reduce potential effects on surface water hydrology and drainage that could result from in-water bridge maintenance activities, or other maintenance and repair of drainages or drainage infrastructure (see the discussion under Operations in Section 6.1.1.1).

6.1.1.4 SR 152 (North) to Road 11 Alternative

Under the SR 152 (North) to Road 11 Wye Alternative, construction and operations effects on drainage patterns would be similar to those described under the SR 152 (North) to Road 13 Wye Alternative because it would cross areas with similar topography, stormwater infrastructure, waterbodies, and land uses.

Construction

Temporary Construction Effects

Temporary construction effects of this Central Valley Wye alternative on drainage patterns would differ from those of the SR 152 (North) to Road 13 Wye Alternative slightly in the total waterbody crossings required (Table 6-1) and total acres disturbed during construction (Table 6-2). This

Central Valley Wye alternative would have a total of 60 waterbody crossings, of which 30 are natural waterbody crossings and 30 are canal and ditch crossings (Table 6-1). The SR 152 (North) to Road 11 Wye Alternative would cross 2 natural waterbodies twice: Ash Slough, and Santa Rita Drain No. 1 (Table 5-5). In addition, the SR 152 (North) to Road 11 Wye Alternative would cross 4 canals and ditches twice: Irrigation Ditch #42, Justin Canal, Lat 24.2-8.9, and the San Juan Canal (Table 5-6)]. This Central Valley Wye alternative would have the lowest total waterbody crossings, and the same number of total waterbody crossings as the SR 152 (North) to Road 19 Wye Alternative.

Temporary disturbance would result in potential changes in stormwater runoff patterns. Design features and measures to maintain pre-project runoff volume and rates, and minimize associated erosion and siltation would minimize temporary construction effects on surface water hydrology. The SR 152 (North) to Road 11 Wye Alternative would not be expected to contribute to a violation of regulatory standards or result in a substantial change in existing on-site or off-site drainage patterns, and conditions would not exceed the capacity of drainage infrastructure.

Permanent Construction Effects

Permanent construction effects of the SR 152 (North) to Road 11 Wye Alternative on drainage patterns would differ from those of the SR 152 (North) to Road 13 Wye Alternative slightly in the resulting amount of new impervious area.

Operations

Intermittent Permanent Effects

Intermittent operation effects of the SR 152 (North) to Road 11 Wye Alternative on drainage patterns would differ from those of the SR 152 (North) to Road 13 Wye Alternative and the Avenue 21 to Road 13 Wye Alternative slightly in the number of bridge crossings that may require maintenance activities (Table 6-1). The SR 152 (North) to Road 11 Wye Alternative would have a total 60 waterbody crossings, of which 30 are natural waterbody crossings and 30 are canal and ditch crossings. The SR 152 (North) to Road 11 Wye Alternative would have the fewest total waterbody crossings, and the same number of total waterbody crossings as the SR 152 (North) to Road 19 Wye Alternative. Despite this difference, the contractor would implement the same measures to reduce potential effects on surface water hydrology and drainage that could result from in-water bridge maintenance activities, or other maintenance and repair of drainages or drainage infrastructure (see the discussion under Operations in Section 6.1.1.1, SR 152 [North] to Road 13 Wye Alternative).

6.2 Surface Water Quality Effects

6.2.1 Overview

The Authority anticipates completing the majority of Central Valley Wye construction within 6 years. Heavy construction (such as grading, excavating, and constructing and laying the trackway for the railbeds) of any of the Central Valley Wye alternatives would be accomplished within the 6-year period, but heavy construction at any one site would not occur continuously for this period. The SR 152 (North) to Road 19 Wye Alternative would result in the largest temporary and permanent areas of ground disturbance, whereas, the Avenue 21 to Road 13 Wye Alternative would result in the smallest temporary and permanent areas of ground disturbance (Table 6-2). Construction would clear these areas of vegetation or otherwise physically disturb them. Surface water quality could be affected by altered drainage patterns and water contaminants generated or inadvertently released during construction (e.g., sediments, fuel, oil, concrete). The Central Valley Wye alternatives would incorporate erosion and sedimentation controls to stabilize disturbed soils and prevent erosion from occurring along slopes or to prevent sediments from entering nearby storm drains and waterbodies; and good housekeeping practices and spill prevention and response to prevent discharge of trash, hazardous substances, and other materials to waters (HYD-IAMF#3, HYD-IAMF#4, GEO-IAMF#6, Geology and Soils, and GEO-IAMF#1D, Water and Wind Erosion [Appendix A]), and waste management and materials pollution controls (HMW-IAMF#1, Transport of Materials, HMW-IAMF#4, Spill Prevention, and BIO-IAMF#18, Construction

Utility Requirements and Waste Disposal [Appendix A]). Effects on surface water quality would be minimized because construction would not result in changes to surface water quality that would contribute to a violation of regulatory standards or waste discharge requirements; would not create or contribute runoff water that would provide substantial additional sources of polluted runoff; or would otherwise substantially degrade water quality.

Channel disturbance associated with construction of piers, bridge abutments, and culverts could result in changes to hydrology from alterations of local drainage patterns and stormwater runoff occurring at crossings of natural and constructed waterbodies. Construction would temporarily disturb stream channels at several crossings. Table 6-1 provides a summary of the number of waterbody crossings by Central Valley Wye alternative. Some of these crossings for all the Central Valley Wye alternatives would require in-water work for the construction of supporting piers. To the extent construction occurs in a stream channel with flowing water, there could be an increase in silt or sediment in the river during construction.

However, the SWPPP would include BMPs, such as installation of coffer dams to temporarily divert flows during in-channel work (HYD-IAMF#3). Prior to Construction of any facility classified as an industrial facility, an Industrial Stormwater Pollution Prevention Plan would be prepared and implemented by the contractor and would comply with existing water quality regulations (HYD-IAMF#4). For industrial facilities that discharge stormwater from the site, a SWPPP and a monitoring plan are required, and includes performance standards for pollution control to manage stormwater quality and runoff. In addition, the Central Valley Wye requires construction activities that involve in-water work would be limited, where feasible, to dry periods when flows in waterbodies are low or absent to manage the amount and quality of stormwater runoff (HYD-IAMF#3). In addition, where fill is planned in or adjacent to streams or rivers, the Authority will comply with Sections 401 and 404 of the CWA and Section 10 of the Rivers and Harbors Act, which require permits for fill activities at specific surface water features, as described in Section 3.8.2. Before construction, the Authority will notify the California Department of Fish and Wildlife and other relevant agencies of planned alterations of channels, if any, pursuant to California Fish and Game Code sections 1601–1603 (CDFG 2009). The contractor would also implement additional erosion control practices, as recommended in the *Merced to Fresno Section: Central Valley Wye Hydrology and Hydraulics Engineering Report* (Authority and FRA 2016a), to reduce the amount of sediment carried in streams where construction would occur near waterbodies or storm drains. The contractor would implement measures and BMPs, and comply with permit requirements to minimize the potential effects on water quality during construction. These efforts would minimize any changes and overall, water quality would remain close to existing conditions within stream channels and construction of the Central Valley Wye would not contribute to a violation of regulatory standards or waste discharge requirements.

During operations, the trains and tracks would not be expected to be major pollutant sources. Central Valley Wye stormwater system design would accommodate runoff and would provide stormwater quality treatment for the new roads (HYD-IAMF#1). The Central Valley Wye stormwater system would direct runoff from new roads to treatment BMPs and would not result in water quality changes to local waterbodies. Temporary effects on surface water quality resulting from the use of herbicides or pesticides would be approximately the same for all alternatives and would be reduced under implementation of an Environmental Management System to promote the use of nonhazardous materials to the extent possible (HMW-IAMF#3, Environmental Management System). Effects on water quality during operations would have a minimal effect because the contractor would implement measures to prevent any measurable changes to surface water quality conditions that would contribute to violations of water quality and regulatory standards or waste discharge requirements, minimize the creation or contribution of runoff water which would provide substantial additional sources of polluted runoff, or otherwise avoid or minimize any substantial degradation to water quality.

6.2.1.1 SR 152 (North) to Road 13 Wye Alternative

Construction

Temporary Construction Effects

Construction could result in a short-term change in drainage patterns after land disturbance or other construction activities occur. Potential effects from temporary construction disturbance such as grading and establishing construction staging areas include changes to drainage and stormwater runoff patterns. As a result, the Central Valley Wye construction would result in temporary degradation of water quality in several waterbodies within the surface water RSA. The SWRCB protects these waterbodies through beneficial use designations and impaired 303(d) listed waters (Tables 5-7 and 5-8) and water quality objectives (Table 5-9).

Construction of the SR 152 (North) to Road 13 Wye Alternative would temporarily disturb the second greatest area (532 acres) and would involve ground disturbance, including handling, storing, excavating, and placing fill; possible pile driving; aerial structure construction; bridge construction; and concrete track bed construction. Soil-disturbing activity during construction (i.e., excavation and grading) can lead to erosion and sedimentation resulting from the exposure of bare soils to stormwater. Bare soils are more likely to erode than vegetated areas that provide infiltration, retention, and dispersion.

Stream crossings would be particularly vulnerable to degraded water quality because construction would occur in the stream channel, and contaminants could have a direct path to surface water. Bridge supports in areas of high groundwater or in surface water would require excavation in the stream channel of the project footprint. The proximity of flowing water to active construction could provide a direct path for construction-related contaminants to reach surface water.

Changes in drainage patterns resulting from the Central Valley Wye construction could temporarily affect several waterbodies within the surface water RSA. Some waterbodies are intermittent streams and are not continuously flowing; therefore, temporary changes in drainage patterns from construction would not affect all waterbodies. The amount of stormwater runoff could increase relative to existing conditions because construction activities include removal of natural vegetation or other barriers to runoff and because the activities result in a net increase in impervious surfaces, including new paved roads constructed as part of the Central Valley Wye. Temporary diversion of stream flow may be necessary during the installation of support piers and bridge abutments in stream channels. This work could temporarily reduce channel capacity. If in-water construction occurs where open or flowing water is present, appropriate water diversion measures would be implemented after consultation and agreement with the appropriate agencies.

Under the SR 152 (North) to Road 13 Wye Alternative, implementation of various control and design features detailed in the SWPPP (HYD-IAMF#3) would minimize the risk of polluted runoff and the potential for sedimentation effects on water quality. The SWPPP provides BMPs to minimize potential increases in sediment transport caused by construction, including erosion control requirements and stormwater management. These BMPs would include measures to provide permeable surfaces where feasible and to retain or detain and treat stormwater on-site. Other BMPs include strategies to manage the overall amount and quality of stormwater runoff such as implementing practices to reduce erosion of exposed soil, including soil stabilization, regular watering for dust control, perimeter siltation fences, and sediment catchment basins. In addition to the General Dewatering Permit, the Construction General Permit, waste discharge requirements, and spill prevention, control, and countermeasure plan would also be implemented (HYD-IAMF#1, HYD-IAMF#4, and HMW-IAMF#4, Spill Prevention) by designing on-site stormwater management measures such as detention or utilizing LID techniques to detain runoff on-site and to reduce off-site runoff using biofiltration and bioretention systems, organic mulch layers, planting soil beds, and vegetated systems (biofilters), such as vegetated swales and grass filter strips, where appropriate. Where fill is planned in or adjacent to streams or rivers, the Authority would comply with CWA sections 401 and 404 and Rivers and Harbors Act section 10, which require permits for fill activities at specific surface water features (Section 3). Before construction, the Authority would notify the California Department of Fish and Wildlife and other

relevant agencies of planned alterations of channels, if any, pursuant to sections 1601–1603 of the California Fish and Game Code (CDFG 2009). These procedures identify pollutant sources that could affect water quality and identify, implement, and maintain BMPs to reduce pollutants and non-stormwater discharges in construction site runoff. The contractor would implement erosion and sedimentation controls (HYD-IAMF#3, GEO-IAMF#6, and GEO-IAMF#1D) and waste management and materials pollution controls (HYD-IAMF#4, HMW-IAMF#1, and BIO-IAMF#18) to reduce these potential effects on water quality. These measures would reduce effects by providing BMPs to minimize potential increases in sediment transport caused by construction, including erosion control requirements; provide measures to retain or detain and treat stormwater; provide design and construction guidelines and standards for soils; and provide methods for controlling water and wind erosion of soils. These methods include the use of mulches, revegetation, and covering areas with geotextiles. Where runoff velocity could be high, riprap and check dams could be used to reduce erosion. These methods would be implemented as appropriate and in coordination with other erosion, sediment, stormwater management and fugitive dust control.

Construction of the SR 152 (North) to Road 13 Wye Alternative could result in a short-term increase in the potential for discharge of pollutants into surface waters. The Central Valley Wye would comply with federal, state, and local regulations (i.e., the SWPPP, MS4, and General Dewatering Permit per HYD-IAMF#3) and the contractor would implement on-site stormwater management and treatment measures prior to discharge of runoff off-site (HYD-IAMF#1) as well as practices to implement on-site limitations and control over activities using hazardous materials and proper disposal of construction-generated wastes (HYD-IAMF#3 and HYD-IAMF#4). These measures would reduce the Central Valley Wye's effects on surface water quality. As a result, the SR 152 (North) to Road 13 Wye Alternative would not result in unacceptable pollutant loads or the discharge of pollutants to on-site and off-site waterbodies that would violate water quality or regulatory standards or waste discharge requirements, contribute to substantial additional sources of polluted runoff, or otherwise substantially degrade water quality.

Permanent Construction Effects

Central Valley Wye construction could result in a change in drainage patterns or an increase in sediment loads in surface waters after land disturbance or other construction activities. Permanent construction effects of the SR 152 (North) to Road 13 Wye Alternative on surface water quality would result in new impervious surface area. These effects would result from the presence of the HSR tracks, relocated roads, and new grade-separated roads. The Authority would implement the same IAMFs under all Central Valley Wye alternatives. In addition, the Authority would implement construction stormwater control and good housekeeping practices (HYD-IAMF#3), which would limit the potential for water contaminants to reach surface waters. To minimize turbidity and siltation from moving downstream, appropriate construction measures, such as turbidity curtains, would be determined and implemented through review and approval by the designated resource agencies.

HSR Tracks and Relocated Roads

During storm events, runoff from the HSR track and relocated roads could come into contact with pollutants and transport them into surface waterbodies. The Central Valley Wye design would prevent discharge of runoff from the Central Valley Wye directly to any surface waterbodies (HYD-IAMF#1). Stormwater management facilities would be designed and constructed to capture runoff and provide treatment prior to discharge of pollutant-generating surfaces such as access roads into receiving waterbodies. LID techniques such as biofiltration and bioretention systems, and vegetated systems (biofilters), such as vegetated swales and grass filter strips, would be used where appropriate to detain runoff on-site and to reduce off-site runoff.

The Central Valley Wye stormwater system would collect and convey runoff from bridges, overheads, underpasses, and aerial structures to an infiltration/detention basin or to a nearby stormwater collection system, or dispersed in a non-erosive manner. The stormwater system also would utilize management techniques to handle runoff from the track rights-of-way (e.g., retained on-site, dispersed in a non-erosive fashion, conveyed to a nearby stormwater collection system,

or directed through swales to infiltration basins located within the HSR right-of-way). The contractor would maintain the stormwater facilities within the HSR right-of-way. The contractor would design the infiltration basins as a water quality control measure.

Elevated crossings would require support piers in various water channels. At-grade crossings of stream channels would require bridge abutments on banks and support piers in the water channel or, in some locations, the alignment would cross natural waterbodies using box culverts. The Central Valley Wye alternatives would not discharge any runoff from the HSR tracks or track rights-of-way directly to any surface waterbodies, irrigation canals, private property, or county roads. Runoff from bridges, overheads, underpasses, and aerial structures at major river and creek crossings would be collected and discharged to the ground surface in a non-erosive manner, discharged to volume-based or flow-based stormwater treatment devices such as infiltration basins, or discharged to adjacent stormwater drainage systems. Any discharges to stormwater drainage systems would be pursuant to requirements of the entity controlling the stormwater drainage system. The Authority has design each crossing in a manner that would maintain the existing hydraulic capacity and pre-project hydrology as required by the Construction General Permit (HYD-IAMF#3). These measures would minimize the effects of placing piers in the floodplains and floodways in the design of these bridge crossings. For example, with Authority approval, construction contractors would design and place piers to minimize backwater effects and local scouring. The shape and alignment of the piers would also be designed to minimize negative hydraulic effects.

The Authority would implement IAMFs (Appendix A) and comply with applicable design standards (Appendix B) such that runoff from the HSR tracks and relocated roads would be dispersed in a non-erosive fashion, infiltrated on-site, conveyed to a nearby stormwater collection system, or directed through swales to infiltration basins. In addition, the technology proposed for the electric HSR system does not require large amounts of lubricants or hazardous materials for operation, and the contractor would implement water quality design measures.

Central Valley Wye construction of HSR tracks and relocated roads could result in permanent changes to runoff and drainage patterns within the surface water RSA. The contractor would reduce effects on surface water quality by implementing measures as part of IAMFs to reduce the potential for any water quality contaminants to reach local surface waterbodies and would require on-site stormwater management and treatment measures prior to discharge of runoff off-site. The Central Valley Wye alternatives would not contribute to a violation of regulatory water quality standards or waste discharge requirements, and would not result in unacceptable pollutant loads, contribute to substantial additional sources of polluted runoff, or otherwise substantially degrade water quality.

Grade-Separated Roads

The Central Valley Wye alternatives would build new grade-separated roads at a number of rail crossings in the surface water RSA. These new sources of road runoff could affect water quality.

The Central Valley Wye stormwater system would collect and treat stormwater per the requirements of the CWA section 401 permit. Underpasses would require pump stations that would pump runoff from the low point of the road to either a municipal drainage system or a treatment system that would treat runoff. This approach would meet or exceed the treatment of Section XIII of the Construction General Permit. It would also meet or exceed the treatment and hydromodification control requirements for compliance with any active Phase I or Phase II permit applicable in those areas of the Central Valley Wye with active MS4 permits (Authority 2013). The contractor would implement these water quality design measures to reduce the potential for effects on water quality, and the Central Valley Wye alternatives would not direct runoff onto private property. Appendix A describes the IAMFs for stormwater management and treatment (HYD-IAMF#1, HYD-IAMF#3). Stormwater management measures would be designed and constructed to capture runoff and provide treatment prior to discharge of pollutant-generating surfaces, including access roads. Stormwater management measures may include infiltration and retention of stormwater runoff, where appropriate, or selected upgrades to the receiving system, to provide adequate capacity and to comply with the design standards in Appendix B and the

latest version of Authority Technical Memorandum *2.6.5 Hydraulics and Hydrology Guidelines* (HYD-IAMF#1). Industrial facilities that discharge stormwater are required to include performance standards for pollution control and comply with existing water quality regulations (HYD-IAMF#4).

Central Valley Wye construction of grade-separated roads could result in permanent changes to runoff and drainage patterns within the surface water RSA. Such changes to drainage patterns as a result of grading activities could affect stormwater runoff during rain events. The Authority would reduce effects on surface water quality by designing the Central Valley Wye in compliance with regulatory permits and requirements (i.e., MS4 permit) that require control and treatment of project-related stormwater, to minimize or avoid violation of regulatory standards. Additional flow control measures would be implemented where local regulations or drainage requirements dictate. Diversion ditches would be used to intercept off-site surface runoff. Through this design, runoff would be expected to enter the same waterbodies as existing conditions and effects on runoff and drainage patterns would be minimized.

The Central Valley Wye design will maintain pre-project hydrology through hydromodification management by emphasizing on-site retention of stormwater runoff using measures such as flow dispersion, infiltration, and evaporation, supplemented by detention, where required (HYD-IAMF#3). In addition, the Central Valley Wye must comply with waste discharge requirements; not contribute to substantial additional sources of polluted runoff; or otherwise substantially degrade water quality. The Authority and FRA would be responsible for the ongoing monitoring, maintenance, and repair of these structures.

Operations

Intermittent Permanent Effects

Routine vegetation removal along the tracks and associated infrastructure may require land disturbance resulting in increased susceptibility to erosion and sedimentation along slopes.

Implementation of SWPPP construction erosion and sediment control measures (HYD-IAMF#3) would reduce the potential for erosion and sedimentation to occur. BMPs used during construction include implementing practices to reduce erosion of exposed soil, including soil stabilization, watering for dust control, perimeter siltation fences, and practices to maintain current water quality including wattle barriers, stabilized construction entrances, grass buffer strips, organic mulch layers, inlet protection, and storage tanks and sediment traps to arrest and settle sediment. In addition, vegetation removal may require the use of herbicides or pesticides. With respect to the pollutants listed on the 303(d) list, the Central Valley Wye would not contribute chlorpyrifos, a more recently developed pesticide, dichlorodiphenyltrichloroethane, diazinon, or *E. coli*. Other herbicides or pesticides may be used to control weeds and vermin. Applicable laws and regulations governing the application of herbicides and pesticides would be followed.

The Authority or its contractors may use herbicides and pesticides along the HSR right-of-way to control weeds and vermin as required by state and federal regulations. Applicators will use and apply herbicides and pesticides in a manner that minimizes the negative effects on the environment. Applicators will take the following precautions:

- The Authority or its contractors will implement herbicide spraying consistent with Pest Control Recommendations prepared by a licensed Pest Control Advisor.
- Applicators will follow herbicide label requirements and refer to other BMPs regarding mandatory measures to protect sensitive resources and employee and public health during herbicide application.
- Herbicide applicators will work under the direction of a person with a Qualified Applicator License or Qualified Applicator Certificate.
- Storage, loading, and mixing of herbicides would be set back from any aquatic feature or special-status species or their habitat or sensitive natural communities.

- Application will not occur when weather parameters exceed label specifications (e.g., when wind exceeds specified speed or when precipitation occurs or is forecasted within a specified period) to prevent sediment and herbicides from entering the water resources via surface runoff.

Applicators will follow appropriate laws and regulations pertaining to the use of herbicides and safety standards for employees and the public, as established by the USEPA and the California Department of Pesticide Regulation. Applications would adhere to label directions for application rates and methods, storage, transportation, mixing, and container disposal. The Authority will retain State-licensed applicators appropriate for the type of application. HSR staff will coordinate with the County Agricultural Commissioners, and obtain any required licenses and permits prior to herbicide application. In addition, to the extent feasible, the Authority is committed to identifying, avoiding, and minimizing hazardous substances in the material selection process for construction, operation, and maintenance of the HSR system (HMW-IAMF#3). To reduce effects, the Authority will use an Environmental Management System to evaluate the full inventory of hazardous materials defined by federal and state law and would replace hazardous substances with nonhazardous materials. Where possible, the contractor will utilize non-toxic pesticides for vegetation control.

The technology proposed for the HSR system does not require large amounts of lubricants or hazardous materials for operation compared to diesel locomotive fuel tanks. However, the Central Valley Wye would need minimal transformers to connect to one Pacific Gas and Electric Company facility, the traction power substations (TPSS) would require maintenance activities and the storage of oil and other materials for equipment maintenance. For example, oil-filled transformers require the storage of chemicals, such as cleaning liquids and mineral oil for proper maintenance. The majority of materials used for maintenance would be non-toxic and would be stored in covered areas. State and federal laws regulate the storage of hazardous materials; regulated materials would be located in maintenance areas with secondary containment to prevent potential spills in compliance with good housekeeping practices. In addition, the Authority would incorporate IAMFs into the Central Valley Wye design to reduce potential effects of hazardous materials (Appendix A). The contractor would implement an Environmental Management System to promote the use of nonhazardous materials to the extent possible (HMW-IAMF#3), and the contractor would reduce the potential effects of the use and storage of hazardous materials at Central Valley Wye facilities (i.e., TPSSs) through the implementation of hazardous materials monitoring plans, including a hazardous materials business plan and a spill prevention, control, and countermeasure plan (HMW-IAMF#4). The Authority would limit the amount of hazardous substances used for HSR operations and would have specific cleanup protocols and trained personnel to prevent regular use or accidental spills of hazardous materials reaching surface waterbodies such that that the Central Valley Wye alternatives would not contribute to a violation of regulatory standards.

Central Valley Wye operations could result in increases in the potential for discharge of pollutants into surface waters. The contractor will implement SWPPP construction erosion and sediment control measures (HYD-IAMF#3 and HYD-IAMF#4) and thereby reduce effects on water quality from vegetation removal and herbicide and pesticide use. The contractor will use pesticides and herbicides in a manner that follows listed precautions and regulatory requirements to prevent sediment and pesticides and herbicides from entering surface waters via surface runoff. In addition, the contractor would implement and Environmental Management System (HMW-IAMF#3) and a spill prevention, control, and countermeasure plan (HMW-IAMF#4) to limit the potential for spills, limit the amount of hazardous substances used for HSR operations, and would have specific cleanup protocols and trained personnel to prevent regular use or accidental spills of hazardous materials and other pollutants reaching surface waterbodies. As a result of these measures, the Central Valley Wye alternatives would not contribute to a violation of regulatory standards or waste discharge requirements, would not create or contribute substantial runoff water which would provide substantial additional sources of polluted runoff, or otherwise substantially degrade water quality.

Continuous Permanent Effects

Because the HSR would run parallel to the existing BNSF corridor for a portion of the Central Valley Wye and potential pollutant types for the HSR are similar to those in existing and active railroads, the Central Valley Wye alternatives would not introduce new types of pollutants to the San Joaquin River Basin in the areas near the existing railway. The presence of the SR 152 (North) to Road 13 Wye Alternative could increase the amount of the pollutants associated with rail operations that may already exist in the watershed because of increased rail service, and introduce new pollutant types in those areas not parallel to the existing BNSF corridor. Because the HSR system would be electrically powered, the HSR trains and associated track runoff would not introduce significant new pollutant sources or types of pollutants. In addition, the electric trains would use a regenerative braking technology, resulting in reduced physical braking and associated wear. When using regenerative braking, the train converts some kinetic energy into electrical energy and feeds this energy back into the overhead contact system to be used by other trains operating close by or to be fed back into the power supply utility network. As a result, the at-grade tracks and the elevated guideways would produce minimal pollutant-generating surfaces.

Berkhardt, Rossi, and Boller (2008) estimated the composition and quantity of substances released by the Swiss Federal Railways network to the environment, based on use of consumable materials (i.e., brake pads, lubricants, and herbicides). In the case of the Swiss Federal Railways, the primary substances released from braking were iron, copper, manganese, and chromium; zinc was released from galvanized poles. Most of the releases into the environment were as particulate matter, which is airborne liquid and solid particles that cause air pollution. Other railway studies also found particle emissions of heavy metals such as chromium, manganese, iron, copper, lead, cadmium, zinc, mercury, cobalt, and molybdenum as a result of train operations and organic pollutants such as polycyclic aromatic hydrocarbons (PAHs) from the use of grease and oils during train operation (Bukowiecki, et. al. 2007; Wilkomirski, et. al. 2011). Additional pollutant sources, such as residual debris from track wear and trash, would also be minimal and would be treated with good housekeeping practices, such as trash pick-up and sweeping at TPSSs and along the tracks. The Authority's MS4 permit for urban runoff includes heavy metals. The pollution prevention and good housekeeping practices for operations include identifying all materials that contain pollutants including metals that could be discharged from Operation and Maintenance activities, and to develop and implement BMPs that, when applied during Permittee Operation and Maintenance activities, would reduce pollutants in stormwater and non-stormwater discharges. The MS4 requires Permittees to develop and implement a Program Effectiveness Assessment and Improvement Plan. This plan includes "Science-based estimates of pollutant load removal for BMPs where direct measurement of pollutant removal is overly challenging", for example the removal of heavy metals through a bioswale.

Central Valley Wye operations could result in increases in the potential for discharges of pollutants into surface waters. Operations and maintenance effects on water quality would be reduced because the Central Valley Wye alternatives would implement IAMFs that require construction stormwater control and good housekeeping practices (HYD-IAMF#3), such as limiting fueling and other activities using hazardous materials to areas distant from surface water, providing drip pans under equipment, and daily checks for vehicle condition, to limit the potential for water contaminants to reach surface waters and would comply with post-construction stormwater requirements and other related requirements. As a result, the Central Valley Wye alternatives would not contribute to a violation of regulatory standards or waste discharge requirements, would not create or contribute substantial runoff water which would provide substantial additional sources of polluted runoff, or otherwise substantially degrade water quality.

6.2.1.2 SR 152 (North) to Road 19 Wye Alternative

Under the SR 152 (North) to Road 19 Wye Alternative, construction and operations effects on surface water quality would be similar to those described under the SR 152 (North) to Road 13 Wye Alternative because it would cross areas with similar stormwater infrastructure, waterbodies, and land uses.

Construction

Temporary Construction Effects

Temporary construction effects of the SR 152 (North) to Road 19 Wye Alternative on surface water quality would differ from those of the SR 152 (North) to Road 13 Wye Alternative slightly in the total acres disturbed during construction. Table 6-2 shows this alternative would temporarily disturb 674 acres and permanently affect 2,752 acres. This alternative would result in the highest number of temporarily and permanently disturbed acres.

Permanent Construction Effects

Permanent construction effects of the SR 152 (North) to Road 19 Wye Alternative on surface water quality would differ from those of the SR 152 (North) to Road 13 Wye Alternative slightly in the size of new impervious surface area. Like the SR 152 (North) to Road 13 Wye Alternative, these effects would result from the presence of the HSR tracks, relocated roads, and new grade-separated roads. The contractor would implement measures under the same IAMFs under both alternatives.

HSR Tracks and Relocated Roads

Construction of HSR tracks and relocated roads could result in permanent changes to runoff and drainage patterns within the surface water RSA similar to those described under the SR 152 (North) to Road 13 Wye Alternative.

Grade-Separated Roads

Construction of grade-separated roads could result in permanent changes to runoff and drainage patterns within the surface water RSA similar to those described under the SR 152 (North) to Road 13 Wye Alternative. The effects on surface water quality would be similar to the SR 152 (North) to Road 13 Wye Alternative despite the slightly greater impervious area from the new grade-separated roads because the Authority would design the Central Valley Wye alternatives in compliance with the same regulations and regulatory permits and implement the same associated measures and requirements that require control and treatment of Central Valley Wye-related stormwater

Operations

Intermittent and continuous operations effects of the SR 152 (North) to Road 19 Wye Alternative on surface water quality would not differ from those of the SR 152 (North) to Road 13 Wye Alternative.

Intermittent Permanent Effects

Central Valley Wye maintenance activities, such as vegetation removal and herbicide and pesticide use and hazardous materials use could have periodic, short-term effects on water quality similar to those described under the SR 152 (North) to Road 13 Wye Alternative.

Continuous Permanent Effects

The SR 152 (North) to Road 19 Wye Alternative would have similar effects and would incorporate measures under the same IAMFs as under the SR 152 (North) to Road 13 Wye Alternative.

6.2.1.3 Avenue 21 to Road 13 Wye Alternative

Under the Avenue 21 to Road 13 Wye Alternative, construction and operation effects on surface water quality would be similar to those described under the SR 152 (North) to Road 13 Wye Alternative. The alternatives would cross areas with similar stormwater infrastructure, waterbodies, and land uses.

Construction

Temporary Construction Effects

Temporary construction effects of the Avenue 21 to Road 13 Wye Alternative on surface water quality would differ from those of the SR 152 (North) to Road 13 Wye Alternative slightly in the

total acres disturbed during construction. Table 6-2 shows the Avenue 21 to Road 13 Wye Alternative would temporarily disturb 361 acres and permanently affect 2,309 acres. This alternative would result in the lowest amount of temporarily and permanently disturbed acres.

Permanent Construction Effects

Central Valley Wye construction could result in a change in drainage patterns or an increase in sediment loads in surface waters after land disturbance or other construction activities.

Permanent construction effects of the Avenue 21 to Road 13 Wye Alternative on surface water quality would differ from those of the SR 152 (North) to Road 13 Wye Alternative slightly in the amount of new impervious surface area. Like the SR 152 (North) to Road 13 Wye Alternative and Avenue 21 to Road 13 Wye Alternative, these effects would result from the presence of the HSR tracks, relocated roads, and new grade-separated roads. The Authority would implement the same IAMFs under all Central Valley Wye alternatives.

HSR Tracks and Relocated Roads

Construction of the HSR tracks and relocated roads could result in permanent changes to runoff and drainage patterns within the surface water RSA. The contractor would implement measures to reduce these effects on surface water quality, as part of IAMFs. The Central Valley Wye would require on-site stormwater management and treatment measures prior to discharge of runoff off-site and would reduce the potential for any water quality contaminants to reach local surface waterbodies (HYD-IAMF#1). Stormwater management measures would capture runoff and provide treatment through LID techniques such as biofiltration systems prior to discharge of pollutant-generating surfaces including new roads. The Central Valley Wye alternatives would not result in unacceptable pollutant loads and would not violate water quality standards or waste discharge requirements, contribute to substantial additional sources of polluted runoff, or otherwise substantially degrade water quality.

Grade-Separated Roads

Construction of grade-separated roads could result in permanent changes to runoff and drainage patterns within the surface water RSA. The effects would be similar to the SR 152 (North) to Road 13 Wye Alternative despite the smaller impervious area from the new grade-separated roads because it would be designed and operated in compliance with the same regulations and implement the same associated measures.

Operations

Intermittent and continuous operation effects of the Avenue 21 to Road 13 Wye Alternative on surface water quality would not differ from those of the SR 152 (North) to Road 13 Wye Alternative.

Intermittent Permanent Effects

Operations could result in increases in the potential for pollutants to be discharged into surface waters similar to those described under the SR 152 (North) to Road 13 Wye Alternative.

Continuous Permanent Effects

The Avenue 21 to Road 13 Wye Alternative would have the same effects and would comply with measures under the same IAMFs as would be implemented under the SR 152 (North) to Road 13 Wye Alternative.

6.2.1.4 *SR 152 (North) to Road 11 Wye Alternative*

Under the SR 152 (North) to Road 11 Wye Alternative, construction and operations effects on surface water quality would be similar to those described under the SR 152 (North) to Road 13 Wye Alternative because it would cross areas with similar stormwater infrastructure, waterbodies, and land uses.

Construction

Temporary Construction Effects

Temporary construction effects of the SR 152 (North) to Road 11 Wye Alternative on surface water quality would differ from those of the SR 152 (North) to Road 13 Wye Alternative slightly in the total acres disturbed during construction. Table 6-2 shows this alternative would temporarily disturb 411 acres and permanently affect 2,460 acres. This alternative would result in the second lowest amount of temporarily and permanently disturbed acres.

Permanent Construction Effects

Permanent construction effects of the SR 152 (North) to Road 11 Wye Alternative on surface water quality would differ from those of the SR 152 (North) to Road 13 Wye Alternative slightly in the amount of new impervious surface area. Like the SR 152 (North) to Road 13 Wye Alternative, these effects would result from the presence of the HSR tracks, relocated roads, and new grade-separated roads. The contractor would implement measures under the same IAMFs under both alternatives.

HSR Tracks and Relocated Roads

Construction of HSR tracks and relocated roads could result in permanent changes to runoff and drainage patterns within the surface water RSA similar to those described under the SR 152 (North) to Road 13 Wye Alternative.

Grade-Separated Roads

Construction of grade-separated roads could result in permanent changes to runoff and drainage patterns within the surface water RSA similar to those described under the SR 152 (North) to Road 13 Wye Alternative. The effects on surface water quality would be similar to the SR 152 (North) to Road 13 Wye Alternative despite the slightly greater impervious area from the new grade-separated roads because the Authority would design the Central Valley Wye alternatives in compliance with the same regulations and regulatory permits and implement the same associated measures and requirements that require control and treatment of Central Valley Wye-related stormwater

Operations

Intermittent and continuous operations effects of the SR 152 (North) to Road 11 Wye Alternative on surface water quality would not differ from those of the SR 152 (North) to Road 13 Wye Alternative.

Intermittent Permanent Effects

Central Valley Wye maintenance activities, such as vegetation removal and herbicide and pesticide use and hazardous materials use could have periodic, short-term effects on water quality similar to those described under the SR 152 (North) to Road 13 Wye Alternative.

Continuous Permanent Effects

The SR 152 (North) to Road 11 Wye Alternative would have similar effects and would incorporate measures under the same IAMFs as under the SR 152 (North) to Road 13 Wye Alternative.

6.3 Groundwater Quality and Volume Effects

6.3.1 Overview

Excavation activities, such as pile driving and utility improvements, could require dewatering affecting groundwater quality if construction crews encounter groundwater. Because of the depth to groundwater (greater than 50 feet), the amount of dewatering is likely to be relatively minor. Dewatering would be temporary and would only occur during construction. The Authority or its construction contractor will conduct dewatering activities according to the Central Valley RWQCB's dewatering requirements by treating the water prior to discharge such that discharges do not contain significant quantities of pollutants or hauling the water to a treatment facility, General Construction Permit, and the Caltrans *Field Guide to Construction Dewatering* (Caltrans

2014). In addition, the contractor will control the amount of groundwater withdrawal, re-inject groundwater at specific locations if necessary, or use alternate foundation designs to offset the potential for groundwater overdraft and resulting ground settlement (GEO-IAMF#1A, Groundwater Withdrawal). The Central Valley Wye alternatives could affect groundwater recharge through the placement of new impervious surfaces. Overall, relative to the size of the groundwater RSA, the Central Valley Wye alternatives would not result in a large area of new impervious surfaces and measures, such as permeable and vegetated areas would be incorporated into the design to provide for soil infiltration (HYD-IAMF#1), and potential effects on groundwater recharge would be minimal.

The Authority and contractor will implement measures during construction and operation activities to avoid or minimize groundwater overdraft that are, to the extent feasible, consistent with local groundwater requirements, as well as future groundwater sustainability plans adopted by groundwater sustainability agencies within groundwater basins that are in high and medium priority, as required by the Sustainable Groundwater Management Act.

Construction and operation of the Central Valley Wye alternatives would have a negligible effect on groundwater supply, resources, and quality because of the minimal new impervious surface area that could interfere with groundwater recharge, and the lack of an on-going need for groundwater supplies during operations. As a result, the changes would be negligible relative to the existing conditions. In addition, during construction of the Central Valley Wye, the contractor will implement measures to comply with waste discharge requirements during construction and other activities such that the Central Valley Wye alternatives would not result in violation of any groundwater quality standards, result in accidental releases of hazardous materials and pollutants, substantially deplete groundwater supplies, or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level.

6.3.1.1 SR 152 (North) to Road 13 Wye Alternative

Construction

Temporary Construction Effects

Groundwater levels in the Central Valley Wye vicinity are generally deeper than anticipated excavation depths. Most of the water depths in the groundwater RSA are greater than 50 feet (Table 5-12), so construction workers would not encounter groundwater. However, under this Central Valley Wye alternative, excavation may affect groundwater quality during dewatering activities if construction crews encounter groundwater. For example, piers that could be either drilled or driven would support the aerial structure sections of the railroad. Bridge supports in areas of shallow groundwater or in surface water would require dewatering during pile driving. Aerial structure footings near waterbodies may also encounter high groundwater levels, which would also require dewatering.

If groundwater is encountered during excavation, the quality of the groundwater may be affected during dewatering activities. If the drilling method uses a slurry, any groundwater encountered would be removed and disposed of by the drilling contractor along with the drilling slurry. If a drilled hole needs to be dewatered, groundwater would be disposed of according to Central Valley RWQCB's dewatering requirements, General Construction Permit, and the Caltrans *Field Guide to Construction Dewatering*, which includes treating the water prior to discharge such that discharges do not contain significant quantities of pollutants or hauling the water to a treatment facility. The amount of dewatering is likely to be relatively small and done in widely spaced locations. In addition, any effects from groundwater dewatering would be temporary, because once construction was completed, dewatering would cease. The natural recharge of the affected groundwater zones would then be re-established. The Authority has established measures as part of IAMFs that involve compliance with dewatering requirements to reduce the potential for effects on groundwater levels (GEO-IAMF#1A and GEO-IAMF#1B, Unstable Soils) and contamination (HYD-IAMF#1). The Central Valley Wye alternatives would minimize the potential effects on regional groundwater levels and quality because the changes would be negligible

relative to the existing conditions. For example, dewatering activities would be temporary and limited, and there would be minimal new impervious surface area that could interfere with groundwater recharge.

Central Valley Wye construction activities could result in accidental releases of construction-related hazardous materials that might affect groundwater. Excavations could provide a direct path for construction-related contaminants to reach groundwater. Excavation could disturb known and undocumented soil or groundwater contamination, resulting in the migration of contaminated groundwater further into the groundwater table and a potential for inadvertent contamination of groundwater.

Implementation of measures such as stormwater management would capture and treat stormwater through LID techniques including biofiltration and bioretention systems and would protect groundwater quality by managing and controlling surface runoff at construction sites to minimize the potential for contaminants to reach groundwater exposed during excavations (HYD-IAMF#1 and HYD-IAMF#3). The Central Valley Wye design would also include measures specified in the spill prevention, control, and countermeasure plan to control and minimize the extent of possible contamination from spills of hazardous materials, prevent hazardous material releases, and clean up any hazardous material releases that may occur (HMW-IAMF#4 [Appendix A]). Implementation of the Central Valley Wye alternatives would include measures to address provisions for the disturbance, minimize the potential for effects on surface and groundwater resources, and address necessary clean-up or disposal from undocumented contamination (e.g., previously contaminated soil or other materials) (HMW-IAMF#5, Undocumented Contamination and HMW-IAMF#3). Should construction crews encounter undocumented contamination of groundwater during construction, the contractor will cease work, contain the area, and coordinate with local agencies to resolve any such encounters.

Resolutions may involve conducting a site investigation, implementing remediation activities, and properly disposing of contaminated materials. The Central Valley Wye alternatives would not contribute to a violation of any groundwater quality or regulatory standards.

Construction of the at-grade and elevated sections of track would require existing permitted commercial sources of water supplies and would not use existing groundwater sources. Any changes in groundwater levels would be temporary and minimal in volume, consistent with IAMFs to protect groundwater levels and ground surface conditions (GEO-IAMF#1A and GEO-IAMF#1B [Appendix A]). These IAMFs would require monitoring and controlling the amount of groundwater withdrawal, and re-injection of groundwater as needed based on site-specific conditions. In addition, the contractor will implement any dewatering that requires disposal of groundwater in compliance with the Central Valley RWQCB's dewatering requirements, General Construction Permit, and the Caltrans *Field Guide to Construction Dewatering* to protect groundwater quality. The Central Valley Wye alternatives would be in compliance with both the Caltrans and the Authority's MS4 requirements, and would include measures for stormwater management and treatment (Appendix A) to reduce effects of new impervious surfaces.

Central Valley Wye construction could result in a potential for discharge of pollutants into groundwater aquifers, and effecting groundwater quality. The Authority will implement IAMFs to control stormwater runoff and manage on-site use of hazardous materials, reducing potential effects on groundwater quality. The contractor would implement erosion and sedimentation controls (HYD-IAMF#1, GEO-IAMF#1B, GEO-IAMF#1D) to capture and reduce runoff, provide design and construction guidelines and standards for soils, and provides methods for controlling water and wind erosion of soils. Methods include the use of mulches, revegetation, and covering areas with geotextiles. These methods would be implemented as appropriate and in coordination with other erosion, sediment, and stormwater management to reduce erosion effects. Waste management and materials pollution controls (HMW-IAMF#1 and BIO-IAMF#18) to protect groundwater levels and quality during the transport of hazardous materials and dewatering activities would also be implemented. In addition, measures as part of the Central Valley Wye design would prevent contamination of groundwater during dewatering and water diversions (BIO-IAMF#20) As a result, the Central Valley Wye alternatives would not result in violation of any

groundwater quality standards, would not result in substantial reduction of groundwater supplies or interfere with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level.

Permanent Construction Effects

Portions of the groundwater RSA serve as recharge areas for the San Joaquin River and its tributaries, primarily along active stream channels containing substantial amounts of sand and gravel (Authority and FRA 2016b). In these areas, construction of the Central Valley Wye would reduce infiltration and groundwater recharge because the Central Valley Wye alternative would increase impermeable surfaces and would redirect runoff (i.e., by placing piers in the channels and in areas with shallow groundwater, as well as new paving for roads and other areas along the alignment). The Central Valley Wye alternatives would result in similar effects on groundwater from new impervious surfaces. Because the piers would have a narrow, linear permanent effect area and other new impervious areas for roads and other infrastructure would be minimal, relatively limited new impermeable surface would result.

The Central Valley Wye alternatives would not likely affect groundwater quality in areas of construction of new impervious surfaces because of the lack of connectivity to the underlying aquifer. Areas of compacted gravel, such as the railbed and unpaved roads, would be relatively unaffected by potential groundwater pollution because the ability for infiltration would be reduced. In addition, the track runoff would likely contain few pollutants because operation of the electrically powered high-speed train would not require oil and gas products. The contractor would implement measures to protect groundwater quality, such as biofiltration and bioretention systems, to manage and treat surface runoff prior to soil infiltration (HYD-IAMF#1). The potential effect on groundwater quality would be reduced because treatment of stormwater runoff would limit the potential for contaminant sources to reach groundwater. The Central Valley Wye alternatives would not result in violation of any groundwater quality standards.

The contractor will incorporate permeable or vegetated areas into the design to allow for infiltration and groundwater recharge. In addition, the Central Valley Wye alternatives would not affect groundwater supply because no groundwater would be used for water supply and the provision of replacement wells would not result in changes to the amount or rate of groundwater pumping relative to the existing groundwater supply conditions. Therefore, the Central Valley Wye alternatives would not result in conditions that affect the availability of groundwater supplies.

Increases in impervious surfaces could result in a net deficit in aquifer volume or a lowering of the groundwater table because of interference with groundwater recharge, including removal or recharge areas. The Central Valley Wye would create new impervious surfaces as a result of the at-grade railbed, aerial structures, and roads.

Further, the amount of impervious surface introduced by construction of the Central Valley Wye alternatives would be small compared to the groundwater subbasin areas, and would still allow for drainage and infiltration along the alignment comparable to existing conditions. Therefore, groundwater recharge effects would be minimal. The central part of the at-grade track, approximately 40 feet wide, would consist of ballast and tie or slab railbed over a dense sub-ballast and sub-grade. This portion of the embankment would be impermeable, or very minimally permeable. As a result, the centerlines of the HSR track embankment would have reduced infiltration. The contractor will grade the remainder of the rail alignment (up to 60 feet) for surface drainage. This peripheral area would be more permeable than the central embankment and would continue to provide infiltration similar to existing conditions. The Central Valley Wye drainage system would direct stormwater runoff from the railbed, aerial structures, and roads into drainage ditches or basins for infiltration or conveyance to an existing stormwater drainage system that includes groundwater recharge. Stormwater would drain from the track embankment toward swales running parallel to at-grade sections of track. Although the Central Valley Wye alternatives would slightly alter the location of infiltration and recharge areas, runoff would drain to the pervious ground surface, unlined drainage ditches, or basins. The increase in the total new impervious area under the Central Valley Wye alternatives would result in a negligible change from the existing groundwater recharge capabilities and would not interfere substantially with

groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table.

New groundwater wells would likely not be needed as part of the SR 152 (North) to Road 13 Wye Alternative to supply water for construction. However, some existing agricultural wells and household domestic wells that are currently within the HSR rights-of-way may be relocated. The displacement of existing wells would not further deplete groundwater supplies through additional groundwater pumping or substantially change the water level in neighboring wells because the replacement wells installed to serve agricultural and domestic users would be located in the same vicinity as the original wells and would pump at the same rate and depth as they did prior to being relocated. The contractor will perform hydraulic studies to determine the location of new wells such that operation of the new wells would not create secondary effects on other wells in the vicinity.

Central Valley Wye construction could result in permanent effects on groundwater supply by depleting groundwater supplies or discharging pollutants into groundwater aquifers. Because the provision of replacement wells would not result in increases to the volume or rate of groundwater pumping relative to existing groundwater supply conditions, there would be no overall change in groundwater levels. The Central Valley Wye alternatives also would not result in the discharge of pollutants to replaced wells because the alternatives would not use groundwater from the wells. As a result, the Central Valley Wye would not substantially deplete groundwater supplies and associated operations and maintenance effects would not occur.

Operations

Because the HSR system would be electrically powered, the track runoff would carry few pollutants. Therefore, even in areas with infiltrative soils, stormwater could percolate into the natural and landscaped areas without affecting groundwater quality. In addition, current water use along this Central Valley Wye alternative would not change because no water would be needed for operations. The design of the SR 152 (North) to Road 13 Wye Alternative would result in minimal new impervious area and stormwater management measures such as detention or selected upgrades to the receiving system and LID techniques such as biofiltration and bioretention systems would be incorporated into the design to allow for infiltration (HYD-IAMF#1), which would avoid or minimize potential effects on groundwater recharge. Operations of the Central Valley Wye alternatives would not involve excavation or other activities that would expose potential pollutants to underlying groundwater aquifers.

6.3.1.2 SR 152 (North) to Road 19 Wye Alternative

Under the SR 152 (North) to Road 19 Wye Alternative, construction and operation effects on groundwater quality would be similar to those described under the SR 152 (North) to Road 13 Wye Alternative because it would cross areas with similar groundwater basins and underlying aquifers.

Construction

Temporary Construction Effects

Temporary construction effects of the SR 152 (North) to Road 19 Wye Alternative on groundwater quality and would differ from those of the SR 152 (North) to Road 13 Wye Alternative as there would be a larger area of ground disturbance (Table 6-2). Despite these differences, the contractor will implement measures under the same IAMFs described under the SR 152 (North) to Road 13 Wye Alternative to reduce effects on groundwater quality.

Permanent Construction Effects

Permanent construction effects of the SR 152 (North) to Road 19 Wye Alternative on groundwater quality and volume would differ from those of the SR 152 (North) to Road 13 Wye Alternative slightly in that the SR 152 (North) to Road 19 Wye Alternative results in the largest area of ground disturbance (Table 6-2). The contractor will implement measures under the same IAMFs

described under the SR 152 (North) to Road 13 Wye Alternative to reduce effects on groundwater.

The SR 152 (North) to Road 19 Wye Alternative would have minimal effects on existing groundwater volume. Although the Central Valley Wye alternatives may slightly alter the location of infiltration, the stormwater system would direct runoff to pervious ground surfaces, allowing for overall groundwater recharge to be maintained. The Central Valley Wye alternatives would result in similar effects on groundwater from new impervious surfaces. Similar to the SR 152 (North) to Road 13 Wye Alternative, the SR 152 (North) to Road 19 Wye Alternative would not likely affect groundwater quality in areas of new impervious surfaces and would have relatively small effects in areas with compacted gravel. Similar to the SR 152 (North) to Road 13 Wye Alternative, the SR 152 (North) to Road 19 Wye Alternative would likely not affect or would have a minimal effect on groundwater quality in areas of new impervious surfaces and in areas with compacted gravel.

Operations

Intermittent and continuous operations effects of the SR 152 (North) to Road 19 Wye Alternative on groundwater quality would differ from those of the SR 152 (North) to Road 13 Wye Alternative in the area of new impervious surfaces affecting the ability for groundwater recharge. Central Valley Wye operation could result in increases in the potential for discharge of pollutants into groundwater and affect groundwater quality. The design of the SR 152 (North) to Road 19 Wye Alternative would incorporate stormwater management measures such as detention or selected upgrades to the receiving system and LID techniques such as biofiltration and bioretention systems into the design to allow for infiltration (HYD-IAMF#1), which would avoid or minimize potential effects on groundwater recharge.

6.3.1.3 Avenue 21 to Road 13 Wye Alternative

Under the Avenue 21 to Road 13 Wye Alternative, construction and operation effects on surface water quality would be similar to those described under the SR 152 (North) to Road 13 Wye Alternative. The alternatives would cross areas with the similar groundwater basins and underlying aquifers.

Construction

Temporary Construction Effects

Temporary construction effects of the Avenue 21 to Road 13 Wye Alternative on groundwater quality and volume would differ from those of the SR 152 (North) to Road 13 Wye Alternative slightly in that it would result in the smallest area of ground disturbance (Table 6-2). Despite these differences, the Authority will require that the contractor implement measures under the same IAMFs to reduce effects, as described under the SR 152 (North) to Road 13 Wye Alternative.

Permanent Construction Effects

The provision of replacement wells would not result in changes to the amount or rate of groundwater pumping relative to the existing groundwater supply conditions. The Central Valley Wye alternatives would result in similar effects on groundwater from new impervious surfaces. The Central Valley Wye would not likely affect groundwater quality in areas of new impervious surfaces and would have small effects in areas with compacted gravel. Similar to the SR 152 (North) Road 13 Wye Alternative, the Authority would protect groundwater quality through implementation of design features, such as biofiltration and bioretention systems, managing and treating surface runoff prior to soil infiltration (HYD-IAMF#1).

Permanent construction effects of the Avenue 21 to Road 13 Wye Alternative on groundwater quality and volume would differ from those of the SR 152 (North) to Road 13 Wye Alternative slightly in that it results in a smaller area of ground disturbance (Table 6-2). The Authority will require that the contractor implement measures under the same IAMFs described under the SR 152 (North) to Road 13 Wye Alternative to reduce effects.

Operations

Intermittent and continuous operations effects of the Avenue 21 to Road 13 Wye Alternative on groundwater quality would differ from those of the SR 152 (North) to Road 13 Wye Alternative in the area of impervious surfaces affecting the ability for groundwater recharge.

Similar to the SR 152 (North) Road 13 Wye Alternative, the design of the Avenue 21 to Road 13 Wye Alternative would result in minimal new impervious area and stormwater management measures such as detention or selected upgrades to the receiving system and LID techniques such as biofiltration and bioretention systems would be incorporated into the design to allow for infiltration (HYD-IAMF#1), which would avoid or minimize potential effects on groundwater recharge.

6.3.1.4 SR 152 (North) to Road 11 Wye Alternative

Under the SR 152 (North) to Road 11 Wye Alternative, construction and operation effects on groundwater quality would be similar to those described under the SR 152 (North) to Road 13 Wye Alternative because it would cross areas with similar groundwater basins and underlying aquifers.

Construction

Temporary Construction Effects

Temporary construction effects of the SR 152 (North) to Road 11 Wye Alternative on groundwater quality and volume would differ from those of the SR 152 (North) to Road 13 Wye Alternative slightly in that there would be a smaller area of ground disturbance (Table 6-3). Despite these differences, the contractor would implement measures under the same IAMFs described under the SR 152 (North) to Road 13 Wye Alternative to reduce effects on groundwater quality.

Permanent Construction Effects

Permanent construction effects of the SR 152 (North) to Road 11 Wye Alternative on groundwater quality and volume would differ from those of the SR 152 (North) to Road 13 Wye Alternative slightly in that the SR 152 (North) to Road 11 Wye Alternative results in the second smallest area of ground disturbance (Table 6-2). The contractor would implement measures under the same IAMFs described under the SR 152 (North) to Road 13 Wye Alternative to reduce effects on groundwater.

The SR 152 (North) to Road 11 Wye Alternative would have minimal effects on existing groundwater volume. Although the Central Valley Wye alternatives may slightly alter the location of infiltration, the stormwater system would direct runoff to pervious ground surfaces, allowing for overall groundwater recharge to be maintained. The Central Valley Wye alternatives would result in similar effects on groundwater from new impervious surfaces. Similar to the SR 152 (North) to Road 13 Wye Alternative, the SR 152 (North) to Road 11 Wye Alternative would not likely affect groundwater quality in areas of new impervious surfaces and would have relatively small effects in areas with compacted gravel.

Similar to the SR 152 (North) to Road 13 Wye Alternative, the SR 152 (North) to Road 11 Wye Alternative would likely not affect or would have a minimal effect on groundwater quality in areas of new impervious surfaces and in areas with compacted gravel.

Operations

Intermittent and continuous operations effects of the SR 152 (North) to Road 11 Wye Alternative on groundwater quality would differ from those of the SR 152 (North) to Road 13 Wye Alternative in the area of new impervious surfaces affecting the ability for groundwater recharge. Central Valley Wye operation could result in increases in the potential for discharge of pollutants into groundwater and affect groundwater quality. The design of the SR 152 (North) to Road 19 Wye Alternative would incorporate stormwater management measures such as detention and selected upgrades to the receiving system and LID techniques such as biofiltration and bioretention

systems would be incorporated into the design to allow for infiltration (HYD-IAMF#1), which would avoid or minimize potential effects on groundwater recharge.

6.4 Floodplain and Flood Risk Effects

6.4.1 Overview

All of the Central Valley Wye alternatives could result in changes to the hydrology, hydraulics, and connectivity of natural watercourses, including floodways. Table 6-3 presents the area of the Central Valley Wye alternatives that lies within the 100-year floodplain in the SFHA (100-year FEMA flood zones). Analysts also evaluated the potential for the Central Valley Wye alternatives to increase flood height or to divert flood flows. Table 4-2 shows the 100-year flow data available from FEMA flood insurance studies.

The Central Valley Wye alternatives cross several waterbodies, many of which are vulnerable to flooding. Table 6-1 identifies the total number of waterbody crossings by each Central Valley Wye alternative. The contractor will design the water crossings to maintain existing hydraulic capacity and connectivity and to minimize any increase in water surface elevation. These design features would prevent operations effects on hydrology and floodplains. As part of the design, the undersides of the bridges would be set above the estimated 100-year flood level, and the total width of openings in the embankment would pass the 100-year flood flows[13] without increasing the water surface elevation in the floodway and without increasing the water surface elevation in the floodplain by more than 1 foot, or as required by state or local agencies. The Authority will design and place piers to minimize backwater effects and local scouring. Additionally, the Authority will design the shape and alignment of the piers to minimize negative hydraulic effects.

At crossings, the Authority will construct culverts, aerial structures, tunnels, drainage channels and ditches, and underdrains to maintain hydraulic capacity (HYD-IAMF#2). In addition, crossings must be designed to maintain hydraulic capacity through such measures as in-line piers, adequate streambank height (freeboard), and measures to protect against streambank and channel erosion. Based on implementation of these design elements, effects on hydraulic capacity at water crossings would be minimized because any measurable change would not result in an exceedance of the existing capacity of these structures and the Central Valley Wye alternatives would not increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site.

Table 6-3 Permanent Effect Area in the Special Flood-Hazard Area (100-Year Federal Emergency Management Agency Flood Zones) for the Central Valley Wye Alternatives

Alternative	Area within 100-Year FEMA Flood Zone		Total
	A	AO	
SR 152 (North) to Road 13 Wye	558	198	756
SR 152 (North) to Road 19 Wye	623	236	859
Avenue 21 to Road 13 Wye	790	195	985
SR 152 (North) to Road 11 Wye	578	126	703

Source: Calculated using FEMA special flood-hazard data for each county in ESRI ArcGIS versions 10.1, 10.2, and 10.3 (FEMA 2008a; FEMA, 2008b)

[1] Acreages are rounded to the nearest whole number. See Table 5-13 for special flood-hazard area zone designations. FEMA = Federal Emergency Management Agency

SR = State Route

[13] The floodplain RSA does not contain any locations that would require protection for the 200-year flood event pursuant to the Central Valley Flood Protection Act of 2008.

Stream crossings must meet the provisions of California Code of Regulations, title 23, division 1, which requires that crossings maintain stream channel flow capacity through such measures as perpendicular crossings (where practical), adequate streambank freeboard, and measures to protect against streambank and channel scour. California Code of Regulations, title 23, section 208.10 requires that construction of improvements, including crossings, do not reduce the capacity of a channel within a federal flood control project. A section 208.10 permission from the USACE would be required where the Central Valley Wye alternatives cross the right-of-way of a federal flood control facility or interfere with its operation or maintenance without changing the system's structural geometry or hydraulic capacity.

The CVFPB reviews applications for encroachment permits for approval of a new channel crossing or other channel modification. For a proposed crossing that could affect a federal flood control project, the CVFPB coordinates review of the encroachment permit application along with the USACE for approval of a request for permission of encroachment[14] on a federal facility or modification of a federal levee under Section 408 of the Rivers and Harbors Act (33 U.S.C. § 408). Under Section 408 of the Rivers and Harbors Act, the USACE must grant permission for any proposed modification that involves a federal flood control project.

California Code of Regulations, title 23, division 1 also includes construction provisions at CVFPB-regulated streams. According to the California Code of Regulations, title 23, division 1, work activities, such as excavation, cut-and-fill construction, and obstruction, within the CVFPB-designated floodway and on levees adjacent to a regulated stream are restricted during the flood season unless specifically permitted by CVFPB, pending weather forecasts and river flood conditions.

The Central Valley Wye alternatives would minimize temporary and permanent effects related to flooding because the contractor will implement measures for flood protection (HYD-IAMF#2 and HYD-IAMF#3), such as designing the floodplain crossings to maintain a 100-year floodwater surface elevation of no greater than 1 foot above current levels, or as required by state or local agencies, and hydromodification management to maintain pre-project hydrology. Construction and operations activities would not exceed the capacity of existing facilities and there would be no increased flood risk. These measures would minimize increases to the rate or amount of surface runoff in a manner which would result in flooding on- or off-site; minimize the placement of structures within a 100-year flood-hazard area that could impede or redirect flood flows; and avoid exposure of people or structures to loss, injury or death involving flooding.

The design of the Central Valley Wye requires development of a flood protection plan specifying the Central Valley Wye would be designed to remain operational during flood events, except when there is risk for overturning of the railbed, and would minimize increases in the 100-year or 200-year flood elevations (HYD-IAMF#2). These measures provide specific requirements to avoid increasing flood depths including: minimizing development within the floodplain, so water surface elevation in the floodplain would not increase by more than 1 foot during the 100-year or 200-year flood flow; raising the ground with fill above the base-flood elevation; designing the floodplain crossings to maintain a 100-year floodwater surface elevation; and elevating bridge crossings at least 3 feet above the high-water surface elevation to provide adequate clearance for floating debris. A geomorphology study would be prepared during the design phase, if required, which would address lateral flows. The design of the Central Valley Wye would avoid effects on floodplains or disruptions to the channels and floodplains.

6.4.1.1 SR 152 (North) to Road 13 Wye Alternative

Construction

Temporary Construction Effects

Construction in a floodplain could temporarily impede or redirect flood flows because of the presence of construction equipment and materials in the floodplain, depending on the activity

[14] Encroachments include levee systems and waterways regulated by the USACE.

occurring within a specific area. Table 5-14 shows the length of the project footprint within SFHAs. The western, northern, eastern, and central portions of the SR 152 (North) to Road 13 Wye Alternative would be partially within the 100-year floodplain (Figure 4-3).

The proposed design includes construction staging areas in the floodplains that the Central Valley Wye alternatives would cross (Table 5-14). The Central Valley Wye also proposes construction staging areas in CVFPB-designated floodways for the Chowchilla River, Ash Slough, and Berenda Slough. Although construction activities would be temporary, a construction staging area may be active for 1–3 years. Structures stored within staging areas would be small compared to the surrounding areas, and not result in a large obstruction to surface flows. The contractor will prepare an SWPPP for construction activities (HYD-IAMF#3), which includes BMPs to provide permeable surfaces where feasible to manage the overall amount of stormwater runoff.

Consistent with typical SWPPP requirements, construction workers and local districts would monitor weather conditions for heavy storms (and potential flood flows) such that the construction workers would be able to relocate construction equipment to minimize the potential flood risk.

The CVFPB requires an encroachment permit for construction areas in a CVFPB-designated floodway. The CVFPB does not allow work activities such as excavation, cut-and-fill construction, and obstruction in the floodway during the flood (or wet) season. If construction is expected to occur over a period of 3 years, then the Authority or other assigned party (e.g., Design/Builder) will need to request the CVFPB exemption for work proposed to be conducted during wet seasons. The CVFPB grants exemptions to this time restriction if they determine that forecasts for weather or river flood conditions are favorable. This exemption can be included as a condition of the CVFPB approval or encroachment permit. The CVFPB permits uses that do not impede the free flow in the floodway or jeopardize public safety in a designated floodway. These permitted uses include structures that do not impede flows, and are anchored to prevent the structure from floating; roads, pipelines, fences, and walls that do not obstruct flood flows; and storage yards for equipment and materials that are securely anchored or can be removed upon notice.

Construction activities in FEMA-designated floodplains would include construction of at-grade and elevated track, HSR bridges with bridge abutments, overheads with bridge abutments, TPSSs, freight rail relocation areas, and a canal realignment area. The Authority will construct bridges with bridge abutments. Bridges would span the Ash Slough, Chowchilla River, Dry Creek, San Joaquin River, and Schmidt Creek floodplains. None of the TPSSs within the Central Valley Wye alternatives would be within floodways. Consistent with typical SWPPP requirements (HYD-IAMF#3), construction workers and local districts would monitor weather conditions for heavy storms (and potential flood flows) such that the construction workers would be able to relocate construction equipment to minimize the potential flood risk.

Construction could result in a short-term increase in the potential for flooding because materials or structures could temporarily impede or obstruct waters during a storm event. Implementing flood protection measures during construction, such as storm monitoring and the ability to efficiently move construction equipment out of the floodway, would prevent the Central Valley Wye alternatives placing structures that would impede or redirect flood flows within the 100-year flood-hazard area. Overall, temporary effects related to construction of the Central Valley Wye alternatives are expected to be similar for all alternatives. The Authority has designed each crossing in a manner that would maintain the existing hydraulic capacity and pre-project hydrology (HYD-IAMF#3) and minimize the effects of pier placement on floodplains and floodways (HYD-IAMF#2). To minimize increases in the 100-year or 200-year flood elevations, floodplain crossings would be designed to maintain a 100-year floodwater surface elevation of no greater than 1 foot above current levels, or as required by state or local agencies. In addition, following design standards would minimize the effects of pier placement on floodplains and floodways. Construction conditions within the floodway would be close to existing conditions.

Permanent Construction Effects

Most river and creek crossings would require bridges and the placement of piers in the floodway or floodplain. The contractor will base pier construction methods on local, site-specific conditions

and conform to local requirements. It is possible that some pier construction at waterbody crossings would require in-water work.

The Authority will include measures to minimize the effects of placing piers in the floodplains and floodways in the design of these bridge crossings. For example, the contractor would place piers parallel to the expected high-water flow direction and design the shape of the piers to minimize flow disturbance, negative hydraulic effects and erosion potential (HYD-IAMF#2).

The Authority has designed each crossing in a manner that would maintain the existing hydraulic capacity and pre-project hydrology and minimize the effects of pier placement on floodplains and floodways (HYD-IAMF#2). Because design features for flood protection (HYD-IAMF#2) would prevent flood flow conditions with the Central Valley Wye alternatives increasing water surface elevation in the floodplain by more than 1 foot or above the BFE, the floodplain would remain close to existing conditions, and the Central Valley Wye alternatives would not result in conditions that exceed the capacity of existing flood channels. The design of the Central Valley Wye alternatives would minimize any changes to existing drainage patterns of the site or area and would maintain the existing flow conveyance capacity at each of these crossings and minimize effects from pier construction techniques.

The SR 152 (North) to Road 13 Wye Alternative would pass through levee-protected flood zones. Levees can fail because of earthquakes or storm events, if not properly maintained or reinforced to withstand potential stresses. DWR has estimated that if one of the levees fails when the water surface elevation is at the top of a levee, between 3 and 9 feet of flooding depths would occur adjacent to the Eastside Bypass and the San Joaquin River (Authority and FRA 2016b). The USACE lists the San Joaquin River, Eastside Bypass, Ash Slough, Berenda Slough, and Chowchilla River levees in the USACE Levee Safety Program. The program protects safety and reduces flood risk of our nation's levee systems. As the local sponsor, DWR receives funding for the operation and maintenance of these levees. The contractor will coordinate with DWR and other relevant agencies to make the Central Valley Wye alternatives consistent with proposed levee improvements in the future. In the event of levee failure, there could be flooding of areas of the HSR alignment. The Central Valley Wye alternatives would not change the existing flooding potential from levee failure.

In overland areas subject to shallow flooding during the 100-year event, flood water could pond and drain slowly with minimal energy because of the flat topography and shallow land gradient. The topography within the floodplain RSA has a relatively flat gradient that slopes gently to the west or southwest. During periods of high stream flow, shallow overland flooding, which can range from 1 to 3 feet in depth, tends to pond against canal berms, levees, and road and railroad embankments that are perpendicular to the land gradient.

Openings in the embankment (e.g., culverts) would continue to allow drainage to pass in the down-gradient direction. Water would continue to pond on both sides of the embankment as it does under existing conditions. Because there would be no substantial change in flow path, there would be no new effects on upstream or downstream landowners.

As listed in Table 6-3, areas lying within the SFHA would range from 703 to 985acres. The SR 152 (North) to Road 13 Wye Alternative would have the second smallest area in the SFHA, 756 acres. Stream crossings could reduce the watercourse's ability to convey peak flows by reducing the floodplain's capacity to convey flow, resulting in potential floodplain effects. The contractor will design openings in the embankments at river and stream crossings (e.g., bridges and culverts) to allow the same volume of water to pass along the same flow path. The contractor would design each stream crossing to maintain existing hydrology and connectivity, but some physical changes could occur. Most canals and channels would require culverts. Most river and creek crossings would require bridges and the placement of piers in the floodway or floodplain. The contractor would base pier construction methods on local conditions. It is possible that pier construction would require in-water work for some crossings. The contractor will design these bridge crossings to include measures to minimize the effects of placing piers in the floodplains and floodways (e.g., crossings to be as nearly perpendicular to the channel as feasible to minimize bridge length, orient piers to be parallel to the expected high-water flow direction to minimize flow disturbance,

elevate bridge crossings at least 3 feet above the high-water surface elevation to provide adequate clearance for floating debris, or as required by local agencies). Effects would be reduced because the design of the Central Valley Wye alternatives would minimize increases in the 100-year or 200-year flood elevations (HYD-IAMF#2). Any changes to existing drainage patterns of the site or area would not be substantial. The crossings would maintain the existing flow conveyance capacity and minimize effects from pier construction techniques.

The HSR tracks could divert shallow flood flows from overflowing channels by serving as an obstacle to the shallow overland flow if the design does not provide sufficient culverts or cross drainage near stream channels. In areas where the Central Valley Wye alternatives are elevated, there would be little potential for such diversion. Where the Central Valley Wye alternatives are adjacent to existing rail or highway embankments, flood barriers might already exist. New effects would be most likely to occur where Central Valley Wye tracks do not run parallel to existing embankments or where flood flows could overtop existing embankments. The design of the Central Valley Wye requires the development of a flood protection plan specifying the Central Valley Wye would be designed to remain operational during flood events, except when there is risk for overturning of the railbed, and would minimize increases in 100-year or 200-year flood elevations (HYD-IAMF#2). The design of the Central Valley Wye alternatives would incorporate adequately sized culverts to avoid the possibility of diverting or redirecting flood flows or increasing the water surface elevation in the 100-year floodplain by more than 1 foot, or as required by state or local agencies. Where FEMA-designated floodways exist, IAMFs would provide for little to no increase in water surface elevation (HYD-IAMF#2), because the design features within the floodway itself would not increase existing 100-year floodwater surface elevation in FEMA-designated floodways, or as otherwise agreed upon with the county floodplains manager.

In overland areas subject to shallow flooding during the 100-year event, flood water would pond and drain slowly with minimal energy because of the flat topography and shallow land gradient. Openings in the embankment (e.g., culverts) would continue to allow drainage to pass in the down-gradient direction. Water would continue to pond on both sides of the embankment as it does under existing conditions. There would be no change in flow path that would affect upstream or downstream landowners.

Bridge abutments associated with bridges or overheads, utility relocation areas, and TPSSs would introduce components that are small compared to the overall size of the floodplain, which in some areas can reach up to several miles wide at a crossing. These components could impede or redirect flood flows in the immediate vicinity of the structure. IAMFs implemented as part of the Central Valley Wye alternatives include the maintenance of the existing flow conveyance capacity at each of these crossings to minimize effects from pier construction techniques and increases in flood elevations (HYD-IAMF#2) such as designing site crossings to be as nearly perpendicular to the channel as feasible to minimize bridge length and positioning piers to be parallel to the expected high-water flow direction to minimize flow disturbance. To retain pre-project hydrology (HYD-IAMF#3), hydromodification management would emphasize on-site retention of stormwater runoff using measures such as flow dispersion, infiltration, and evaporation, supplemented by detention, where required. Additional flow control measures would be implemented where local regulations or drainage requirements dictate. Construction could also result in an increase in the potential for flooding from the impedance of flood flows by materials or Central Valley Wye structures or redirection of flows as a result of changes to existing drainage patterns. The Authority will implement design features (HYD-IAMF#2) such as establishing track elevation to prevent saturation and infiltration of stormwater into the sub-ballast and elevating bridge crossings at least 3 feet above the high-water surface elevation to provide adequate clearance for floating debris, or as required by local agencies to reduce these effects. This would prevent flood flow conditions increasing water surface elevation in the floodplain by more than 1 foot or above the BFE, any measureable change would not result in conditions that exceed the capacity of the existing flood channels or floodplains and the floodplain would remain similar to existing conditions. Also, these measures avoid any substantial changes to existing drainage patterns of

the site or area and would maintain the existing flow conveyance capacity at each of these crossings and minimize effects from pier construction techniques.

Operations

Intermittent Permanent Effects

Intermittent effects on flooding could occur during in-water bridge maintenance activities, such as those requiring barge or dredge equipment, temporary coffer dams, or other activities conducted in or near waters. The CVFPB does not allow work activities, such as excavation, cut-and-fill construction, and obstruction within the floodway and on levees adjacent to a regulated stream during a storm event. In addition, consistent with typical SWPPP requirements, maintenance workers and local districts would monitor weather conditions for heavy storms (and potential flood flows) such that the maintenance workers would be able to relocate construction equipment to minimize the potential flood risk. The Authority may place some structures in construction staging areas that are within 100-year flood-hazard areas, which could obstruct flows. These structures would be small compared to the surrounding areas, and not result in a large obstruction to surface flows.

Central Valley Wye operations and maintenance activities could result in increases in the potential for flooding from the impedance of materials or structures during a storm event. The contractor would avoid effects on flood flows by implementing flood protection measures during maintenance-related activities, not conducting work during a storm event, including storm monitoring, and maintaining the ability to efficiently move construction equipment out of the floodway. This would prevent conditions within the floodway that would exceed the capacity of the flood control and drainage systems and the Central Valley Wye would be close to existing conditions. In addition, the Central Valley Wye alternatives would not result in placing structures within the 100-year flood-hazard area that would impede or redirect flood flows. In addition, consistent with typical SWPPP requirements, during maintenance activities, construction workers and local districts would monitor weather conditions for heavy storms (and potential flood flows) such that the maintenance crew would be able to relocate construction equipment, which could impede flows and increase flood risks, to minimize the potential flood risk (HYD-IAMF#3).

6.4.1.2 SR 152 (North) to Road 19 Wye Alternative

Under the SR 152 (North) to Road 19 Wye Alternative, construction and operations effects on floodplains would be similar to those described under the SR 152 (North) to Road 13 Wye Alternative. The Central Valley Wye alternatives would cross areas with similar floodplains, waterbodies, and land uses.

Construction

Temporary Construction Effects

Temporary construction effects of the SR 152 (North) to Road 19 Wye Alternative on floodplains would differ from those of the SR 152 (North) to Road 13 Wye Alternative slightly in that portions of the SR 152 (North) to Road 19 Wye Alternative lie in different parts of the 100-year floodplain (Figures 4-3 and 5-2a through 52l). Despite this difference, the contractor will comply with SWPPP requirements (i.e., weather monitoring) to minimize potential flood risk (HYD-IAMF#3).

Permanent Construction Effects

Permanent construction effects of the SR 152 (North) to Road 19 Wye Alternative on floodplains would result in a larger area (859 acres) within 100-year FEMA flood zones than the SR 152 (North) to Road 13 Wye Alternative (756 acres) (Table 6-3). Despite this difference, construction of the SR 152 (North) to Road 19 Wye Alternative would likewise implement measures (HYD-IAMF#2) such as positioning piers to be parallel to the expected high-water flow direction to minimize flow disturbance, maintain existing flows, minimize potential flood risk and retain pre-project hydrology.

Operations

Intermittent Permanent Effects

Intermittent operations effects of the SR 152 (North) to Road 19 Wye Alternative on floodplains would differ from those of the SR 152 (North) to Road 13 Wye Alternative in that it would cover a different area within 100-year FEMA flood zones (Table 6-3). The contractor will implement the same work restrictions (i.e., no obstructions within floodways or on levees during the storm events) and IAMFs (i.e., SWPPP requirements to monitor weather conditions and ability to relocate construction equipment out of the floodway), but applied to the larger area, as necessary.

6.4.1.3 Avenue 21 to Road 13 Wye Alternative

Under the Avenue 21 to Road 13 Wye Alternative, construction and operation effects on floodplains would be similar to those described under the SR 152 (North) to Road 13 Wye Alternative. The Central Valley Wye alternatives cross areas with similar floodplains, waterbodies, and land uses.

Construction

Temporary Construction Effects

Temporary construction effects of the Avenue 21 to Road 13 Wye Alternative on floodplains would differ from those of the SR 152 (North) to Road 13 Wye Alternative slightly in that portions of the Avenue 21 to Road 13 Wye Alternative lie in different parts of the 100-year floodplain (Figures 4-3 and 5-2a through 52l). Despite this difference, the contractor will comply with SWPPP requirements (i.e., weather monitoring) to minimize potential flood risk (HYD-IAMF#3).

Permanent Construction Effects

Permanent construction effects of the Avenue 21 to Road 13 Wye Alternative on floodplains would differ from those of the SR 152 (North) to Road 13 Wye Alternative in that it would result in the largest area (985 acres) within 100-year FEMA flood zones as compared to the SR 152 (North) to Road 13 Wye Alternative (756 acres) and the SR 152 (North) to Road 19 Wye Alternative (859 acres), and the SR 152 (North) to Road 11 Wye Alternative (703acres) (Table 6-3). Despite this difference, the contractor will implement measures to maintain existing flows (HYD-IAMF#2) such as designing the floodplain crossings to maintain a 100-year floodwater surface elevation and positioning piers to be parallel to the expected high-water flow direction to minimize flow disturbance, minimize potential flood risk and retain pre-project hydrology.

Operations

Intermittent Permanent Effects

Intermittent operation effects of the Avenue 21 to Road 13 Wye Alternative on floodplains would differ from those of the SR 152 (North) to Road 13 Wye Alternative in that it would cover a larger area (1,323 acres) within 100-year FEMA flood zones than all other Wye alternatives, as previously described (Table 6-3). The contractor will implement the same work restrictions (i.e., no obstructions within floodways or on levees during the flood season) and IAMFs (i.e., SWPPP requirements to monitor weather conditions and ability to relocate construction equipment out of the floodway), but applied to the larger area, as necessary.

6.4.1.4 SR 152 North to Road 11 Wye Alternative

Under the SR 152 (North) to Road 11 Wye Alternative, construction and operations effects on floodplains would be similar to those described under the SR 152 (North) to Road 13 Wye Alternative. The Central Valley Wye alternatives would cross areas with similar floodplains, waterbodies, and land uses.

Construction

Temporary Construction Effects

Temporary construction effects of the SR 152 (North) to Road 11 Wye Alternative on floodplains would differ from those of the SR 152 (North) to Road 13 Wye Alternative slightly in that portions of the SR 152 (North) to Road 11 Wye Alternative lie in different parts of the 100-year floodplain (Figures 4-3 and 5-2a through 52l). Despite this difference, the contractor will comply with SWPPP requirements (i.e., weather monitoring) to minimize potential flood risk (HYD-IAMF#3).

Permanent Construction Effects

Permanent construction effects of the SR 152 (North) to Road 11 Wye Alternative on floodplains would result in the smallest area (703acres) within 100-year FEMA flood zones as compared to the other Wye alternatives (Table 6-3). Despite this difference, construction of the SR 152 (North) to Road 11 Wye Alternative would likewise implement measures (HYD-IAMF#2) such as designing the floodplain crossings to maintain a 100-year floodwater surface elevation and positioning piers to be parallel to the expected high-water flow direction to maintain existing flows and minimize potential flood risk and retain pre-project hydrology.

Operations

Intermittent Permanent Effects

Intermittent operations effects of the SR 152 (North) to Road 11 Wye Alternative on floodplains would differ from those of the SR 152 (North) to Road 13 Wye Alternative in that it would cover a different area within 100-year FEMA flood zones (Table 6-3). The contractor will implement the same work restrictions (i.e., no obstructions within floodways or on levees during the storm events) and IAMFs (i.e., SWPPP requirements to monitor weather conditions and ability to relocate construction equipment out of the floodway), but applied to the larger area, as necessary.

7 REFERENCES

Authority	California High-Speed Rail Authority
Cal. Code Regs.	California Code of Regulations
Caltrans	California Department of Transportation
CalWater	California Water Service Company
Cal. Water Code	California Water Code
CDEC	California Data Exchange Center
CDFG	California Department of Fish and Game
Central Valley RWQCB	Central Valley Regional Water Quality Control Board
CNRA	California Natural Resources Agency
CVFPB	Central Valley Flood Protection Board
DWR	California Department of Water Resources
ESRI	Environmental Systems Research Institute
FEMA	Federal Emergency Management Agency
FRA	Federal Railroad Administration
MSWG	Merced Storm Water Group
NRCS	Natural Resources Conservation Service
RWQCB	Regional Water Quality Control Board
SJRRP	San Joaquin River Restoration Program
SWRCB	State Water Resources Control Board
UPRR	Union Pacific Railroad
USBR	U.S. Bureau of Reclamation
USDOA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
U.S.C.	United States Code
WRCC	Western Regional Climate Center

Berkhardt, M., L. Rossi, and M. Boller. 2008. *Release of Various Substances to the Environment by Regular Railway Operation*. www.researchgate.net/publication/37457664_Release_of_various_substances_to_the_environment_by_regular_railway_operation/links/00463 51f96becc332e000000 (accessed January 15, 2015).

BNSF Railway (BNSF) and Union Pacific Railroad (UPRR). 2007. Guidelines for Railroad Grade Separation Projects http://www.up.com/cs/groups/public/@uprr/@customers/@industrialdevelopment/@operationsspecs/@specifications/documents/up_pdf_nativedocs/pdf_up_str_grade-separation.pdf.

Boyle Engineering Corporation. 2008. *Integrated Regional Water Management Plan*. Volume 1. Prepared in association with Kenneth D. Schmidt and Associates for Madera County, CA Resource Management Agency. Fresno, California: Boyle Engineering Corporation. April 2008.

Bukowiecki, N., Gehrig, R., Hill, M., Lienemann, P., Zwicky, C., Buchmann, B., Weingartner, E., Baltensperger, U. 2007. Iron, manganese and copper emitted by cargo and passenger trains in Zurich (Switzerland): Size-segregated mass concentrations in ambient air. Atmospheric Environment. 41. Pages. 878-889.

California Data Exchange Center (CDEC). 2012a. "Kings River – Pine Flat Dam." http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=KGF (accessed June 13, 2012).

———. 2012b. "Kaweah River – Terminus Dam." http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=KWT (accessed June 13, 2012).

———. 2012c. "Kern River – Bakersfield" http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=KRB (accessed June 13, 2012).

California Department of Fish and Game (CDFG). 2009. *Lake and Streambed Alteration Program, Lake or Streambed Alteration Agreement*. www.dfg.ca.gov/habcon/1600/ (accessed October 7, 2010).

California Department of Transportation (Caltrans). 2014. Field Guide to Construction Site Dewatering. CTSW-OT-14-314.08.1. June.

California Department of Water Resources (DWR). 2003. *California's Groundwater: Bulletin 118*. Updated October 2003. www.water.ca.gov/pubs/groundwater/bulletin_118/california's_groundwater_bulletin_118_-_update_2003_/bulletin118_entire.pdf (accessed December 30, 2014).

———. 2004a. San Joaquin Valley Groundwater Basin, Chowchilla Subbasin. In *California's Groundwater: Bulletin 118*. Updated February 27, 2004. www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/5-22.05.pdf (accessed January 7, 2015).

———. 2004b. San Joaquin Valley Groundwater Basin, Madera Subbasin. In *California's Groundwater: Bulletin 118*. Updated February 27, 2004. www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/5-22.06.pdf (accessed January 7, 2015).

———. 2004c. San Joaquin Valley Groundwater Basin, Merced Subbasin. In *California's Groundwater: Bulletin 118*. Updated February 27, 2004. www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/5-22.04.pdf (accessed January 7, 2015).

———. 2006. San Joaquin Valley Groundwater Basin, Delta-Mendota Subbasin. In *California's Groundwater: Bulletin 118.* Updated January 20, 2006. www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/5-22.07.pdf (accessed January 7, 2015).

———. 2008a. *San Joaquin River Restoration Program. Project Study Area*. Available: http://www.water.ca.gov/rivers/sanjoaquin/program/images/basemap.pdf (accessed December 20, 2016).

———. 2008b. *FloodSAFE Strategic Plan*. Draft. May 28. www.water.ca.gov/floodsafe/docs/FloodSAFE_Strategic_Plan-Public_Review_Draft.pdf (accessed January 8, 2015).

———. 2009. Using Future Climate Projections to Support Water Resources Decision Making in California. CEC-500-2009-052-F. August.

———. 2010. State Plan of Flood Control Descriptive Document. Division of Flood Management. Section 3. November.

———. 2011. Water Data Library. www.water.ca.gov/waterdatalibrary/index.cfm (accessed May 29, 2013).

———. 2012a. *2012 Central Valley Flood Protection Plan*. Central Valley Flood Management Planning Program. June. www.water.ca.gov/cvfmp/docs/2012%20CVFPP%20FINAL%20lowres.pdf (accessed February 10, 2016).

———. 2012b. Lines of Equal Depth to Water in Wells: Unconfined Aquifer San Joaquin Valley. Spring 2010. www.water.ca.gov/pubs/groundwater/lines_of_equal_depth_of_water_in_wells_unconfined_aquifer_san_joaquin_valley_spring_2010/sjv2010spr_unc_depth.pdf (accessed January 15, 2015).

———. 2013. *Climate Change*. May 16. www.water.ca.gov/climatechange/ (accessed May 29, 2013). Website was last modified May 16, 2013.

———. 2014. *California Water Plan, Update 2013*. San Joaquin River Hydrologic Region. http://www.water.ca.gov/waterplan/docs/cwpu2013/Final/ (accessed December 20, 2016).

———. 2016. *Final List of Critically Overdrafted Basins.* January 2016. Sustainable Groundwater Management. http://www.water.ca.gov/groundwater/sgm/cod.cfm (accessed May 17, 2016).

California High-Speed Rail Authority (Authority). 2013. California High-Speed Train Project Merced to Fresno Section: Wye Alternatives Hydrology and Water Resources Technical Report. Sacramento, CA.

———. 2016. Merced to Fresno: Central Valley Wye, Record Set 15% Design, Design Baseline Report. May 2015.

California High-Speed Rail Authority and Federal Railroad Administration (Authority and FRA). 2005. *Statewide Final Program Environmental Impact Report (EIR)/Environmental Impact Statement (EIS) for the Proposed California High-Speed Train System*. Vol. 1, Report. Sacramento and Washington, DC: California High-Speed Rail Authority and USDOT Federal Railroad Administration. August 2005.

———. 2012. Merced to Fresno Section Final Environmental Impact Report/Environmental Impact Statement.

———. 2016a. *Merced to Fresno Central Valley Wye Hydrology and Hydraulics Engineering Report. Prepared by Parsons Corporation for the California High-Speed Rail Authority. November.*

———. 2016b. *Merced to Fresno Section: Central Valley Wye Geology, Soils, and Seismicity Technical Report*. Prepared by Parsons Corporation for the California High-Speed Rail Authority.

California Natural Resources Agency (CNRA). 2009. *2009 California Climate Adaptation Strategy*. http://resources.ca.gov/docs/climate/Statewide_Adaptation_Strategy.pdf retrieved on 2016-12-20 (accessed December 20, 2016).

California Water Service Company (CalWater). 2007. Statewide map of nested watersheds from CalWater version 2.2. Original data source: Department of Forestry and Fire Protection. http://frap.fire.ca.gov/data/frapgismaps/calwater_download (accessed December 20, 2016).

Central Valley Flood Protection Board (CVFPB). 1973a. Designated Floodways – Madera County – Chowchilla River. http://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/2016july_1994_sacsjr_bpas.pdf (accessed December 20, 2016).

———. 1973b. Designated Floodways – Madera County – Ash Slough. http://cvfpb.ca.gov/maps/designated_floodway/Merced%20County/ (accessed January 8, 2015).

———. 2011. *Designated Floodways*. November 22. www.cvfpb.ca.gov/maps/DesignatedFloodways.doc (accessed January 8, 2015).

Central Valley Regional Water Quality Control Board (Central Valley RWQCB). 2016. *The Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board Central Valley Region*. Fourth Edition, Revised April 2016 (with approved amendments). The Sacramento River Basin and San Joaquin River Basin. Sacramento, CA.http://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/2016july_1994_sacsjr_bpas.pdf (accessed December 5, 2016).

City of Chowchilla. 2010. General Plan Update 2040 Draft Environmental Impact Report. Chapter 4.9 Hydrology and Water Quality. www.ci.chowchilla.ca.us/dept.%20forms/Com%20Dev/General%20Plan%20Update/2040%20GP%20RC%20DEIR/Volume%201/4.9%20Hydrology%20and%20Water%20Quality%20.pdf (accessed December 30, 2014).

———. 2011. *City of Chowchilla 2040 General Plan*. Adopted May 2. Open Space Element, Public Facilities and Services Element and Public Safety Element. www.ci.chowchilla.ca.us/dept.%20forms/Com%20Dev/General%20Plan/Table%20of%20Contents.pdf (accessed April 8, 2015).

City of Chowchilla, Chowchilla Water District, City of Madera, Madera County, Madera Irrigation District, South-East Madera County United. 2014. Draft Madera Regional Groundwater Management Plan. November. http://www.madera-county.com/index.php/county-forms/category/633-groundwater-management-plan?download=5668:draft-madera-regional-groundwater-management-plan (accessed December 20, 2016).

City of Madera. 2011. 2010 Urban Water Management Plan. www.water.ca.gov/urbanwatermanagement/2010uwmps/Madera,%20City%20of/UWMP_Final.pdf (accessed December 30, 2014).

City of Merced. 2011. *2010 Urban Water Management Plan*. June. Environmental Systems Research Institute (ESRI). 2013. Streetmap USA 10.2. (GIS shapefiles: railroads.sdc, highway.sdc) (accessed May 29, 2013).

Environmental Systems Research Institute (ESRI). 2013. Streetmap USA 10.2. (GIS shapefiles: railroads.sdc, highway.sdc) (accessed May 29, 2013).

ESRI/National Geographic. 2015. National Geographic World Map (Streaming). http://goto.arcgisonline.com/maps/NatGeo_World_Map (accessed September 2015).

Federal Emergency Management Agency (FEMA). 2008a. Flood Insurance Rate Map Panels – Merced County. Effective December 2, 2008.

———. 2008b. Flood Insurance Rate Map Panels – Madera County. Effective September 26, 2008.

———. 2008c. Flood Insurance Study, Merced County, California and Incorporated Areas. Washington, DC. December 2, 2008.

———. 2008d. Flood Insurance Study, Madera County, California and Incorporated Areas. Washington, D.C. September 26, 2008.

———. 2009. Guidelines and Specifications for Flood Hazard Mapping Partners. November 2009. www.fema.gov/library/viewRecord.do?id=2206 (accessed March 12, 2010).

———. 2015. Floodplain Management Regulations.

Gronberg, J.M., N.M. Dubrovsky, C.R. Kratzer, J.L. Domagalski, L.R. Brown, and K.R. Burrow. 1998. Environmental Setting of the San Joaquin–Tulare Basins, California. U.S. Geological Survey Water-Resources Investigations Report 97-7205, p. 6. http://ca.water.usgs.gov/sanj/pub/usgs/wrir97-4205/wrir97-4205.pdf.

ICF Jones & Stokes. 2008. Irrigated Lands Regulatory Program Existing Conditions Report. Prepared for the Central Valley Regional Water Quality Control Board. December. http://www.swrcb.ca.gov/public_notices/petitions/water_quality/docs/a2239/overview/References/AR-Refs%20(9).pdf. Accessed December 20, 2016.

Luers, A., and M.D. Mastrandrea. 2008. Climate Change in California: Scenarios for Adaptation. Public Policy Institute of California. November. www.ppic.org/content/pubs/report/R_1108ALR.pdf (accessed May 28, 2013).

Madera County. 1995. Madera County General Plan. Policy Document. Adopted October 24. (accessed May 28, 2013).

———. 2013. Madera County Storm Water Management Plan. Prepared by Provost & Pritchard Consulting Group. February. www.ebidboard.com/docs/1503/060066/Final%20Madera%20Co%20SWMP.pdf (accessed May 28, 2013)

Madera County Planning Department. 2012. *Fairmead Colony Area Plan*.

McBain and Trush, Inc. 2002. *San Joaquin River Restoration Study Background Report.* Prepared for the Friant Water Users Authority and the Natural Resources Defense Council. December. www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/bay_delta_plan/water_quality_control_planning/docs/sjrf_spprtinfo/mcbainandtrush_2002.pdf (accessed May 28, 2013)

Merced County. 1990. Merced County Year 2000 General Plan. Adopted December 4.

———. 2013. *2030 Merced County General Plan*. Adopted December 10. Merced Storm Water Group (MSWG). 2007. Storm Water Management Program. www.waterboards.ca.gov/water_issues/programs/stormwater/swmp/merced_swmp.pdf (accessed May 28, 2013).

Merced Storm Water Group (MSWG). 2007. Storm Water Management Program. April. Submitted to Regional Water Quality Control Board Central Valley Region, Fresno Office. Available at: http://www.co.merced.ca.us/DocumentCenter/Home/View/635.

Planert, M. and J.S. Williams. 1995. Ground Water Atlas of the United States: California, Nevada. HA 730-B. U.S. Geological Survey. http://pubs.usgs.gov/ha/ha730/ch_b/index.html (accessed May 28, 2013).

State Water Resources Control Board (SWRCB). 2015. *2012 Integrated Report* (Clean Water Act Section 303(d) List / 305(b) Report). July 30, 2015. http://www.swrcb.ca.gov/public_notices/petitions/water_quality/docs/a2239/overview/References/AR-Refs%20(9).pdf (accessed December 20, 2016).

U.S. Bureau of Reclamation (USBR). 2008. *Draft Environmental Assessment – Annexation of Subordinate Lands in Chowchilla Water District.* EA-07-44. May. Mid Pacific Region, South Central California Area Office. Fresno, California.

———. 2011. *San Joaquin River Restoration Program Environmental Impact Statement/Report*. Draft. April. www.usbr.gov/mp/nepa/documentShow.cfm?Doc_ID=7558 (accessed December 20, 2016).

———. 2014. *San Joaquin River Restoration Flows and Seepage Update*. San Joaquin River Restoration Program (SJRRP) Update. December. www.restoresjr.net/wp-content/uploads/General_Outreach/Program_Updates/20141202Update_web_ADA.pdf.

U.S. Bureau of Reclamation and California Department of Water Resources (USBR and DWR). 2012. *San Joaquin River Restoration Program Programmatic Environmental Impact Statement/Environmental Impact Report*. July. www.restoresjr.net/ (accessed January 20, 2015).

U.S. Department of Agriculture, Natural Resources Conservation Service (USDOA-NRCS). 2010. *Web Soil Survey*.

U.S. Environmental Protection Agency (USEPA). 2009. *Designated Sole Source Aquifers in U.S. EPA Region IX*. www.epa.gov/safewater/sourcewater/pubs/qrg_ssamap_reg9.pdf (accessed September 15, 2009).

U.S. Geological Survey (USGS). 2013. Land Subsidence along the Delta-Mendota Canal in the Northern Part of the San Joaquin Valley, California, 2003–10. Scientific Investigations Report 2013-5142.

Western Regional Climate Center (WRCC). 2016a. *Cooperative Climatological Data Summaries: Central California: Merced Municipal Arpt, California (045532)*. www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca5532 (accessed November 14, 2016).

———. 2016b. *Cooperative Climatological Data Summaries: Central California: Madera, California (045233)*. www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca5233 (accessed November 14, 2016).

Wilkomirski, B., Sudnik-Wojcikowska, B., Galera, H., Wierzbicka, M., Malawska, M. 2011. *Railway Transportation as a serious source of organic and inorganic pollution*. Water Air Soil Pollution. 218. Pages 333-345.

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