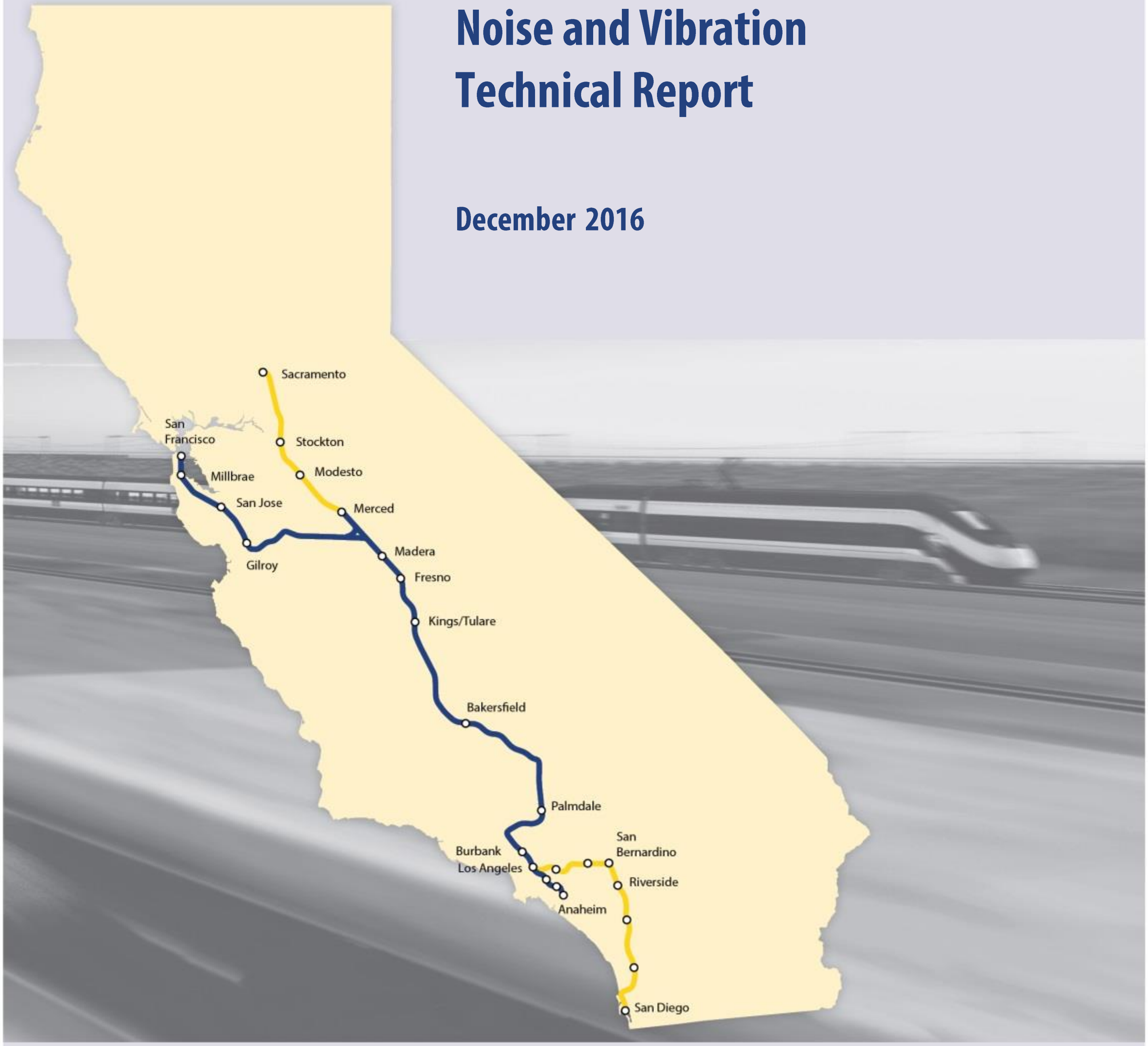
California High-Speed Rail Authority

Merced to Fresno Section: Central Valley Wye



Noise and Vibration Technical Report

December 2016

CALIFORNIA High-Speed Rail Authority

U.S. Department of Transportation
Federal Railroad Administration

TABLE OF CONTENTS

Tables

Figures

Appendices

ACRONYMS AND ABBREVIATIONS

Authority	California High-Speed Rail Authority
BNSF	BNSF Railway
C.F.R.	Code of Federal Regulations
Caltrans	California Department of Transportation
Central Valley Wye	Merced to Fresno Section: Central Valley Wye
CEQA	California Environmental Quality Act of 1970
CNEL	Community Noise Equivalent Level
dB	decibel(s)
dBA	A-weighted decibel(s)
EIR	environmental impact report
EIS	environmental impact statement
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FRA guidance manual	*High-Speed Ground Transportation Noise and Vibration Impact Assessment* manual
FTA	Federal Transit Administration
HSR	high-speed rail
Hybrid Alignment	Merced to Fresno Section: Hybrid Alignment
IAMF	impact avoidance and minimization features
L_{dn}	day-night sound level, dBA
L_{eq}	equivalent sound level, dBA
L_{max}	maximum sound level, dBA
$L_{max,fast}$	maximum sound level, “fast” response
$L_{max,slow}$	maximum sound level, “slow” response
L_v	RMS vibration level
mph	mile(s) per hour
NAC	Noise Abatement Criteria
NEPA	National Environmental Policy Act of 1969
PPV	peak particle velocity
RMS	root mean square
RSA	resource study area
SEL	sound exposure level
SR	State Route
TPSS	traction power substation
UPRR	Union Pacific Railroad
VdB	RMS vibration velocity level, decibels

EXECUTIVE SUMMARY

The California High-Speed Rail Authority (Authority) has prepared this *Merced to Fresno Section: Central Valley Wye Noise and Vibration Technical Report* (Central Valley Wye Noise and Vibration Technical Report) to support the *Merced to Fresno Section: Central Valley Wye Draft Supplemental Environmental Impact Report (EIR)/Supplemental Environmental Impact Statement (EIS)* (Supplemental EIR/EIS). The Supplemental EIR/EIS tiers from the original *Merced to Fresno Section Final EIR/EIS* (Merced to Fresno Final EIR/EIS) (Authority and FRA 2012a). When the Authority Board of Directors and the Federal Railroad Administration (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 noise and vibration effects of the four Central Valley Wye alternatives:

- 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

Noise and vibration effects consist of construction-related noise and vibration effects, High-Speed Rail (HSR) operational noise and vibration effects, operational traffic noise effects, and noise effects from HSR pass-bys. 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 sensitive receptors to noise and vibration 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.

Summary of Effects

The effects of the Central Valley Wye alternatives related to noise and vibration include:

Construction-Related Noise and Vibration Effects

Construction of the Central Valley Wye alternatives would require the use of mechanical equipment that would generate temporary increases in noise and ground-borne vibration. Temporary noise and vibration increases could result in human annoyance, and vibration has the potential to result in structural damage to buildings. Construction of the Central Valley Wye alternatives would result in noise impacts on 46 to 98 sensitive receptors, depending on the alternative selected. Vibration impacts due to construction of the Central Valley Wye are not expected. The Authority has established NV-IAMF#1, which would confirm that Federal Transit Administration (FTA) and FRA guidelines for minimizing noise and vibration effects at sensitive receptors would be implemented during construction of the Central Valley Wye. Implementation of NV-IAMF#1 would reduce temporary construction effects on sensitive receptors, but effects would continue to remain adverse.

HSR Operational Noise Effects and Vibration Effects

Operation of the Central Valley Wye alternatives would increase noise levels above the ambient noise environment by as much as 19 dBA L_{dn} and would result in moderate and severe noise impacts on 79 to 92 sensitive receptors, depending on the alternative selected. There are no IAMFs available to reduce these impacts; therefore they would remain adverse.

Human annoyance as a result of operational vibration would generally be limited to the HSR right-of-way. As a result, there would be no operational vibration effects on sensitive receptors.

Traffic Noise Effects

Construction of the Central Valley Wye would result in temporary and permanent changes in the local roadway network that would require some diversion and rerouting of traffic. Because existing traffic volumes in the RSAs are very low, traffic on local roadways provides only a minor contribution to overall noise levels. The diversion of traffic would not be expected to affect noise levels. Additionally, operation of the Central Valley Wye would not generate additional traffic and traffic-related noise because there are no proposed stations or other HSR facilities associated with the Central Valley Wye.

Noise Effects from HSR Pass-bys

HSR pass-bys would result in a sudden increase in noise for receivers along the alignment and has the potential to result in annoyance and startle effects on humans and expose wildlife and domestic animals to stress. Annoyance and startle effects for humans would be primarily limited to areas within the Central Valley Wye right-of-way. Therefore, sensitive receptors along the alignment would not experience adverse effects. Wildlife and domestic animals would have to be within approximately 50 feet of the edge of the HSR right-of-way to experience noise effects above the FRA's recommended threshold. Where domestic animal operations (dairy farms) are adjacent to the HSR right-of-way, adverse effects could occur; however, in most cases unconfined livestock or wildlife could avoid noise stress by walking away from the track as a train approaches.

1 INTRODUCTION

1.1 Background of HSR Program

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

The Authority commenced its environmental planning process with the 2005 *Final Program EIR/ EIS for the Proposed California High-Speed Train System* (Authority and FRA 2005) (Statewide Program EIR/EIS), and then began preparing second-tier, project environmental evaluations for sections of the statewide HSR system. The 2012 *Merced to Fresno Section Final EIR/EIS* (Merced to Fresno Final EIR/EIS) (Authority and FRA 2012a) was the first project-level EIR/EIS that the Authority certified and the Federal Railroad Administration (FRA) approved.

The Merced to Fresno Final EIR/EIS identified the Hybrid Alignment as the preferred alternative and examined two design options for an east-west connection to the San Jose to Merced Section, referred to as the "wye connection" (Authority and FRA 2012a: pages 2-3 and 2-21). When the Authority Board of Directors and the FRA approved the Merced to Fresno Section later in 2012, they deferred a decision on the wye connection for a future environmental analysis. The Authority and FRA have prepared the Supplemental EIR/EIS as the next step in the environmental review process to select a Central Valley Wye connection. Chapter 2 of the Supplemental EIR/EIS provides a detailed history of how the Authority developed the Central Valley Wye alternatives.

1.2 Organization of this Technical Report

This technical report includes the following chapters:

- Chapter 1, Introduction
- Chapter 2, Merced to Fresno Chapter: Central Valley Wye, provides a description of the Central Valley Wye alternatives.
- Chapter 3, Noise and Vibration Descriptors, provides definitions of key terminology.
- Chapter 4, Laws, Regulations, and Orders, identifies the federal, state, and local laws, guidance, and policies relevant to noise and vibration for the Central Valley Wye.
- Chapter 5, Methods for Evaluating Effects and Impacts, describes the methods used to determine and evaluate potential effects.
- Chapter 6, Affected Environment, describes existing conditions.
- Chapter 7, Effects Analysis, describes effects, both adverse and beneficial.
- Chapter 8, References, provides a list of the references cited in this technical report.
- Chapter 9, Preparer Qualifications, identifies the individuals involved in preparing this report and their credentials.

Additional details on noise and vibration are provided in:

- Appendix A, Fundamental Concepts of Noise and Vibration for High-Speed Trains
- Appendix B, Local Regulations
- Appendix C, Noise and Vibration Measurement Sites and Noise Impacts
- Appendix D, Field Noise Measurement Documentation and Detail

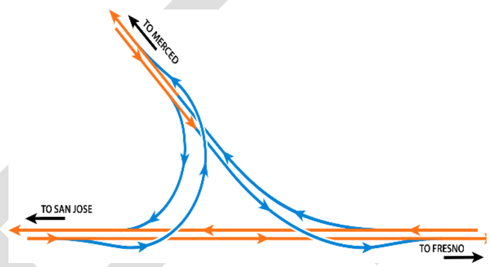
- Appendix E, Field Vibration Measurement Documentation Detail
- Appendix F, Rail Corridor Construction Equipment List by Construction Phase

2 MERCED TO FRESNO SECTION: CENTRAL VALLEY WYE

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

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

Central Valley Wye Schematic



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

2.1 Common Features

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

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

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

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

[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.

these existing transportation routes or corridors are necessary to accommodate design requirements; specifically, wider curves are necessary to accommodate the speed of the HSR compared to lower-speed roadway alignments. The SR 152 (North) to Road 13 Wye Alternative would not follow existing transportation rights-of-way where it transitions from following one transportation corridor to another.

2.2.1 Alignment and Ancillary Features

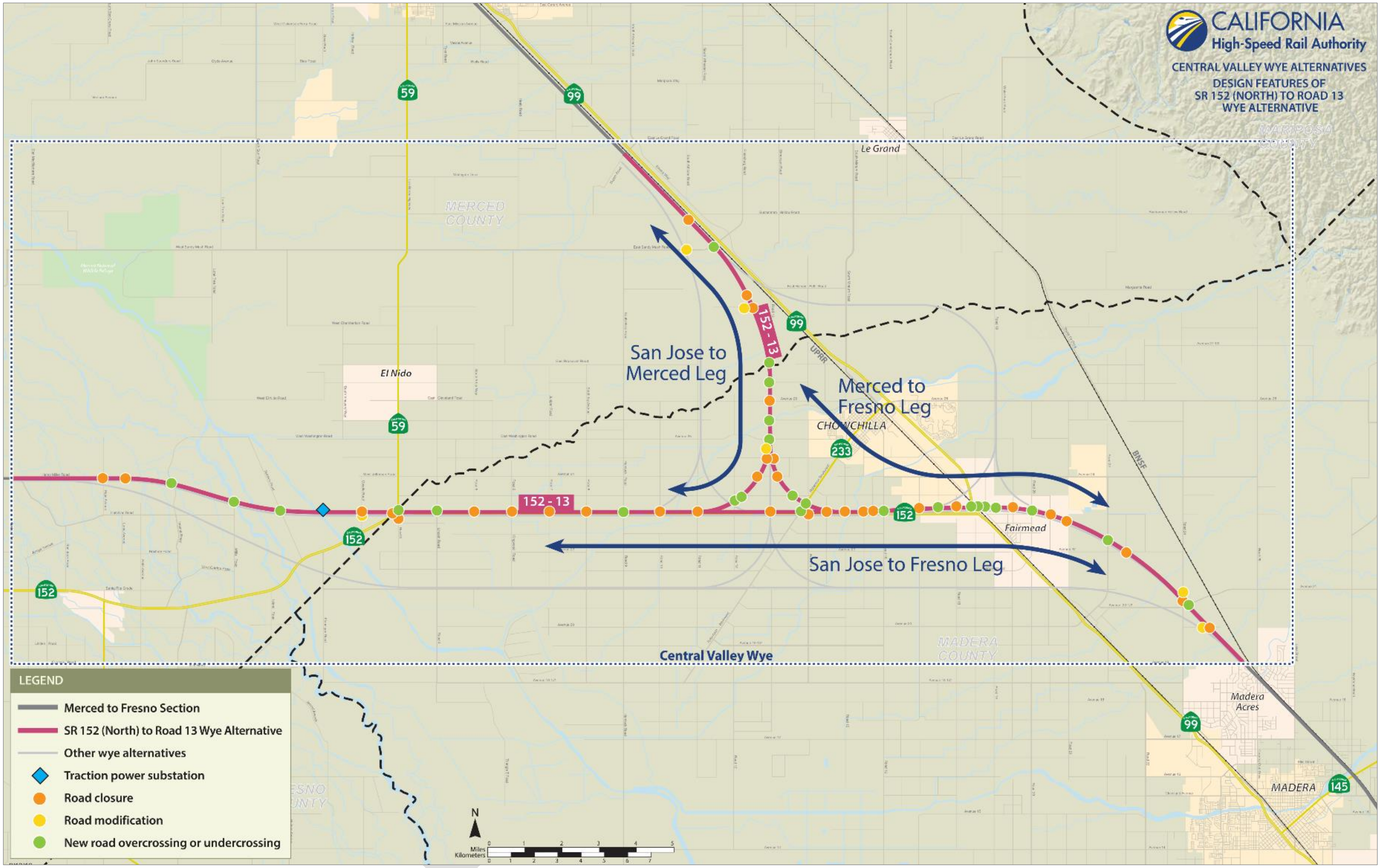
The SR 152 (North) to Road 13 Wye Alternative would extend approximately 52 miles, mostly at-grade on raised embankment, although it would also have aerial structures and a segment of retained cut (depressed alignment). The wye configuration of this alternative would be located southwest of the city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

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

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

[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; CAL FIRE, 2004; ESRI/National Geographic, 2015

FINAL – SEPTEMBER 13, 2016

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

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

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

2.2.2 State Highway or Local Roadway Modifications

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

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

2.2.3 Freight or Passenger Railroad Modifications

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

2.2.4 Summary

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

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

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

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

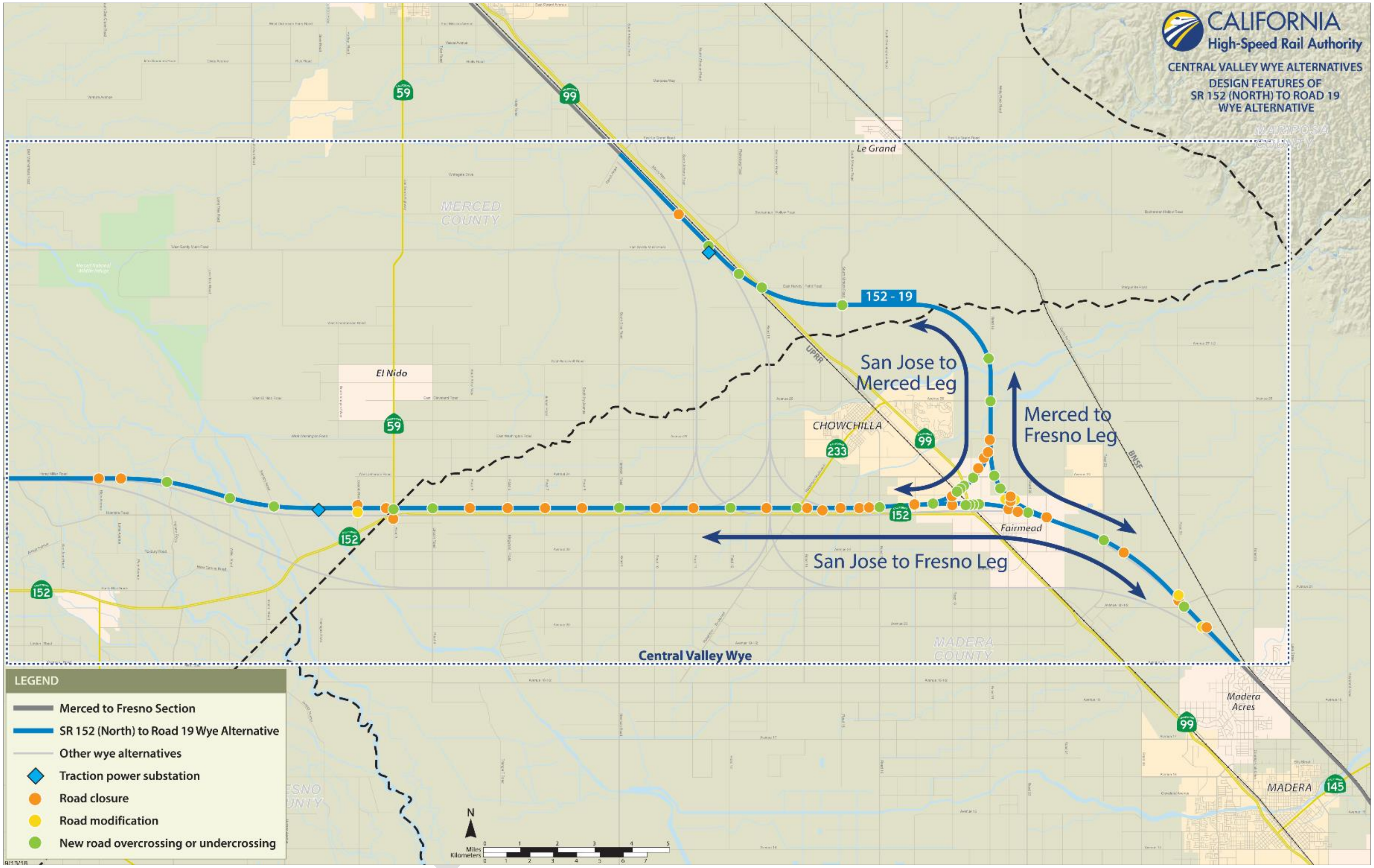
Source: Authority, 2016b
[1] Lengths shown are based on equivalent dual-track alignments and are one-way mileages. For example, the length of single-track elevated structure will be divided by a factor of 2 to convert to dual-track equivalents.

2.3 SR 152 (North) to Road 19 Wye Alternative

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

2.3.1 Alignment and Ancillary Features

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



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

FINAL – SEPTEMBER 13, 2016

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

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

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

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

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

2.3.2 State Highway or Local Roadway Modifications

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

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

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

2.3.3 Freight or Passenger Railroad Modifications

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

2.3.4 Summary

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

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

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

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

Feature	SR 152 (North) to Road 19 Wye
Traction power substation sites	2
Switching and paralleling stations	3 switching stations, 7 paralleling stations
Signaling and train-control elements	21
Communication towers	6
Wildlife crossing structures	41

Source: Authority, 2016b

[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 Wye2 Alternative

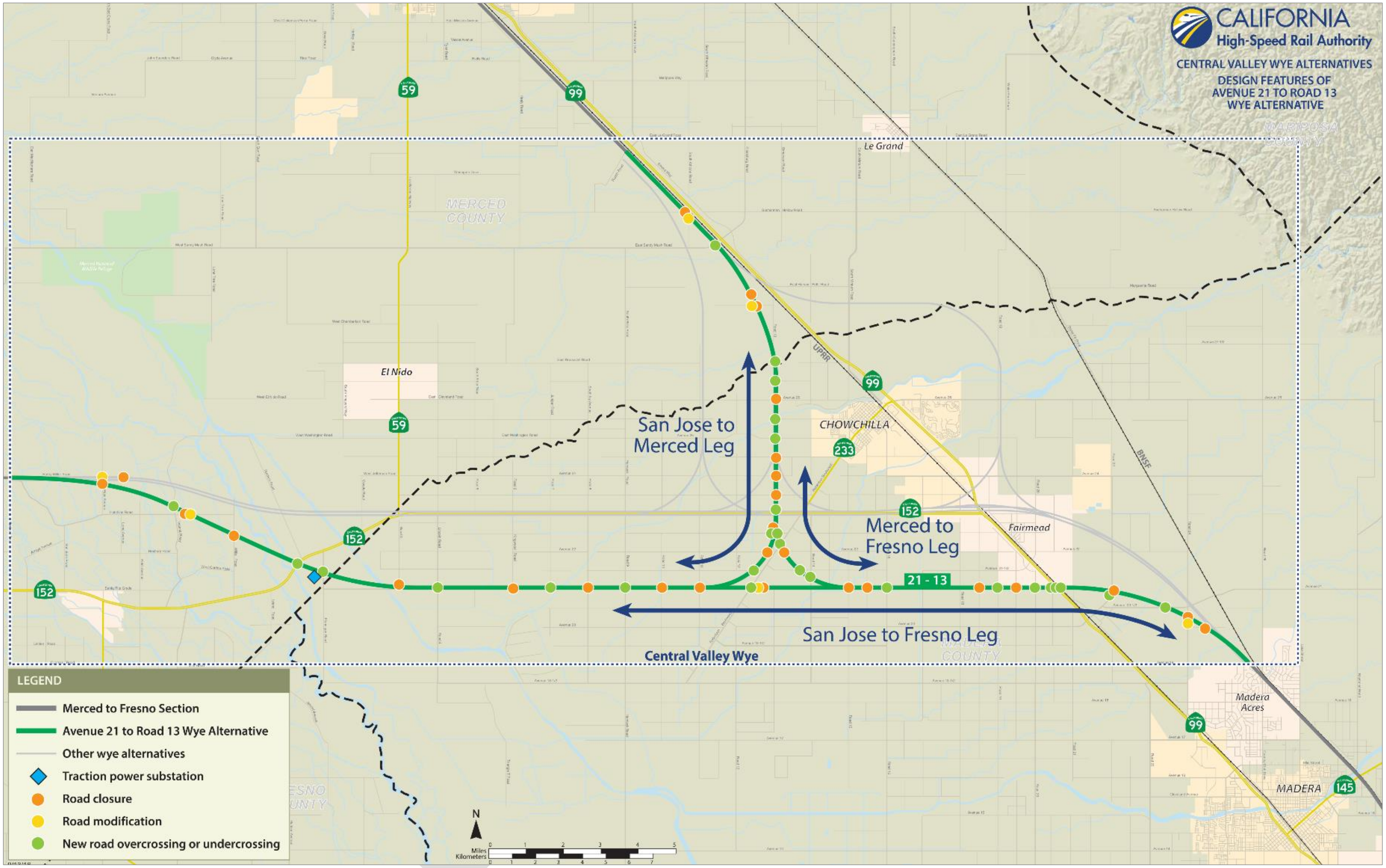
The Avenue 21 to Road 13 Wye Alternative (Figure 2-3) is designed to follow the existing Henry Miller Road and Avenue 21 rights-of-way as closely as practicable in the east-west direction and the Road 13, SR 99, and BNSF rights-of-way in the north-south direction. Deviations from these existing transportation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

2.4.1 Alignment and Ancillary Features

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

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

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



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

FINAL – SEPTEMBER 13, 2016

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

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

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

2.4.2 State Highway or Local Roadway Modifications

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

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

2.4.3 Freight or Passenger Railroad Modifications

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

2.4.4 Summary

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

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

Feature	Avenue 21 to Road 13 Wye
Total length (linear miles)[1]	53
At-grade profile (linear miles)[1]	48.5
Elevated profile (linear miles)[1]	4
Below-grade profile (linear miles)[1]	0.5
Number of straddle bents	32
Number of railroad crossings	1
Number of major water crossings	11

Feature	Avenue 21 to Road 13 Wye
Number of road crossings	58
Approximate number of public roadway closures	30
Number of roadway overcrossings and undercrossings	28
Traction power substation sites	1
Switching and paralleling stations	3 switching stations, 7 paralleling stations
Signaling and train-control elements	15
Communication towers	6
Wildlife crossing structures	44

Source: Authority, 2016b

[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 1252 (North) to Road 11 Wye Alternative

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

2.5.1 Alignment and Ancillary Features

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

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

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

FINAL – SEPTEMBER 13, 2016

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

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

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

2.5.2 State Highway or Local Roadway Modifications

The SR 152 (North) to Road 11 Wye Alternative would require the permanent closure of 33 public roadways at selected locations and the construction of 24 overcrossings or undercrossings in lieu of closure. Table 2-4 and Figure 2-4 show the anticipated state highway and local roadway closures and modifications. Fourteen of these permanent road closures would be located at SR 152 where roads currently cross at-grade but need to be closed in order to convert SR 152 to a fully access-controlled corridor. The 14 proposed closures are Road 5, Road 6, Road 7, Road 8, Road 10, Road 11, Road 13, Road 14, Road 14 1/2, Road 15, Road 15 1/2, Road 15 3/4, Road 17, and Road 18. Planned new grade separations along SR 152 at the SR 59/SR 152 Interchange, Road 4/Lincoln Road, Road 12, and Road 17 1/2 would maintain access to SR 152. These roadways would be reconfigured to two 12-foot lanes with two 8-foot shoulders. Several of these new interchanges would require realigning SR 152. Three new interchanges are proposed between SR 59 and SR 99 to provide access to SR 152: at Road 9/Hemlock Road, SR 233/Robertson Boulevard, and Road 16.

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

2.5.3 Freight or Passenger Railroad Modifications

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

2.5.4 Summary

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

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

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

Source: Authority, 2016b
[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 G presents complete descriptions of all IAMFs related to noise and vibration. Volume 2 of the Supplemental EIR/EIS, Appendix 2-B, California High-Speed Rail Environmental Commitments: 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 noise and vibration. These IAMFs include measures that are specific to noise and vibration and IAMFs for other resources (socioeconomics) that are also related to noise and vibration effects:

2.6.1.1 Noise and Vibration

- NV-IAMF#1: Noise and Vibration

2.6.1.2 Socioeconomics and Communities

- SO-IAMF#1: Construction Management Plan

3 NOISE AND VIBRATION DESCRIPTORS

This chapter identifies the basic descriptors and metrics used to quantify noise and vibration and to assess associated effects in this report. Appendix A, Fundamental Concepts of Noise and Vibration for High-Speed Trains, provides further background information regarding HSR noise and vibration. Much of this chapter has been adapted from the FRA's *High-Speed Ground Transportation Noise and Vibration Impact Assessment* manual (FRA guidance manual) (FRA 2012).

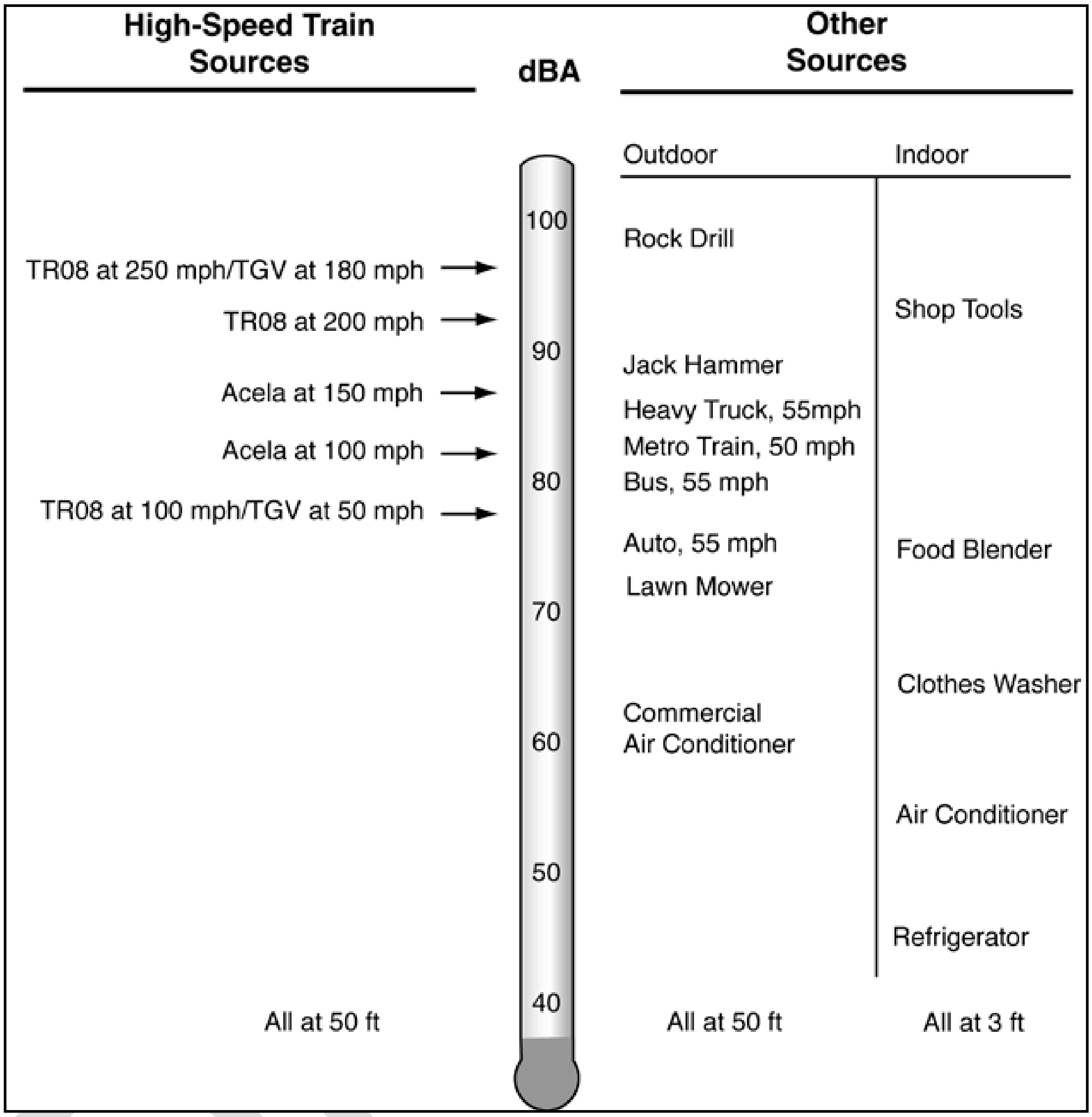
3.1 Noise Descriptors

Noise is usually defined as sound that is undesirable because it interferes with speech communication and hearing, or is otherwise annoying. Under certain conditions, noise may affect hearing loss, interfere with human activities, and in various ways may affect people's health and wellbeing.

The decibel (dB) is the accepted standard unit for measuring the amplitude of sound because it accounts for the large variations in sound pressure amplitude. When describing sound and its effect on a human population, A-weighted decibel (dBA) sound pressure levels are typically used to account for the response of the human ear. The term "A-weighted" refers to a filtering of the noise signal in a manner corresponding to the way the human ear perceives sound. The A-weighted noise level correlates well with people's judgments of the noisiness of different sounds and has been used for many years as a measure of community noise. Figure 3-1 illustrates typical A-weighted sound pressure levels for different high-speed trains and various noise sources. Typical A-weighted sound levels range from the 40s to the 90s, where 40 is very quiet and 90 is very loud. On average, each A-weighted sound level increase of 10 dB corresponds to an approximate doubling of subjective loudness.

This report uses the following single-number descriptors, all based on the A-weighted sound pressure levels as the fundamental unit for environmental noise measurements, computations, and assessment:

- **Maximum Sound Level (L_{max})**—Refers to the maximum observed or recorded noise level during a single noise event or measurement period. There are two standard ways of obtaining the L_{max}, one using the "fast" response setting on the sound level meter, or $L_{max,fast}$ (obtained by using a 0.125-second averaging time), and the other using the "slow" setting, or $L_{max,slow}$ (obtained by using a 1-second averaging time). $L_{max,\ fast}$ can occur arbitrarily and is usually caused by a single component on a moving train, often a defective component such as a flat spot on a wheel. As a result, inspectors from the FRA use $L_{max,fast}$ to identify excessively noisy locomotives and rail cars during enforcement of Railroad Noise Emission Compliance Regulations. $L_{max,slow}$, with its greater averaging time, tends to de-emphasize the effects of non-representative impacts and impulses and is generally better correlated with the sound exposure level (SEL), defined in the following bullet, which is the basis of impact assessment. Thus, $L_{max,slow}$ is typically used for modeling train noise mathematically. In general, however, the L_{max} descriptor in either form is not recommended for noise impact assessment because it is used in vehicle noise specifications and commonly measured for individual vehicles.
- **Sound Exposure Level (SEL)**—Refers to a receiver's combined noise exposure from a single noise event. It is represented by the total A-weighted sound energy during the event, normalized to a 1-second interval. SEL is the primary descriptor of HSR vehicle noise emissions and an intermediate value in the calculation of both L_{eq} and L_{dn} (defined in the following text).



Source: FRA, 2012.

Figure 3-1 Typical A-Weighted Maximum Sound Pressure Levels

- **Equivalent Sound Level (L_{eq})**—Refers to a receiver's energy-averaged noise exposure from all events over a specified period (e.g., 1 minute, 1 hour, 24 hours). The L_{eq} for a 1-hour period may be indicated as $L_{eq(1\text{-}h)}$ or L_{eq}(h). The L_{eq} value for the 15-hour daytime period (7 a.m. to 10 p.m.) is described as $L_{eq(d)}$ and the 9-hour nighttime period (10 p.m. to 7 a.m.) as $L_{eq(n)}$. L_{eq} is generally used in this document to report results of short-term noise measurements (usually ranging between 20 minutes and 1 hour). The measured or estimated $L_{eq(1\text{-}h)}$ or $L_{eq(d)}$ values are generally used to assess noise impacts for non-residential land uses with daytime-only uses.
- **Day-Night Sound Level (L_{dn})**—Refers to a receiver's energy-averaged noise exposure from all events over a 24-hour period with a penalty added for nighttime noise periods. The basic unit used in calculating L_{dn} is the L_{eq}(h) for each 1-hour period. It may be thought of as a noise exposure, totaled after increasing all nighttime A-weighted levels (between 10 p.m. and 7 a.m.) by 10 dB to take into account the increased sensitivity of most people to nighttime noise. Every noise event during the 24-hour period increases this exposure, louder events more than quieter events, and events that are of longer duration more than briefer events. In

this report, L_{dn} is used to assess noise for residential land uses. Typical community L_{dn} values range from about 50 to 70 dBA, where 50 dBA represents a quiet noise environment and 70 dBA is a noisy one.

- **Community Noise Equivalent Level (CNEL)**—A community noise descriptor frequently used in California. CNEL is calculated in a manner similar to L_{dn} except with an additional 5-dBA penalty added for evening hours (between 7 p.m. and 10 p.m.), to take into account residential evening activities. CNEL values are generally within about 1 dBA of L_{dn} values measured for the same noise environments.

3.2 Vibratory Motion

Vibration is an oscillatory motion, which can be described in terms of displacement, velocity, or acceleration. Because the motion is oscillatory, there is no net movement of the vibration element, and the average of any of the motion descriptors is zero. Displacement is the easiest descriptor to understand. For a vibrating floor, the displacement is simply the distance that a point on the floor moves away from its static position. The velocity represents the instantaneous speed of the floor movement, and acceleration is the rate of change of the speed.

Although displacement is easier to understand than velocity or acceleration, it is rarely used to describe ground-borne vibration. This is because most transducers for measuring ground-borne vibration use either velocity or acceleration, and, even more importantly, the response of humans, buildings, and equipment to vibration is more accurately described using velocity or acceleration.

3.3 Amplitude Descriptors

Vibration consists of rapidly fluctuating motions with an average motion of zero. The various methods used to quantify vibration amplitude are shown on Figure 3-2. The raw signal is the lighter weight curve in the top graph of this figure. This is the instantaneous vibration velocity, which fluctuates about the zero point. The peak particle velocity (PPV) is defined as the maximum instantaneous positive or negative peak of the vibration signal. PPV often is used in monitoring blasting vibration because it is related to the stresses that are experienced by buildings.

Although PPV is appropriate for evaluating the potential of building damage, it is not suitable for evaluating human response. It takes some time for the human body to respond to vibration signals. In a sense, the human body responds to average vibration amplitude. Because the net average of a vibration signal is zero, the root mean square (RMS) amplitude is used to describe the "smoothed" vibration amplitude. The RMS of a signal is the average of the squared amplitude of the signal. The average is typically calculated over a 1-second period. The RMS amplitude is shown superimposed on the vibration signal on Figure 3-2. The RMS amplitude is always less than the PPV and is always positive. The ratio of PPV to maximum RMS amplitude is defined as the crest factor for the signal. The crest factor is always greater than 1.71, although a crest factor of 8 or more is not unusual for impulsive signals. For ground-borne vibration from trains, the crest factor is usually 4 to 5.

The PPV and RMS velocities are normally described in inches per second in the United States. Although it is not universally accepted, decibel notation is in common use for vibration. Decibel notation serves to compress the range of numbers required to describe vibration. The bottom graph on Figure 3-2 shows the RMS curve of the top graph expressed in decibels. Vibration velocity level in decibels is defined as:

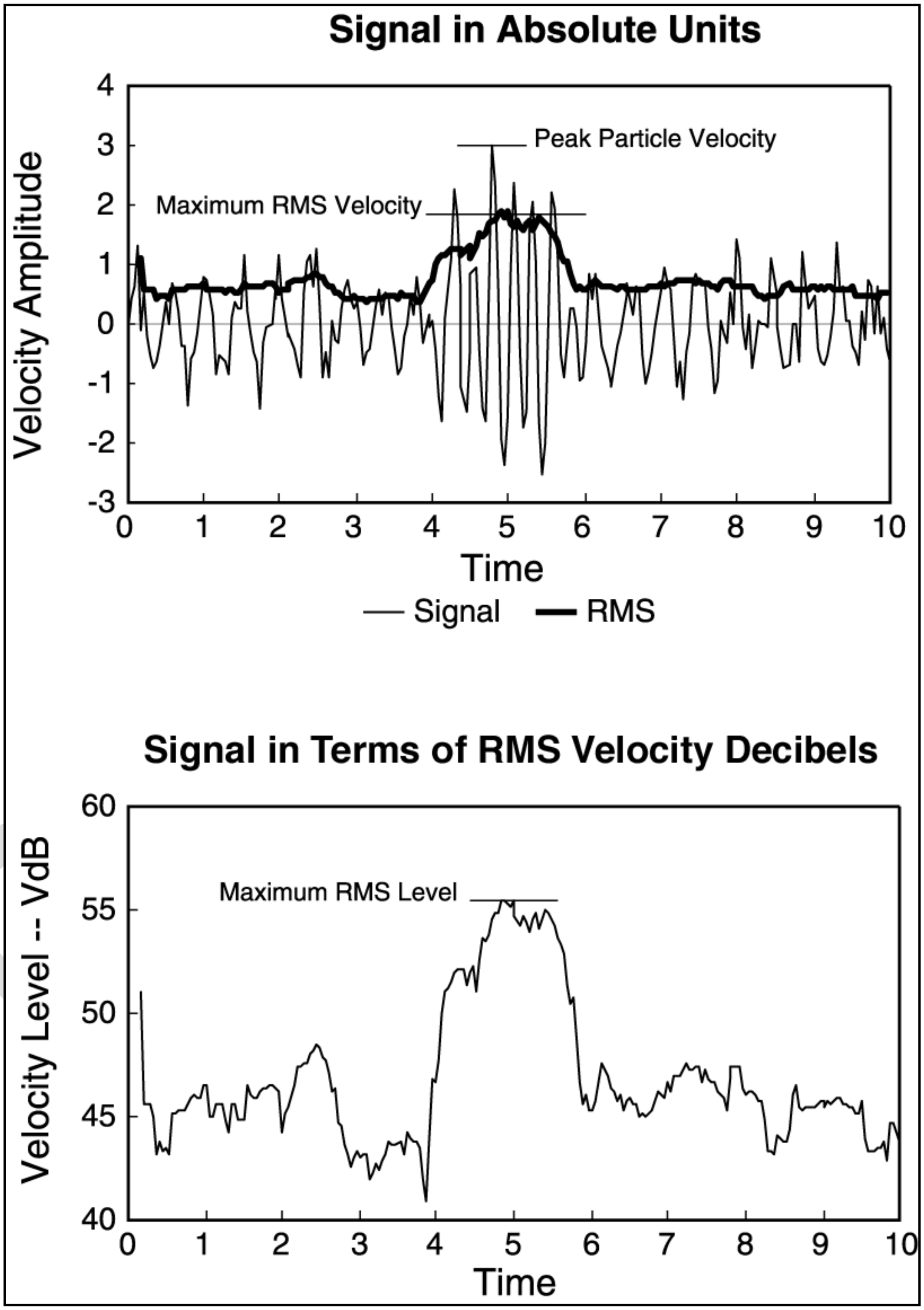
$$L_v = 20 \times \text{Log}_{10} (v/v_{ref})$$

Where: L_v = velocity level in decibels

v = RMS velocity amplitude

v_{ref} = reference velocity amplitude

A reference always must be specified whenever a quantity is expressed in terms of decibels. The accepted reference quantity for vibration velocity level in the United States is 1×10^{-6} inches per second; however, it is important to state clearly the reference quantity being used whenever velocity levels are specified. All vibration levels in this report are referenced to $1x10^{-6}$ inches per second. Although not a universally accepted notation, the abbreviation VdB (RMS vibration velocity level, decibels) is used in this document for vibration decibels to reduce the potential for confusion with sound decibels.



Source: FRA, 2012

Figure 3-2 Different Methods of Describing a Vibration Signal

3.4 Ground-Borne Noise

The rumbling sound caused by the vibration of room surfaces is called ground-borne noise. The annoyance potential of ground-borne noise is usually characterized using the A-weighted sound level. Although the A-weighted level is typically the only descriptor used for community noise, there are potential problems with characterizing low-frequency noise using A-weighting. This is because of the non-linearity of human hearing, which causes sounds dominated by low-frequency components to seem louder than broadband sounds that have the same A-weighted level. The result is that a ground-borne noise level of 40 dBA sounds louder than 40 dBA broadband airborne noise. This anomaly is accounted for by setting the limits for ground-borne noise lower than would be the case for broadband noise.

Ground-borne noise is generally only an issue for trains operating underground. For systems where the train is operating either at- or above-grade, the airborne noise level is generally significantly louder than the ground-borne component, so that the ground-borne noise is masked by the airborne noise. This would be the case for the Central Valley Wye, because there would be limited sections of track run below grade for this section of the HSR project.

4 LAWS, REGULATIONS, AND ORDERS

This chapter provides a summary of federal, state, and local laws, regulations, orders, or plans that pertain to noise and vibration in the geographic area that is affected by the Central Valley Wye. For complete descriptions, refer to Section 3.4.2, Laws, Regulations, and Orders, of the Merced to Fresno Final EIR/EIS. Where applicable, the summaries that follow identify updates or amendments that have been made since the Merced to Fresno Final EIR/EIS was completed.

4.1 Noise Regulations

4.1.1 Federal

4.1.1.1 Noise Control Act of 1972 (42 U.S.C. § 4910)

The Noise Control Act of 1972 was the first comprehensive statement of national noise policy. The act declared "it is the policy of the U.S. to promote an environment for all Americans free from noise that jeopardizes their health or welfare." Although the act, as a funded program, was ultimately abandoned at the federal level, it served as the catalyst for comprehensive noise studies and the generation of noise assessment and mitigation policies, regulations, ordinances, standards and guidance for many states, counties and even municipal governments. For example, the "noise elements" of community general plan documents and local noise ordinances studied as part of this technical report were largely created in response to passage of the act.

4.1.1.2 Federal Railroad Administration Guidelines (Updated Since the Merced to Fresno Final EIR/EIS)

The criteria in the FRA guidance manual (FRA 2012) were used to assess existing ambient noise levels and future noise impacts from proposed high-speed train operations. This guidance manual was updated in 2012, since the Merced to Fresno Final EIR/EIS, to reflect the most current knowledge on noise and vibration emissions from high-speed trains, noise source mitigation, and clarifications to policy-related topics such as guidance on determining the need for mitigation of moderate noise impacts. However, the noise and vibration impact criteria and the analytical methodologies for noise and vibration impacts in the updated guidance are the same as those provided in the previous version. Therefore, no change in the methodology followed for this analysis was required.

The FRA has no standardized construction noise criteria for assessing noise impacts at sensitive receivers due to construction; however, FRA has developed guidelines that can be considered for assessment purposes. In addition, FRA undertakings, such as the Central Valley Wye, are not subject to regional or local policies or ordinances, including those related to local noise criteria for construction. FRA detailed construction assessment criteria were used for this report. The values presented in Table 4-1 are considered appropriate for a "detailed" impact assessment, which is appropriate for this noise study.

Table 4-1 FRA Construction Noise Assessment Criteria

Land Use	8-hour L_{eq}, dBA		L_{dn}, dBA
	Day	Night	30-day Average
Residential	80	70	75[1]
Commercial	85	85	80[2]
Industrial	90	90	85[2]

Source: FRA, 2012

[1] In urban areas with very high ambient noise levels (L_{dn} > 65 dB), L_{dn} from construction operations should not exceed existing ambient noise levels + 10 dB.

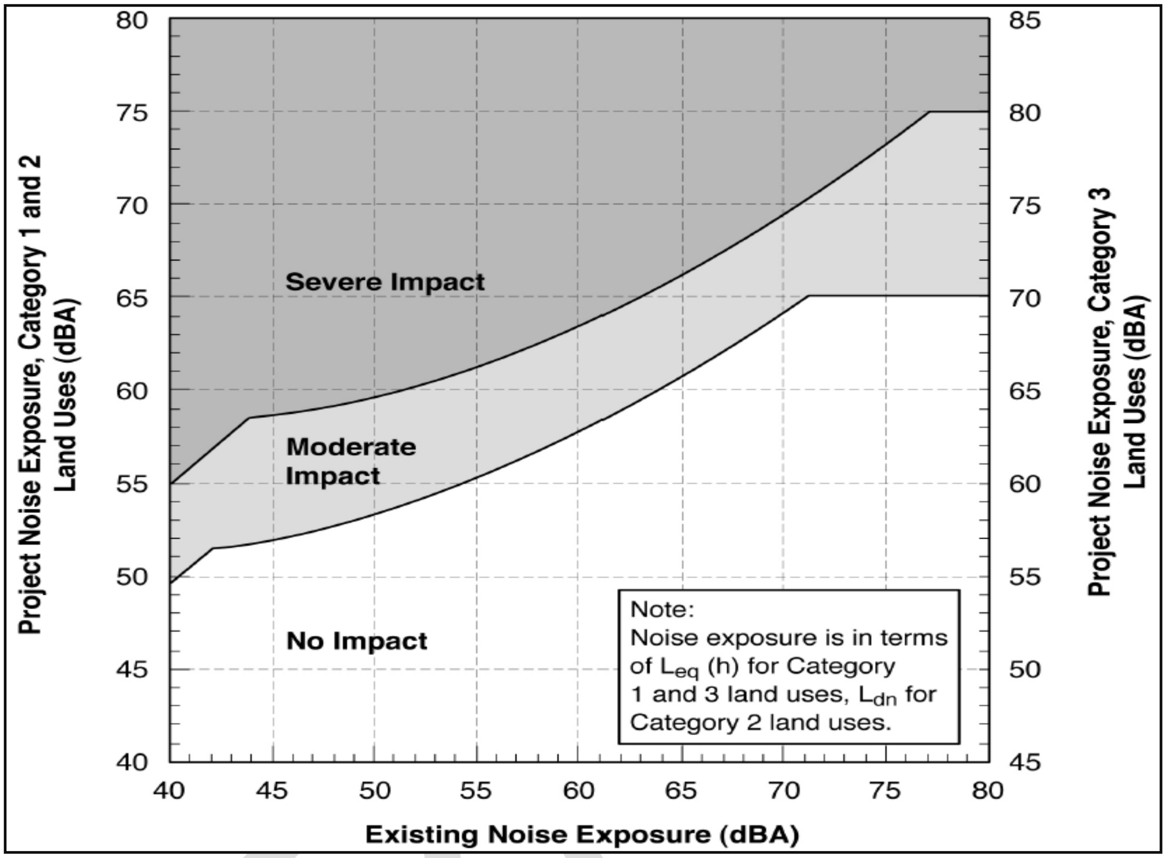
[2] Twenty-four-hour L_{eq}, not L_{dn}

dBA = A-weighted decibels

L_{dn} = day-night sound level, dBA

L_{eq} = equivalent sound level, dBA

The noise impact criteria for rail projects are shown graphically on Figure 4-1. The land use categories (1, 2, 3) shown on Figure 4-1 are defined in Table 4-2.



Source: FRA, 2012

Figure 4-1 Noise Impact Criteria for Transit Projects

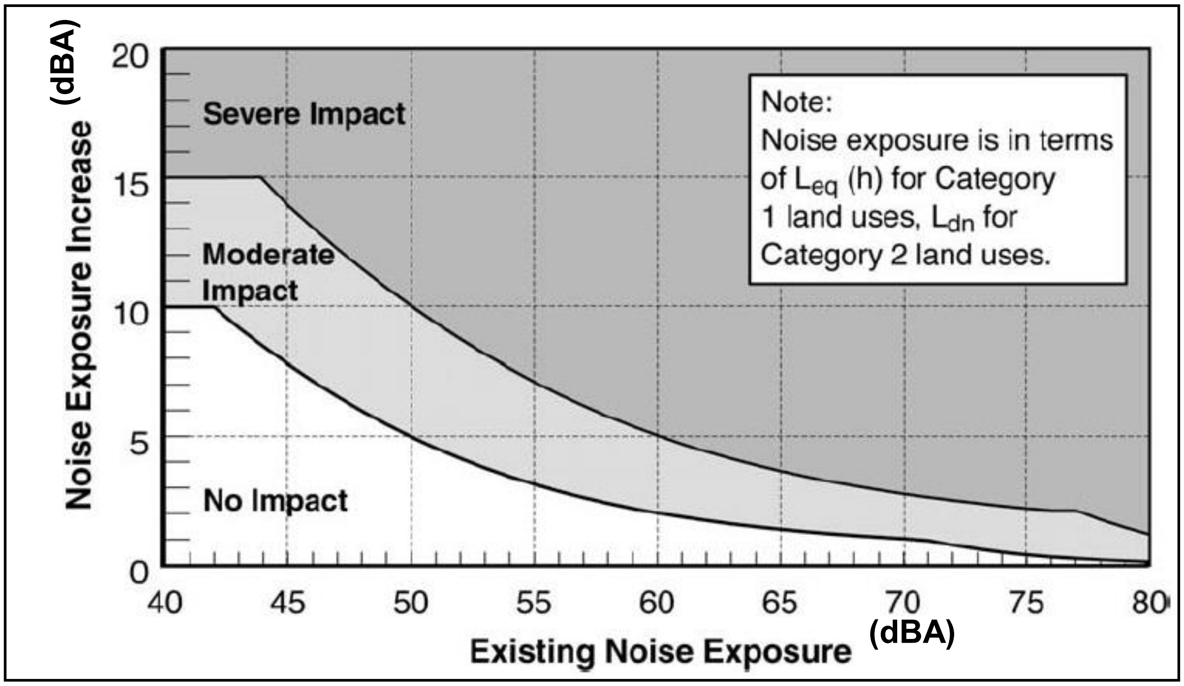
Table 4-2 Land Use Categories and Metrics for Transit Noise Impact Criteria

Land Use Category	Noise Metric (dBA)	Description of Land Use Category
1	Outdoor $L_{eq}(h)$[1]	Tracts of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet, and such land uses as outdoor amphitheaters and concert pavilions, as well as National Historic Landmarks with significant outdoor use.
2	Outdoor L_{dn}	Residences and buildings where people normally sleep. This category includes homes, hospitals, and hotels where a nighttime sensitivity to noise is assumed to be of utmost importance.
3	Outdoor $L_{eq}(h)$[1]	Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, and churches where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material. Buildings with interior spaces where quiet is important, such as medical offices, conference rooms, recording studios, and concert halls fall into this category. Places for meditation or study associated with cemeteries, monuments, and museums and certain historical sites, parks, and recreational facilities are also included.

Source: FRA, 2012
[1] L_{eq} for the noisiest hour of rail-related activity during hours of noise sensitivity.
dBA = A-weighted decibels
$L_{eq}(h)$ = equivalent sound level for a 1-hour period, dBA
L_{dn} = day-night sound level, dBA

With a noise exposure below the lower of the two curves on Figure 4-1, a proposed project is considered to have no noise impact because, on average, the introduction of the project would result in an insignificant increase in the number of people highly annoyed by the new noise. The curve defining the onset of noise impact stops increasing at 65 dBA for Categories 1 and 2 land uses, a standard limit for an acceptable living environment defined by a number of federal, state, and local agencies. Project noise above the upper curve is considered to cause a severe impact because a significant percentage of people would be highly annoyed by the new noise. The curve flattens at 75 dBA for Categories 1 and 2 land uses, indicating a level associated with an unacceptable living environment. As indicated by the right-hand scale on Figure 4-1, the project noise criteria are 5 dB higher for Category 3 land uses because these types of land uses are considered to be less sensitive to noise than the types of land uses in Categories 1 and 2.

Between the two curves, a proposed project is judged to have a moderate impact. The change in the combined noise level—when project-generated noise is added to existing noise levels—is noticeable to most people, but may not be sufficient to cause strong, adverse reactions from the community. In this transitional area, other project-specific factors must be considered to determine the magnitude of the impact and the need for mitigation, such as the existing noise level, predicted level of increase over existing noise levels, and the types and numbers of noise-sensitive land uses affected. Although the curves on Figure 4-1 are defined in terms of the project noise exposure and the existing noise exposure, it is important to emphasize that it is the increase in the combined noise that is the basis for the criteria. The complex shapes of the curves are based on the considerations of combined noise increase described in Appendix A. To illustrate this point, Figure 4-2 shows the noise impact criteria for Category 1 and Category 2 land uses in terms of the allowable increase in the combined noise exposure. Because L_{dn} and L_{eq} are measures of total acoustic energy, any new noise source in a community will cause an increase, even if the new source level is less than the existing level. Referring to Figure 4-2, it can be seen that the criterion for moderate impact allows a noise exposure increase of 10 dB if the existing noise exposure is 42 dBA or less, but only a 1 dB increase when the existing noise exposure is 70 dBA.



Source: FRA, 2012

Figure 4-2 Allowable Increase in Combined Noise Levels (Categories 1 & 2)

As the existing level of ambient noise increases, the allowable level of transit noise increases, but the total amount that community noise exposure is allowed to increase is reduced. This accounts for the unexpected result that a project noise exposure that is less than the existing noise exposure can still cause an impact. This is clearer from the examples given in Table 4-3, which indicate the level of transit noise allowed for different existing levels of exposure.

Table 4-3 Noise Impact Criteria: Effect on Combined Noise Exposure

L_{dn} or L_{eq} in dBA (rounded to nearest whole decibel)			
Existing Noise Exposure	Allowable Project Noise Exposure	Allowable Combined Total Noise Exposure	Allowable Noise Exposure Increase
45	52	53	8
50	53	55	5
55	55	58	3
60	57	62	2
65	60	66	1
70	64	71	1
75	65	75	0

Source: FRA, 2012
dBA = A-weighted decibels
L_{dn} = day-night sound level, dBA
L_{eq} = equivalent sound level, dBA

Noise effects on wildlife (mammals and birds) and domestic animals (livestock and poultry) are also addressed in the FRA guidelines. Table 4-4 shows the usage of SEL as the applicable noise metric for wildlife and livestock noise impact assessment.

Table 4-4 Interim Criteria for High-Speed Train Noise Effects on Animals

Animal Category	Class	Noise Metric	Noise Level (dBA)
Domestic	Mammals	SEL	100
	Birds	SEL	100
Wild	Mammals	SEL	100
	Birds	SEL	100

Source: FRA, 2012
dBA = A-weighted decibels
SEL = sound exposure level

4.1.1.3 Occupational Safety and Health Administration Occupational Noise Exposure (29 C.F.R. § 1910.95)

The Occupational Safety and Health Administration has regulated worker noise exposure to a time-weighted-average of 90 dBA over an 8-hour work shift. Areas where levels exceed 85 dBA must be designated and labeled as high-noise-level areas where hearing protection is required. This noise exposure criterion for workers would apply to construction activities associated with the HSR project. Noise from the HSR project might also elevate noise levels at nearby construction sites to levels that exceed 85 dBA and thus trigger the need for administrative/engineering controls and hearing conservation programs as detailed by the Occupational Safety and Health Administration for worker safety.

4.1.1.4 FRA Railroad Noise Emission Compliance Regulations (49 C.F.R. § 210)

The FRA's Railroad Noise Emission Compliance Regulations (49 C.F.R. § 210) adopt and enforce the U.S. Environmental Protection Agency's railroad noise emission standards (40 C.F.R. Part § 201).

4.1.1.5 Federal Highway Administration Procedures for Abatement of Highway Traffic Noise and Construction Noise (23 C.F.R. § 772)

The Federal Highway Administration (FHWA) stipulates procedures and criteria for noise assessment studies of highway projects (23 C.F.R. § 772). It requires that noise abatement measures be considered on all major highway projects, if the project will cause a substantial increase in traffic noise levels, or if projected traffic noise levels approach or exceed the Noise Abatement Criteria (NAC) level for activities occurring on adjacent lands. FHWA NAC for various land use ratings (called activity categories) are given in Table 4-5. These noise criteria are assigned to exterior and interior activities.

If motor vehicle traffic noise from federally funded projects is predicted to be approached or exceeded during the noisiest 1-hour period, noise abatement measures must be considered and, if determined to be reasonable and feasible, they must be incorporated as part of the project. Consistent with FHWA guidelines, Caltrans defines "approach" as a peak-noise-hour sound level of 66 dBA L_{eq}. Caltrans criteria also consider that a 12 dB increase in peak-hour traffic noise is a significant increase as defined by the FHWA procedures.

Table 4-5 FHWA Traffic Noise Abatement Criteria

Activity Category	Activity $L_{eq}(h)$[1], dBA	Evaluation Location	Description of Activities
A	57	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B[2]	67	Exterior	Residential.
C[2]	67	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	52	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E	72	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties, or activities not included in A–D or F.
F	--	--	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G	--	--	Undeveloped lands that are not permitted (without building permits).

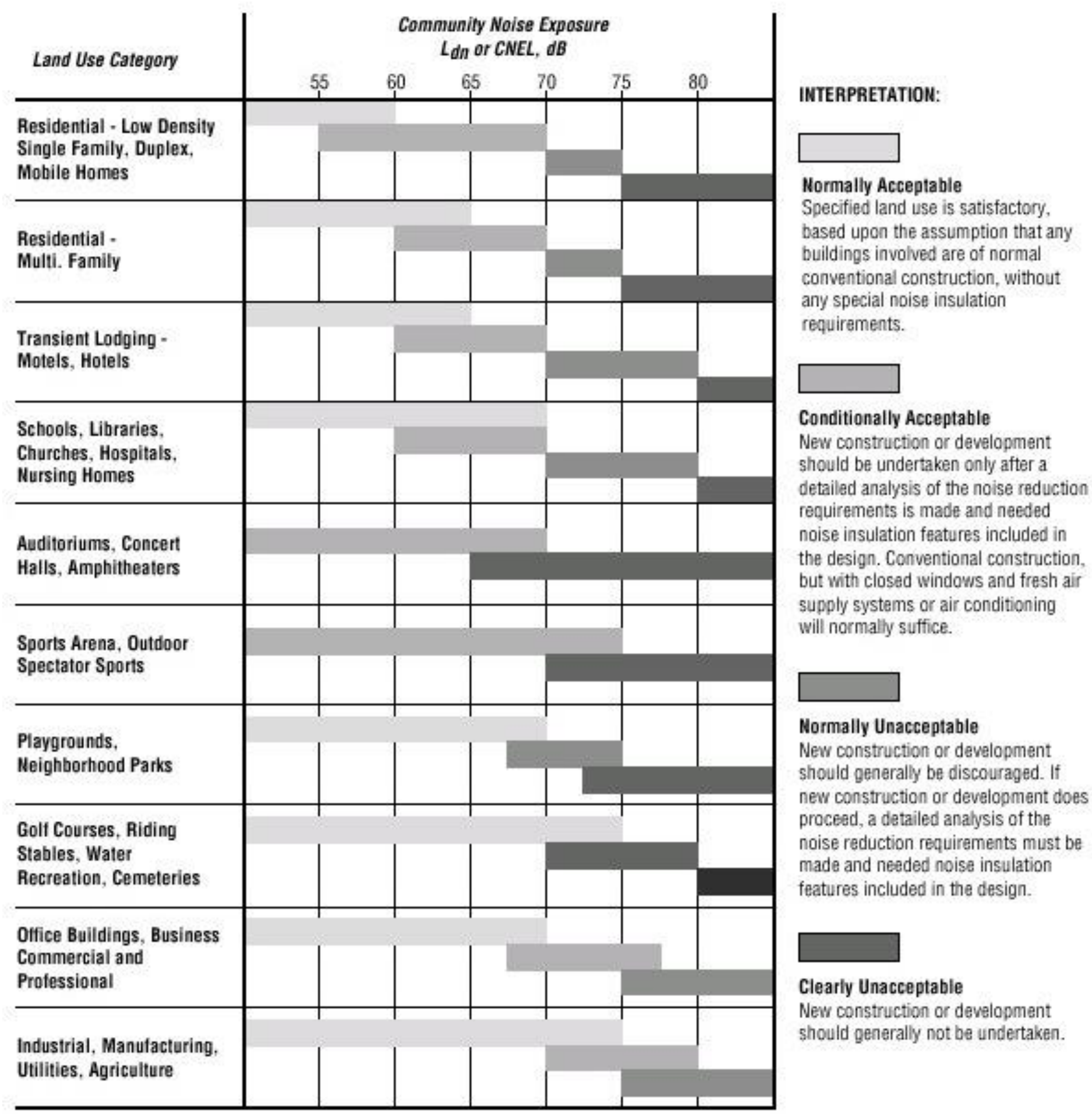
Source: 23 C.F.R. Part 772
[1] The $L_{eq}(h)$ activity criteria values are for effect determination only and are not design standards for noise abatement measures. All values are in dBA.
[2] Includes undeveloped lands permitted for this activity category.
dBA = A-weighted decibels
Leq(h) = hourly noise equivalent level

4.1.2 State

4.1.2.1 General Plan Guidelines, Appendix C, Noise Element Guidelines

The noise element of the general plan provides a basis for comprehensive local programs to control and abate environmental noise and to protect citizens from excessive exposure. The California Governor's Office of Planning and Research *General Plan Guidelines* (OPR 2003) outlines the development of the noise element for local agencies.

Figure 4-3 from the noise compatible land use planning guidance is often adopted by city and county agencies for land use planning purposes for acoustical compatibility based on existing ambient noise levels in the community. For example, commercial land uses are considered appropriate where existing noise levels might be considered too high for residential development.



Source: OPR, 2003

Figure 4-3 State of California Land Use Compatibility Guidelines

4.1.2.2 California Department of Transportation Traffic Noise Analysis Protocol (Updated Since the Merced to Fresno Section Final EIR/EIS)

The Caltrans *Traffic Noise Analysis Protocol* (Caltrans 2011) establishes guidelines for evaluating traffic noise impacts along highways where frequent outdoor use areas are located and determining the feasible abatement measures. Under FHWA and Caltrans policies, noise barriers should be considered for transportation improvement projects when the following criteria are met:

1. Predicted maximum hourly noise level is expected to approach or exceed the FHWA NAC (e.g., 67 dBA L_{eq} for residences or other noise sensitive land uses) or increase ambient noise levels substantially. In California, a noise level is considered to approach the NAC for a given activity category if it is within 1 dB of the NAC. In California, a

substantial noise increase is considered to occur when the project's predicted worst-hour design-year traffic noise level exceeds the existing worst-hour-noise level by 12 dB or more. Under current Caltrans policy, a noise level of 66 dBA is considered to be approaching the NAC of 67 dBA.

2. Noise abatement must be predicted to reduce noise by at least 5 dB at an affected receiver to be considered feasible from an acoustical perspective.
3. The overall reasonableness of noise abatement is determined by the following three factors:

- The noise reduction design goal.
- The cost of noise abatement.
- The viewpoints of benefited receivers (including property owners and residents of the benefited receivers).

4. The noise barrier should interrupt the line of sight between the stack of a truck to the receiver. The truck stack height is assumed to be 11.5 feet above the pavement. The receiver is assumed to be 5 feet above the ground.

Caltrans *Traffic Noise Analysis Protocol* and FHWA (23 C.F.R. § 772) policies address the timing and applicability of noise abasement measures as part of a roadway project. Noise abatement at noise-sensitive land uses must be considered as part of the project (when NAC are approached or exceeded) if noise-sensitive development was planned, designed, and programmed prior to the roadway project's date of public knowledge. A development is considered planned, designed, and programmed on the date that final approval is granted from the local jurisdiction (for example, issuance of building permits from a city planning agency). The date of public knowledge of the roadway project is the date of approval of the final environmental decision document (for example, the Record of Decision).

4.1.2.3 California Noise Control Act (Cal. Health and Safety Code, § 46010 et seq.)

At the state level, the California Noise Control Act of 1973 (Cal. Health and Safety Code, § 46010 et seq.) provided for the Office of Noise Control in the Department of Health Services to assist communities in developing local noise control programs and to work with the Office of Planning and Research to provide guidance for the preparation of the required noise elements in city and county general plans, pursuant to California Government Code, Section 65302(f). In preparing the noise element, a city or county must identify local noise sources and analyze and quantify, to the extent practicable, current and projected noise levels for various sources, including highways and freeways, passenger and freight railroad operations, ground rapid transit systems, commercial, general, and military aviation and airport operations, and other ground stationary noise sources (these would include HSR alignments). Noise-level contours must be mapped for these sources, using both community noise equivalent level and day-night average level, and are to be used as a guide in land use decisions to minimize the exposure of community residents to excessive noise.

4.1.3 Regional and Local (Updated Since Merced to Fresno Final EIR/EIS)

Counties and cities in California prepare general plans with noise elements and may also have noise ordinances (outlined in Section 4.1.2, State). These noise elements and ordinances can incorporate specific allowable noise levels to achieve a quality environment. Where airports exist, the general plans often include a section on airport land use compatibility with respect to noise so that new, noise-sensitive uses are not located near or do not encroach on areas surrounding airports. General plans usually do not address ground-borne vibration. See Appendix B, Local Regulations, for more information on regional and local policies and plans.

This section provides a summary of the significant local noise criteria for each of the jurisdictions along the Central Valley Wye to determine compatibility of the HSR project with local requirements. However, the HSR project is not subject to local general plan policies and ordinances related to noise limits on construction or to locally based criteria for determining the significance of a noise increase from a project.

4.1.3.1 County of Merced (Updated Since Merced to Fresno Final EIR/EIS)

The *2030 Merced County General Plan* (Merced County 2013) establishes noise level standards for new land uses in the County. The maximum acceptable noise level for most noise-sensitive land uses affected by traffic, railroad, or airport noise sources is L_{dn} of 65 dBA (exterior standard) and L_{dn} of 45 dBA (interior standard with windows and doors closed). When noise-sensitive land uses are proposed in areas exposed to existing or projected exterior noise levels exceeding these noise levels, the general plan requires new development projects to prepare acoustical analysis as part of the environmental review process. The general plan requires transportation projects to consider noise mitigation to reduce noise levels to comply with the exterior and interior standards. If pre-project noise levels already exceed the prescribed noise levels, then mitigation is to be considered if transportation project noise level is considered a significant increase. The County's definition of a significant increase is provided in Table 4-6.

Table 4-6 Significant Increase of Noise Levels as a Result of Transportation Projects

Pre-Project Noise Environment (L_{dn})	Significant Increase
Less than 60 dB	5+ dB
60–65 dB	3+ dB
Greater than 65 dB	1.5+ dB

Source: Merced County, 2013
dB = decibel
L_{dn} = day-night sound level, dBA

Merced County's general plan limits noise-generating activities, such as construction, to hours of normal business operation.

4.1.3.2 County of Madera

The *Madera County General Plan* (Madera County 1995) requires that the development of new noise-sensitive land uses, including residential uses, schools, hospitals, and convalescent homes, not be permitted in areas exposed to existing or projected future noise levels from transportation noise sources that exceed 60 dBA L_{dn} (exterior standard) and 45 dBA L_{dn} (interior standard). However, the areas adjacent to SR 99 and the mainlines of the BNSF are exceptions, where an exterior noise level standard of 65 dBA L_{dn} applies. Otherwise, noise created by new transportation noise sources is to be mitigated so as not to exceed these standards.

The Madera County Municipal Code Chapter 9.58 requires that construction activities are to be limited to the hours between 7:00 a.m. and 7:00 p.m. Monday through Friday and between 9:00 a.m. and 5:00 p.m. on Saturdays. Construction activities are prohibited on Sundays (Madera County 2015).

4.1.3.3 City of Chowchilla

The Noise Element of the *City of Chowchilla 2040 General Plan* (City of Chowchilla 2011) establishes an exterior noise standard of 60 dBA L_{dn} as normally acceptable for noise-sensitive land uses (e.g., residential, schools, hospitals, childcare) affected by transportation noise. Agricultural, industrial, and commercial areas are the least sensitive land uses, with normally acceptable exterior noise standards ranging from 65 to 70 dBA L_{dn}. If noise levels exceed these standards, then a detailed analysis of noise reduction requirements must be made and new construction or development would be conditional based on insulation features included in the design.

The general plan establishes limits for construction activities between the hours of 7:00 a.m. and 7:00 p.m., Monday through Saturday. Additionally, for all temporary construction, demolition, or other necessary short-term noise events, the stationary noise standards established in Table 4-7 may be exceeded within the receiving land use by:

- 5 dB for a period of no more than 15 minutes in any hour
- 10 dB for a period of no more than 5 minutes in any hour
- 15 dB for a period of no more than 1 minute in any hour

The stationary noise use standards shall not be exceeded by more than 15 dB for any period of time.

Table 4-7 Stationary Noise/Land Use Compatibility Guidelines for Exterior Noise Levels

Land Use	Exterior Noise Exposure ($dBA\ L_{eq}$ / L_{50})					
	Normally Acceptable[1]		Conditionally Acceptable[2]		Unacceptable[3]	
	Daytime (10 pm - 7 am)	Nighttime (10 pm - 7 am)	Daytime (10 pm - 7 am)	Nighttime (10 pm - 7 am)	Daytime (10 pm - 7 am)	Nighttime (10 pm - 7 am)
Single Family Home, Duplex, Triplex, Mobile Home	≤ 55	≤ 45	55 - 60	45 - 50	> 60	> 50
Fourplex, Apartment, Condonimum, Townhome	≤ 55	≤ 50	55 - 65	50 - 55	> 65	> 55
Mixed Use, Infill Residential	≤ 60	≤ 50	60 - 70	50 - 60	> 70	> 60
Commercial – Motel, Hotel, Transient Lodging	≤ 65	≤ 50	65 - 70	50 - 60	> 70	> 60
School, Library, Church, Hospital, Nursing Home	≤ 60	≤ 50	60 - 65	50 - 55	> 60	> 55
Auditorium, Concert Hall, Amphitheater			≤ 65	≤ 60		
Sports Arena, Outdoor Spectator Sport			≤ 75	≤ 70		
Playgrounds, Park	≤ 65	≤ 50	65 - 70	≤ 60		
Golf Course, Water Recreation, Cemetery	≤ 55	≤ 50	55 - 60	50 - 55	> 60	> 55
Office Building, Business, Commercial, Retail	≤ 65	≤ 55	65 - 70	55 - 60	> 70	> 60
Freeway Adjacent Commercial, Office and Industrial Uses	≤ 65	≤ 60	65 - 70	60 - 65	> 70	> 65
Industrial, Manufacturing, Utility, Agriculture	≤ 65	≤ 60	65 - 70	60 - 65	> 70	> 65

Notes:

[1]**Normally Acceptable =** Specific land use is satisfactory, based on the assumption that any building is of normal conventional construction, without any special noise insulation requirements.

[2]**Conditionally Acceptable =** New construction or development should be undertaken only after a detailed analysis of noise reduction requirements is made and needed noise insulation features included in design. Conventional construction, but with closed windows and fresh air supply systems or air conditioning, will normally suffice. With the exception of industrial, manufacturing, utility and agricultural uses, the analysis shall identify attenuation required to maintain an indoor level of ≤ 45 dBA.

[3]**Unacceptable =** New construction or development should not be undertaken, unless it can be demonstrated that noise reduction requirements can be employed to reduce noise impacts to an acceptable level. With the exception of industrial, manufacturing, utility and agricultural uses, the Analysis shall identify attenuation required to maintain an indoor level of ≤ 45 dBA.

Source: City of Chowchilla, 2011
dBA = A=weighted decibel
L_{dn} = day-night sound level, dBA
L_{50} = sound level exceeded 50 percent of the time.

4.2 Vibration Regulations

4.2.1 Federal

Federal Railroad Administration Guidelines (Updated Since the Merced to Fresno Final EIR/EIS): As described under Section 4.1.1.1, the FRA guidance manual was updated in 2012, since the Merced to Fresno Final EIR/EIS; however, the noise and vibration impact criteria and the analytical methodologies for noise and vibration impacts in the updated guidance are the same as those provided in the previous version. Therefore, no change in the methodology followed for this analysis was required.

The evaluation of vibration impacts can be divided into two categories: (1) human annoyance and (2) building damage. The FRA Guidance Manual (FRA 2012) provides ground-borne noise and vibration criteria as shown in Table 4-8. These levels represent the maximum RMS level of an event. In addition, the guidelines provide criteria for special buildings that are very sensitive to ground-borne noise and vibration. The impact criteria for these special buildings are shown in Table 4-9. However, there are no special building types located within the RSA.

Both Tables 4-8 and 4-9 differentiate vibration impact threshold depending on the number of vibration events per day, with fewer than 30 vibration events per day considered “infrequent,” between 30 and 70 events considered “occasional,” and more than 70 events considered “frequent.” These dividing lines were originally selected so that most commuter rail or intercity rail projects would fall into the “infrequent” category and most urban transit projects (subway and light rail transit) would more typically be in the “frequent” category. Sensitive receptors within the resource study area (RSA) (i.e., residences, churches, historical buildings, and cemeteries) fall under Land Use Categories 2 or 3. The FRA criteria for “Frequent Events” are used for this project, because there would be 98 new daily high-speed passenger trains (196/2 round trips) during operations.

Table 4-8 Ground-Borne Vibration and Noise Impact for Affected Communities

Land Use Category	Ground-Borne Vibration Impact Levels (VdB re 1 micro inch/second)			Ground-Borne Noise Impact Levels (dB re 20 micropascals)		
	Frequent Events1	Occasional Events2	Infrequent Events3	Frequent Events1	Occasional Events2	Infrequent Events3
Category 1: Buildings where vibration would interfere with interior operations	65 VdB[3]	65 VdB[3]	65 VdB[3]	N/A[4]	N/A[4]	N/A[4]
Category 2: Residences and buildings where people normally sleep	72 VdB	75 VdB	80 VdB	35 dBA	38 dBA	43 dBA
Category 3: Institutional land uses with primarily daytime use	75 VdB	78 VdB	83 VdB	40 dBA	43 dBA	48 dBA

Source: FRA, 2012
[1] “Frequent events” are defined as more than 70 vibration events of the same kind per day.
[2] “Occasional events” are defined as between 30 and 70 vibration events of the same kind per day.
[3] “Infrequent events” are defined as fewer than 30 vibration events of the same kind per day.
[4] This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Vibration-sensitive manufacturing or research will require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the heating, ventilation, and air conditioning systems and stiffened floors.
dB = decibel
dBA = A-weighted decibel
N/A = not applicable
VdB = root mean square vibration velocity level, decibels

Table 4-9 Ground-Borne Vibration and Noise Impact Criteria for Special Buildings

Type of Building or Room	Ground-Borne Vibration Impact Levels (VdB re 1 micro inch/second)		Ground-Borne Noise Impact Levels (dB re 20 micropascals)	
	Frequent Events[1]	Occasional or Infrequent Events[2]	Frequent Events[1]	Occasional or Infrequent Events[2]
Concert halls	65 VdB	65 VdB	25 dBA	25 dBA
Television studios	65 VdB	65 VdB	25 dBA	25 dBA
Recording studios	65 VdB	65 VdB	25 dBA	25 dBA
Auditoriums	72 VdB	80 VdB	30 dBA	38 dBA
Theaters	72 VdB	80 VdB	35 dBA	43 dBA

Source: FRA, 2012
[1] "Frequent events" are defined as more than 70 vibration events of the same kind per day.
[2] "Occasional or infrequent events" are defined as fewer than 70 vibration events of the same kind per day.
dB = decibel
dBA = A-weighted decibel
VdB = root mean square vibration velocity level, decibels

Construction activities can result in varying degrees of ground vibration, depending on the equipment and method employed. The vibration associated with typical transit construction is not likely to damage building structures, but it may cause cosmetic building damage. Consequently, construction vibration impact on a building is generally assessed in terms of PPV (inches per second), as defined in Section 3.3, Amplitude Descriptors. Table 4-10 summarizes the construction vibration limits shown in FRA guidelines.

Table 4-10 Construction Vibration Building Damage Criteria

Building Category	PPV (inches per second)	Approximate L_v[1]
I. Reinforced-concrete, steel or timber (no plaster)	0.5	102 VdB
II. Engineered concrete and masonry (no plaster)	0.3	98 VdB
III. Non-engineered timber and masonry buildings	0.2	94 VdB
IV. Buildings extremely susceptible to vibration damage	0.12	90 VdB

Source: FRA, 2012
[1] VdB re 1 micro-inch per second
L_v = velocity level
PPV = peak particle velocity
VdB = root mean square vibration velocity level, decibels

4.2.2 State

Appendix G, Section XI, Item b of the California CEQA Guidelines refers to potential vibration effects. CEQA does not have specific standards listed, but allows the use of standards developed for a given industry.

4.2.3 Regional and Local (Updated Since the Merced to Fresno Final EIR/EIS)

The City of Madera does not address vibration effects from construction in either their General Plan or City Ordinance. The City of Chowchilla has a vibration ordinance that requires the project developers to provide a study demonstrating that ground-borne vibration issues associated with rail operations have been adequately addressed, for habitable buildings located within 100 feet from the centerline of railroad tracks and does not have a quantified vibration effect criteria.

The 2030 Merced County General Plan (Merced County 2013), which was updated since the Merced to Fresno Final EIR/EIS, establishes ground-borne vibration mitigation requirements for new rail projects:

- *Policy HS-7.15: New Project Groundborne Vibration Mitigation Requirements* (RDR): For residential projects within 1,000 feet of a rail line with at least 30 operations per day, or an existing industrial or commercial groundborne vibration source, require new residential projects to include appropriate groundborne vibration mitigation measures to reduce groundborne vibration levels to less than 70 VdB within structures. However, if a groundborne vibration-generating use is proposed adjacent to lands zoned for residential uses, then the groundborne vibration-generating use shall be responsible for mitigating its groundborne vibration generation to a state of compliance with the 70 VdB standard at the property line of the generating use in anticipation of the future residential development.

Because the HSR project is not subject to local general plan policies and ordinances related to vibration limits on construction or the project, the criteria in the FRA guidance manual (FRA 2012) was used to evaluate vibration effects from construction activities at these municipalities. These criteria and effects are listed in Tables 4-8 through 4-10. These criteria were also used to evaluate vibrations from project operations.

Additional regional and local policies relevant to vibration are presented in Appendix B, Local Regulations.

5 METHODS FOR EVALUATING EFFECTS

The effects of noise and vibration from construction and operation of the Central Valley Wye were analyzed quantitatively using FRA-approved methods. Design information on the Central Valley Wye alternatives and HSR operations assumptions from Authority's 2016 Business Plan (Authority 2016a) were used in the noise and vibration models. Field noise and vibration measurements along with professional judgment were used in the FRA's models as well.

This technical report evaluates both direct and indirect noise and vibration effects. Direct effects consist of increases in noise and vibration as a result of construction activities or HSR operation, while indirect effects for noise include the Central Valley Wye's effect on traffic patterns, which indirectly affect noise levels. This chapter provides additional details of the methodology for the noise and vibration assessments.

5.1 Definition of Resource Study Areas

The RSA is the area in which all environmental investigations specific to noise and vibration are conducted to determine the resource characteristics and potential effects of the Central Valley Wye. As described in Section 5.1.1, Noise Resource Study Area, the boundaries of the RSA for noise and vibration extend beyond the project footprint. The noise and vibration effect analysis focuses on the effects of noise and vibration sources on sensitive receivers. Sensitive receivers include, but are not limited to, residences, schools and daycare centers, churches, hospitals, parks and recreational facilities, community facilities, public or nonprofit institutional structures, radio, television and recording studios, and in some cases historic properties.

5.1.1 Noise Resource Study Area

The noise RSA for the Central Valley Wye extends 2,500 feet from the Central Valley Wye alternatives' centerlines and includes all sensitive receivers that could potentially be exposed to noise impacts. The noise RSA for the Central Valley Wye is larger than the maximum FRA-recommended screening distance from centerline for considering noise impacts, presented in Table 5-1. The maximum FRA-recommended screening distance is 1,300 feet in quiet suburban/rural environments with trains operational speeds greater than 170 mph; however, this assumes that there would be 50 train operations per day and that the existing noise conditions of the quiet suburban/rural environment would be approximately 50 dBA. The Central Valley Wye noise RSA was extended farther than the maximum FRA screening distances because it is expected that train operations would reach almost 200 trains a day based on the Authority's 2016 Business Plan. Additionally, some areas along the Central Valley Wye have low existing noise conditions (35 to 50 dBA) and flat topography, which enables noise to travel farther as it would not be blocked by intervening buildings or topography.

Table 5-1 FRA Recommended Screening Distances for Evaluation of High-Speed Rail Noise Impacts[1]

Corridor Type	Existing Noise Environment	Screening Distance for High-Speed Rail (feet from centerline)[2]	
		90 to 170 miles per hour	> 170 miles per hour
Railroad	Urban/noisy suburban – unobstructed	300	700
	Urban/noisy suburban – intervening buildings [2]	200	300
	Quiet suburban/rural	500	1,200
Highway	Urban/noisy suburban – unobstructed	250	600

Corridor Type	Existing Noise Environment	Screening Distance for High-Speed Rail (feet from centerline)[2]	
		90 to 170 miles per hour	> 170 miles per hour
	Urban/noisy suburban – intervening buildings [2]	200	350
	Quiet suburban/rural	600	1,100
New	Urban/noisy suburban – unobstructed	350	700
	Urban/noisy suburban – intervening buildings [3]	250	350
	Quiet suburban/rural	600	1,300[4]

Source: FRA, 2012
[1] Noise screening distances for Regime II (mechanical noise resulting from wheel/rail interactions and guideway vibrations) and Regime III (aerodynamic noise resulting from airflow moving past the train).
[2] Measured from centerline of the alignment. Minimum distance is assumed to be 50 feet.
[3] Rows of buildings are assumed to be 200, 400, 600, 800, and 1,000 feet away, parallel to the alignment.
[4] Distance was extended to 2,500 feet for analysis of Central Valley Wye alternatives.

5.1.2 Vibration Resource Study Area

The vibration RSA for the Central Valley Wye extends 275 feet from the Central Valley Wye alternatives' centerlines. The vibration effect assessment uses the FRA screening procedure. Screening distances indicate the potential for effects on vibration-sensitive receivers. FRA guidance determined that receivers located beyond the screening distances are not likely to be affected by the HSR. Table 5-2 presents the screening distances for vibration assessment.

Table 5-2 FRA Vibration Screening Distances

Land Use	Train Frequency[1]	Screening Distance (feet from centerline)	
		Train Speed of 100 to 200 mph	Train Speed of 200 to 300 mph
Residential	Frequent or Occasional	220	275
	Infrequent	100	140
Institutional	Frequent or Occasional	160	220
	Infrequent	70	100

Source: FRA, 2012.
[1] Frequent = greater than 70 pass-bys per day; occasional = between 70 and 30 pass-bys per day; infrequent = less than 30 pass-bys per day.
mph = mile(s) per hour

5.2 Methods for Establishing Existing Noise and Vibration Levels

5.2.1 Existing Noise Levels

A series of noise measurements along the Central Valley Wye alternatives was conducted to establish the baseline of existing environmental noise levels for the noise impact assessment in accordance with FRA guidelines. Analysts conducted a total of 12 long-term and four short-term measurements in November 2010, January 2011, and January 2012. Long-term measurement instruments continuously monitored the measurement sites for at least 24 hours to record the L_{dn}. Short-term measurements were at least 20 minutes in length and the hourly L_{eq} was recorded. Additionally, four measurements conducted as part of the *Merced to Fresno Section Project EIR/EIS Noise and Vibration Technical Report* (Authority and FRA 2012b) are located within the noise RSA for the Central Valley Wye and are included in this technical report. These four measurements were conducted in December 2009 and April 2010. Appendix C, Noise and Vibration Measurement Sites and Noise Impacts, identifies the noise measurement sites.

Long-term noise measurements were taken to determine the existing noise levels for the noise RSA. Most of these measurements were conducted at the property line of noise-sensitive areas closest to the alternative alignments. Further details of the noise measurements, including field data sheets and site photos, are provided in Appendix D, Field Noise Measurement Documentation Detail.

Short-term noise measurement sites were selected to determine L_{dn} for Category 2 residential land uses for locations where long-term noise measurements could not be conducted because the sound level meters could not be left for 24 hours for security reasons. Analysts converted noise levels at the short-term sites into L_{dn} by comparing the short-term measurement results with the results of a 24-hour long-term noise measurement at a nearby site with similar geometries that was running when the short-term measurement was conducted. Also, noise levels at the short-term sites conducted during time intervals outside of the peak noise hour were adjusted to reflect the peak hourly noise levels by modifying the short-term measurement site results with the results of a 24-hour long-term noise measurement at a nearby site with similar geometries that was running when the short-term measurement was conducted.

Noise measurements were conducted using the following instruments:

- American National Standards Institute Type 1 instrumentation: Larson Davis (LD) Model 820 sound level meters, LD Model 812, LD Model LxT, LD 824, and Bruel and Kjaer 2238 sound level meters.
- Microphones used with these systems: LD Model 2559 and Bruel and Kjaer Model 4134.
- Noise measurement systems calibrated using either an LD model CAL200 or an LD Model CA250 acoustical calibrator.

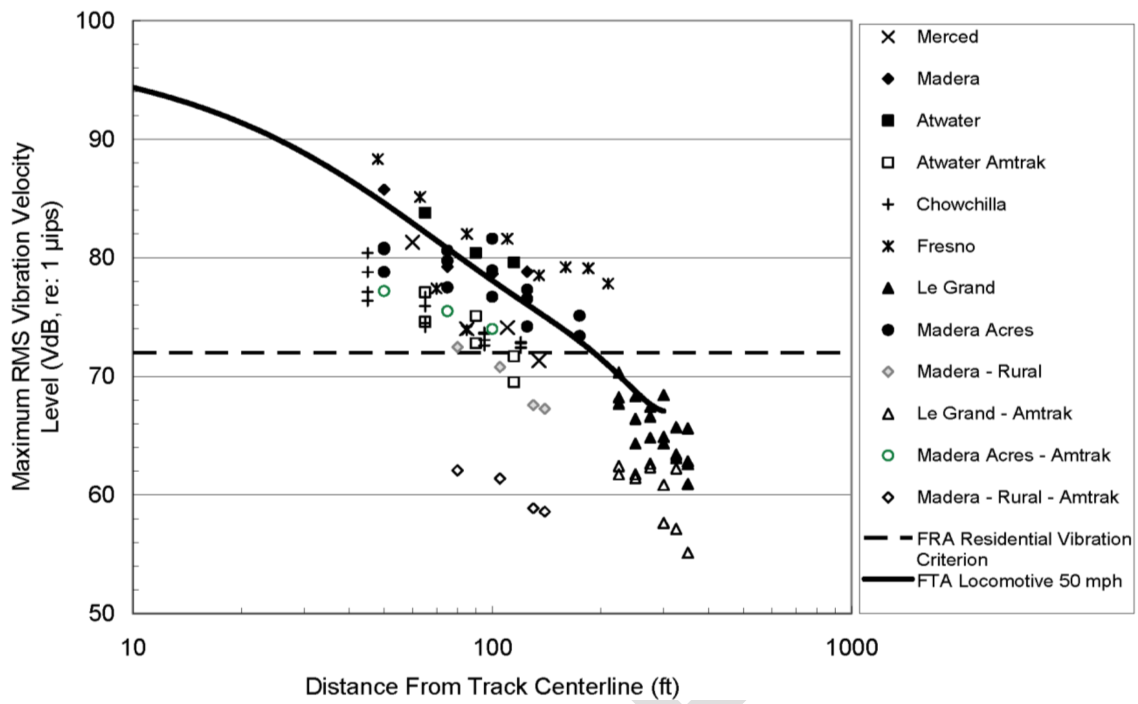
Instruments calibrated and operated according to the manufacturers' specifications.

5.2.2 Existing Vibration Levels

Train-related vibration effect thresholds are not dependent on existing ground vibration levels, so the empirical documentation of existing ground vibration levels is not as critical as for noise levels. However, due to the inherent variability of ground propagation characteristics from one location to another, it is helpful to collect train-induced ground vibration level data to assess whether FRA general train-related ground vibration prediction methods are sufficiently conservative for determining vibration impacts.

Background and train pass-by vibration measurements at locations adjacent to the Central Valley Wye alternatives were conducted to assess and document the existing vibration environment. The assessment of 12 vibration measurements presented in this report was extracted from the *Noise and Vibration Technical Report for the Merced to Fresno Section Project EIR/EIS* (Authority and FRA 2012b). Analysts conducted measurements with PCB 393A and 393C accelerometers and a TEAC LX-110 digital recorder.

Vibrations from freight and Amtrak trains were measured in communities along the Merced to Fresno Section, some of which are also within the Central Valley Wye RSA, to compare the resulting data points with the FRA vibration curve for locomotives, as shown on Figure 5-1. The vibration data from locomotives measured in each community along the Merced to Fresno Section showed patterns similar to the general trend of the FRA vibration curve. This comparison shows that the FRA curve can be used to determine the range of distances at which existing train vibrations exceed FRA vibration criteria.



Source: Authority and FRA, 2012b

Figure 5-1 Existing Train Locomotive Vibration Levels

5.3 Construction Noise and Vibration Methodology

5.3.1 Construction Noise Criteria

Construction noise criteria based on the FRA guidance manual's detailed assessment for noise effects at sensitive receivers from construction were used because the HSR project is not subject to local general plan policies and ordinances related to noise limits on construction. However, local ordinances and standards were investigated to determine their compatibility with the project and are listed in Section 4.1.3, Regional and Local.

Table 4-1 presents the recommended FRA noise limits for the proposed project. These limits are for 8-hour average noise levels (L_{eq}) at the property line of the nearest noise-sensitive area from the construction site.

The analysis for construction noise effects used the FRA guidelines for the purposes of this report. The distances to the 80 and 70 dBA 8-hour L_{eq} noise contours were calculated for the Central Valley Wye construction phases. Most construction activities are anticipated to occur during daytime hours, but some nighttime construction may be necessary. While FRA guidelines take precedence over local jurisdiction, each local jurisdiction should be contacted before any construction activities commence.

5.3.2 Rail Corridor Construction

Central Valley Wye construction would result in a temporary increase in the ambient noise level. Noise would result from the operation of various types of construction equipment expected to be used during the development of this project. The increased noise level would be experienced close to the noise source, at the noise-sensitive receivers in the vicinity of the project site. The magnitude of the effect would depend on the type of construction activity, the volume of construction equipment, and the noise level generated by various pieces of equipment.

There are seven distinct phases of construction activities for the Central Valley Wye: mobilization, land clearing, earth moving, construction of grade separations, construction of elevated track structures, track laydown, and demobilization. Each construction phase has a unique set of construction equipment.

Table 5-3 presents typical construction noise levels for various pieces of construction equipment at a distance of 50 feet. The sound levels would be attenuated with distance from the source by a variety of mechanisms, but the most significant of these mechanisms is the diversion of sound waves with distance from the source (i.e., attenuation by divergence). In general, there would be a 6 dB decrease in the sound level with every doubling of distance from the source. Therefore, at a distance of 100 feet, the noise levels would be about 6 dB lower than at the 50-foot reference distance. Similarly, at a distance of 200 feet, the noise levels would be approximately 12 dB lower than at the 50-foot reference distance.

The following equation calculates the resulting L_{eq} at a sensitive receiver for an individual piece of construction equipment and was used to estimate the distance to the 80 and 70 dBA L_{eq} for all construction activities:

$$L_{eq}(equip) = E.L. + 10\log(U.F.) - 20\log\left(\frac{D}{50}\right) - 10G\log\left(\frac{D}{50}\right)$$

where: L_{eq}(equip) = L_{eq} at a receiver resulting from the operation of a single piece of equipment over a specified time period

E.L. = noise emission level of the particular piece of equipment at a reference distance of 50 feet

G = constant that accounts for topography and ground effects

D = distance from the receiver to the piece of equipment

U.F. = usage factor that accounts for the fraction of time that the equipment is in use over the specified period of time

Table 5-3 Typical Noise Levels from Construction Activities for Public Works Projects

Construction Equipment	Sound Level at 50 feet (dBA L_{max})
Air Compressor	81
Auger Drill Rig	85
Backhoe	80
Ballast Equalizer	82
Ballast Tamper	83
Compactor	82
Concrete Mixer	85
Concrete Pump	82
Concrete Vibrator	76
Crane Derrick	88
Crane Mobile	83
Dozer	85
Generator	81
Grader	85

Construction Equipment	Sound Level at 50 feet (dBA L_{max})
Impact Wrench	85
Jack Hammer	88
Loader	85
Paver	89
Pile-driver (Impact)	101
Pile-driver (Sonic)	96
Pneumatic Tool	85
Pump	76
Rail Saw	90
Rock Drill	98
Roller	74
Saw	76
Scarifier	83
Scraper	89
Shovel	82
Spike Driver	77
Tie Cutter	84
Tie Handler	80
Tie Inserter	85
Truck	88

Source: FRA, 2012
dBA = A-weighted decibel
L_{max} = maximum sound level

The following assumptions were used for a general assessment of each phase of construction:

- Noise source level: Emission levels for construction equipment items were from Table 5-3. Usage factors for each piece of construction equipment were determined based on the past experience in order to calculate L_{eq} for each construction phase.
- Noise propagation: For construction assessment, ground was considered hard and *G* = 0.
- All pieces of equipment are assumed to operate at the center of the project, or centerline, in the case of a guideway or highway construction project.

Two assumptions were made regarding construction equipment for every phase. First, all of the equipment will not be in operation simultaneously. Second, the equipment will be working within the right-of-way and will likely be spread out along the entire work site. Taking these two conditions into account, it was estimated that only one-quarter of the amount of equipment that is listed for each construction phase would be heard in any one location adjacent to construction activities.

5.3.3 Construction Vibration Criteria

During construction of the proposed Central Valley Wye, some construction equipment has the potential to increase ground-borne vibration levels near sensitive receivers. For construction-related vibration, the FRA guidance manual provides vibration source levels for various pieces of construction equipment. These are listed in Section 5.5.2, Predicting Future Vibration and Vibration Effects (Table 5-7), and include the PPV in inches per second, along with the corresponding velocity level (L_v) in VdB at a distance of 25 feet from the source. The construction operation sequences and equipment types have not yet been established.

It is unlikely that vibration from construction would damage any existing structures. Impact pile driving activities generate the highest levels of ground-borne vibration; however, pile drivers are not expected to be used for construction of the Central Valley Wye. Vibration damage criteria have been established by the FRA and are listed in Table 4-10.

5.4 Operational Noise Modeling Prediction Components

In order to model predicted noise levels at noise-sensitive receivers as a result of the Central Valley Wye, analysts considered noise source reference levels, operating conditions, propagation paths (i.e., the manner in which sound travels, which is affected by many factors which include spreading, absorption, terrain, and obstacles), and distances, in conjunction with existing background noise. Before any noise predictions could be made, noise-sensitive receivers were identified (in accordance with the screening distances described in Section 5.1.1, Noise Resource Study Area) and quantified existing noise levels at these noise-sensitive receivers. Chapter 6, Affected Environment, of this report identifies potentially affected noise-sensitive receivers and existing noise conditions.

The noise assessment presented in this report follows the methods and procedures established by the FRA guidance manual (FRA 2012). FRA guidelines are utilized when determining the effects of high-speed train noise on various types of noise-sensitive receivers that range from livestock and wildlife to human receivers at residential land uses. For noise impact criteria from high-speed train noise, the FRA uses a sliding scale that is shown on Figures 4-1 and 4-2.

Two distinct speeds were taken into account when predicting future noise levels as a result of the Central Valley Wye at noise-sensitive receivers. A maximum design speed of 220 mph was used for most of the length of the Central Valley Wye alternatives' alignments. Due to engineering constraints within the wye portion of the alignment, the top design speed is constrained 150 mph in these locations.

5.4.1 Sources of High-Speed Rail Noise

There are several individual noise mechanisms that generate noise levels at nearby noise-sensitive receivers as a high-speed train passes by. These mechanisms are all dependent on source location, noise level, frequency content, directivity (a measure of the directional characteristic of a sound source), and speed. These noise mechanisms can be generalized into three major regimes:

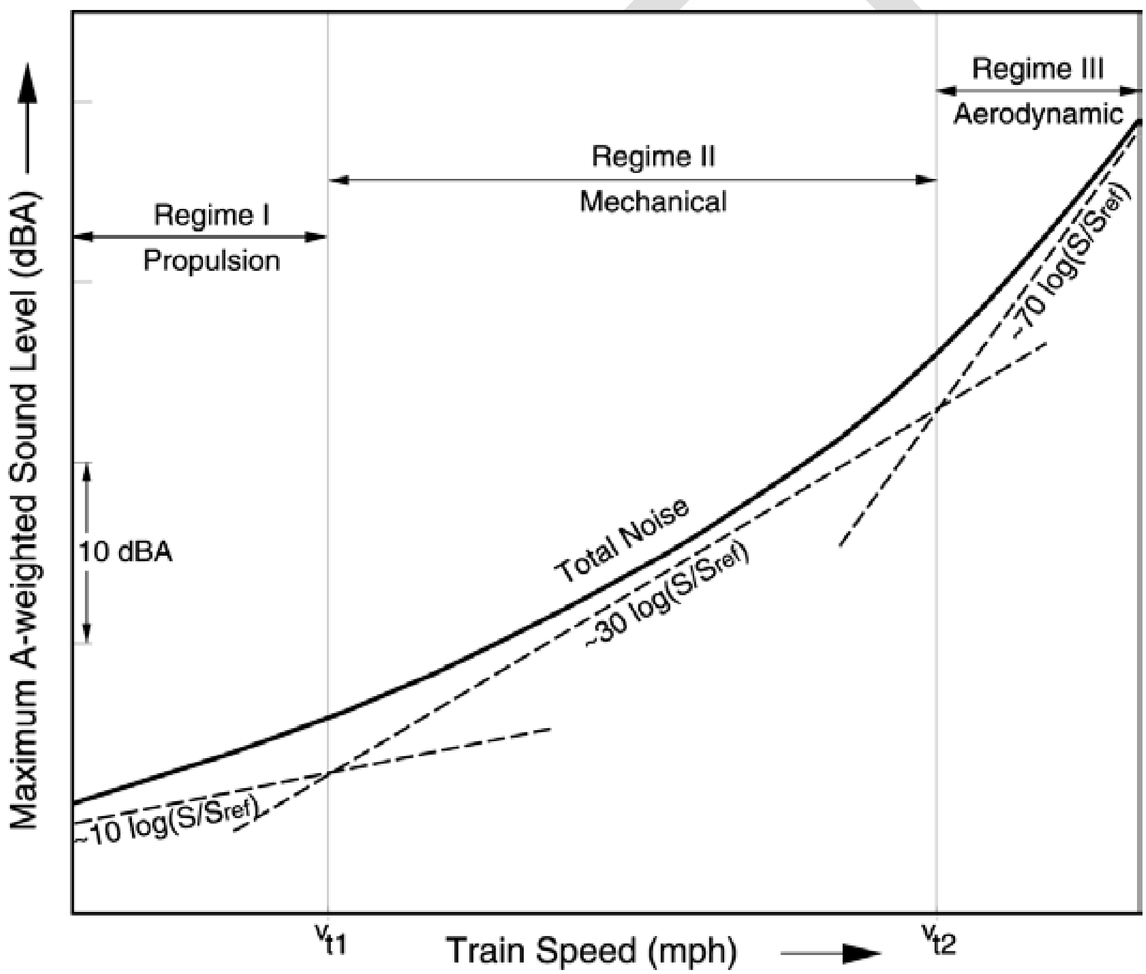
- Regime I—propulsion or machinery noise
- Regime II—mechanical noise resulting from wheel/rail interactions or guideway vibrations
- Regime III—aerodynamic noise resulting from airflow moving past the train

There are three different regimes involved in predicting noise levels because certain regimes dominate the overall noise level depending on the previously mentioned noise components and the speed of the train. For steel-wheeled trains, low speeds are dominated by mechanical noise sources that are involved with the propulsion of the train (Regime I). Internal cooling fans are located near the power units at approximately 3 feet above the rails and dominate noise levels around the frequency spectrum near 1,000 hertz when the train is in motion while external cooling fans dominate the total noise level when the train is stopped at a station.

Wheel interactions with the railway define Regime II. Noise is generated when the steel wheels roll along the rail. A majority of the noise falls into the frequency spectrum that ranges from 2 to 4 kilohertz. Wheel-rail interactions tend to dominate the A-weighted overall noise levels up to about 160 mph. After the train speed reaches above 160 mph, aerodynamic noise (Regime III) begins to become a critical part of the overall noise level. Significant contributions to the overall noise level from aerodynamic noise begin at 180 mph. Noise is generated by the airflow around the train. Discontinuities in the surface along the length of the train and inter-coach gaps are a couple of the structural components that contribute to aerodynamic noise.

Figure 5-2 illustrates the generalized sound level dependence on speed for the three Regimes. V_{t1} is the speed where the dominant noise source transitions from propulsion to wheel-rail interaction. V_{t2} is the speed where the dominant noise source transitions from wheel-rail interaction to aerodynamic noise.

The reference SEL, length, and speed relationships for each noise subsource generated by the train are then used to find the total noise level that is propagating from the train. The source reference level is referenced to a given distance. Generalized noise levels will need to be established for each subsource under a fixed set of operating conditions. Table 5-4 lists seven different types of systems that are commonly used for determining sound levels generated by high-speed trains. The reference SEL for each subsource is given at a reference distance of 50 feet from the centerline of the proposed track alignment. The SELs in Table 5-4 originate from background measurement and research programs that examined noise levels from different high-speed trains throughout the world.



Source: FRA, 2012

Figure 5-2 Criteria for Detailed Vibration Analysis

Table 5-4 Source Reference Sound Exposure Levels at 50 Feet

System Category and Features	Example Systems	Subsource Component		Subsource Parameters: Length Definition	Subsource Parameters: Height Above Rails (feet)	Subsource Parameters: SEL_{ref} (dBA)	Reference Quantities: Len_{ref} (feet)	Reference Quantities: S_{ref} (mph)	Reference Quantities: K
High-Speed Electric Multiple Units (EMU) Steel-Wheeled High-Speed EMU	Pendolino IC-T	Propulsion		Len_{power}	3	86	73	20	1
		Wheel-rail		Len_{train}	1	91	634	90	20
Very-High Speed Electric Steel-Wheeled Very High-Speed Locomotive-Hauled Electric Power	TGV Eurostar ICE Shinkansen	Propulsion		Len_{power}	3	86	73	20	0
		Wheel-rail		Len_{train}	1	91	634	90	20
		AERO	Train Noise	Len_{power}	10	89	73	180	60
		AERO	Wheel Region	Len_{train}	5	89	634	180	60
		AERO	Pantograph	Originates as a point source (no length)	15	86	-	180	60

Source: FRA, 2012
AERO = Aerodynamic
dBA = A-weighted decibel
EMU = electric multiple unit
ICE = Inter-City Express
IC-T = InterCity-Triebwagen
Len_{ref} = subsource length reference
mph = miles per hour
SEL = sound exposure level
SEL_{ref} = sound exposure level reference
S_{ref} = train speed reference
TGV = Trains à Grande Vitesse

At the directive of the Authority, the propulsion and wheel-rail source noise levels for the high-speed electric multiple unit components in Table 5-4 were used for this study. The very-high speed electric components in Table 5-4 were used for the aerodynamic source noise level.

5.4.2 Operating Conditions

Central Valley Wye operating conditions are important in determining peak hour noise levels, hourly L_{eq} values, and L_{dn} values at noise-sensitive receivers. The values from Table 5-4 were used as reference values for determining the predicted Central Valley Wye SELs. Once the appropriate system category and reference quantities were established, the following input parameters were used to adjust each reference SEL to the Central Valley Wye operating conditions:

- number of passenger cars in the train, N_{cars}
- number of power units in the trains, N_{power}
- length of one passenger car, $ulen_{car}$
- length of one power unit, $ulen_{power}$
- train speed in miles per hours, S

The following equation was used to adjust each "*n*th" subsource SEL to the Central Valley Wye operating conditions specified:

$$SEL_n = (SEL_{ref})_n + 10\log\left(\frac{len}{len_{ref}}\right) + K\log\left(\frac{S}{S_{ref}}\right)_n$$

The constant adjustment in this equation is reflected in the "10 log(len/len_{ref})" term, where "len" represents the subsource length (len_{power}, len_{train}) specified in Table 5-3. These variables are defined as:

$$len_{power} = N_{power} \times ulen_{power} \quad \text{and} \quad len_{train} = \left(N_{power} \times ulen_{power}\right) + \left(N_{cars} \times N_{car}\right)$$

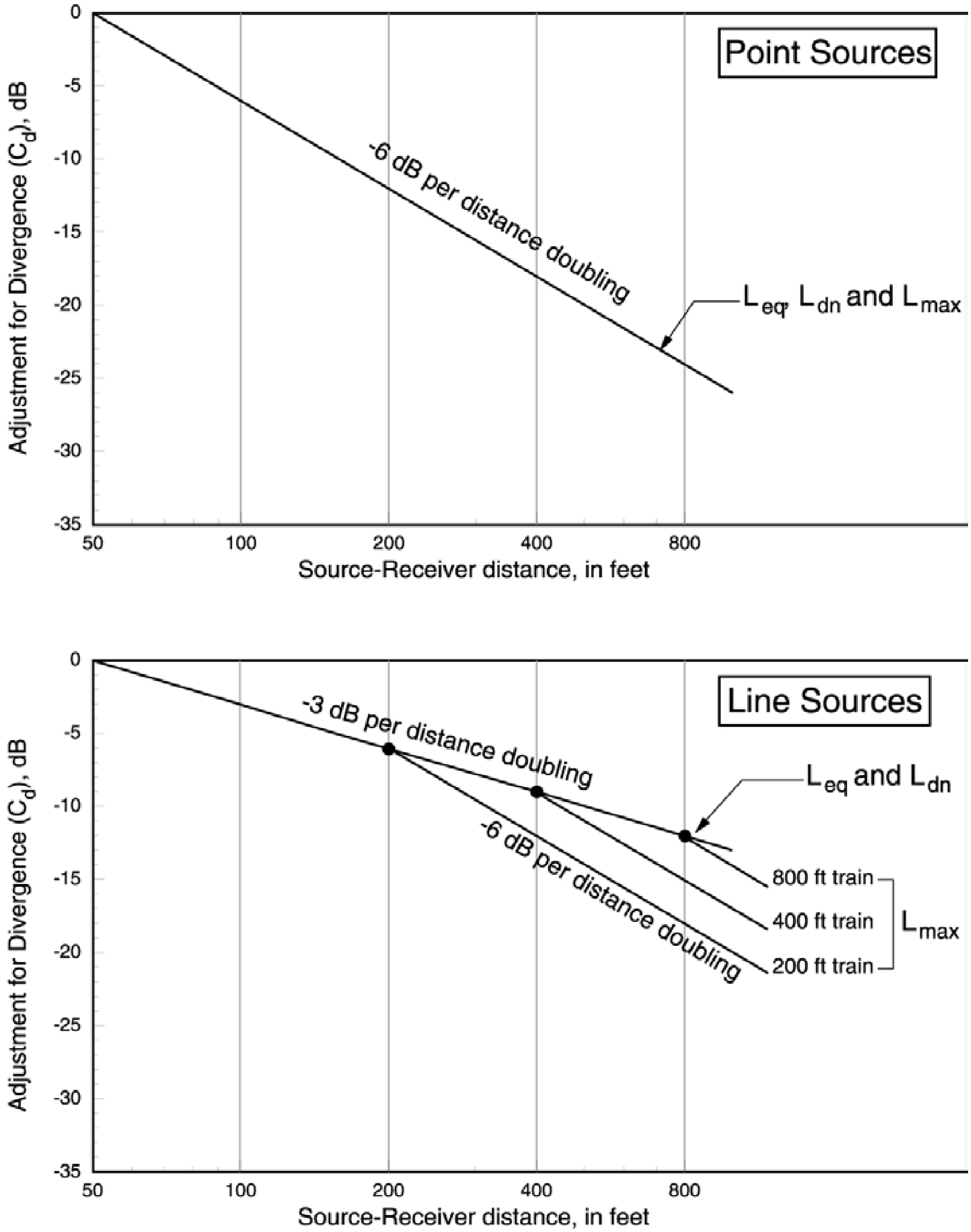
The Authority implemented changes to the source reference values that included modeling the propulsion noise source height at 3 feet above the rails and using a K factor of 1 for the propulsion source. These adjustments were made to account for the assumed train set having distributed-power electric multiple unit vehicles with a maximum speed of 220 mph. Also, the train set was assumed to be eight cars in length.

5.4.3 Propagation of Noise to Receivers

The propagation of noise from the three high-speed train subsources depends on several key components that pertain to the specific noise exposure-versus-distance relationship. The propagation characteristics between each subsource and each receiver were determined and used to calculate an SEL-distance relationship for each subsource. Final adjustments were then made to the SEL-distance relationship due to terrain, shielding, or any other propagation path intervening features.

The distances between each subsource on the high-speed train and noise-sensitive receivers have a unique relationship pertaining to how the noise levels attenuate over a given distance. Sound levels naturally attenuate (i.e., decrease) over distance. Figure 5-3 shows the attenuation over distance for both point sources and line sources from a high-speed train. For point sources, noise levels are attenuated by 6 dB per doubling of distance.

Each subsource on the high-speed train radiates individually as a point source. Most of the individual subsources on the train are arranged in a linear arrangement and act as line sources. Noise levels from line sources attenuate by 3 dB per doubling of distance for L_{eq} and L_{dn} values and 3 to 6 dB per doubling of distance for L_{max} values. The amount of attenuation for L_{max} values is dependent upon the length of the train. Once the distance from the noise source to the noise-sensitive receiver is equal to that of the length of the train, the L_{max} values attenuate by 6 dB per doubling of distance. This concept is illustrated on Figure 5-3.



Source: FRA, 2012

Figure 5-3 Attenuation Due to Distance (Divergence)

The cross-sectional geometry between the subsource and the receiver is a very significant aspect in determining the SEL-distance relationship. More attenuation due to ground absorption will occur as the distance between the subsource and receiver increases. The heights of receivers and subsources, as well as their relation to each other and the ground, are all relevant to the propagation path and SEL-distance relationship. The amount of attenuation due to ground absorption from subsource to noise-sensitive receiver is dependent upon the direct line of sight from one to the other and the average height between the two. As the average height decreases, the ground will absorb more noise generated by propulsion subsources and wheel-rail interaction. Ground absorption does little to attenuate aerodynamic noise.

The following equations are examples of how to determine the effect of ground attenuation on the noise propagation path. H_{eff} represents the average path height between the subsource and the noise-sensitive receiver. *G* represents the ground factor. For hard ground, there is no noise attenuation due to ground absorption.

For soft ground:

$$G = \begin{cases} 0.66 & H_{eff} < 5 \\ 0.75\left(1 - \frac{H_{eff}}{42}\right) & 5 < H_{eff} < 42 \\ 0 & H_{eff} < 42 \end{cases}$$

For hard ground: $G = 0$

Because the Central Valley Wye alternatives would traverse primarily farm land, soft ground was assumed for the operation noise calculations.

Shielding due to terrain and the introduction of noise barriers are two important components in determining the propagation of noise to noise-sensitive receivers. If there is line of sight from a subsource on the high-speed train to a noise-sensitive receiver, the ground factor becomes more critical in determining the amount of attenuation over a given distance. Once line of sight is broken, additional attenuation will be accrued. Line of sight may be broken due to intervening noise barriers and uneven terrain features in the natural topography and this allows for shielding along the noise propagation path.

An SEL versus distance relationship was established for the three types of subsources from the high-speed train. Using the distance from the each subsource to the noise-sensitive receiver and the amount of ground absorption and attenuation provided by intervening noise barriers and shielding due to natural topography, the total noise exposure at specific noise-sensitive receivers was determined for the Central Valley Wye.

5.4.4 Combined Noise Exposure

All subsource SEL values need to be combined to form a total SEL value for a single train pass-by, in order to establish the combined noise exposure at noise-sensitive receivers. The combined high-speed train subsource noise levels, operating schedules, and the propagation paths of noise from subsources to individual noise-sensitive receivers were factored into the prediction of noise levels at all noise-sensitive receivers as a result of the Central Valley Wye.

5.4.5 Benchmark Test to Validate Noise Prediction Modeling

To calculate the future noise level from proposed HSR operations, the noise parameters and equations within the FRA guidance manual (FRA 2012) needed to be compiled into a useable coded noise model. During the development of the noise model, the environmental program manager for the Authority distributed a series of input parameters and output results against which the noise model could be compared for accuracy. The input parameters included operational assumptions (length of train, number of trains during daytime and nighttime hours, train speed) as well as a range of site conditions (height of source, height of receiver, and distance to receiver). The results of noise model used for this study were compared to the sample results provided and the results of these comparisons are presented in Tables 5-5 and 5-6.

Table 5-5 Comparison of Modeled Results to Reference Results at 100 mph

100 mph Results and Model Input Parameters Using High-Speed Electric Multiple Units					Modeled Barrier Height, h(b) (feet)	Barrier to Near Track Distance (feet)	Reference Results, dBA			Model Results, dBA		
Test Case	Receiver Height (feet)	Floor of Building	Receiver to Near Track Distance (feet)	Source Ground Height (height added to each subsource height in Table 5-4) (feet)			L_{dn}	Peak Hour L_{eq}	L_{max}	L_{dn}	Peak Hour L_{eq}	L_{max}
Case 1	5	1st	100	4	4	6	69.3	69.4	86.7	69.3	69.6	86.7
Case 1	5	1st	200	4	4	6	64.9	65.0	79.2	64.9	65.1	79.2
Case 1	5	1st	400	4	4	6	60.4	60.5	71.7	60.4	60.7	71.7
Case 1	25	3rd	100	4	4	6	70.2	70.3	87.6	70.2	70.4	87.6
Case 1	25	3rd	200	4	4	6	66.3	66.5	80.7	66.4	66.6	80.7
Case 1	25t	3rd	400	4	4	6	62.4	62.5	73.7	62.4	62.6	73.7
Case 2	5	1st	100	4	12	21.5	68.2	68.3	87.4	68.0	68.1	87.4
Case 2	5	1st	200	4	12	21.5	64.7	64.8	80.4	64.7	64.9	80.4
Case 2	25	3rd	100	4	12	21.5	70.3	70.4	88.4	70.2	70.4	88.4
Case 2	25	3rd	200	4	12	21.5	66.3	66.4	81.9	66.3	66.5	81.9
Case 3	5	1st	200	60	63	15.5	66.2	66.4	83.5	66.1	66.4	83.3
Case 3	25	3rd	200	60	63	15.5	67.8	67.9	83.5	67.8	68.0	83.5
Case 4	5	1st	200	60	67	15.5	61.0	61.1	78.7	61.2	61.3	78.6
Case 4	25	3rd	200	60	67	15.5	65.3	65.5	83.0	64.7	64.9	83.0

mph = miles per hour
dBA = A-weighted decibels
L_{dn} = day-night sound level, dBA
L_{eq} = equivalent sound level, dBA
L_{max} = maximum sound level

Table 5-6 Comparison of Modeled Results to Reference Results at 200 mph

200 mph Results and Model Input Parameters Using High-Speed Electric Multiple Units							Reference Results, dBA			Model Results, dBA		
Test Case	Receiver Height (feet)	Floor of Building	Receiver to Near Track Distance (feet)	Source Ground Height (height added to each subsource height in Table 5-4) (feet)	Modeled Barrier Height, h(b) (feet)	Barrier to Near Track Distance (feet)	L_{dn}	Peak Hour L_{eq}	L_{max}	L_{dn}	Peak Hour L_{eq}	L_{max}
Case 1	5	1st	100	4	4	6	74.0	74.2	89.3	73.9	74.2	90.0
Case 1	5	1st	200	4	4	6	70.3	70.4	84.2	70.0	70.3	84.6
Case 1	5	1st	400	4	4	6	66.6	66.7	78.3	66.2	66.5	78.5
Case 1	25	3rd	100	4	4	6	74.6	74.7	90.0	74.5	74.8	91.0
Case 1	25	3rd	200	4	4	6	71.0	71.2	85.4	70.9	71.1	85.8
Case 1	25	3rd	400	4	4	6	67.5	67.6	80.1	67.3	67.5	80.2
Case 2	5	1st	100	4	12	21.5	71.3	71.4	89.8	71.3	71.5	90.7
Case 2	5	1st	200	4	12	21.5	68.3	68.5	82.7	67.5	67.8	83.6
Case 2	25	3rd	100	4	12	21.5	73.9	74.0	89.2	73.3	73.5	90.2
Case 2	25	3rd	200	4	12	21.5	69.6	69.7	84.2	68.9	69.1	85.2
Case 3	5	1st	200	60	63	15.5	68.7	68.8	85.8	68.1	68.4	86.6
Case 3	25	3rd	200	60	63	15.5	70.0	70.1	85.8	69.6	69.9	86.8
Case 4	5	1st	200	60	67	15.5	65.2	65.4	81.0	65.5	65.8	81.9
Case 4	25	3rd	200	60	67	15.5	67.8	67.9	85.4	67.0	67.3	85.2

dBA = A-weighted decibels
L_{dn} = day-night sound level, dBA
L_{eq} = equivalent sound level, dBA
L_{max} = maximum sound level
mph = miles per hour

5.5 Detailed Vibration Assessment of HSR Operations

Analysts conducted an FRA General Vibration Assessment followed by an FRA Detailed Vibration Assessment. The FRA General Vibration Assessment establishes screening distances, and an FRA Detailed Vibration Assessment is designed to develop specific vibration projections from the high-speed train at sensitive buildings where no existing railway corridors are present in the surrounding environment. If a sensitive receiver or an area of sensitive receivers has been determined to be inside the screening distance of a proposed alignment or new railway corridor, a Detailed Vibration Assessment is conducted. An FRA Detailed Vibration Assessment consists of:

- Surveying the existing vibration conditions
- Predicting future vibration and vibration effects
- Developing mitigation measures

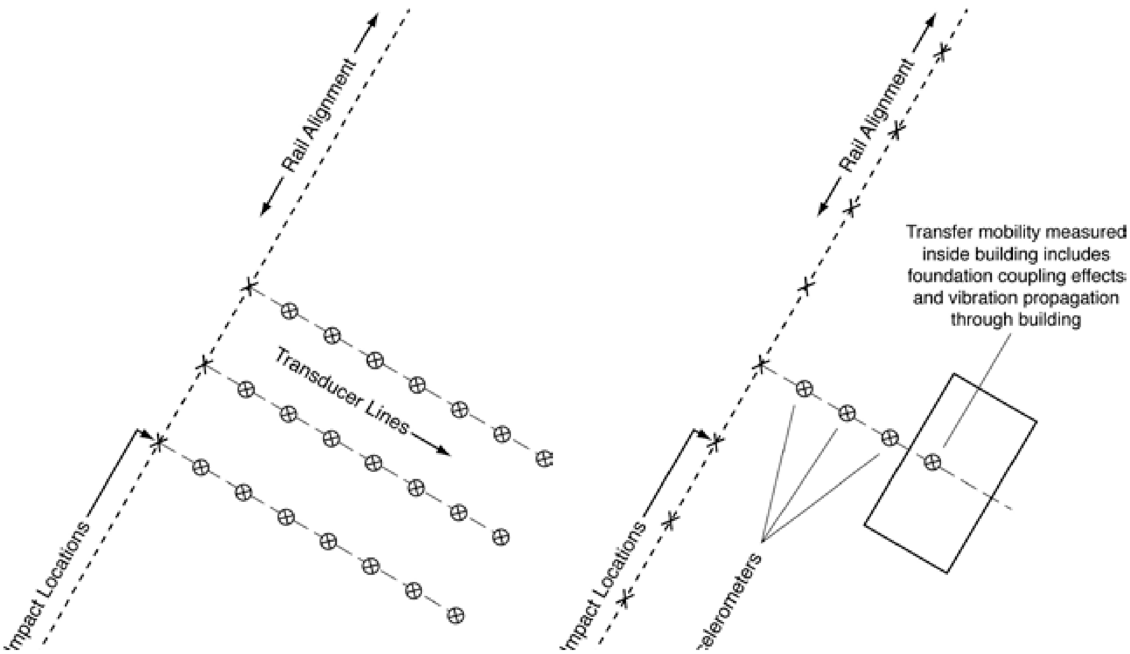
5.5.1 Surveying the Existing Vibration Conditions

Transfer mobility (i.e., vibration propagation) is a function of both the frequency and the distance from the source. Unlike the FRA General Vibration Assessment, all frequencies of vibration are taken into account during the FRA Detailed Vibration Assessment. In order to estimate future conditions along existing railway corridors, vibration measurements have been conducted at critical sensitive receivers within the screening distance for the RSA. Vibration levels caused by existing conditions from trains and other potential vibration generating sources are taken into account.

Tables 4-8 and 4-9 establish ground-borne vibration and noise thresholds for different land uses and special buildings. The screening distance for existing railway corridors is discussed in Section 5.1.2, Vibration Resource Study Area. The results of the existing conditions are described in Chapter 6, Affected Environment.

Vibration measurements conducted with the use of transfer mobility testing are used in order to predict future vibration levels as a result of the Central Valley Wye in areas where there are no existing railway corridors. Transfer mobility testing defines the vibration propagation characteristics near a sensitive receiver due to the geological composition of the surrounding area. The source is best characterized as a line source. Transfer mobility testing is a vibration propagation procedure aimed at measuring the force of an effect by reading the vibration pulses at varying distances along two perpendicular linear systems of accelerometers. Figure 5-4 illustrates an example of what a transfer mobility test procedure setup would look like.

The propagation procedure test consists of dropping a weight on the ground (force density) and measuring the force of the effect at each accelerometer along the linear setups. Taking the vibration measurement results at each accelerometer due to the force density helps calculate vibration propagation characteristics in the surrounding area near sensitive receivers. These transfer functions take all propagation paths into account and define the relationship between a source causing vibration and the resulting propagation of vibration due to the geological composition of the ground.



Source: FRA, 2012

Figure 5-4 Transfer Mobility Test Procedure Setup

5.5.2 Predicting Future Vibration and Vibration Effects

Vibration propagation paths were empirically defined near sensitive receivers for the proposed Central Valley Wye railway corridor from the completed transfer mobility tests. The data are taken from each accelerometer used at each location in order to calculate 1/3 octave band transfer mobilities from the narrowband results as a function of distance. Tables 4-8 and 4-9 list the criteria that are recommended by the FRA for ground-borne vibration and noise at sensitive land uses and special buildings, respectively. The projected vibration source levels caused by the implementation of the Central Valley Wye can be input into a formula along with the results from transfer mobility testing to estimate what the vibration levels caused by the train sources are at sensitive receivers due to Central Valley Wye conditions. For construction-related vibration, the FRA guidance manual provides vibration source levels for various pieces of construction equipment, identified in Table 5-7.

The following formula defines vibration levels at sensitive receivers. It accounts for transfer mobility, force density, and vibration adjustments that account for ground-building interaction at the receiver.

$$L_V = L_F + TM_{line} + C_{build}$$

where: L_V = RMS vibration velocity level in one 1/3 octave band

LF = force density for a line vibration source such as a train

TMline = line source transfer mobility from the tracks to the sensitive site

Cbuild = adjustments to account for ground-building foundation interaction and attenuation of vibration amplitudes as vibration propagates through buildings

Table 5-7 Vibration Source Levels for Construction Equipment

Equipment		PPV at 25 feet (inches per second)	Approximate L_v[1] at 25 feet
Pile Driver (impact)	Upper range	1.518	112
	Typical	0.644	104
Pile Driver (sonic)	Upper range	0.734	105
	Typical	0.170	93
Vibratory Roller		0.210	94
Hoe Ram		0.089	87
Large Bulldozer		0.089	87
Caisson Drilling		0.089	87
Loaded Trucks		0.076	86
Jackhammer		0.035	79
Small Bulldozer		0.003	58

Source: FRA, 2012
[1] VdB re 1 micro-inch/second
L_v = velocity level
PPV = peak particle velocity
VdB = root mean square vibration velocity level, decibels

The following equation was used to determine if there would be vibration effects at sensitive receivers as the result of construction activities.

$$PPV_{equip} = PPV_{ref} \times \left(\frac{25}{D}\right)^{1.5}$$

where: PPV_{equip} = The peak particle velocity in inches/second of the equipment adjusted for distance

PPV_{ref} = The reference vibration level in inches/second at 25 feet from Table 4-8

D = Distance, in feet, from the equipment to the receiver

Vibration from construction activities can also cause human annoyance at sensitive receiver locations. The following equation estimates the RMS vibration level (L_v) at any distance (D). The calculated level can then be compared to the criteria listed in Table 4-10 in order to see if there would be vibration effects from construction equipment at sensitive receivers.

$$L_v(D) = L_v(25\,ft) - 30log\left(\frac{D}{25}\right)$$

where: $L_v(D)$ = RMS vibration level at a given distance (in feet)

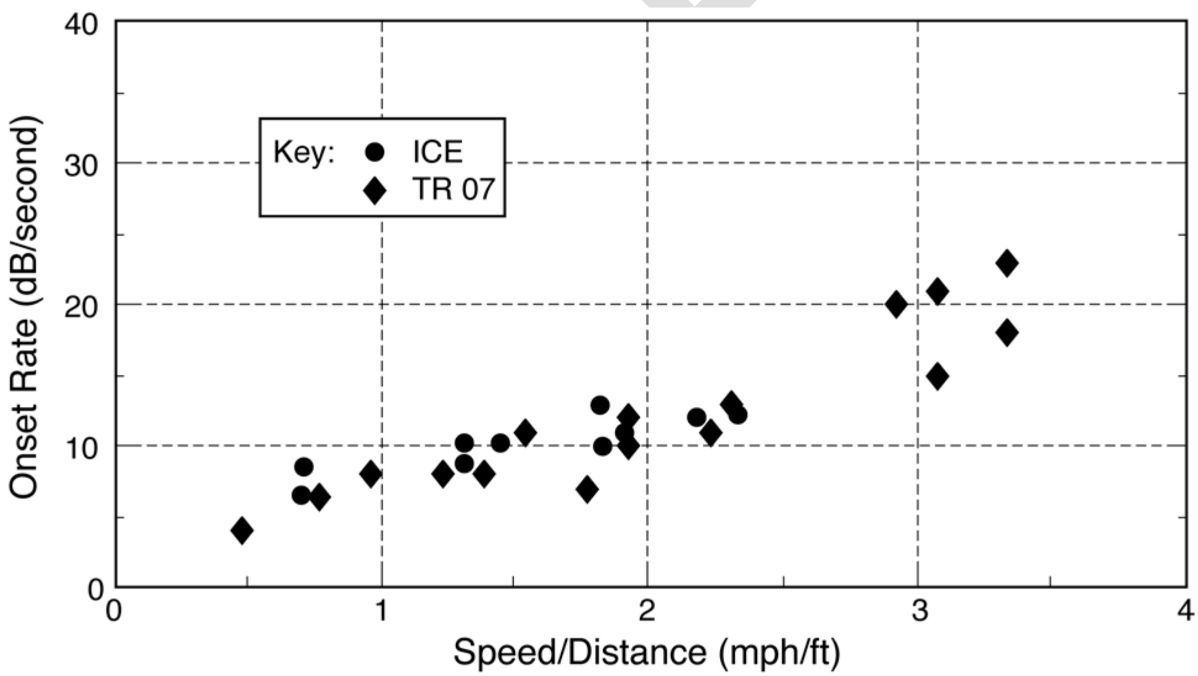
D = Distance, in feet, from the equipment to the receiver

5.6 Operational Noise Effects from High-Speed Train Pass-Bys

5.6.1 Annoyance and Startle Effects Due to Rapid Onset Rates

Rapid onset rates from train noise may cause annoyance and startle effects on humans and wildlife. With high onset rates, noise-sensitive receivers tend to be startled, or surprised, by the sudden approaching sound. The onset rate is defined as the average rate of change of increasing sound pressure level in decibels per second (dB/sec) during a single noise event. Such events have short duration. For the Central Valley Wye, a single noise event would be a single train pass-by. As a high-speed train approaches a noise-sensitive receiver located nearby, the noise levels would suddenly increase.

The FRA used aircraft noise annoyance and startle response data from a 1992 U.S. Air Force study in order to develop a distance versus level chart for which startle effects can occur. Figure 5-5 represents the collected data for high-speed trains. The X-axis is calculated by dividing the speed of the high-speed train by the distance to the receiver. The Y-axis is the onset rate with that speed-distance relationship. The “ICE” points are measured steel-wheeled high-speed train events and “TR 07” points are measured magnetically levitated and powered train events. Figure 5-5 shows that onset rates at noise-sensitive receivers will increase as speeds increase and onset rates will increase as the distance between the train and a noise-sensitive receiver is reduced. Figure 5-5 shows that for a given distance, onset rates will increase at noise-sensitive receivers as the speed of the train increases. For a given speed, onset rates will decrease as the distances from the trains to the noise-sensitive receivers decrease.

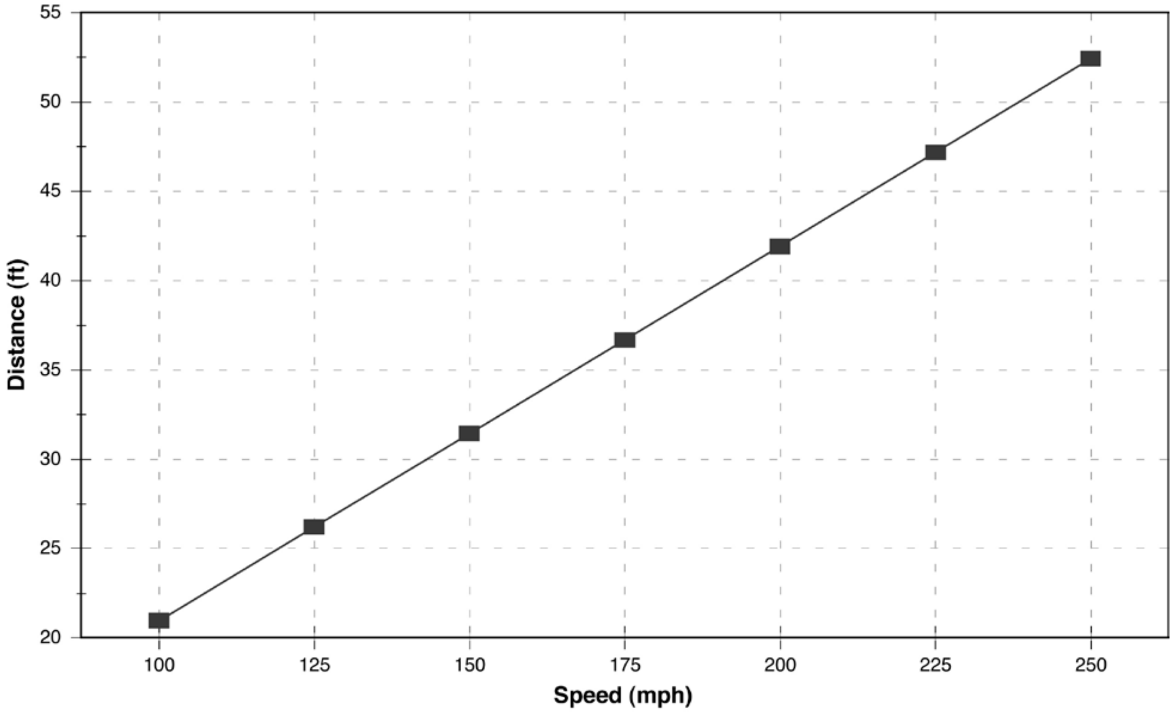


Source: FRA, 2012

Figure 5-5 Measured High-Speed Rail Onset Rates

Figure 5-6 illustrates the distance versus speed relationship for rapid onset rates. The distance (in feet) represents the distance at which a startle response can occur at a human noise-sensitive receiver if the area being analyzed is open flat terrain with an unobstructed view of the tracks.

The SEL represents a receiver's combined noise exposure from an event, and represents the total A-weighted sound during the event normalized to a 1-second interval. A screening assessment determined typical and maximum distances from the HSR tracks at which this limit may be exceeded. Screening distances indicate the potential for noise to adversely affect noise-sensitive receivers.



Source: FRA, 2012

Figure 5-6 Distance from Tracks within which Startle Can Occur for High-Speed Trains

Project analysts computed train pass-by SELs for two conditions: at-grade and on a 60-foot-high elevated guideway. To provide a conservative estimate of the impact level, in each case the HSR maximum operating speed of 220 mph was used, and no shielding from intervening structures or terrain was assumed. Assuming the presence of a safety barrier on the edge of the guideways that is 3 feet above the top of the rail height for the elevated guideway locations, a single-train pass-by SEL of 100 dBA would not occur at the ground level. Along at-grade sections, the screening distance for a single-train pass-by SEL of 100 dBA would be approximately 100 feet from the track centerline.

The freight trains that currently use the UPRR and BNSF tracks were used as a reference to determine the screening distances for potential wildlife impacts. The distance to an impact for a freight train is 75 feet when the warning horn is not sounded, and 400 feet when the crossing is at–grade and the horn is sounded. These screening distances assume a freight train consisting of two locomotives and 100 railcars traveling at 50 mph, which is typical for trains on the UPRR and BNSF tracks. With the screening distance of 100 feet, wildlife might be within the screening distance for an at-grade high-speed train.

5.6.2 Noise Impacts on Wildlife Noise-Sensitive Receivers

Noise impacts can potentially affect wildlife in multiple ways, and one of the most pronounced is the potential masking of communication within and between species. Wildlife depends on calls and song for species identification, mate attraction, and territorial defense. Hearing in all forms of wildlife is not analogous to hearing in mammals. For example, birds show a high degree of frequency selectivity and vocalize in a much higher frequency range than most rail noise produces.

Past studies evaluated the potential for masking of bird song by traffic noise, and recommended that continuous noise levels above 60 dBA L_{eq} within habitat areas may affect the suitability of habitat use (SANDAG 1988). Many regulatory agencies recommend the use of 60 dBA L_{eq} hourly levels to be considered an impact at the edge of suitable habitat. Research indicated that SEL values at wildlife noise-sensitive receivers are a useful indicator of what type of response to expect from specific types of wildlife. Table 4-4 of this report lists 100 dBA SEL for all domestic and wild birds as well as mammals as an effective criterion level for determining impacts resulting from a train pass-by. It is possible that some animals may become habituated to higher noise levels and will exhibit reduced response to noise after prior exposure. There is no developed general criterion level or threshold for habituation.

Wildlife responses to noise are species-dependent; their responses to noise are dependent upon the same components as any other noise-sensitive receiver, but each animal's responses and thresholds are unique enough that noise standards cannot be established. The duration of the noise, type of noise, and level of existing ambient noise weigh differently upon what type of response to expect from individual species.

6 AFFECTED ENVIRONMENT

6.1 Existing Noise Environment

6.1.1 Noise-Sensitive Receivers

Analysts identified noise-sensitive receivers along the Central Valley Wye alternatives' footprints that could potentially be affected by project-related noise. These noise-sensitive receivers were identified according to the FRA screening distances for potential noise effects based on existing land use and the speed at which future railroad operations are expected to operate. Noise sensitive-receivers for the Central Valley Wye are depicted in Appendix C.

6.1.2 Existing Noise Environmental Setting

The ambient noise sources in the noise RSA for the Central Valley Wye include freeway traffic along SR 99 and SR 152 and noise from train operations along the BNSF and UPRR. Noise levels were measured at noise-sensitive land uses throughout the noise RSA and are presented in Table 6-1. Existing L_{dn} noise levels along the project alignment range from 48 to 73 dBA and peak-hour noise levels range from 45 to 70 dBA. These noise levels are typical for rural settings dominated by vehicular traffic and railroad operations. More detailed land use and existing environmental setting descriptions for segments of the Central Valley Wye alternatives appear in the paragraphs following Table 6-1.

Table 6-1 Existing Noise Measurement Results

Site No.	City	Address	Land Use	Type of Measurement	Date	Start Time	Duration	L_{eq} (dBA)	L_{dn}[2] (dBA)
N70	Los Banos	12051 Carlucci Rd	SFR	Long-Term	11/18/2010	10:00 a.m.	24 hours	58.3	57.3
N73	Chowchilla	6448 Ave 21	SFR	Long-Term	11/16/2010	3:00 p.m.	24 hours	53.6	54.3
N74	Chowchilla	8382 Ave 21	SFR	Long-Term	11/16/2010	5:00 p.m.	24 hours	59.9	53.8
N75	Chowchilla	3716 Hwy 152	SFR	Long-Term	1/19/2011	10:00 a.m.	25 hours	66.7	69.5
N76	Chowchilla	22839 Rd 6	SFR	Long-Term	1/19/2011	10:00 a.m.	25 hours	63.2	63.7
N77	Chowchilla	22766 Roberson Rd	SFR	Long-Term	1/10/2012	9:00 a.m.	25 hours	59.0	60.4
N78	Chowchilla	22858 Rd 18	SFR	Short-Term	1/12/2012	12:00 p.m.	20 minutes	61.7	61.3
						5:00 p.m.	20 minutes	55.8	61.3
N79	Chowchilla	19383 Ave 23	SFR	Long-Term	1/9/2012	3:00 p.m.	25 hours	59.0	62.7
N80	Chowchilla	19882 Ave 23	SFR	Long-Term	1/10/2012	4:00 p.m.	24 hours	60.0	62.4
N81	Chowchilla	22750 Maple St	SFR	Long-Term	1/9/2012	4:00 p.m.	25 hours	59.0	62.0

Site No.	City	Address	Land Use	Type of Measurement	Date	Start Time	Duration	L_{eq} (dBA)	L_{dn}^2 (dBA)
N82	Chowchilla	18188 Ave 24 1/2	SFR	Long-Term	1/11/2012	10:00 a.m.	26 hours	58.0	60.6
N83	Chowchilla	15220 Torrey Pines Circle	SFR	Long-Term	1/10/2012	4:00 p.m.	25 hours	49.0	48.6
N84	Chowchilla	24900 Ave 20 1/2	SFR	Long-Term	1/11/2012	8:00 a.m.	27 hours	70.0	72.5
N85	Chowchilla	Plainsburg Rd and Sandy Mush Rd	COM	Short-Term	1/12/2012	8:00 a.m.	20 minutes	65.1	70.6
						1:00 p.m.	20 minutes	60.5	70.6
LT8	Chowchilla	24290 Rd 9	SFR	Long-Term	12/10/2009	12:00 p.m.	24 hours	45.0	51.0
LT26	Madera Acres	26226 Wayside Dr	SFR	Long-Term	4/29/2010	1:00 p.m.	24 hours	66.0	69.0
LT29	Madera	20978 Rd 18	SFR	Long-Term	4/29/2010	10:00 a.m.	24 hours	50.0	49.0
LT31	Chowchilla	23711 Fairmead Blvd	SFR	Long-Term	12/10/2009	12:00 p.m.	24 hours	63.0	64.0

Source: Data provided in this table were compiled by Parsons and from the Merced to Fresno Section Project EIR/EIS Noise and Vibration Technical Report (Authority and FRA, 2012b).
COM = commercial building
dBA = A-weighted decibels
L_{dn} = day-night sound level, dBA
L_{eq} = equivalent sound level, dBA
SFR = single-family residence

Henry Miller Road to SR 152: This portion of the noise RSA is predominately rural agricultural, with scattered residential and commercial buildings along SR 152, a cemetery, and several small private airstrips. The alternative alignments would begin along Henry Miller Road and continue southeast to parallel the north side of SR 152. The ambient noise sources for this area include traffic on SR 152 and SR 99, trains on the UPRR, small aircrafts, and agricultural activities. The L_{dn} in the area, as indicated by the measurement results at monitoring sites N75 to N78, ranged from 60 to 70 dBA L_{dn}.

Henry Miller Road to Avenue 21: This portion of the noise RSA is mostly rural agricultural, with scattered residences and one small private airstrip. The Fossil Discovery Center of Madera County, located along Avenue 21 1/2, is within the noise RSA of the Avenue 21 to Road 13 Wye Alternative. Alview Elementary School is over 2,000 feet from the track centerline, outside of the RSA but the Avenue 21 to Road 13 Wye Alternative's footprint requires a permanent utility easement that encroaches on the property of Alview Elementary School in unincorporated Madera County. As this utility easement would not directly affect the school's facilities and would not generate noise or vibration to the school, there is no further analysis of this property. The alignment would begin along Henry Miller Road and curve south and east along the north side of Avenue 21. The ambient noise sources for this area include traffic on Avenue 21 and SR 99, trains on the UPRR, small aircrafts, and agricultural activities. The L_{dn} in the area, as indicated by the measurement results at monitoring sites N70, N73, N74, and LT29, ranged from 49 to 57 dBA L_{dn}.

Road 11 Wye: This portion of the noise RSA is rural agricultural, with some scattered rural residences. The SR 152 (North) to Road 11 Wye Alternative would curve north from SR 152 through agricultural lands in a new right-of-way. This alternative would continue north, adjacent to the east side of Road 11, then curve west toward and along the SR 99/UPRR corridor. The ambient noise sources in this area are traffic on Road 11 and SR 99, UPRR trains, small aircraft, and agricultural activities. L_{dn} in the area, as indicated by the measurement results at monitoring sites N85 and LT 8, ranged from 51 to 71 dBA.

Road 13 Wyes: This portion of the noise RSA is rural agricultural, with some scattered residences. A private elementary school and church, Chowchilla Seventh-day Adventist School, is located along Road 13 within the noise RSA of the Avenue 21 to Road 13 Wye Alternative. The Central Valley Wye alternatives would curve north from either SR 152 or Avenue 21 through agricultural lands in a new right-of-way. Then, the Central Valley Wye alternatives would continue north adjacent to the east side of Road 13, and curve west toward and along the SR 99/UPRR corridor. The ambient noise sources for this area are traffic on Road 13 and SR 99, trains on the UPRR, small aircrafts, and agricultural activities. The L_{dn} in the area, as indicated by the measurement results at monitoring sites N85, and LT8, ranged from 51 to 71 dBA L_{dn}.

Road 19 Wye: This portion of the noise RSA is primarily rural agricultural, with scattered residences. East of SR 99 there is a large cluster of low-density residences associated with the community of Fairmead, located near Road 19 and bounded by SR 99, Avenue 25, and Road 20 1/2. The SR 152 (North) to Road 13 Wye Alternative would curve north from SR 152, cross the SR 99/UPRR corridor into the northern portion of Fairmead, and continue north along the east side of Road 19. The alignment would then curve west through agricultural lands, continue west north of Porters Road, and curve north toward and across the SR 99/UPRR corridor. The ambient noise sources for this area include vehicular traffic on Avenue 26 and SR 99, trains on the UPRR, and agricultural activities. The L_{dn} in the area, as indicated by the measurement results at monitoring sites N82, N83, and LT31, ranged from 48 to 64 dBA.

Chowchilla to Madera Acres: For the Central Valley Wye alternatives situated along SR 152, the noise RSA extends through the rural residential community of Fairmead—with surrounding land uses of low-density single-family residences and several community facilities including Fairmead Elementary School and Fairmead Headstart—and then curves southeast. South of Fairmead, the three Central Valley Wye alternatives continue through rural agricultural lands towards the BNSF corridor, where they terminate at Avenue 19, just north of Madera Acres. The ambient noise sources for this area include vehicular traffic along Avenue 23 and Maple Street in Fairmead, trains on the BNSF, and agricultural activities. The L_{dn} in the area, as indicated by the measurement results at monitoring sites N79 to N81, N84, and LT26, ranged from 62 to 73 dBA.

6.2 Existing Vibration Environment

6.2.1 Vibration-Sensitive Receivers

The vibration-sensitive receivers would be similar to the noise-sensitive receivers described in Section 6.1, Existing Noise Environment, except limited to those with sensitive structures within an appropriate screening distance of the Central Valley Wye alternatives. FRA established screening distances for potential vibration effects based on existing land use and the speed at which future railroad operations are expected to operate, which is discussed in Section 5.1.2, Vibration Resource Study Area.

6.2.2 Measured Vibration Levels

Existing vibration sources within the vibration RSA for the Central Valley Wye are primarily train operations between Merced and Fresno. Trains traveling along the project corridor include freight services operated by UPRR and BNSF, as well as Amtrak passenger trains.

Analysts conducted measurements with PCB 393A and 393C accelerometers and a TEAC LX-110 digital recorder. Detailed discussions of these measurements are in Section 6.3 of the *Noise and Vibration Technical Report for the Merced to Fresno Section Project EIR/EIS* (Authority and FRA 2012b) and includes measurements conducted within the RSA. Appendix E, Field Vibration Measurement Documentation Detail provides details of vibration measurement data and documentation, including field data graphs and site photos.

7 EFFECTS ANALYSIS

This chapter describes the potential noise and vibration effects from construction and operation of the Central Valley Wye alternatives.

7.1 Introduction

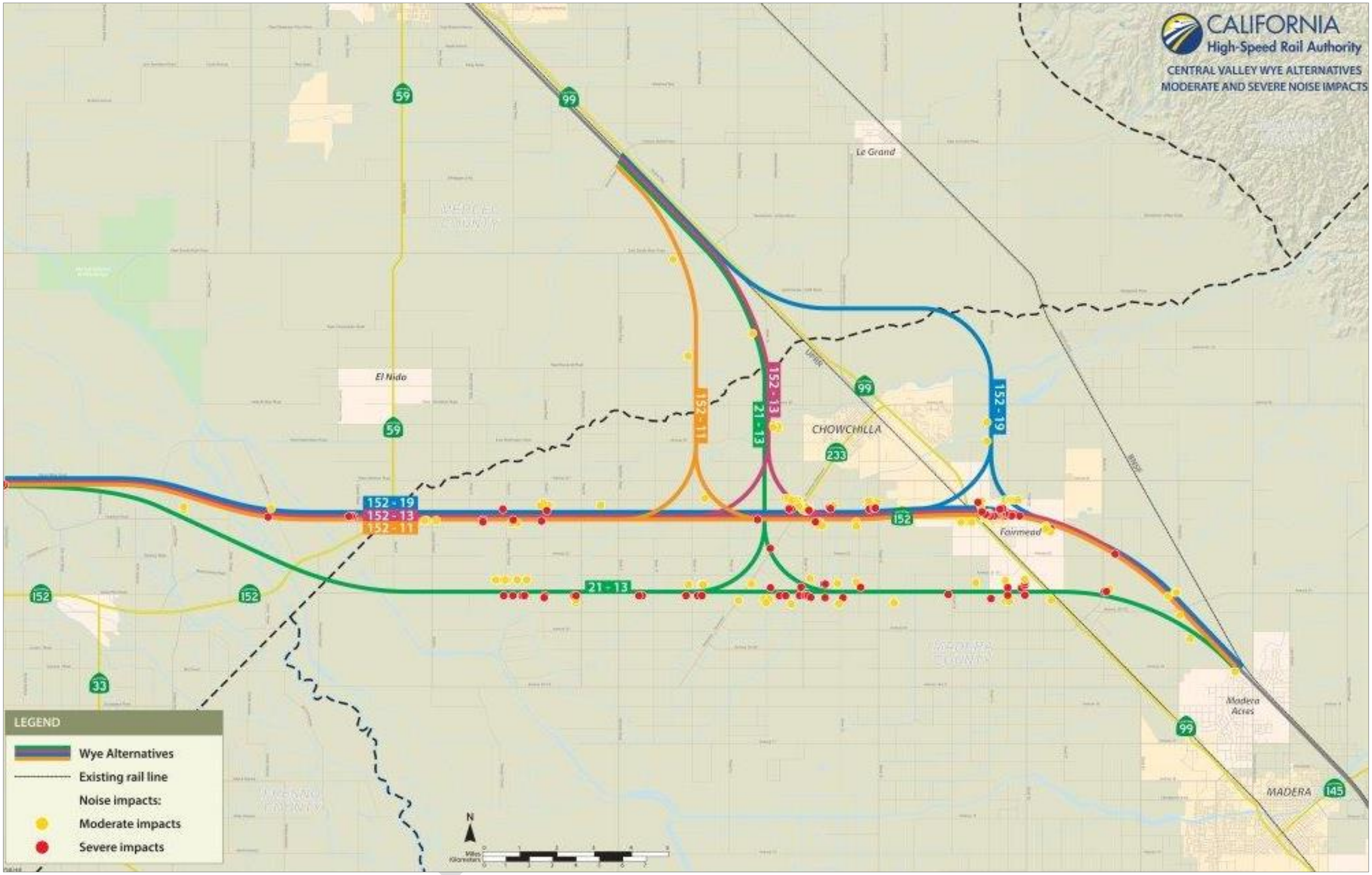
Construction activities would temporarily increase noise and vibration levels within the RSA. Construction effects would be the same for all Central Valley Wye alternatives. The construction activities and methods would be the same regardless of the alternative selected, and the same effect would apply in any area of the RSA.

Operation of the Central Valley Wye alternatives could cause annoyance from onset of HSR pass-bys, noise effects on wildlife and domestic animals, vibration effects, and increased traffic noise. HSR train operations would increase L_{dn} noise levels above the ambient noise environment by as much as 19 dBA L_{dn}. Project noise effects are highly dependent on the number of operating trains, and the effects presented are a conservative analysis assuming the maximum frequency of trains anticipated with full system (Phase 1) operations in 2040. The initial stages of system development would have considerably lower noise effects. Table 7-1 summarizes the number of noise impacts with moderate and severe intensity by alternative determined using full system operations in 2040. Moderate and severe impacts are defined in accordance with FRA guidance, and are shown on Figure 4-1. Figure 7-1 and Appendix C show the location and types of impacts.

Table 7-1 Summary of Operation Noise Impacts for the Central Valley Wye Alternatives

Alternative	Train Speed Range, (mph)	Range of Existing Noise Level Ldn, (dBA)	Projected Noise Level Range from HSR Ldn, (dBA)	Number of Impacts	
				Moderate	Severe
SR 152 (North) to Road 13 Wye	150–220	54–73	45–72	65 Single-family Residences	27 Single-family Residences
SR 152 (North) to Road 19 Wye	150–220	48–73	46–80	58 Single-family Residences	23 Single-family Residences
Avenue 21 to Road 13 Wye	150–220	49–73	44–72	40 Single-family Residences	39 Single-family Residences
SR 152 (North) to Road 11 Wye	150–220	51–73	45–72	61 Single-family Residences	35 Single-family Residences

Source: Calculated based on Merced to Fresno Section: Central Valley Wye Final 15% Plans; Authority 2016b.
mph = miles per hour
L_{dn} = day-night sound level
dBA = decibels, A-weighted



Source: Calculated based on Merced to Fresno Section: Central Valley Wye Final 15% Plans; Authority 2016b.

FINAL – August 26, 2016

Figure 7-1 Noise Impacts in the Central Valley Wye RSA

7.2 No Project Alternative

Currently, sources of noise and vibration within the Central Valley Wye RSA include traffic and rail operations associated with the UPRR/SR 99, BNSF, and SR 152. Under the No Project Alternative, population growth is expected to increase at the historical average population growth rate of approximately 2.5 percent for Merced and Madera Counties. Infrastructure improvements, such as the widening of the existing SR 99, would be conducted to accommodate this growth, and traffic volumes along SR 99 and SR 152 could be expected to increase at a corresponding rate of 2.5 percent per year. As a result, traffic noise would increase under the No Project Alternative.

Under the No Project Alternative, freight trains currently operating along the UPRR and BNSF between Merced and Fresno would continue to operate. Train service on UPRR is approximately 20 to 25 trains per day. The BNSF operates 35 to 40 freight trains and 12 Amtrak passenger trains per day (Council of Fresno County Governments 2010). Future freight traffic on privately owned railroads for the year 2040 is subject to commercial demands and cannot be determined to a level to conduct an assessment. While there may be increases in freight volume, a 100 percent increase in volume would be required for a 3 dB increase in future freight noise levels. Because the increases in freight volumes would likely be substantially below 100 percent, the noise increases would be minimal.

Future developments planned under the No Project Alternative would require individual environmental review, including an analysis of noise and vibration. Any increases in noise and vibration would be regulated by local general plans and noise and vibration ordinances in place to make certain that standards are met. Consistency with these local regulations and ordinances would confirm that any permanent increases in noise and vibration levels would not be substantial.

7.3 Construction Noise and Vibration Effects

7.3.1 Noise Effects

Construction of the Central Valley Wye alternatives would require the use of mechanical equipment, including hand-held pneumatic tools to scrapers, bulldozers, dump trucks, and tie and rail handling equipment that would generate temporary increases in noise over a period of 1to 3 years. Construction effects would be the same under all Central Valley Wye alternatives.

Construction noise varies greatly depending on the construction process, type and condition of equipment used, and layout of the construction site. There are seven distinct construction phases for the HSR corridor – mobilization, land clearing, earth moving, construction of grade separations, construction of elevated track structures, track laydown, and demobilization. These seven phases are discussed in more detail in the following sections, and the list of construction equipment for each construction phase is provided in Appendix F.

Two assumptions were made regarding construction equipment for every phase. First, not all of the equipment will be operated simultaneously. Second, the equipment will be used within the right-of-way and will likely be distributed along the entire work site. On the basis of these two assumptions, it was estimated that only one-quarter of the amount of equipment that is listed for each construction phase would be heard in any one location adjacent to construction activities. Table 7-2 summarizes the distance from each construction phase where construction-related human noise annoyance would occur during daytime and nighttime hours based on FRA-specified limits.

Table 7-2 Distances to Construction Federal Railroad Administration Noise Level Limits

Construction Activity	Daytime 80 dBA L_{eq}	Nighttime 70 dBA L_{eq}
Mobilization	95	290
Land Clearing	150	460
Earth Moving	210	660
Grade Separation – No Pile Driving	180	575
Elevated Track – No Pile Driving	220	690
Lay Track	340	*
Demobilization	95	290

Source: Authority 2014
FRA = Federal Railroad Administration
dBA = A-weighted decibel
L_{eq} = equivalent noise level, decibels
* There will be no nighttime activity

It is assumed that construction will likely occur 5 days a week between the hours of 7:00 a.m. and 7:00 p.m. Some construction activities may be conducted outside of this time interval. Elevated track would be constructed of precast, pre-stressed concrete box girders, cast-in-place concrete box girders, or steel box girders. Drill-out, cast-in-place piling will be utilized near the beginning of grade separation construction activities. No impact pile driving would occur for the Central Valley Wye alternatives. Likely exceptions to the anticipated construction times include construction over the freeway. Work is assumed to occur at night for these activities in order to limit effects on highway traffic. Construction in rural areas would primarily take place during daytime hours because of the higher cost of nighttime construction in remote areas.

The Authority has established NV-IAMF#1, which requires the Contractor to prepare and submit to the Authority prior to construction a noise and vibration technical memorandum documenting how the FTA and FRA guidelines for minimizing construction noise and vibration impacts will be employed when work is being conducted within 1,000 feet of sensitive receptors. FTA and FRA guidelines for minimizing construction noise and vibration levels are further explained in **NV MM#1**.

7.3.1.1 Mobilization

This phase would involve mostly flatbed trucks, dump trucks, backhoes, dozers, and an excavator. There would be 15 flatbed trucks, 5 dump trucks, 2 backhoes, 2 dozers, and 1 excavator in operation per site.

Noise-sensitive receptors within a distance of 95 feet of mobilization construction activities would be exposed to noise levels greater than L_{eq} of 80 dBA and noise-sensitive receptors within a distance of 290 feet would be exposed to noise levels greater than L_{eq} of 70 dBA. Noise-sensitive receptors within these distances would be affected by noise exposure levels that are greater than the recommended FRA threshold guidelines for day and nighttime construction noise level limits, respectively.

7.3.1.2 Land Clearing

This phase would involve mostly backhoes, dozers, excavators, loaders, scrapers, and flatbed trucks. There would be 15 backhoes, 4 dozers, 4 loaders, 4 scrapers and 8 flatbed trucks in operation per site.

Noise-sensitive receptors within a distance of 150 feet of site preparation construction activities would be exposed to noise levels greater than L_{eq} of 80 dBA and noise-sensitive receptors within a distance of 460 feet would be exposed to noise levels greater than L_{eq} of 70 dBA. Noise-sensitive receptors within these distances would be affected by noise exposure levels that are greater than the recommended FRA threshold guidelines for day and nighttime construction noise level limits, respectively.

7.3.1.3 Earth Moving Construction Activities

This phase would involve mostly backhoes, bulldozers, excavators, loaders, graders, and scrapers. There would be 8 backhoes, 8 dozers, 8 excavators, 8 wheeled loaders, 8 graders, 8 scrapers, 8 rollers, 8 roadway saws, and 16 flatbed trucks in operation per site.

Noise-sensitive receptors within a distance of 210 feet of earth moving construction activities would be exposed to noise levels greater than L_{eq} of 80 dBA and noise-sensitive receptors within a distance of 660 feet would be exposed to noise levels greater than L_{eq} of 70 dBA. Noise-sensitive receptors within these distances would be affected by noise exposure levels that are greater than the recommended FRA threshold guidelines for day and nighttime construction noise level limits, respectively.

7.3.1.4 Grade Separation Construction Activities

This phase would include a majority of the equipment that would also be used in earth moving construction activities except for a drill-out, cast-in-place auger. Some of the equipment that would be utilized during grade separation construction activities include 9 air compressors, 9 roadway saws, 9 backhoes, 9 concrete saws, 9 bulldozers, 9 excavators, 9 wheeled loaders, 18 cranes, 18 rollers, 9 graders, 9 augers, and 18 generators. Drill-out, cast-in-place piling is expected to occur near the beginning of grade separation construction activities at each site.

For the grade separation construction activities, residences within a distance of 180 feet of grade separation construction activities would be exposed to noise levels greater than L_{eq} of 80 dBA and residences within a distance of 575 feet would be exposed to noise levels greater than L_{eq} of 70 dBA. Noise-sensitive receptors within these distances would be affected by noise exposure levels that are greater than the recommended FRA threshold guidelines for day and nighttime construction noise level limits, respectively.

7.3.1.5 Elevated Track Structure Construction Activities

This phase would include a majority of the equipment that would also be used in earth moving and grade separation construction activities. Some of the equipment that would be utilized during elevated track structure construction activities include 20 air compressors, 8 concrete saws, 8 rollers, 16 cranes, 8 bulldozers, 8 excavators, 8 wheeled loaders, 8 graders, 8 augers, 8 cement mixers and 8 concrete pumps. Drill-out, cast-in-place piling is expected to occur near the beginning of grade separation construction activities at each site.

For the elevated track structure construction activities, residences within a distance of 220 feet of elevated track structure construction activities would be exposed to noise levels greater than L_{eq} of 80 dBA and residences within a distance of 690 feet would be exposed to noise levels greater than L_{eq} of 70 dBA. Noise-sensitive receptors within these distances would be affected by noise exposure levels that are greater than the recommended FRA threshold guidelines for day and nighttime construction noise level limits respectively.

7.3.1.6 Track-Laying Construction Activities

This phase will be comprised mostly of work trains, track mobiles, welders, tampers, rail swings, and grinders. There will be 16 work trains, 16 track mobiles, 16 rail butt welders, 16 welders, 32 tampers, 16 rail swings, and 32 flatbed trucks in operation per site.

Noise-sensitive receptors within a distance of 340 feet of track-laying construction activities would be exposed to noise levels greater than L_{eq} of 80 dBA. Track laying would not be conducted during nighttime hours. Noise-sensitive receptors within these distances would be affected by noise exposure levels that are greater than the recommended FRA threshold guidelines for daytime construction noise level limits.

7.3.1.7 Demobilization

This phase will be comprised mostly of flatbed trucks, dump trucks, backhoes, dozers, and an excavator. There will be 15 flatbed trucks, 5 dump trucks, 2 backhoes, 2 dozers and 1 excavator in operation per site.

Noise-sensitive receptors within a distance of 95 feet of demobilization construction activities would be exposed to noise levels greater than Leq of 80 dBA and noise- sensitive receptors within a distance of 290 feet would be exposed to noise levels greater than L_{eq} of 70 dBA. Noise-sensitive receptors within these distances would be affected by noise exposure levels that are greater than the recommended FRA threshold guidelines for day and nighttime construction noise level limits respectively.

7.3.2 Traffic-Generated Noise from Construction Road Closures

Construction of the Central Valley Wye would result in temporary or permanent closure of some local roads, which would require rerouting traffic and other roadway modifications. Rerouted traffic could affect existing noise levels within the noise RSA, as would the construction of any needed roadway modifications. Because conditions would be similar under all the Central Valley Wye alternatives, the effects from construction-related vibration would be the same under all of them.

Daily traffic volumes on the local roads that would be closed during construction are 50 to 500 vehicles. Because the low traffic volumes on local roads provide only a minor contribution to overall noise levels, the noise levels from traffic rerouted by temporary or permanent road closures would not be noticeable by a significant number of people. Furthermore, because of the low traffic volumes, the level of service is expected to change for the construction traffic operations. There is a possibility of temporary lane closures for SR 152 and SR 99 during various stages of the construction. It is anticipated that traffic would not be diverted to the local roads during such lane closures; therefore, no additional traffic noise impacts are anticipated as a result of these lane closures during construction. Traffic noise as a result of road closures would not substantially increase the ambient noise level in the vicinity of any of the Central Valley Wye alternatives above existing levels.

7.3.3 Noise Impacts

Noise impacts were assessed by determining the number of noise sensitive areas that were within the calculated noise impact distances for laying track, as well as other construction activities such as earth moving and land clearing. These activities were expected to cause the greatest noise impact during construction. Table 7-3 shows that construction of the Central Valley Wye alternatives may temporarily affect between 46 and 60 sensitive receivers due to daytime construction and 55 and 98 sensitive receivers due to nighttime construction, depending on the selected alternative alignment. Construction noise impacts for all alternatives are shown on Figure 7-2. Track laying is typically not performed at night.

Table 7-3 Summary of Construction Noise Impacts for the Central Valley Wye Alternatives

Construction Activity	Daytime Impacts Number of Sensitive Receivers (Single-family Residences) Affected Per Alternative				Nighttime Impacts Number of Sensitive Receivers (Single-family Residences) Affected Per 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	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
Lay Track	35	41	33	33	-	-	-	-
Other Activities	19	17	27	13	82	98	55	76

Source: Author's compilation, 2016
- There will be no nighttime activity

7.3.4 Vibration Effects

Construction of Central Valley Wye alternatives would require the use of equipment that would generate temporary ground-borne vibration for a period of 1–3 years. The effects from construction related vibration would be the same under all Central Valley Wye alternatives.

Construction vibration could result in human annoyance and building damage. Human annoyance occurs when construction vibration rises above the threshold of human perception for extended periods of time. The ground-borne vibration effect criteria for different land use categories are presented in Tables 4-8 and 4-9. Building damage occurs when construction activities produce waves in the ground that are strong enough to cause cosmetic or structural damage.

Calculations were performed to determine the distances at which vibration effects would occur according to the criteria established by the FTA and listed in Table 4-10. Table 7-3 shows the maximum distances at which short-term construction vibration effects on nearby structures and buildings could occur. The results show that none of the vibration sources would produce construction-related vibration that could result in structural damage outside of the right-of-way. .

Table 7-4 Distances to Construction Vibration Damage Criteria for HSR Corridor

Vibration Source	PPV at Receiver (in/sec)	L_v at Receiver (VdB)	Distance from Centerline (feet)	Within Right-of-Way?	Effect
Vibratory Roller	0.117	89	37	Yes	No
Caisson Drilling	0.116	89	21	Yes	No
Large Bulldozer	0.116	89	21	Yes	No

Source: Authority and FRA, 2014
HSR = high-speed rail
L_v = velocity level
PPV = peak particle velocity
VdB = root mean square vibration velocity level, decibels

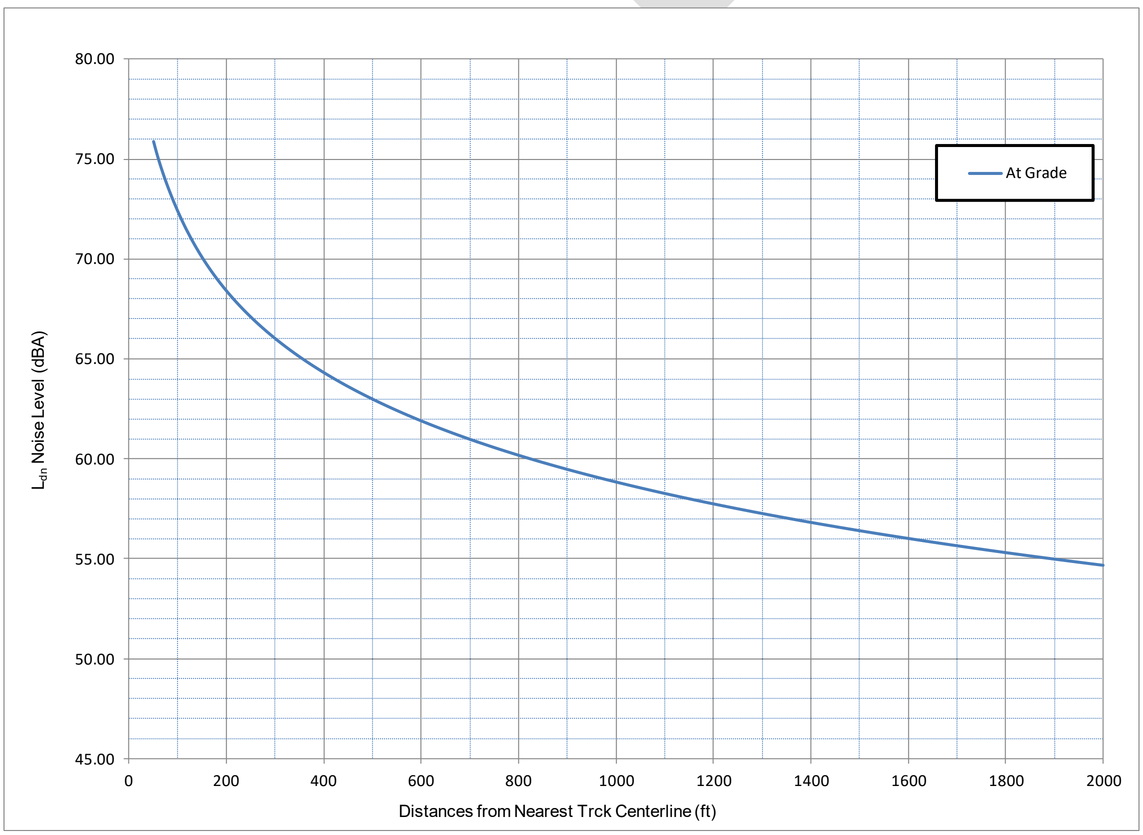
7.4 HSR Operational Noise Impacts and Vibration Effects

7.4.1 Noise Impacts

Analysts conducted the operational noise impact analysis for the Central Valley Wye using FRA methodology (Section 5. Methods for Evaluating Effects), and the results of the impact analysis are listed in the following sections for each Central Valley Wye alternative. Analysts calculated train noise levels for at-grade and aerial structure cases at different speeds, and then evaluated projected noise level increases relative to existing conditions at noise-sensitive receptors.

Depending upon the land use, analysts measured this noise level increase in terms of either 1-hour equivalent sound level (L_{eq}[h]) or the day-night sound level (L_{dn}). Calculation results were used to draw moderate and severe impact lines on the aerial photos. The number and types of affected noise-sensitive receptors were then tabulated using aerial photos and site visits. Appendix C, Noise and Vibration Measurement Sites and Noise Impacts, illustrates the locations of the moderate and severe impact lines in relation to the Central Valley Wye alternatives and identifies the types of affected noise-sensitive receptors. Noise impacts were assessed at the edge of the property closest to the Central Valley Wye alternatives; therefore, if any portion of the property fell within the impact lines, that property was determined to be affected. It was assumed that for rural areas there would be no noise impacts beyond 2,500 feet from the tracks. Other variables used to calculate the noise impact distances are consistent with the assumptions described in Chapter 5, Methods for Evaluating Effects. Figure 7-2 shows the L_{dn} levels at different distances from the track from the HSR traveling at 220 mph for at-grade elevation of 10 feet.

According to FRA impact criteria, the potential for noise impacts for the Central Valley Wye is determined by comparing the increase in noise exposure levels attributable to the proposed project with the ambient noise environment into which the project is being constructed. Noise impacts are determined using two types of impact classifications: moderate impacts and severe impacts. These classifications are shown on Figure 4-1.



Source: Calculated based on Merced to Fresno Section: Central Valley Wye operation noise methodology.

Figure 7-2 Project HSR Noise Level L_{dn} versus Distance

7.4.1.1 SR 152 (North) to Road 13 Wye Alternative

Sensitive receptors within the RSA consist primarily of rural residences, Fairmead Elementary School, and Fairmead Headstart. As shown in Table 6-1, existing L_{dn} within the RSA ranges between 54 and 73 dBA. The low existing noise levels, flat topography, and lack of building shielding within most of the RSA enables noise to travel farther and affect noise-sensitive receptors at greater distances from the alignment.

Operation of the SR 152 (North) to Road 13 Wye Alternative would generate increased noise levels above existing ambient levels. The level of operational noise would depend on the number of trains per day, speed of the trains, and track configuration. The conceptual operations schedule has up to 196 trains per day passing through the Central Valley Wye in 2040. Additionally, project elements, such as the specific vehicle type, track structure and other elements, could affect operational noise impacts. As project elements affecting noise either change or are refined, additional analyses will be conducted to reflect these changes.

Analysts calculated project noise levels at both noise measurement and modeled sites. The project noise levels at all of the noise measurement and modeled sites range from 45 and 72 dBA L_{dn}. Analysts determined operations impacts (no impact, moderate, or severe) based on the difference between the project noise level and the existing noise level. The results of the analysis show a potential for moderate and severe noise impacts for some of the receivers along the alignment, according to the FRA impact criteria. The distances from the alignment to the location of the severe impact and moderate impact thresholds were calculated for each analysis site and these results are also presented in Table 7-5. These values represent the distances to the severe- and moderate-impact thresholds, while taking into account the existing ambient level and the future HSR noise levels at each modeling site. From these values, generalized contours were developed and analyzed with respect to existing electronic land use maps along the project alignment. The number of noise- sensitive land uses within these impact contours was counted for this alternative, and the results are presented in Table 7-5. Counts of individual severe impacts are for those properties that are between the alignment and the severe noise contour. Counts of individual moderate impacts are for the properties between the severe contour and the moderate contour, and these count locations are displayed in Appendix C.

Based on the FRA's impact assessment criteria, the SR 152 (North) to Road 13 Wye Alternative would have moderate and severe noise impacts on 65 and 27 single-family residences, respectively. No school or community facilities would be impacted. The increase in noise level from HSR operation would be as high as 14 dB L_{dn} at the noise measurement sites. As shown on Figure 7-1, the moderate and severe noise impacts under this alternative would be distributed along the alignment, with a higher concentration of impact in Fairmead. There are no impact avoidance and minimization features available to reduce this impact to single-family residences. As a result, this alternative would result in increased noise levels in the noise RSA.

7.4.1.2 SR 152 (North) to Road 19 Wye Alternative

Within this RSA, existing L_{dn} ranges between 48 and 73 dBA, and sensitive receptors consist primarily of rural residences. The Central Valley Wye actions that would affect the noise levels are described under SR 152 (North) to Road 13 Wye Alternative.

As shown in Table 7-6, operation of the SR 152 (North) to Road 19 Wye Alternative would have moderate and severe noise impacts on 58 and 23 single-family residences, respectively, in the Horizon Year 2040 based on the FRA's impact assessment criteria. No school or community facilities would be impacted. There are no impact avoidance and minimization features available to reduce this impact to single-family residences. As a result, this alternative would result in increased noise levels in the noise RSA.

7.4.1.3 Avenue 21 to Road 13 Wye Alternative

Within this RSA, existing L_{dn} ranges between 49 and 73 dBA, and sensitive receptors consist primarily of rural residences. The Central Valley Wye actions that would affect noise levels are described under SR 152 (North) to Road 13 Wye Alternative.

As shown in Table 7-7, operation of the Avenue 21 to Road 13 Wye Alternative would have moderate and severe noise effects on 40 single-family residences and 39 single-family residences, respectively, in the Horizon Year 2040 based on the FRA's effect assessment criteria. There is one church within the RSA but it would not be impacted. There are no impact avoidance and minimization features available to reduce this impact to single-family residences. As a result, this alternative would result in increased noise levels in the noise RSA.

7.4.1.4 SR 152 (North) to Road 11 Wye Alternative

Within this RSA, existing L_{dn} ranges between 51 and 73 dBA, and sensitive receptors consist primarily of rural residences. The Central Valley Wye actions that would affect the noise levels are described under the SR 152 (North) to Road 13 Wye Alternative.

As shown in Table 7-8, operation of the SR 152 (North) to Road 11 Wye Alternative would have moderate and severe noise impacts on 61 and 35 single-family residences, respectively, in the Horizon Year 2040 based on the FRA's impact assessment criteria. No school or community facilities would be impacted. There are no impact avoidance and minimization features available to reduce this impact to single-family residences. As a result, this alternative would result in increased noise levels in the noise RSA.

Table 7-5 Detailed Noise Impact Analysis Results for SR 152 (North) to Road 13 Wye Alternative

Site No.	Direction from Alternative	Land Use	Location Figure Number	Profile Type	Speed (mph)	Existing Noise Level L_{dn} (dBA)	Moderate Impact Noise Level	Severe Impact Noise Level	Moderate Impact Distance (feet)	Severe Impact Distance (feet)	Number of Moderate Impacts	Number of Severe Impacts
N70	South	SFR	1-2	At grade	220	57.3	56	62	1345	493	1 SFR	1 SFR
N75B	South	SFR	3	At grade	220	69.5	64	69	352	150	0	1 SFR
N75A	South	SFR	4-5	At grade	220	69.5	64	69	352	150	0	3 SFR
N75	South	SFR	6	At grade	220	69.5	64	69	352	150	2 SFR	0
N75C	South	SFR	7	At grade	220	69.5	64	69	352	150	0	0
N76A	South	SFR	8	At grade	220	63.7	60	65	690	297	0	1 SFR
N76	South	SFR	8	At grade	220	63.7	60	65	690	297	2 SFR	1 SFR
N76C	North	SFR	8	At grade	220	63.7	60	65	690	297	0	1 SFR
N76B	South	SFR	9	At grade	220	63.7	60	65	690	297	0	1 SFR
N76D	North	SFR	9	At grade	220	63.7	60	65	690	297	3 SFR	1 SFR
N76E	North	SFR	11	At grade	220	63.7	60	65	690	297	1 SFR	0
N77AA	South	SFR	12	At grade	220	60.4	58	63	964	417	0	0
N77A	South	SFR	13	At grade	220	60.4	58	63	964	417	1 SFR	1 SFR
N77	South	SFR	13	At grade	220	60.4	58	63	964	417	0	0
N77B	North	SFR	14	At grade	220	60.4	58	63	964	417	9 SFR	0
N77BB	North	SFR	13-14	At grade	220	60.4	58	63	1153	499	0	1 SFR
N77C	South	SFR	14	At grade	220	60.4	58	63	1153	499	4 SFR	2 SFR
N77C[1]	North	CEMT	14	At grade	220	59	62	68	642	233	0	0
N77CC	North	SFR	15	At grade	220	60.4	58	63	1153	499	1 SFR	0
N77D	South	SFR	15	At grade	220	60.4	58	63	1153	499	2 SFR	0
N77E	South	SFR	16	At grade	220	60.4	58	63	1153	499	0	0
N77F	North	SFR	15-16	At grade	220	60.4	58	63	1153	499	3 SFR	2 SFR
N78	South	SFR	17-18	At grade	220	61.3	58	64	1153	422	3 SFR	0
N79A	North	SFR	18-19	At grade	220	62.7	59	64	976	422	5 SFR	2 SFR

Site No.	Direction from Alternative	Land Use	Location Figure Number	Profile Type	Speed (mph)	Existing Noise Level L_{dn} (dBA)	Moderate Impact Noise Level	Severe Impact Noise Level	Moderate Impact Distance (feet)	Severe Impact Distance (feet)	Number of Moderate Impacts	Number of Severe Impacts
N79	South	SFR	18-19	At grade	220	62.7	59	64	976	422	14 SFR	7 SFR
N79*	South	SCH	19	At grade	220	59	62	68	642	233	0	0
N80	South	SFR	19-20	At grade	220	62.4	59	64	976	422	0	1 SFR
N80A	South	SFR	19-20	At grade	220	62.4	59	64	976	422	1 SFR	0
N80C	South	SFR	22	At grade	220	62.4	59	64	976	422	0	1 SFR
N81	South	SFR	18-19	At grade	220	62	59	64	976	422	3 SFR	0
N81[1]	South	SCH	19	At grade	220	59	62	68	642	233	0	0
N84A	North	SFR	24	At grade	220	72.5	65	71	356	127	3 SFR	0
N84	North	SFR	25-27	At grade	220	72.5	65	71	356	127	0	0
LT26	North	SFR	27	At grade	220	69	64	69	422	180	1 SFR	0
N85	South	SFR	31-33, 63	At grade	150	70.6	64	69	67	--	0	0
LT8A	West	SFR	64	At grade	150	54	54	60	392	142	1 SFR	0
LT8B	West	SFR	65	At grade	150	54	54	60	392	142	0	0
LT8C	West	SFR	66	At grade	150	54	54	60	392	142	0	0
LT8D	East	SFR	66	At grade	150	54	54	60	392	142	2 SFR	0
LT8E	West	SFR	67	At grade	150	54	54	60	392	142	0	0
N77G	South	SFR	70	At grade	150	60.4	58	63	200	81	3 SFR	0
										Total	**65 SFR**	**27 SFR**

Source: Calculated based on Merced to Fresno Section: Central Valley Wye Final 15% Plans; Authority 2016b.
[1] L_{eq} was considered in the analysis of this receiver because it is an Activity Category 3
dBA = A-weighted decibels
L_{dn} = day-night sound level, dBA
L_{eq} = equivalent sound level, dBA
mph = miles per hour
SFR = single family residence
SCH = School
CEMT = cemetery

Table 7-6 Detailed Noise Impact Analysis Results for SR 152 (North) to Road 19 Wye Alternative

Site No.	Direction from Alternative	Land Use	Location Figure Number	Profile Type	Speed (mph)	Existing Noise Level L_{dn} (dBA)	Moderate Impact Noise Level	Severe Impact Noise Level	Moderate Impact Distance (feet)	Severe Impact Distance (feet)	Number of Moderate Impacts	Number of Severe Impacts
N70	South	SFR	1-2B	At grade	220	57.3	56	62	1345	493	1 SFR	1 SFR
N75B	South	SFR	3B	At grade	220	69.5	64	69	352	150	0	0
N75A	South	SFR	5B	At grade	220	69.5	64	69	352	150	0	3 SFR
N75	South	SFR	6B	At grade	220	69.5	64	69	352	150	2 SFR	0
N75C	South	SFR	7B	At grade	220	69.5	64	69	352	150	0	0
N76A	South	SFR	8B	At grade	220	63.7	60	65	690	297	0	1 SFR
N76	South	SFR	8B	At grade	220	63.7	60	65	690	297	2 SFR	1 SFR
N76B	South	SFR	9B	At grade	220	63.7	60	65	690	297	0	1 SFR
N76C	North	SFR	8B	At grade	220	63.7	60	65	690	297	0	1 SFR
N76D	North	SFR	9B	At grade	220	63.7	60	65	690	297	3 SFR	1 SFR
N76E	North	SFR	11B	At grade	220	63.7	60	65	690	297	1 SFR	0
N77AA	South	SFR	12B	At grade	220	60.4	58	63	964	417	0	0
N77A	South	SFR	13B	At grade	220	60.4	58	63	964	417	1 SFR	1 SFR
N77	South	SFR	13B	At grade	220	60.4	58	63	964	417	0	0
N77BB	North	SFR	13B-14B	At grade	220	60.4	58	63	964	417	0	1 SFR
N77B	North	SFR	14B	At grade	220	60.4	58	63	964	417	9 SFR	1 SFR
N77C	South	SFR	14B	At grade	220	60.4	58	63	964	417	3 SFR	1 SFR
N77C[1]	North	CEMT	14B	At grade	220	59.0	62	68	493	178	0	0
N77CC	North	SFR	15B	At grade	220	60.4	58	63	964	417	1 SFR	0
N77D	North	SFR	15B	At grade	220	60.4	58	63	964	417	0	0
N77E	South	SFR	15B-16B	At grade	220	60.4	58	63	964	417	1 SFR	0
N77F	North	SFR	15B-16B	At grade	220	60.4	58	63	964	417	2 SFR	1 SFR
N78	South	SFR	17B-18B	At grade	220	61.3	58	64	964	352	1 SFR	0
N79A	North	SFR	18B-19B, 40	At grade	220	62.7	59	64	815	352	1 SFR	3 SFR

Site No.	Direction from Alternative	Land Use	Location Figure Number	Profile Type	Speed (mph)	Existing Noise Level L_{dn} (dBA)	Moderate Impact Noise Level	Severe Impact Noise Level	Moderate Impact Distance (feet)	Severe Impact Distance (feet)	Number of Moderate Impacts	Number of Severe Impacts
N79	South	SFR	18B-19B	At grade	220	62.7	59	64	815	352	16 SFR	5 SFR
N79[1]	South	SCH	19B	At grade	220	59.0	62	68	493	178	0	0
N81	South	SFR	19B-20B	At grade	220	62	59	64	815	352	2 SFR	0
N81[1]	South	SCH	19B	At grade	220	59	62	68	493	178	0	0
N80B	South	SFR	19B	At grade	220	62.4	59	64	976	422	0	0
N80	South	SFR	19B-20B	At grade	220	62.4	59	64	976	422	0	0
N80A	South	SFR	20B	At grade	220	62.4	59	64	976	422	3 SFR	1 SFR
N80C	South	SFR	22B	At grade	220	62.4	59	64	976	422	0	0
N84A	North	SFR	24B	At grade	220	72.5	65	71	356	127	2 SFR	0
N84	North	SFR	25B- 27B	At grade	220	72.5	65	71	356	127	0	0
LT26	North	SFR	27B	At grade	220	69	64	69	422	180	1 SFR	0
N85	South	SFR	31B -34	At grade	150	70.6	64	69	67	--	0	0
N85A	North	SFR	35-36	At grade	150	70.6	64	69	67	--	0	0
N82A	West	SFR	37-39,41	At grade	150	60.6	58	63	200	81	2 SFR	0
N83A	West	SFR	37D-37	At grade	150	48.6	53	59	463	169	0	0
N80AA	East	SFR	38-39	At grade	150	62.4	59	64	169	67	1 SFR	0
N80	South	SFR	40	"Aerial/ At grade	150	62.4	59	64	354	99	3 SFR	0
										Total	**58 SFR**	**23 SFR**

Source: Calculated based on Merced to Fresno Section: Central Valley Wye Final 15% Plans; Authority 2016b.

1 Leq was considered in the analysis of this receiver because it is an Activity Category 3.

dBA = A-weighted decibels
Ldn = day-night sound level, dBA
Leq = equivalent sound level, dBA
mph = miles per hour
SFR = single family residence
SCH = School
CEMT = cemetery

Table 7-7 Detailed Noise Impact Analysis Results for Avenue 21 to Road 13 Wye Alternative

Site No.	Direction from Alternative	Land Use	Location Figure Number	Profile Type	Speed (mph)	Existing Noise Level L_{dn} (dBA)	Moderate Impact Noise Level	Severe Impact Noise Level	Moderate Impact Distance (feet)	Severe Impact Distance (feet)	Number of Moderate Impacts	Number of Severe Impacts
N70	South	SFR	1C	At grade	220	57.3	56	62	1345	493	0	1 SFR
N70A	North	SFR	2C	At grade	220	57.3	56	62	1345	493	0	1 SFR
N73A	North	SFR	43	At grade	220	54.3	55	61	1589	583	2 SFR	0
N73B	North	SFR	44	At grade	220	54.3	55	61	1589	583	0	0
N73	South	SFR	45	At grade	220	54.3	55	61	1589	583	6 SFR	4 SFR
N73C	South	SFR	46	At grade	220	54.3	55	61	1589	583	0	2 SFR
N73D	South	SFR	47	At grade	220	54.3	55	61	1589	583	2 SFR	2 SFR
N74	South	SFR	48	At grade	220	53.8	54	60	1650	690	0	2 SFR
N74A	South	SFR	49	At grade	220	53.8	54	60	1650	690	1 SFR	0
N74BB	North	SFR	50	At grade	220	53.8	54	60	1650	690	3 SFR	0
N74B	South	SFR	50	At grade	220	53.8	54	60	1650	690	0	3 SFR
N74C	South	SFR	50 & 51	At grade	220	53.8	54	60	1650	690	5 SFR	1 SFR
N74D	South	SFR	52	At grade	220	53.8	54	60	1650	690	1 SFR	6 SFR
N74DD	North	SFR	52	At grade	220	53.8	54	60	1650	690	0	1 SFR
N74E	North	SFR	52	At grade	220	53.8	54	60	1650	826	1 SFR	0
N74H	North	SFR	53	At grade	220	53.8	54	60	1650	826	1 SFR	2 SFR
N74I	North	SFR	53	At grade	220	53.8	54	60	1650	826	1 SFR	1 SFR
N74G	South	SFR	53	At grade	220	53.8	54	60	1650	826	1 SFR	2 SFR
LT29A	South	SFR	54-55	At grade	220	49	53	59	1650	976	2 SFR	0
LT29	South	SFR	56	At grade	220	49	53	59	1650	976	1 SFR	1 SFR
LT29B	South	SFR	57	At grade	220	49	53	59	1650	976	0	1 SFR
LT29C	South	SFR	57	At grade	220	49	53	59	1650	976	0	1 SFR
LT29D	South	SFR	57	At grade	220	49	53	59	1650	976	2 SFR	1 SFR

Site No.	Direction from Alternative	Land Use	Location Figure Number	Profile Type	Speed (mph)	Existing Noise Level L_{dn} (dBA)	Moderate Impact Noise Level	Severe Impact Noise Level	Moderate Impact Distance (feet)	Severe Impact Distance (feet)	Number of Moderate Impacts	Number of Severe Impacts
LT29E	North	SFR	57	At grade	220	49	53	59	1650	976	2 SFR	1 SFR
LT29F	North	SFR	57	At grade	220	49	53	59	1650	976	1 SFR	3 SFR
N78C	South	SFR	58	At grade	220	61.3	58	64	1153	422	2 SFR	0
N80D	South	SFR	59	At grade	150	62.4	59	64	976	422	1 SFR	2 SFR
N80E	South	SFR	60	At grade	220	62.4	59	64	976	422	0	0
N80F	North	SFR	61	At grade	220	62.4	59	64	976	422	1 SFR	0
N84B	South	SFR	62 & 27C	At grade	220	72.5	65	71	356	127	1 SFR	0
LT26	North	SFR	27C	At grade	220	69	64	69	422	180	1 SFR	0
N85	South	SFR	31C-33C, 63C	At grade	150	70.6	64	69	53	--	0	0
LT8A	West	SFR	64C	At grade	150	54	54	60	342	115	0	0
LT8B	West	SFR	65C	At grade	150	54	54	60	342	115	0	0
LT8C	West	SFR	66C	At grade	150	54	54	60	342	115	0	0
LT8D	East	SFR	66C	At grade	150	54	54	60	342	115	2 SFR	0
N77E	West	SFR	67C	At grade	150	60.4	58	63	168	65	0	0
N77H	West	SFR	68C	At grade	150	60.4	58	63	168	65	0	0
N77J	West	SFR	68C and 71	Aerial / At grade	150	60.4	58	63	265	105	0	0
N77I	East	SFR	68C	Aerial / At grade	150	60.4	58	63	265	105	0	0
N74J	West	SFR	71 and 72	At grade	150	53.8	54	60	342	115	0	0
N74M	South	SFR	71	Aerial / At grade	150	53.8	54	60	699	118	0	0
N74M[1]	South	CHR	71	Aerial / At grade	150	59.9	62	68	179	--	0	0
N74F	East	SFR	73	At grade	150	53.8	54	60	342	115	0	0

Site No.	Direction from Alternative	Land Use	Location Figure Number	Profile Type	Speed (mph)	Existing Noise Level L_{dn} (dBA)	Moderate Impact Noise Level	Severe Impact Noise Level	Moderate Impact Distance (feet)	Severe Impact Distance (feet)	Number of Moderate Impacts	Number of Severe Impacts
N74K	West	SFR	73	At grade	150	53.8	54	60	342	115	0	0
N74L	East	SFR	71	At grade	150	53.8	54	60	342	115	0	1 SFR
										Total	**40 SFR**	**39 SFR**

Source: Calculated based on Merced to Fresno Section: Central Valley Wye Final 15% Plans; Authority 2016b.
[1] L_{eq} was considered in the analysis of this receiver because it is an Activity Category 3.
[2] Effect number adjusted to account for building rows.
dBA = A-weighted decibels
L_{dn} = day-night sound level, dBA
L_{eq} = equivalent sound level, dBA
mph = miles per hour
SFR = single family residence
CHR = church

Table 7-8 Detailed Noise Impact Analysis Results for SR 152 (North) to Road 11 Wye Alternative

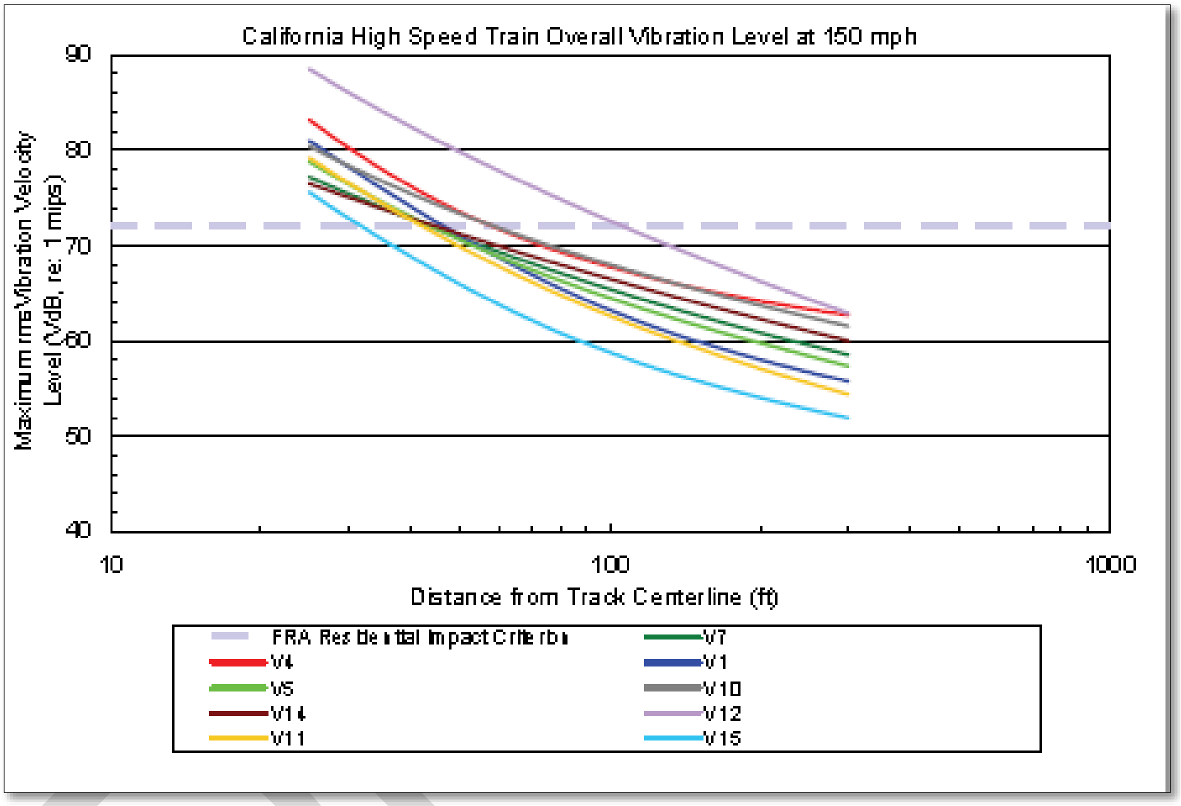
Site No.	Direction from Alternative	Land Use	Location Figure Number	Profile Type	Speed (mph)	Existing Noise Level L_{dn} (dBA)	Moderate Impact Noise Level	Severe Impact Noise Level	Moderate Impact Distance (feet)	Severe Impact Distance (feet)	Number of Moderate Impacts	Number of Severe Impacts
N70	South	SFR	1E-2E	At grade	220	57.3	56	62	1345	493	1 SFR	1 SFR
N75B	South	SFR	3E	At grade	220	69.5	64	69	352	150	0	1 SFR
N75A	South	SFR	5E	At grade	220	69.5	64	69	352	150	0	3 SFR
N75	South	SFR	6E	At grade	220	69.5	64	69	352	150	2 SFR	0
N75C	South	SFR	7E	At grade	220	69.5	64	69	352	150	0	0
N76A	South	SFR	8E	At grade	220	63.7	60	65	690	297	0	1 SFR
N76	South	SFR	8E	At grade	220	63.7	60	65	690	297	2 SFR	1 SFR
N76C	North	SFR	8E	At grade	220	63.7	60	65	690	297	0	1 SFR
N76B	South	SFR	9E	At grade	220	63.7	60	65	690	297	0	1 SFR
N76D	North	SFR	9E	At grade	220	63.7	60	65	690	297	3 SFR	1 SFR
N76E	North	SFR	11E	At grade	220	63.7	60	65	690	297	1 SFR	0
N77AA	South	SFR	12E	At grade	220	60.4	58	63	964	417	0	0
N77A	North	SFR	13E	At grade	220	60.4	58	63	1153	499	0	4 SFR
N77	South	SFR	13E	At grade	220	60.4	58	63	1153	499	0	0
N77B	South	SFR	14E	At grade	220	60.4	58	63	1153	499	8 SFR	2 SFR
N77BB	South	SFR	13E-14E	At grade	220	60.4	58	63	1153	499	0	1 SFR
N77C	South	SFR	14E	At grade	220	60.4	58	63	1153	499	4 SFR	3 SFR
N77C*	South	CEMT	14E	At grade	220	59	62	68	642	233	0	0
N77CC	South	SFR	15E	At grade	220	60.4	58	63	1153	499	1 SFR	1 SFR
N77D	South	SFR	15E	At grade	220	60.4	58	63	1153	499	2 SFR	0
N77E	South	SFR	16E	At grade	220	60.4	58	63	1153	499	0	0
N77F	North	SFR	15E-16E	At grade	220	60.4	58	63	1153	499	3 SFR	2 SFR
N78	South	SFR	17E-18E	At grade	220	61.3	58	64	1153	422	3 SFR	0

Site No.	Direction from Alternative	Land Use	Location Figure Number	Profile Type	Speed (mph)	Existing Noise Level L_{dn} (dBA)	Moderate Impact Noise Level	Severe Impact Noise Level	Moderate Impact Distance (feet)	Severe Impact Distance (feet)	Number of Moderate Impacts	Number of Severe Impacts
N79A	North	SFR	18E-19E	At grade	220	62.7	59	64	976	422	5 SFR	2 SFR
N79	South	SFR	18E-19E	At grade	220	62.7	59	64	976	422	17 SFR	9 SFR
N79*	South	SCH	19E	At grade	220	59	62	68	642	233	0	0
N80	South	SFR	19E-20E	At grade	220	62.4	59	64	976	422	0	0
N80A	South	SFR	19E-20E	At grade	220	62.4	59	64	976	422	1 SFR	0
N80C	South	SFR	22E	At grade	220	62.4	59	64	976	422	0	1 SFR
N81	South	SFR	18E-19E	At grade	220	62	59	64	976	422	1 SFR	0
N81*	South	SCH	19E	At grade	220	59	62	68	642	233	0	0
N84A	North	SFR	24E	At grade	220	72.5	65	71	356	127	3 SFR	0
N84	North	SFR	25E-27E	At grade	220	72.5	65	71	356	127	0	0
LT26	North	SFR	27E	At grade	220	69	64	69	422	180	1 SFR	0
N85A	South	SFR	31E-33E	At grade	150	70.6	64	69	67	--	0	0
LT8A	West	SFR	33E, 63E-64E	At grade	150	54	54	60	392	142	1 SFR	0
LT8B	West	SFR	65E	At grade	150	54	54	60	392	142	1 SFR	0
LT8C	West	SFR	66E-67E	At grade	150	54	54	60	392	142	0	0
LT8D	East	SFR	70E	At grade	150	54	54	60	392	142	1 SFR	0
N77AA	South	SFR	70E	At grade	150	60.4	58	63	200	81	0	0
										Total	**61 SFR**	**35 SFR**

Source: Calculated based on Merced to Fresno Section: Central Valley Wye Final 15% Plans; Authority 2016b.
[1] L_{eq} was considered in the analysis of this receiver because it is an Activity Category 3
dBA = A-weighted decibels
L_{dn} = day-night sound level, dBA
L_{eq} = equivalent sound level, dBA
mph = miles per hour
SFR = single family residence
SCH = School
CEMT = cemetery

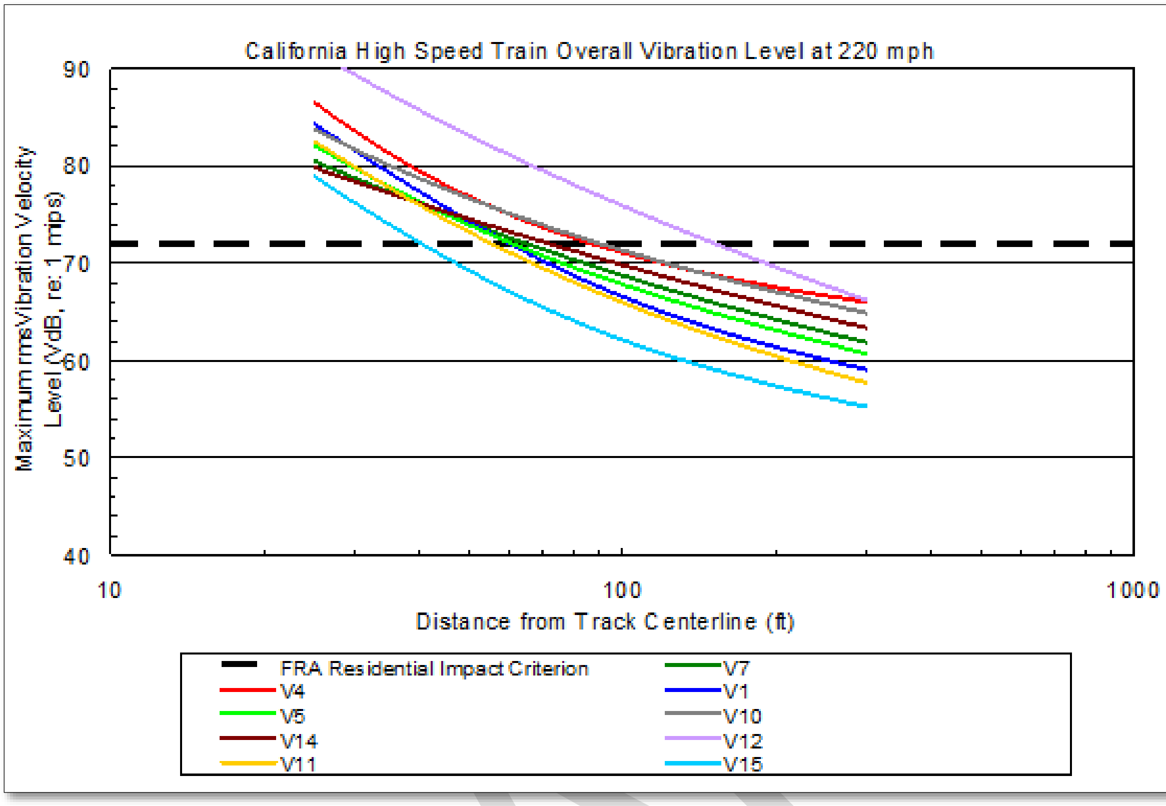
7.4.2 Vibration Effects

Operation of Central Valley Wye would generate increased vibration levels above existing levels. Analysts conducted background and train pass-by vibration measurements at selected locations adjacent to the Central Valley Wye alternatives as part of this study to assess the existing vibration environment. Figures 7-3 and 7-4 provide projections of maximum ground vibration levels from Central Valley Wye operations for each vibration propagation measurement site and were provided by the *Merced to Fresno Section Project EIR/EIS Noise and Vibration Technical Report* (Authority and FRA 2012b). The figures plot the FRA residential effect criterion against maximum vibration levels from the HSR at 150 mph and 220 mph, respectively.



Source: Authority and FRA, 2012b

Figure 7-3 Overall HSR Vibration Levels versus Distance at 150 mph



Source: Authority and FRA, 2012b

Figure 7-4 Overall HSR Vibration Levels versus Distance at 220 mph

The maximum distance from the track where human annoyance would occur is 70 feet, which would typically be contained within the HSR right-of-way. This is because of the very inefficient propagation of vibration through the soils in the vicinity of the Central Valley Wye and the low vehicle input force, which provides significant attenuation of vibration levels in areas where vibration-sensitive receivers are located. As a result, vibration levels from operation of the Central Valley Wye alternatives would not cause human annoyance.

7.5 Traffic Noise Effects

This section addresses any additional traffic noise caused by temporary or permanent local road closures. Existing traffic levels in the RSA are very low and the majority of the roadways within the RSA—with the exception of SR 152 and SR 99— have average daily traffic volumes of fewer than 500 vehicles, with many having average daily traffic volumes of fewer than 50 vehicles.. Traffic on SR 152 and SR 99 dominates noise levels in areas close to the highway. Traffic noise from construction activities is discussed in Section 7.3, Construction Noise and Vibration Effects.

There are no proposed stations or other HSR facilities in the Central Valley Wye vicinity that would generate additional traffic. The only traffic effects during Central Valley Wye operation would result from the diversion of traffic due to temporary and permanent closures of some local roads, which would require the rerouting of traffic or other roadway modifications. As traffic on these local roads provides only a minor contribution to overall noise levels, diversion of traffic on these roads is not expected to affect noise levels for the Central Valley Wye alternatives.

7.6 Noise Effects from High-Speed Train Pass-Bys

7.6.1 Annoyance and Startle Effects

Operation of the HSR would result in a sudden increase in noise for receivers along the alignment due to the rapid approach of a high-speed train and a quick onset rate. Onset rate is the average rate of change of increasing sound pressure level measured in dB/sec during a single noise event. The rapid approach of an HSR is accompanied by a sudden increase in noise for a receiver near the tracks.

As discussed in Section 5.6.1, on the basis of U.S. Air Force research, fast onset rates greater than 15 dB/sec will increasingly annoy humans. The trains for the Central Valley Wye would travel at speeds up to 220 mph. At 220 mph, onset rates of 15 dB/sec could annoy human noise-sensitive receivers within a distance of approximately 90 feet from the train.

Startle effects are likely to occur in humans as onset rates approach 30 dB/sec. According to Figure 5-5 of this report, once the high-speed train reaches 220 mph, the onset rate is 30 dB/sec when the noise-sensitive receiver is within a distance of 45 feet from the train.

To avoid annoyance to humans from onset rates caused by the high-speed train, noise-sensitive receivers need to be at a distance greater than 90 feet from the track. To avoid startle effects at human noise-sensitive receivers due to onset rates, noise-sensitive receivers need to be at a distance greater than 45 feet from the track.

The Central Valley Wye right-of-way would be a minimum of 100 feet wide. As the distance for the startle effect for humans is 45 feet, it is expected that distance for the startle effect would fall mostly within the right-of-way. Therefore, there would not be startle effects on humans. Annoyance and startle effects should only be considered to be additional information for this effect assessment rather than a part of a noise exposure calculation.

7.6.2 Noise Effects on Wildlife and Domestic Animals

Dairy products are one of the most important agricultural products in Merced and Madera Counties. While the majority of land in the study area is actively being used for agriculture, wildlife corridors are also present and considered important in the context of the existing conditions of the study area and San Joaquin Valley.

Operation of the Central Valley Wye could stress wildlife and domestic animals by subjecting them to uncomfortable noise and vibration levels. The FRA guidance manual (FRA 2012) addresses the effects of the HSR on wildlife (mammals and birds) and domestic animals (livestock and poultry). The noise exposure limit for each type of animal is an SEL of 100 dBA from passing trains. According to the screening distance information provided in Table 7-9, wildlife and domestic animals might be within the screening distance for an at-grade HSR (i.e., within 100 feet of either side of the track centerline [for a total width of 200 feet]). Because fences control access to the right-of-way and the right-of-way would be approximately 100 feet wide in rural locations, wildlife and domestic animals would have to be within approximately 50 feet of the edge of the HSR right-of-way to experience noise effects above the recommended threshold. This issue would primarily occur where wildlife migration routes cross the HSR right-of-way along at-grade locations. Where domestic animal operations are adjacent to the HSR right-of-way, effects could also occur; however, in most cases unconfined livestock could avoid noise stress by walking away from the track as a train approaches.

Table 7-9 Detailed Screening Distances for Noise Effects on Wildlife and Domestic Animals

Track Location	Speed (mph)	SEL[1] (dBA)	Distance from Trackway Centerline Where Effects Could Result (feet)
HSR at-grade	220	100	100
HSR 60-foot-high elevated structure	220	100	15[2]
Freight train, no horn noise	50	100	75
Freight train, sounding horn at at-grade crossing	50	100	400

Source: Authority and FRA, 2012b

[1] The SEL represents a receiver's combined noise exposure from an event and represents the total A-weighted sound during the event normalized to a 1-second interval. This noise descriptor is used to assess effects on wildlife and domestic animals.

[2] These projections assume a safety barrier on the edge of the aerial structure as shown in typical cross-sections (see Chapter 2, Alternatives, of the Supplemental EIR/EIS). The safety barrier is assumed to be 3 feet above the top of rail height and 15 feet from the track centerline. There would be no effect at grade level.

dBA = A-weighted decibel(s)
HSR = high-speed rail
mph = mile(s) per hour
SEL = sound exposure level

At locations adjacent to the UPRR/SR 99 or BNSF where the existing noise is already high, there would be no effects because animals would be expected to be habituated to the noise. However, in rural areas there could be adverse effects. Because most unconfined animals would be able to avoid noise stress by walking away from the track as a train approaches so that they are not exposed to noise levels above the FRA's noise exposure limit, the effect would be reduced.

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9 PREPARER QUALIFICATIONS

Project Role	Name, Registration	Years Experience	Qualifications
Noise and Vibration	Areg Gharabegian, P.E.	40 years' experience	B.S. Mechanical Engineering; M.S. Energy, Resources, and Environment.
Noise and Vibration	Martin Meyer, INCE Member	16 years' experience	M.S. Physics, University of New Orleans; B.A. Physics, Oakland University