3.4 Noise and Vibration

3.4.1 Introduction

This section describes the regulatory setting, affected environment, impacts, and mitigation measures for noise and vibration resulting from the California HST Project. Noise and vibration comprise key elements of the environmental impact analysis because their increases over existing levels near the HST project are a potentially significant impact concern.

The 2005 and 2010 HST Program EIR/EIS documents identified project engineering and design elements to reduce or avoid potential noise and vibration impacts. During the period between the scoping meetings and preparation of this Project EIR/EIS, the alternative analysis process identified those alignments and design options that would avoid or minimize potential impacts on noise and vibration-sensitive receivers. The distributed-power electric multiple unit (EMU) trainset chosen for the HST System will have lower noise emissions than a locomotive-hauled electric trainset.

The noise and vibration limits chosen for construction and operation of the HST System satisfy the federal guidelines of the FRA and Federal Transit Administration (FTA) for train and HST facility operations, and of FHWA as defined by Caltrans for traffic noise.

3.4.2 Laws, Regulations and Orders

Identification of noise and vibration impacts from a major transportation project is subject to federal and state environmental review requirements. In order to aid in compliance with environmental regulations related to noise and vibration, FRA and FTA have developed guidance manuals for assessing noise and vibration impacts from major rail projects like HST. Although not at the level of a rule or a standard, the FRA and FTA guidance is intended to satisfy environmental review requirements and assist project sponsors in addressing predicted construction and operation noise and vibration during the design process.

3.4.2.1 Federal

Federal Noise Emission Compliance Regulation

FRA has a regulation governing compliance of noise emissions from interstate railroads. FRA's Railroad Noise Emission Compliance Regulation (49 CFR Part 210) prescribes compliance requirements for enforcing railroad noise emission standards adopted by the EPA (40 CFR Part 201).

FHWA Procedures for Abatement of Highway Traffic Noise and Construction Noise, as provided in 23 CFR Subchapter H, Section 772

The criteria for highway noise impacts (relevant to the extent HST causes changes in traffic patterns) are included in the FHWA Procedures for Abatement of Highway Traffic Noise and Construction Noise (23 CRF Part 772).

3.4.2.2 State

California Noise Control Act

At the state level, the California Noise Control Act, enacted in 1973 (Health and Safety Code § 46010 et seq.), requires the Office of Noise Control in the Department of Health Services to provide assistance to local communities developing local noise control programs and works with the Office of Planning and Research to provide guidance for preparing required noise elements in city and county general plans, pursuant to Government Code § 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 HST alignments. The California Noise Control Act stipulates the mapping of noise-level contours for these sources, using community noise metrics appropriate for environmental impact assessment as defined in Section 3.4.3. Cities and counties use these as guides to making land use decisions to minimize the community residents' exposure to excessive noise.

3.4.2.3 Regional and Local

Counties and cities in California prepare general plans with noise policies and ordinances outlined in the section on state regulations. These noise elements often incorporate specific allowable noise levels to achieve a quality environment. Many noise elements reviewed for cities and counties in the Merced to Fresno Section include restrictions on construction hours; none have numerical limits on construction noise levels. Where airports exist, the general plans includes a section on airport land use compatibility plans with respect to noise so that new noise-sensitive uses are not located near or encroach on the area. The general plans do not address ground-borne vibration. The *Merced to Fresno Section Noise and Vibration Technical Report* (Authority and FRA 2011) summarizes the noise-related information from the city and county general plans for the Merced to Fresno Section, which was considered in the preparation of this analysis. The general plans do not address vibration.

3.4.3 Methods for Evaluating Impacts

The analysis of noise and vibration impacts used design information for the proposed alignment and field noise and vibration measurements when applying FTA- and FRA-approved methods. The FRA guidance manual (FRA 2005) was the primary source of guidance for analyzing HST noise and vibration impacts and mitigation, which was supplemented by FTA guidance for non-HST noise. FRA's *High-Speed Ground Transportation Noise and Vibration Impact Assessment* (2005) provides guidelines for establishing the extent of the study area to be used for the noise and vibration impact analyses. It also provides guidance for identifying noise-sensitive locations where increased annoyance (the startle effect) can occur from HST pass-bys. The methodology followed by the analysts is described below.

- For HST noise sources, analysts used the FRA guidance manual (FRA 2005, Chapter 9, Detailed Noise Assessment) at selected residences, schools, hotels/motels, medical facilities, or other noise-sensitive receivers. Analysts also used the FTA guidance manual for the detailed vibration impact analysis (FTA 2006, Chapter 11, Detailed Vibration Analysis).

- For non-HST noise sources, such as stations, maintenance facilities, and construction, analysts followed the methods described in the FTA guidance manual (FTA 2006).

- For traffic noise sources, analysts followed the methods described in the FHWA Highway Traffic Noise: Analysis and Abatement Guidance (FHWA 2010).

The following thresholds were used for the impact analyses:

- FRA Severe Noise Impact Criteria for HST Operations
- FRA Increased Annoyance from Rapid Onset Rates of HST Pass-bys
- FRA Interim Criteria for Noise Impacts on Animals
- FTA Detailed Vibration Impact Criteria for HST Operations
- Caltrans Noise Abatement Criteria for Traffic
- FTA Noise Impact Criteria for Ancillary and Non-HST Noise Sources such as stations and maintenance facilities

Additional details regarding evaluation methods are provided in the following sections and in the *Merced to Fresno Section Noise and Vibration Technical Report* (Authority and FRA 2011).

3.4.3.1 What is Noise?

Noise from an HST system is expressed in terms of a “source-path-receiver” framework. The “source” generates noise levels that depend on the type of source (e.g., a high-speed rail) and its operating characteristics (e.g., speed). The “receiver” is the noise-sensitive land use (e.g., residence, hospital, or school) exposed to noise from the source. In between the source and the receiver is the “path,” where the noise is reduced by distance, intervening buildings, and topography. Environmental noise impacts are assessed at the receiver. Noise criteria are established for the various types of receivers because not all receivers have the same noise sensitivity.

Analysts use three primary noise measurement descriptors to assess noise impacts from traffic and transit projects. They are the equivalent sound level (L_{eq}), the day-night sound level (L_{dn}), and the sound exposure level (SEL):

- **L_{eq}:** The level of a constant sound for a specified period of time that has the same sound energy as an actual fluctuating noise over the same period of time. The peak-hour L_{eq} is used for all traffic and light rail noise analyses at locations with daytime use, such as schools and libraries.
- **L_{dn}:** The L_{eq} over a 24-hour period, with 10 dB added to nighttime sound levels (between 10 p.m. and 7 a.m.) as a penalty to account for the greater sensitivity and lower background sound levels during this time. The L_{dn} is the primary noise-level descriptor for rail noise in residential land uses. Figure 3.4-1 shows typical L_{dn} noise levels. The *Merced to Fresno Section Noise and Vibration Technical Report* (Authority and FRA 2011) provides details regarding noise and noise descriptors.
- **SEL:** The SEL during a single noise event is the primary descriptor of a single noise event, and used to describe noise from an HST passing a location along the track. SEL is an intermediate value in the calculation of both L_{eq} and L_{dn}. It represents a receiver's cumulative noise exposure from an event (train pass-by) and represents the total A-weighted sound during the event normalized to a 1-second interval.

In addition to the L_{eq}, L_{dn}, and SEL, there is another descriptor used to describe noise. The loudest 1 second of noise over a measurement period (L_{max}) is used in many local and state ordinances for noise coming from private land uses and for construction impact evaluations.

Measuring Noise Levels

Noise is unwanted sound. Sound is measured in terms of sound pressure level and is usually expressed in decibels (dB). The human ear is less sensitive to higher and lower frequencies than it is to mid-range frequencies. All noise ordinances, and this noise analysis, use the A-weighting system, which measures what humans hear in a more meaningful way because it reduces the sound levels of higher and lower frequency sounds—similar to what humans hear. Measurements taken with this A-weighted filter are referred to as dBA readings.

3.4.3.2 What Is Vibration?

Vibration from an HST system is also expressed in terms of a "source-path-receiver" framework. The "source" is the train rolling on the tracks, which generates vibration energy transmitted through the supporting structure under the tracks and into the ground. Once the vibration gets into the ground, it propagates through the various soil and rock strata—the "path"—to the foundations of nearby buildings—the "receivers." Ground-borne vibrations generally reduce in levels with distance depending on the local geological conditions. A "receiver" is a vibration-sensitive building (e.g., residence, hospital, or school) where the vibrations may cause perceptible shaking of the floors, walls, and ceilings and a rumbling sound inside rooms. Not all receivers have the same vibration-sensitivity. Consequently, vibration criteria are established for the various types of receivers. Ground-borne vibration can be described in terms of displacement, velocity, or acceleration for evaluating impacts from transit projects. Ground-borne noise occurs as a perceptible rumble and is caused by the noise radiated from the vibration of room surfaces. Vibration above certain levels can damage buildings, disrupt sensitive operations, and cause annoyance to humans within buildings.

Figure 3.4-2 illustrates typical ground-borne vibration velocity levels for common sources and thresholds for human and structural response to ground-borne vibration. As shown, the range of interest is from approximately 50 to 100 vibration velocity level (VdB) (i.e., from imperceptible background vibration to the threshold of damage). Although the threshold of human perception to vibration is approximately 65 VdB, annoyance does not usually occur unless the vibration exceeds 70 VdB.

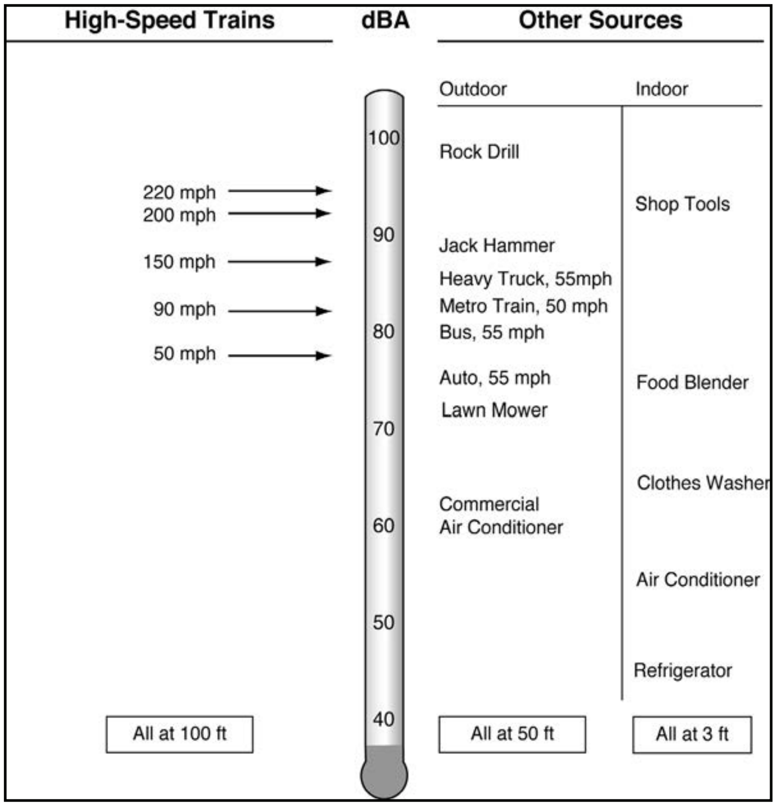


Figure 3.4-1
Typical 24-hour L_{dn} Noise Levels

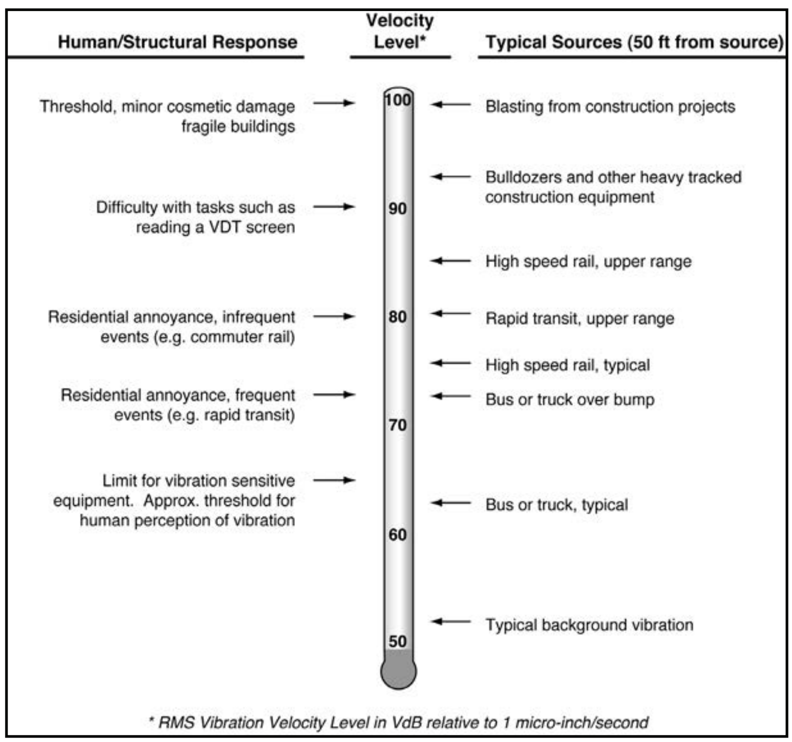


Figure 3.4-2
Typical Levels of Ground-Borne Vibration
Source: FRA (2005)

3.4.3.3 Impact Assessment Guidance

For the impact assessment for noise and vibration, two different guidance documents are used to assess impacts. For construction impacts, the FTA (2006) assessment document is used to assess impacts, while for project impacts the FRA (2005) assessment document is used. The reason for this is that the FTA (2006) guidance is a more recent and complete addition to the measurement of noise and vibration impacts; however it does not specially discuss impacts from the operation of a HST while the FRA guidance does. So therefore for construction impacts that do not differ by transportation type the more recent and complete FTA (2006) guidance is used, while for project operations the FRA (2005) guidance is used.

Construction Thresholds

Construction activities associated with a large transportation project often generate noise and vibration complaints even though they only take place for a limited time. For the impact assessment from construction noise and vibration, the HST project uses exposure of noise- and vibration-sensitive receivers to construction-related noise or vibration in levels exceeding standards established by FTA and established thresholds for architectural and structural building damage (FTA 2006).

Construction Noise

Table 3.4-1 shows the FTA noise assessment criteria for construction. The last column applies to construction activities that extend over 30 days near any given receiver. Day-night sound level, L_{dn}, is used to assess impacts in residential areas and 24-hr L_{eq} is used in commercial and industrial areas. The 8-hr L_{eq} and the 30-day average L_{dn} noise exposure from construction noise calculations use the noise emission levels of the construction equipment, their location, and operating hours. The construction noise limits are normally assessed at the noise-sensitive receiver property line edge.

Table 3.4-1
FTA Construction Noise Assessment Criteria

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

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

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

Source: FTA (2006).

Construction Vibration

Guidelines in the FTA guidance manual (FTA 2006) provide the basis for the construction vibration assessment. FTA provides construction vibration criteria designed primarily to prevent building damage, and to assess whether vibration might interfere with vibration-sensitive building activities or temporarily annoy building occupants during the construction period. The FTA criteria include two ways to express vibration levels: (1) root-mean-square (RMS) VdB for annoyance and activity interference, and (2) peak particle velocity (PPV), which is the maximum instantaneous peak of a vibration signal used for assessments of damage potential.

To avoid temporary annoyance to building occupants during construction or construction interference with vibration-sensitive equipment inside special-use buildings, such as a magnetic resonance imaging (MRI) machine, FTA recommends using the long-term operational vibration criteria provided below in the Vibration Criteria – HST Operations section.

> **Measuring Vibration Levels**
>
> Ground-borne noise occurs as a perceptible rumble and is caused by the noise radiated from the vibration of room surfaces. Vibration above certain levels can damage buildings, disrupt sensitive operations, and cause annoyance to humans within buildings.
>
> The response of humans, buildings, and equipment to vibration is most accurately described using velocity or acceleration. In this analysis, vibration velocity is expressed in terms of VdB as the primary measurement to evaluate the effects of vibration. The frequency distribution of vibration energy is important for detailed impact analyses. Analysts break the frequency range into segments called 1/3-octave bands for detailed analyses.

Table 3.4-2 shows the FTA building damage criteria for construction activity; the table lists PPV limits for four building categories. These limits are used to estimate potential problems that should be addressed during final design. See the *Merced to Fresno Section Noise and Vibration Technical Report* (Authority and FRA 2011) for a description of the metrics.

Table 3.4-2
Construction Vibration Damage Criteria

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

[a] An RMS vibration velocity level in VdB relative to 1 micro-inch/second.
Source: FTA (2006).

Project Thresholds

Noise Criteria — HST Operations

The descriptors and criteria for assessing noise impact vary according to land use categories adjacent to the track. For land uses where people live and sleep (e.g., residential neighborhoods, hospitals, and hotels), the day-night average sound level (L_{dn}) is the assessment parameter. For other land use types where there are noise-sensitive uses (e.g., outdoor concert areas, schools, and libraries), the equivalent noise level (L_{eq}(h)) for an hour of noise sensitivity that coincides with train activity is the assessment parameter. Table 3.4-3 summarizes the three land use categories.

Table 3.4-3
FRA Noise-Sensitive Land Uses

Land Use Category	Noise Metric (dBA[a])	Land Use Category
1	Outdoor $L_{eq}(h)$[b]	Tracts of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet, such as outdoor amphitheaters, concert pavilions, and National Historic Landmarks with significant outdoor use.
2	Outdoor L_{dn}	Residences and buildings where people normally sleep. This category includes homes and hospitals, where nighttime sensitivity to noise is of utmost importance.
3	Outdoor $L_{eq}(h)$[b]	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. Buildings with interior spaces where quiet is important, such as medical offices, conference rooms, recording studios, and concert halls fall into this category, as well as places for meditation or study associated with cemeteries, monuments, and museums. Certain historical sites, parks, and recreational facilities are also included.

[a] Onset-rate adjusted sound levels (L_{eq} and L_{dn}) are to be used where applicable.
[b] L_{eq} for the noisiest hour of transit-related activity during hours of noise sensitivity.
Source: FRA (2005).

Specific types of impacts use other noise descriptors. For disturbance of wildlife and domestic animals, the noise exposure from an individual train passage, called the SEL, is determined. The potential for startle effects for people near the HST is addressed in terms of a combination of train speed and distance from the track.

The noise impact criteria used by the FTA and FRA are ambient-based; the increase in future noise (future noise levels with the project compared to existing noise levels) is assessed rather than the noise caused by each passing train. It is important to note that the criteria do not specify a comparison of future project noise with projections of future *no project* noise. This is because comparison of a noise projection with an existing noise condition is more accurate than comparison of a projection with another noise projection (FRA 2005, Section 3.2.2). Because background noise is expected to increase by the time the project starts generating noise, this approach of using existing noise conditions is conservative. Figure 3.4-3 shows the FRA noise impact criteria for human annoyance. Depending on the magnitude of the cumulative noise increases, FTA and FRA categorize impacts as (1) no impact, (2) moderate impact, or (3) severe impact. Severe impact is where a significant percentage of people would be highly annoyed by the project’s noise. Moderate impact is where the change in cumulative noise level would be noticeable to most people, but may not be sufficient to generate strong, adverse reactions.

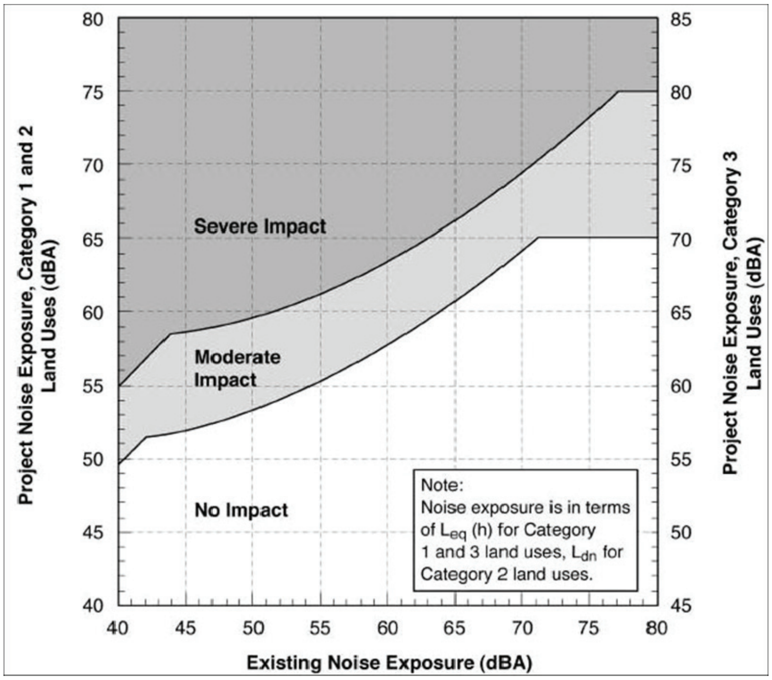


Figure 3.4-3
FRA Noise Impact Criteria
Source: FRA (2005)

Noise Criteria – Traffic

The criteria for highway noise impacts (relevant to the extent that the HST causes changes in traffic patterns) are from the FHWA Procedures for Abatement of Highway Traffic Noise and Construction Noise, as provided in 23 CFR Subchapter H, Section 772. Table 3.4-4 summarizes the traffic noise abatement criteria. A noise impact occurs if projected noise levels approach the levels for specific land use categories listed in Table 3.4-4 or substantially exceed existing noise levels, as defined by Caltrans. In accordance with the regulations, a traffic noise analysis is required only for projects that include: (1) construction of a new highway, (2) reconstruction of an existing highway with a substantial change in the horizontal alignment or vertical profile or an increase in the number of through traffic lanes. If impacts are identified, noise abatement must be considered. In addition, FHWA guidance regarding the physical alteration of an existing highway states “changes in the horizontal alignment that reduce the distance between the source and the receiver by half or more result in a Type 1 project” (FHWA 2010). A Type 1 project is defined in 23 CFR 772 as a proposed federal or federal-aid highway project for the construction of a highway at new location or the physical alteration of an existing highway that significantly changes either the horizontal or vertical alignment or increases the number of through-traffic lanes. FHWA requires identifying highway traffic noise impacts and examining potential abatement measures for all Type 1 projects receiving federal funds.

Caltrans is responsible for implementing FHWA regulations in California. Under Caltrans policy, a traffic-noise impact occurs if projected noise levels are within 1 dB of the FHWA criteria shown in Table 3.4-4; therefore, a residential impact occurs at 66 dBA L_{eq}, and a commercial impact occurs at 71 dBA L_{eq}. Caltrans also considers a 12-dB increase in noise to be a substantial impact, regardless of the original noise level.

Table 3.4-4
FHWA Traffic Noise Abatement Criteria

Land Use Category		Hourly L_{eq}[a]
Type A	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	57 (Exterior)
Type B[b]	Residential	67 (Exterior)
Type C[b]	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	67 (Exterior)
Type D	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	52 (Interior)
Type E[b]	Hotels, motels, offices, restaurants/bars, and other developed lands, properties, or activities not included in A-D or F	72 (Exterior)
Type 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	NA
Type G	Undeveloped lands that are not permitted (without building permits)	NA

[a] Hourly Equivalent A-weighted Sound Level (dBA)
[b] Includes undeveloped lands permitted for this activity category
Source: FHWA Procedures for Abatement of Highway Traffic Noise and Construction Noise (23 CFR 772).

Noise Effects on Wildlife and Domestic Animals

FRA also addresses impacts on wildlife (mammals and birds) and domestic animals (livestock and poultry). Noise exposure limits for each are an SEL of 100 dBA from passing trains, as shown in Table 3.4-5.

Table 3.4-5
Interim Criteria for High-Speed Train Noise Effects on Animals

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

Source: FRA (2005).

Vibration Criteria – HST Operations

Ground-borne vibration impacts from HST operations inside vibration-sensitive buildings are defined by the vibration velocity level, expressed in terms of VdB, and the number of vibration events per day of the same kind of source. Table 3.4-6 summarizes vibration-sensitivity in terms of the three land use categories and the criteria for acceptable ground-borne vibrations and acceptable ground-borne noise. Ground-borne noise is a low-frequency rumbling sound inside buildings, caused by vibrations of floors, walls, and ceilings. Ground-borne noise is generally not a problem for buildings near railroad tracks at- or above-grade, because the airborne noise from trains typically overshadows effects of ground-borne noise. Ground-borne noise becomes an issue in cases where airborne noise cannot be heard, such as for buildings near tunnels.

The FRA provides guidelines to assess the human response to different levels of ground-borne noise and vibration, as shown in Table 3.4-6. These levels represent the maximum vibration level of an individual train pass-by. A vibration event occurs each time a train passes the building or property and causes discernible vibration. "Frequent Events" are more than 70 vibration events per day, and "Infrequent Events" are fewer than 70 vibration events per day. The guidelines also provide criteria for special buildings very sensitive to ground-borne noise and vibration, such as concert halls, recording studios, and theaters. Table 3.4-7 shows the impact criteria for special buildings.

Table 3.4-6
FRA Ground-Borne Vibration and Ground-Borne Noise Impact Criteria

Land Use Category	Ground-Borne Vibration Impact Criteria (VdB relative to 1 micro inch/second)		Ground-Borne Noise Impact Criteria (dB re 20 micro-Pascals)	
	Frequent Events[a]	Infrequent Events[b]	Frequent Events[a]	Infrequent Events[b]
Category 1: Buildings where vibration would interfere with interior operations.	65 VdB[c]	65 VdB[c]	NA[d]	NA[d]
Category 2: Residences and buildings where people normally sleep.	72 VdB	80 VdB	35 dBA	43 dBA
Category 3: Institutional land uses with primarily daytime use.	75 VdB	83 VdB	40 dBA	48 dBA

[a] *Frequent Events* is defined as more than 70 vibration events per day.

[b] *Infrequent Events* is defined as fewer than 70 vibration events per day.

[c] 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, ventilating and air conditioning systems, and stiffened floors.

[d] Vibration-sensitive equipment is not sensitive to ground-borne noise.

NA = not applicable

Source: FRA (2005).

Table 3.4-7
FRA Ground-Borne Vibration and Ground-Borne Noise Impact Criteria for Special Buildings

Type of Building or Room	Ground-Borne Vibration Impact Criteria (VdB relative to 1 micro-inch/second)		Ground-Borne Noise Impact Criteria (dB relative to 20 micro-Pascals)	
	Frequent[a] Events	Infrequent[b] Events	Frequent Events	Infrequent[b] Events
Concert Hall	65 VdB	65 VdB	25 dBA	25 dBA
TV Studio	65 VdB	65 VdB	25 dBA	25 dBA
Recording Studio	65 VdB	65 VdB	25 dBA	25 dBA
Auditorium	72 VdB	80 VdB	30 dBA	38 dBA
Theater	72 VdB	80 VdB	35 dBA	43 dBA

[a] *Frequent Events* is defined as more than 70 vibration events per day.
[b] *Infrequent Events* is defined as fewer than 70 vibration events per day.
Source: FRA (2005).

Tables 3.4-6 and 3.4-7 include separate FRA criteria for ground-borne noise (the "rumble" that radiates from the motion of room surfaces in buildings from ground-borne vibration). Although the criteria are expressed in dBA, which emphasizes the more audible middle and high frequencies, the criteria are significantly lower than airborne noise criteria to account for the annoying low-frequency character of ground-borne noise. Because airborne noise often masks ground-borne noise for aboveground (i.e., at-grade or elevated) HSTs, ground-borne noise criteria apply primarily to operations in a tunnel, where airborne noise is not a factor. The Merced to Fresno alignment is planned be above ground. As a result for the Merced to Fresno corridor, ground-borne noise criteria apply only to buildings with sensitive interior spaces that are well insulated from exterior noise.

Specification of mitigation measures requires more detailed information and more refined impact criteria using the frequency distribution, or spectrum of the vibration energy. A detailed vibration analysis method provides impact criteria in terms of the 1/3-octave band frequency spectrum. A detailed vibration analysis has been conducted for the Merced to Fresno Section HST assessment. Figure 3.4-4 shows the FTA detailed ground-borne vibration impact criteria used in assessing this project's impacts. The criteria in Figure 3.4-4 are based on exceedances of the 1/3-octave band vibration levels over the frequency range of 8 to 80 Hz. For example, if the vibration levels in any frequency band from an HST go over the Residential (Night) line in Figure 3.4-4 at a residential location, a vibration impact would be assessed. In addition, the detailed criteria are used to assess vibration impact at highly sensitive locations using the VC-A through VC-E thresholds shown in the figure.

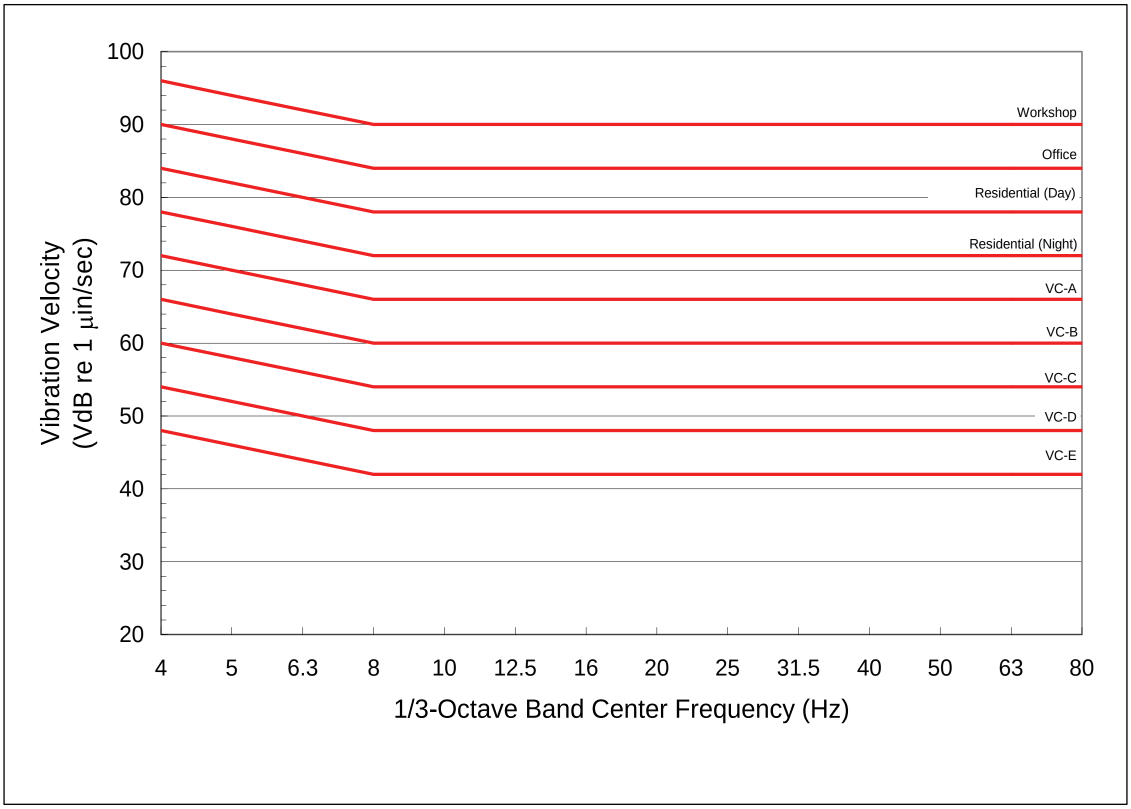


Figure 3.4-4
FTA Detailed Ground-Borne Vibration Impact Criteria
Source: FTA (2006)

Construction Noise Impact Methodology

The construction noise impact assessment used the methodology described in the FTA guidance manual (FTA 2006). The contractor and the Authority will make decisions regarding procedures and equipment. For this analysis, construction scenarios for typical railroad construction projects are used to predict noise impacts. The construction noise and vibration methodology includes the following:

- Noise emissions from typical equipment used by contractors.
- Construction methods.
- Scenarios for equipment usage.
- Estimated site layouts of equipment along the right-of-way.
- Relationship of the construction operations to nearby noise-sensitive receivers.

Table 3.4-1 above lists FTA criteria for the maximum acceptable 8-hour noise levels (L_{eq}) for daytime and nighttime. It also shows the 30-day average L_{dn} values for long-term construction projects.

Criteria for Construction Noise Impact Assessment

The construction noise assessment is based on guidelines included in the FTA guidance manual (FTA 2006), as well as consideration of local noise ordinances, which are presented in the *Merced to Fresno Section Noise and Vibration Technical Report* (Authority and FRA 2011). The Authority applies uniform noise and vibration criteria for construction based on FTA guidance.

Table 3.4-1 shows FTA assessment criteria for construction noise. An 8-hour L_{eq} and a 30-day average noise exposure are used to assess impacts. A 30-day average L_{dn} is used to assess impacts in residential areas, and a 30-day average 24-hr L_{eq} is used to assess impacts in commercial and industrial areas. The noise emission levels of the construction equipment, utilization factor, hours of operation, and location of equipment are used to calculate 8-hour and 30-day average noise exposures.

Construction Vibration Impact Methodology

The FTA guidance manual (FTA 2006) provides the methodology for the assessment of construction vibration impact. Estimated construction scenarios have been developed for typical railroad construction projects allowing a quantitative construction vibration assessment to be conducted. Construction vibration is assessed quantitatively where a potential for blasting, pile-driving, vibratory compaction, demolition, or excavation close to vibration-sensitive structures exists. Criteria for annoyance (see Tables 3.4-6 and 3.4-7) and damage (see Table 3.4-2) were applied to determine construction vibration impacts. The methodology included the following:

- Vibration source levels from equipment used by contractors.
- Estimated site layouts of equipment along the right-of-way.
- Relationship of the construction operations to nearby vibration-sensitive receivers.

Train Operation Noise and Vibration Methodology

HST operation noise and vibration levels were projected using current conceptual HST System operation plans and the prediction models provided in the FRA guidance manual (FRA 2005). Potential noise and vibration impacts also were evaluated in accordance with the FRA guidance manual. This section describes the applicable criteria. This section, as well as the *Merced to Fresno Section Noise and Vibration Technical Report* (Authority and FRA 2011), provide further detail about the assessment methodology, including modeling assumptions. The methodology and assumptions for train operation are listed below:

- Noise modeling projections assumed atmospheric absorption of sound based on the International Standard ISO 9613-2.
- The noise analysis used source reference levels for the VHS Electric vehicle type listed in Table 5-2 of the FRA Guidance Manual (FRA 2005). These adjustments assumed that trainsets would be distributed-power EMU vehicles with 8 cars and a maximum speed of 220 mph.
- The noise sources included the wheel/rail interface at one foot above top of rail, the propulsion noise at 2 feet above top of rail, and the aerodynamic noises from the train nose (at 10 feet above top of rail), the wheel region (at 5 feet above top of rail), and the pantograph (at 15 feet above top of rail).
- HST track was assumed to be ballast and tie with continuous welded rail, consistent with the assumptions in the FRA guidance manual (FRA 2005). Ballast and tie track is typically 2 to 4 dB quieter than slab track.
- Modeling used the full system schedule of conceptual train operations as outlined in Chapter 2, Alternatives, and detailed in the *Merced to Fresno Section Noise and Vibration Technical Report* (Authority and FRA 2011).
- Maximum speed was assumed to be 220 mph along the corridor based on speed profiles developed as part of preliminary project design.
- Top of rail elevations are based on 15% preliminary design as available in April 2011. For at-grade sections on the Ave 21 Wye from Road 15 to Road 8, tracks were assumed to be on an embankment 5 feet above existing grade.
- The track was assumed to be on aerial structure wherever top-of-rail elevations are more than 15 feet above existing grade.
- All aerial structure sections of the corridor were assumed to be as described in Technical Memorandum 1.1.21 Typical Cross Section 15% R0 090404 (Authority 2009).

- Noise and vibration projections assumed that any buildings within property acquisition footprint were not to be included in the impact assessment.
- There would be only one closure of the existing roadway/freight train/Amtrak train at-grade crossings in the corridor, located in Madera Acres on the BNSF Alternative. A road overcrossing would separate both the HST and the BNSF freight line. Trains passing through the existing at-grade crossings between roadways and freight/Amtrak railroad tracks currently are required to blow their horns as a warning to oncoming traffic and pedestrians. Noise modeling projections assumed no change to any of the existing at-grade crossings and, therefore, no change to locations where the freight and Amtrak trains will blow their horns, except in Madera Acres. There would be no at-grade crossings for HSTs.
- No adjustments were made to projected noise levels to account for increases in localized noise due to special trackwork, such as crossovers and turnouts since the project will use special trackwork which will not have gaps associated with crossovers.
- No noise exposure effects were assumed associated with changes in freight rail or Amtrak operations due to the implementation of the HST project.

Project analysts tabulated projected noise and existing ambient noise exposures at the identified receivers or clusters of receivers. The analysts found the levels of impact (no impact, moderate impact, or severe impact) by comparing the existing and project noise exposure based on the impact criteria shown in Figure 3.4-3.

Station Noise

Project analysts assessed the noise impacts associated with HST stations in the cities of Merced and Fresno at each noise-sensitive receiver by using the FTA methodology in the guidance manual (FTA 2006, Section 6.7). The detailed noise analysis included a measurement program at representative clusters of receivers to determine existing ambient noise conditions and a noise prediction method to determine future noise conditions. The noise predictions at these receivers were based on the following information:

- Type of train equipment to be used.
- Train schedules (number of stopping trains and number of through trains during daytime and nighttime hours).
- Train consists (number of cars).
- Speed profiles of stopping trains and through trains.
- Plan and profiles of elevated station structures.
- Landform topography such as buildings in the immediate vicinity of the station.

Project analysts tabulated the projected noise and existing ambient noise exposures at the identified receivers or clusters of receivers. The analysts then determined the levels of impact (no impact, moderate impact, or severe impact) by comparing the existing and project noise exposure with the impact criteria shown in Figure 3.4-3.

Traffic Noise at Stations, Parking Facilities, and Grade-Separations

In addition to noise from conceptual HST operations, project analysts assessed changes in traffic volume, primarily near the proposed HST station sites. Although the UPRR/SR 99 Alternative would relocate SR 99 frontage roads and other local roads, traffic on SR 99 currently dominates noise levels in areas close to the highway and will continue to do so in the future. Because traffic on local roads provides only a minor contribution to overall noise levels, relocation of these local roads would not cause substantial changes in noise levels, based on current information. In addition, because the dominant noise source at stations would be the HST through trains moving at 220 mph, any changes in traffic near the stations would provide only a minor contribution to the project noise at stations.

Wherever the project would realign SR 99, however, the potential exists for noise impacts in locations where the relocated highway would be closer to receivers than it is currently. FHWA guidance (2010) regarding the physical alteration of an existing highway states “changes in the horizontal alignment that reduce the distance between the source and the receiver by half or more result in a Type 1 project.” FHWA requires identification of highway traffic noise impacts and examination of potential abatement measures for all Type 1 projects receiving federal funds.

Stationary HST-Related Noise Sources

Noise from other railroad noise sources than HSTs includes noise from the three types of maintenance facilities (heavy maintenance, maintenance-of-way, and overnight servicing) and electrical power substations.

The noise analysis used FTA (2006) methodology to analyze noise from the HST traction power substations, maintenance facilities, and activities associated with maintenance, repair, and storage of HSTs. Source noise included wheel squeal as the trains pass through the curved sections at the ends of the storage tracks, shop activities, railcar washes, and warning horns.

3.4.3.4 Methods for Evaluating Effects under NEPA

Pursuant to NEPA regulations (40 CFR 1500-1508), project effects are evaluated based on the criteria of context and intensity. Context means the affected environment in which a proposed project occurs. Intensity refers to the severity of the effect, which is examined in terms of the type, quality, and sensitivity of the resource involved, location and extent of the effect, duration of the effect (short- or long-term), and other consideration of context. Beneficial effects are identified and described. When there is no measurable effect, impact is found not to occur. Intensity of adverse effects is summarized as the degree or magnitude of a potential adverse effect where the adverse effect is thus determined to be negligible, moderate, or substantial. It is possible that a significant adverse effect may still exist when on balance the impact is negligible or even beneficial. For this assessment, FTA terminology of no impact was used rather than the NEPA term negligible.

If the project results in an insignificant increase in the number of people highly annoyed by the project noise, there would be no impact. If the project results in a change in the cumulative noise level that would be noticeable to most people, but may not be sufficient to generate strong, adverse reactions, the impact is defined as moderate. If the project results in a change in the cumulative noise level that would cause a significant percentage of people to be highly annoyed by the project’s noise, the impact is defined as substantial.

3.4.3.5 CEQA Significance Criteria

The FRA noise and vibration criteria for evaluating effects under NEPA may be used as the CEQA significance criteria. In addition to these criteria, CEQA guidelines also define an impact pertaining to noise and vibration as considered significant if it would result in any of the following environmental effects:

- Exposure of persons to or generation of noise levels in excess of standards for a severe impact established by the FRA for high-speed ground transportation and by the FTA for transit projects. These standards cover both permanent and temporary/periodic increases in ambient noise levels in the project vicinity above levels existing without the project.

- Exposure of persons to or generation of excessive ground-borne vibration or ground-borne noise levels.

3.4.3.6 Study Area for Analysis

Noise Study Area

The study area is the noise environment around the HST alternatives at the screening distances shown in Table 3.4-8. This table, which groups screening distances by the type of corridor the project would occupy, takes into account where the HST alignment follows along an existing rail line or highway or along a new transportation corridor. Screening distances indicate whether any noise-sensitive receivers are near enough to the proposed alignment for a noise impact to be possible. If receivers fall beyond these screening distances, FRA guidance has determined that impacts would be unlikely. The FRA has three speed ranges in its screening methodology; the highest speed range category (Regime III – 170 mph or greater) was used to define the Merced to Fresno HST alignment screening distance (see Table 3.4-8). Consistent with FRA methodology, screening distances were adjusted to match project conditions such as speeds up to 220 mph and project schedules.

Table 3.4-8
Screening Distances for High-Speed Rail Speed Regime III[a]

Corridor Type	Existing Noise Environment	Screening Distance for Train Type and Speed Regime[b]
Railroad	Urban/noisy suburban – unobstructed	700 feet
	Urban/noisy suburban – intervening buildings[c]	300 feet
	Quiet suburban/rural	1,200 feet
Highway	Urban/noisy suburban – unobstructed	600 feet
	Urban/noisy suburban – intervening buildings[c]	350 feet
	Quiet suburban/rural	1,100 feet
New	Urban/noisy suburban – unobstructed	700 feet
	Urban/noisy suburban – intervening buildings[c]	350 feet
	Quiet suburban/rural	1,300 feet

[a] 170 mph or greater.
[b] Measured from centerline of alignment. Minimum distance is assumed to be 50 feet.
[c] Rows of buildings are assumed to be 200, 400, 600, 800, and 1,000 feet away, parallel to the alignment.
Source: FRA (2005).

Vibration Study Area

For the proposed project, the study area for vibration is as follows:

- HST station study area: 150 feet from the station boundary.
- HST alignment study area, including existing railroads: up to 275 feet from the edge of the right-of-way.
- Highway study area: 50 feet from the roadway centerline.

The vibration impact assessment uses the FRA screening procedure. Screening distances indicate the potential for vibration impact on vibration-sensitive receivers. FRA guidance has determined that receivers located beyond the screening distances are not likely to be affected by the HST. Table 3.4-9 presents the screening distances for vibration assessment.

Table 3.4-9
FRA Screening Distances for Vibration Assessment

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

[a] Frequent = greater than 70 pass-bys per day; Infrequent = less than 70 pass-bys per day.
Source: FRA (2005).

The study areas for the vibration impact assessment analysis generally follow the HST corridor between Merced (and Atwater) and Fresno. Most of the study area along the north-south alignment lies along active railroad and highway rights-of-way. Vibration study areas are defined within the FRA vibration screening distances as ranging from 220 feet for institutional land uses to 275 feet for residential land uses (see Table 3.4-9).

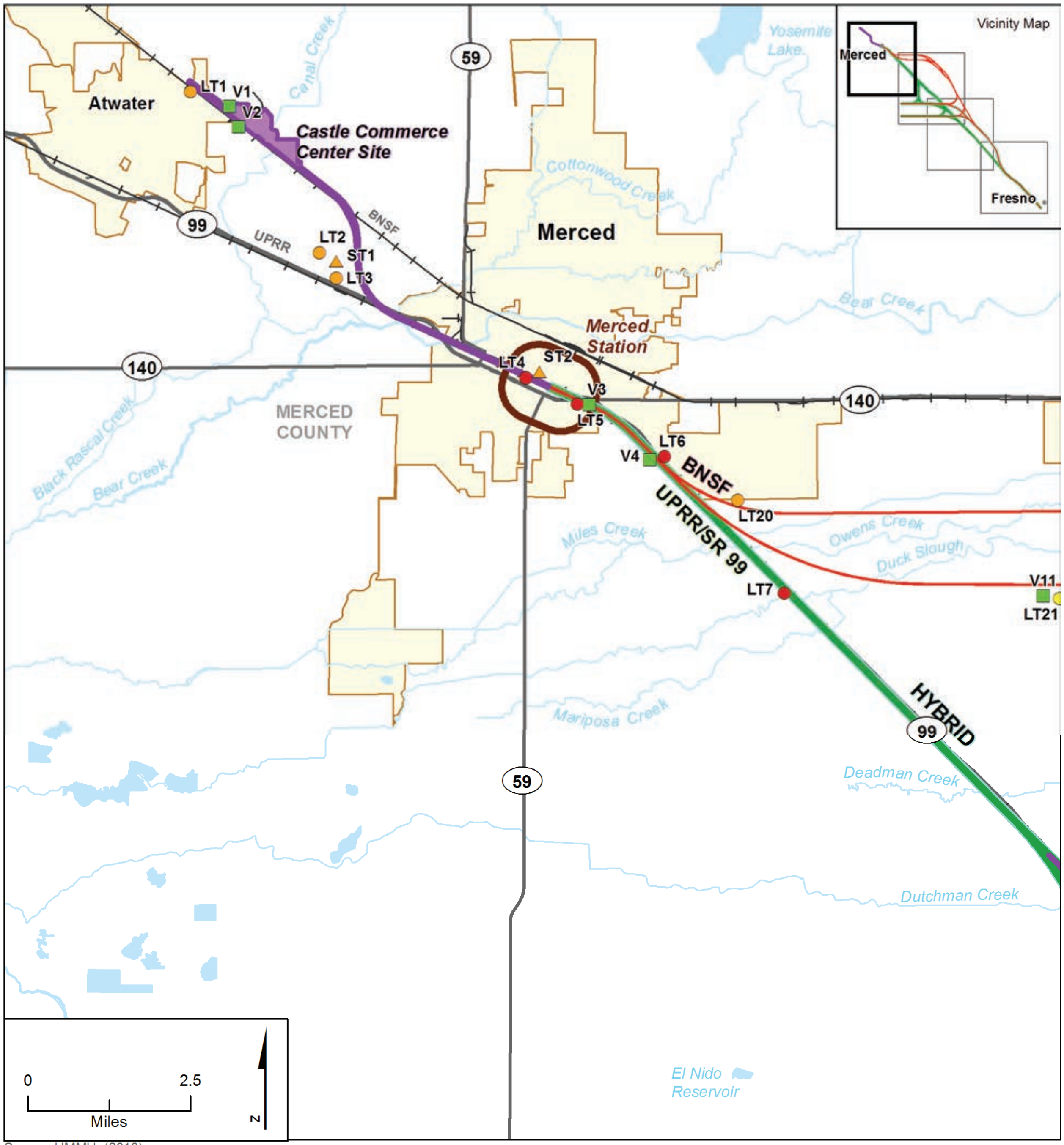
3.4.4 Affected Environment

Concentrations of residences and other potentially noise- and vibration-sensitive receivers exist in the cities of Merced, Chowchilla, Madera, and Fresno. Outside of these urban and suburban areas, land is mostly agricultural.

The Merced to Fresno Section HST alternatives follow SR 99, which is a primary source of motor vehicle noise, or active UPRR and BNSF railroads. The existing railroads generate noise throughout the corridor, and they are the primary source of ground-borne noise and vibration.

3.4.4.1 Existing Noise Levels

To establish a baseline of existing environmental noise levels for project noise impact assessment, project analysts took a series of noise measurements according to FRA guidelines at selected sites along the proposed corridor between December 7, 2009, and April 30, 2010. The measurements consisted of long-term (24 hours in duration) and short-term (generally 15 to 60 minutes in duration) monitoring of the A-weighted sound level at representative noise-sensitive locations. A total of 32 long-term and 13 short-term noise measurements were taken at locations selected to be representative of the noise environment throughout the study area, and especially at those locations most likely to be affected by HST noise. Long-term measurements were taken at residential properties including single-family homes, multifamily buildings, and hospitals. Short-term measurements were taken at noise-sensitive institutions and residences. At each site, the measurement microphone was positioned to characterize the exposure of the site to the dominant noise sources in the area. Figures 3.4-5 through 3.4-8 show the locations of the measurement sites.



Source: HMMH, (2010).

MF_EIS_NV_10-13_a Jun 09, 2011

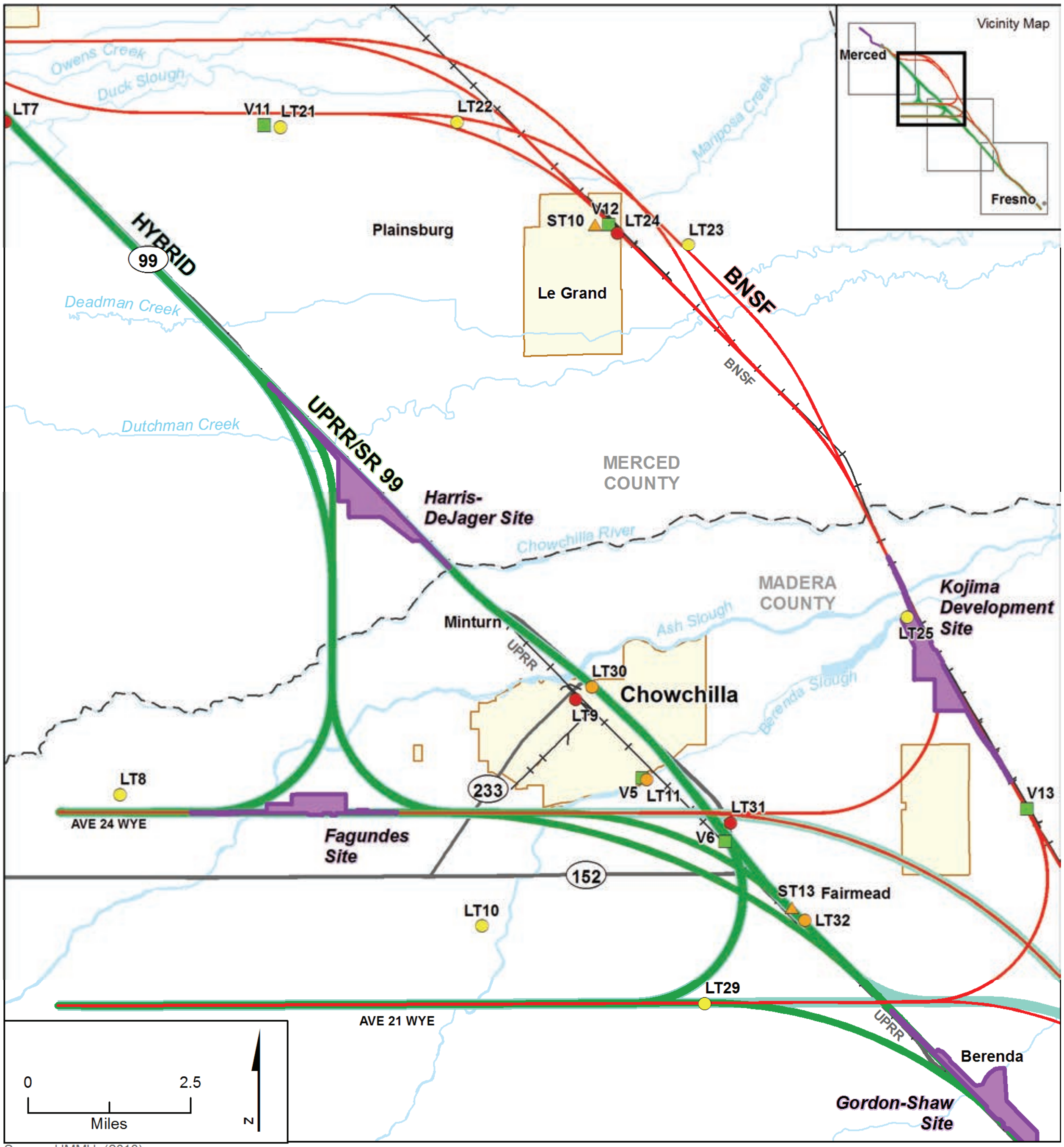
UPRR/SR 99 Alternative
BNSF Alternative
Hybrid Alternative
Potential Heavy Maintenance Facility
Station Study Area
City Limit
County Boundary
Railroad

Vibration Measurement Site

Long-term Noise Monitoring Site
- Between 40 and 55 dBA
- Between 56 and 64 dBA
- Above 65 dBA

Short-term Noise Monitoring Site
- Between 40 and 55 dBA
- Between 56 and 64 dBA
- Above 65 dBA

Figure 3.4-5
Noise and Vibration Measurement Locations in the Merced Project Vicinity



Source: HMMH, (2010).

MF_EIS_NV_10-13_b Jun 09, 2011

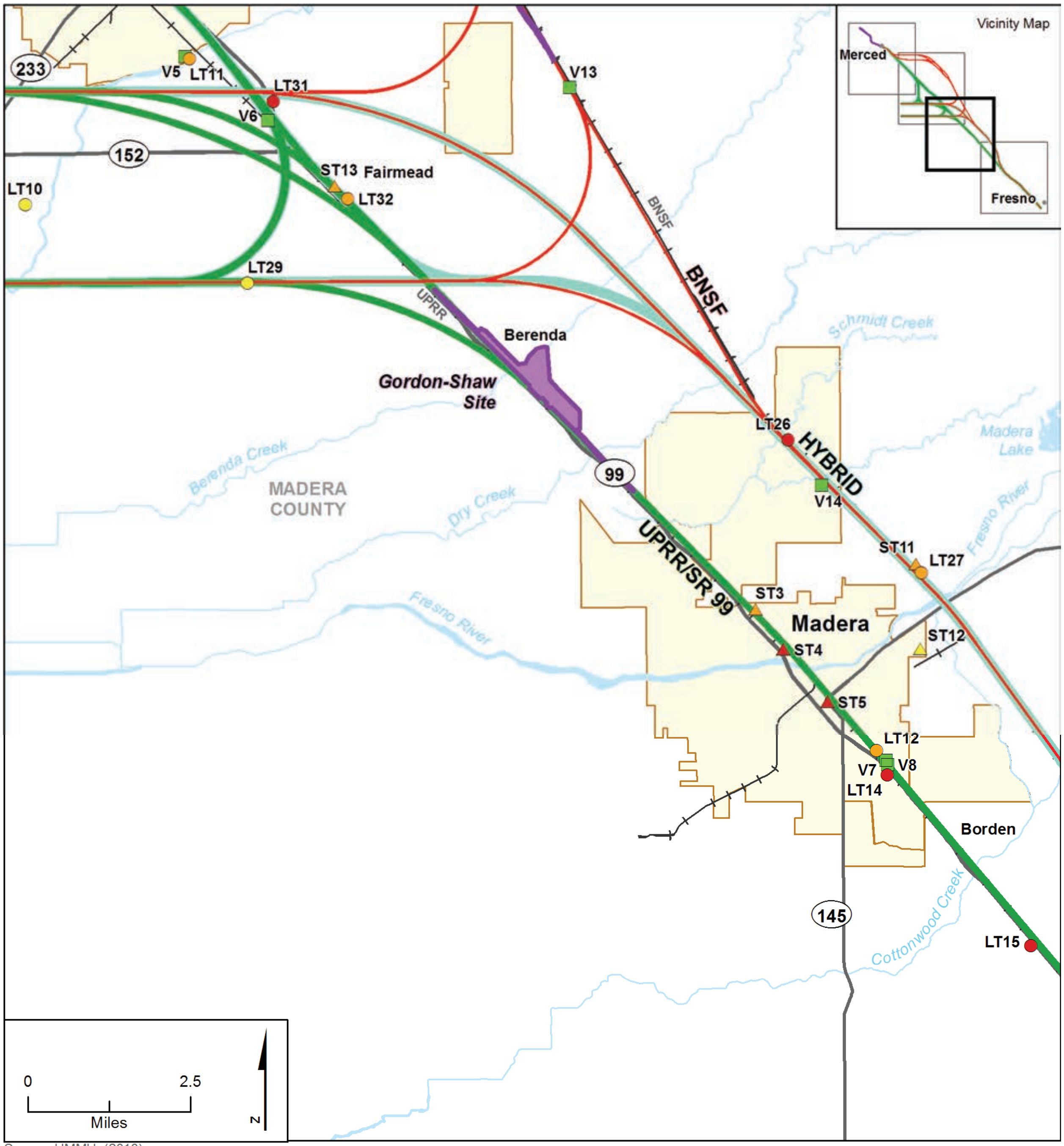
UPRR/SR 99 Alternative
BNSF Alternative
Hybrid Alternative
Potential Heavy Maintenance Facility
Station Study Area
City Limit
County Boundary
Railroad

Vibration Measurement Site

Long-term Noise Monitoring Site
- Between 40 and 55 dBA
- Between 56 and 64 dBA
- Above 65 dBA

Short-term Noise Monitoring Site
- Between 40 and 55 dBA
- Between 56 and 64 dBA
- Above 65 dBA

Figure 3.4-6
Noise and Vibration Measurement Locations in the Chowchilla Project Vicinity



Source: HMMH, (2010).

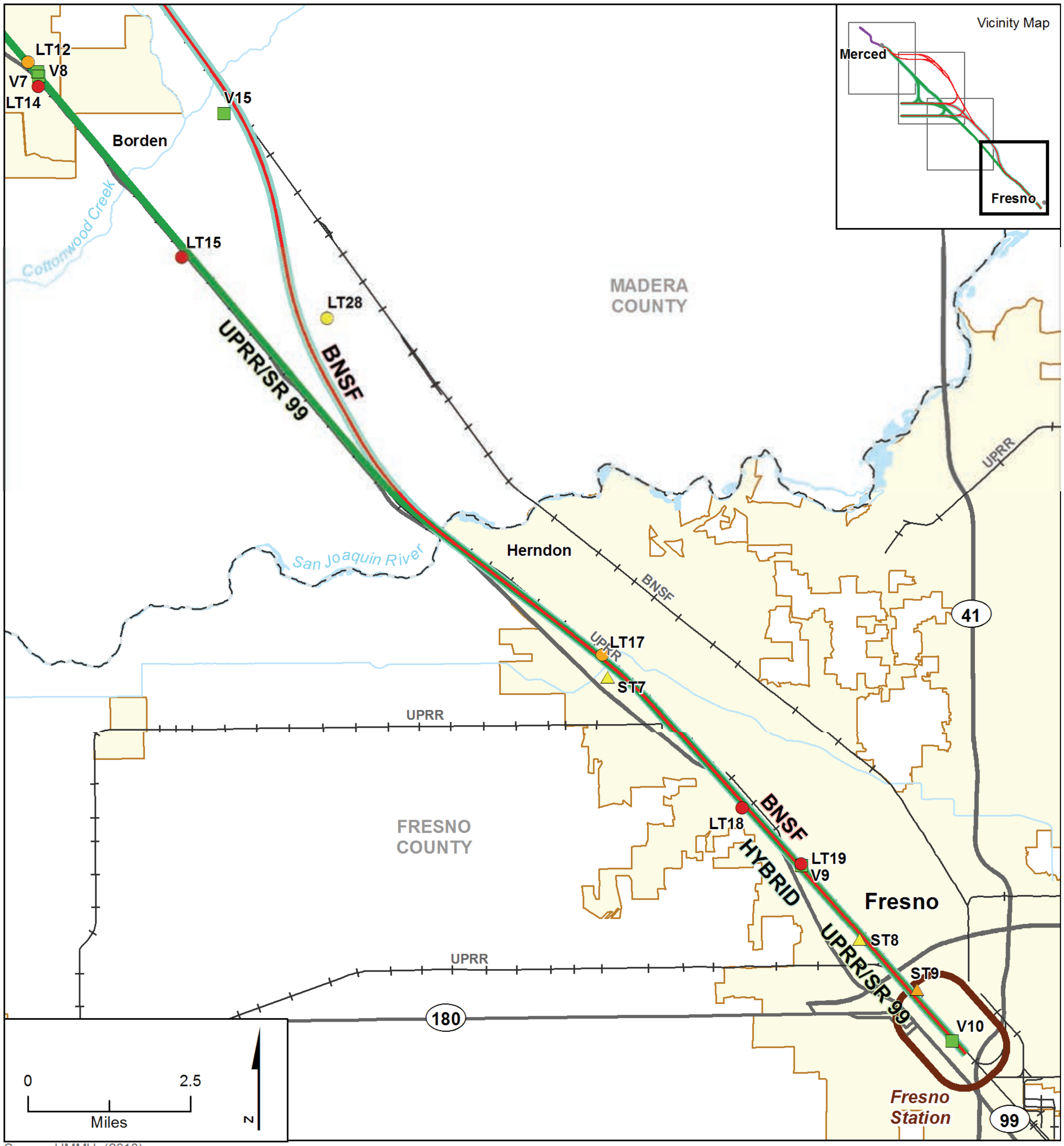
MF_EIS_NV_10-13_c Jun 09, 2011

- UPRR/SR 99 Alternative
- BNSF Alternative
- Hybrid Alternative
- Potential Heavy Maintenance Facility
- Station Study Area
- City Limit
- County Boundary
- Railroad
- Vibration Measurement Site

Long-term Noise Monitoring Site
- Between 40 and 55 dBA
- Between 56 and 64 dBA
- Above 65 dBA

Short-term Noise Monitoring Site
- Between 40 and 55 dBA
- Between 56 and 64 dBA
- Above 65 dBA

Figure 3.4-7
Noise and Vibration Measurement Locations in the Madera Project Vicinity



Source: HMMH, (2010).

MF_EIS_NV_10-13_d Jun 09, 2011

UPRR/SR 99 Alternative
BNSF Alternative
Hybrid Alternative
Potential Heavy Maintenance Facility
Station Study Area
City Limit
County Boundary
Railroad

Vibration Measurement Site
Long-term Noise Monitoring Site
Between 40 and 55 dBA
Between 56 and 64 dBA
Above 65 dBA
Short-term Noise Monitoring Site
Between 40 and 55 dBA
Between 56 and 64 dBA
Above 65 dBA

Figure 3.4-8
Noise and Vibration Measurement
Locations in the Fresno Project Vicinity

Table 3.4-10 provides the long-term measurement results and Table 3.4-11 provides the short-term measurement results. Measured L_{dn} levels ranged from 56 dBA to 75 dBA along the UPRR/SR 99 Alternative where measurement locations were either in urban or suburban areas or near SR 99; L_{dn} levels along this alignment vary because of the proximity to SR 99. Day-night sound level, L_{dn}, values ranged from 46 dBA to 69 dBA in areas along the BNSF Alternative where measurement locations were in suburban and rural environments; L_{dn} values vary, depending on community activity and traffic. A description of the existing noise environment in each portion of the study area follows the tables.

Table 3.4-10
Long-Term Existing Noise Measurement Locations

Site	NSA	City	Address	Project Component	Contributing Noise Sources	Measured L_{dn} (dBA)	Peak-Hour[a] L_{eq} (dBA)
UPRR/SR 99 Alternative North-South Alignment							
LT1	1W	Atwater	3005 Lucky Debonair Street	Castle Commerce Center	BNSF, local traffic	56	51
LT9	13W	Chowchilla	240 Front Street	UPRR/SR 99	UPRR, local traffic	67	58
LT11	13W	Chowchilla	240 Front Street	UPRR/SR 99 Hybrid BNSF Ave 24 Wye	UPRR, local traffic	67	58
LT12	24E	Madera	2046 Varbella Park	UPRR/SR 99	SR 99, UPRR, local traffic	64	57
LT14	25W	Madera	1250 E Almond Avenue	UPRR/SR 99	SR 99, UPRR, local traffic	71	65
LT15	26W	Madera	10696 SR 99	UPRR/SR 99	SR 99, UPRR, local traffic	66	61
LT30	13	Chowchilla	309 Prosperity Blvd	UPRR/SR 99	SR 99, UPRR, local traffic	63	63
LT31	15	Chowchilla	23711 Fairmead Blvd	UPRR/SR 99 Hybrid BNSF Ave 24 Wye	SR 99, UPRR, local traffic	64	63
LT32	16E	Chowchilla	22327 Arnott Drive	UPRR/SR 99	SR 99, UPRR, local traffic	61	61
City of Merced							
LT2	3E	Merced	3227 W Culley Court	Castle Commerce Center Lead Track	SR 99, local traffic	58	50
LT3	4E	Merced	2350 Franklin Road	Castle Commerce Center Lead Track	SR 99, UPRR, local traffic	63	59
LT4	7W	Merced	720 W 15th Street	UPRR/SR 99 BNSF Hybrid	SR 99, UPRR, local traffic	73	64
LT5	9W	Merced	301 E 13th Street	UPRR/SR 99 BNSF Hybrid	SR 99, UPRR, local traffic	72	62

Site	NSA	City	Address	Project Component	Contributing Noise Sources	Measured L_{dn} (dBA)	Peak-Hour[a] L_{eq} (dBA)
LT6	10E	Merced	340 S Parsons Avenue	UPRR/SR 99 BNSF Hybrid	SR 99, UPRR, local traffic	75	71
LT7	11	Merced	4000 Mariposa Way	UPRR/SR 99 Hybrid	SR 99, UPRR	67	58
City of Fresno							
LT17	32E	Fresno	5468 Delbert Avenue	UPRR/SR 99 BNSF Hybrid	UPRR, local traffic	63	57
LT18	34W	Fresno	3089 N Feland Avenue	UPRR/SR 99 BNSF Hybrid	SR 99, UPRR rail yard, local traffic	72	68
LT19	36E	Fresno	2020 N Weber Avenue	UPRR/SR 99 BNSF Hybrid	UPRR, local traffic	70	66
Ave 24 Wye							
LT8	39	Chowchilla	24290 Road 9	Ave 24 Wye	Rural traffic	51	45
Ave 21 Wye							
LT10	41	Chowchilla	22283 Road 14½	Ave 21 Wye	Rural traffic	50	42
LT29	55	Madera	20978 Road 18	Ave 21 Wye	UPRR, local traffic	49	50
Unique Portion of the BNSF Alternative North-South Alignment							
LT20	39	Merced	3269 E. Mission Avenue	Mission Ave design option	SR 99, UPRR, local traffic	56	59
LT21	43	Merced	823 Mariposa Way	Mariposa Way design option	Local traffic	48	46
LT22	44	Le Grand	2373 S Burchell Avenue	Mariposa Way design option	Local traffic, BNSF	49	50
LT23	46	Le Grand	4280 S Ipsen Avenue	East of Le Grand design options	BNSF, local traffic	47	48
LT24	47	Le Grand	4112 Marshall Street	Le Grand design options	BNSF, local traffic	67	64
LT25	49	Chowchilla	27112 Santa Fe Drive	BNSF	BNSF, local traffic	54	50
LT26	51	Madera Acres	26226 Wayside Drive	BNSF Hybrid	BNSF, local traffic	69	66
LT27	52	Madera	16494 Harper Blvd	BNSF Hybrid	BNSF, local traffic	59	59
LT28	54	Madera	9691 Road 32	BNSF Hybrid	SR 99, BNSF, local traffic	46	44

[a]L_{eqs} were averaged over two ranges of typical peak traffic hours: 6:00 a.m. to 9:00 a.m. and 4:00 p.m. to 7:00 p.m. The lower of the two averages was used to accentuate the potential impacts.

NSA = noise-sensitive area

Source: Authority and FRA (2011).

Table 3.4-11
Short-Term Existing Noise Measurement Locations

Site	NSA	City	Location	Project Component	Contributing Noise Sources	Duration	Measured L_{eq} (dBA)	Estimated L_{dn}[a] (dBA)
UPRR/SR 99 Alternative North-South Alignment								
ST3	20	Madera	Progressive Church of God in Christ: 15879 Cardwell Street	UPRR/SR 99	UPRR, local traffic	1 hour	61	59
ST4	21W	Madera	Rotary Park: N. Gateway Drive	UPRR/SR 99	SR 99, UPRR, local traffic	1 hour	69	67
ST5	23W	Madera	Courthouse Park: W. Yosemite Avenue	UPRR/SR 99	UPRR, local traffic	1 hour	67	65
ST13	16E	Chowchilla	Galilee Missionary Baptist Church	UPRR/SR 99	SR 99, local traffic	1 hour	60	58
City of Merced								
ST1	4E	Merced	Franklin Elementary School: 2736 Franklin Road	Castle Commerce Center Lead Track	SR 99, local traffic	15 minutes	56	54
ST2	8E	Merced	Bob Hart Park: W Main Street	UPRR/SR 99 BNSF Hybrid	UPRR, local traffic	15 minutes	61	59
City of Fresno								
ST7	33W	Fresno	First Spanish Baptist Church: 5365 W Mission Avenue	UPRR/SR 99 BNSF Hybrid	SR 99, UPRR, local traffic	1 hour	54	52
ST8	37W	Fresno	Roeding Park: W Belmont Avenue	UPRR/SR 99 BNSF Hybrid	UPRR tracks, local traffic	1 hour	55	53
ST9[b]	38E	Fresno	H St Lofts: 1814 H Street	UPRR/SR 99 BNSF Hybrid	UPRR, local traffic	1 hour	61	59
BNSF Alternative North-South Alignment								
ST10	47	Le Grand	Le Grand Elementary School	Le Grand design options	Local traffic	1 hour	57	55
ST11	52	Madera	Morning Star Baptist	BNSF Hybrid	Local traffic	1 hour	56	54

[a]Based on adjustment option 4 (FTA 2006).

NSA = noise-sensitive area

Source: Authority and FRA (2011).

UPRR/SR 99 Alternative

The noise environment along the proposed UPRR/SR 99 Alternative is influenced by SR 99, UPRR and BNSF railroad traffic, local community noise, and local roadway traffic. At the northern end of the alignment in Atwater, passenger and freight trains dominate the noise exposure in areas close to the UPRR and BNSF tracks. In areas close to Santa Fe Avenue, local roadway traffic dominates the noise environment. Nearing Merced from the north, traffic on SR 99 and freight trains on the UPRR railroad dominate the noise exposure, with roadway traffic contributing more noise near the city center where SR 99, SR 59, and SR 140 converge. Merced Regional Airport is located approximately 2 miles southwest of Merced's city center and contributes aircraft noise to the environment.

South of Merced, noise from SR 99 and UPRR dominates the noise environment in unincorporated areas between Merced and Chowchilla. Because noise-sensitive areas in Chowchilla are farther from SR 99 than the UPRR, freight trains and local community noise dominate the noise environment for both Chowchilla design options. In addition, there is a general aviation airport in Chowchilla located 1 mile southeast of the city center.

South of Chowchilla, noise from SR 99 and UPRR dominates the existing noise environment at scattered residences. Upon entering Madera, the HST alignment moves farther from SR 99, and the noise environment near Madera's city center is dominated by UPRR traffic and local community noise. Madera Municipal Airport is located approximately 3 miles northwest of the city center. This general aviation airport contributes aircraft noise to the environment.

In the unincorporated area between Madera and Fresno, SR 99 and UPRR traffic dominate the noise environment. Entering Fresno, the noise environment is dominated by freight trains and local roadway traffic. UPRR runs through Fresno east of SR 99, and the UPRR rail yard is located between Ashlan Avenue and Clinton Avenue. In this area, the rail yard contributes to the noise environment along with SR 99 and local community noise. South of the rail yard, the noise environment is dominated by UPRR traffic and local community noise.

Fresno is the most densely populated city along the proposed corridor, with several highways, busy local roads, UPRR, and aircraft noise contributing to the noise environment. SR 99, SR 180, and SR 41 are all near the proposed HST station site in Fresno. Fresno has two airports, Fresno-Yosemite International and Fresno Chandler Downtown. Fresno-Yosemite International Airport is located approximately 3 miles northeast of Fresno's city center and operates scheduled commercial flights. Fresno Chandler is located approximately 2.5 miles southwest of the city center and is a public airport used for general aviation. Sierra Sky Park Airport, a privately owned airport used for general aviation, is located approximately 8 miles northwest of Fresno's city center. Aircraft noise from these three airports adds to the existing noise environment in the Fresno area.

Wye Design Options

The Ave 24 Wye and the Ave 21 Wye are in a rural, unincorporated portion of Madera County. The existing noise environment is dominated by natural sounds, distant traffic, and agricultural activities.

BNSF Alternative

The BNSF Alternative corridor is the same as the UPRR/SR 99 Alternative corridor for portions of the study area. The noise environments where the corridor differs from the UPRR/SR 99 Alternative are discussed below. The noise environments for the City of Merced and the City of Fresno are the same as the UPRR/SR 99 Alternative.

The BNSF Alternative shares the same corridor as the UPRR/SR 99 Alternative as far as the south end of the City of Merced, where the BNSF Alternative moves east into rural unincorporated areas by following one of four design options: Mariposa Way, Mariposa Way East of Le Grand, Mission Ave, and Mission Ave East of Le Grand. The City of Le Grand has a small population and is mainly residential; therefore, it is considered suburban. After Le Grand, the design options merge and the BNSF Alternative continues south toward Madera Acres. This portion of the alignment runs through farmland with a noise environment dominated by rural activities. Madera Acres is just north of Madera and also is mainly residential, so it is considered suburban. The BNSF Alternative continues through the suburban areas of Madera Acres and Madera until it moves west back toward the UPRR/SR 99 Alternative just before the Madera County line. Traffic on local roadways is likely the greatest contributor of noise, added to by agricultural activity and aircraft noise during the growing and harvesting season. The alternatives continue to share the corridor to the proposed Fresno HST station.

Wye Design Options

The Ave 24 Wye and the Ave 21 Wye are in a rural, unincorporated portion of Madera County. The existing noise environment is dominated by natural sounds, distant traffic, and agricultural activities.

Hybrid Alternative

The Hybrid Alternative alignment is a combination of the UPRR/SR 99 and BNSF alternatives. The alternative follows two different corridors depending on wye design option. For the Ave 24 Wye design option, the alignment follows the UPRR/SR 99 alignment with the West Chowchilla design option from Merced to Chowchilla. From Chowchilla to Fresno, the alignment follows the BNSF Alternative alignment with the Ave 24 Wye. With the Ave 21 Wye design option, the Hybrid Alternative follows the UPRR/SR 99 alignment with the East Chowchilla design option from Merced to Chowchilla. From Chowchilla to Fresno, the alignment follows the BNSF alignment with the Ave 21 Wye. The noise environments for these locations are identical to the UPRR/SR 99 and BNSF Alternatives.

Wye Design Options

The Ave 24 Wye and the Ave 21 Wye are in a rural, unincorporated portion of Madera County. The noise environments for these locations are identical to the UPRR/SR 99 and BNSF Alternatives.

Heavy Maintenance Facility Alternatives

- **Castle Commerce Center**: The existing noise environment near the Castle Commerce Center HMF site consists of noise from BNSF freight traffic and roadway noise from traffic on Santa Fe Drive in Atwater and other local roads as well as local community noise.
- **Harris–DeJager**: The existing noise environment near the Harris-DeJager HMF site consists of noise from UPRR freight traffic and roadway noise from traffic on SR 99 and other local roads as well as local community noise.
- **Fagundes**: The existing noise environment near the Fagundes HMF site consists of local roadway traffic noise as well as local community noise.
- **Gordon–Shaw**: The existing noise environment near the Gordon-Shaw HMF site consists of noise from UPRR freight traffic and roadway noise from traffic on SR 99 and other local roads as well as local community noise.
- **Kojima Development**: The existing noise environment near the Kojima Development HMF site consists of noise from BNSF freight traffic and local roadway traffic noise as well as local community noise.

3.4.4.2 Existing Vibration Levels

Project analysts identified vibration-sensitive areas (VSAs) within the study areas by locating the vibration-sensitive land use categories listed in Table 3.4-6 (i.e., residential and institutional) within an appropriate screening distance for the proposed HST alternatives. The screening distances used to identify VSAs are based on FRA guidance, as listed in Table 3.4-9. Some of these VSAs are exposed to existing sources of ground-borne vibration. The existing levels were measured by placing vibration sensors at representative vibration-sensitive locations throughout the corridor along the UPRR and BNSF tracks.

UPRR/SR 99 Alternative

Sources of existing vibrations along the alignment include UPRR and BNSF freight trains, Amtrak passenger trains, and truck traffic on SR 99. Consequently, vibration from the trains was measured in each community along the corridor to estimate the range where existing train vibrations are considered substantial by FRA and FTA threshold levels. Overall ground-borne vibration levels measured in Chowchilla from UPRR trains ranged from 80 VdB at 45 feet to 72 VdB at 120 feet; the measured levels in Madera from UPRR trains ranged from 84 VdB at 50 feet to 77 VdB at 125 feet. Ground-borne vibration was also measured for truck traffic on SR 99 at approximately 150 feet from the highway centerline. The overall vibration levels, ranging from about 35 to 55 VdB, are well below the 65 VdB threshold of perception. Therefore, truck traffic is not considered to affect the vibration analysis in the Merced to Fresno Section.

Project analysis compared the ground-borne vibration from trains measured in each community with the generalized vibration curve in Figure 10-1 in the FTA guidance manual (FTA 2006). The measured vibration levels are from trains traveling at various speeds; these vibration levels were normalized to 50 mph for comparison to each other and the generalized vibration curve. The vibration data for each community along the corridor closely matched the levels of typical trains found in the FTA guidance manual, which are shown in the *Merced to Fresno Section Noise and Vibration Technical Report* (Authority and FRA 2011).

In addition to measurements of vibration from existing sources, vibration measurements for the project focused on characterizing the way ground-borne vibration is transmitted through soil at representative locations along the alignments. Nine vibration propagation test sites (these locations are shown in Figures 3.4-5 through 3.4-8) were selected to represent the range of soil conditions in areas along the corridor where there are a significant number of vibration-sensitive receivers. At each of these sites, ground-borne vibration propagation tests were conducted by striking the ground and measuring the input force and corresponding ground vibration response at various distances. The resulting force-response transfer function can be combined with the known input force characteristics of the HST to predict future vibration levels at locations along the alignment.

Downtown Merced and Downtown Fresno Stations

Overall vibration levels in the City of Merced measured for UPRR freight trains ranged from 80 VdB at 60 feet to 70 VdB at 135 feet from the tracks. In the City of Fresno, overall vibration levels for freight and passenger trains ranged from 87 VdB at 48 feet to 77 VdB at 210 feet from the tracks.

Wye Design Options

There are no significant existing sources of ground-borne vibration along either the Ave 24 or the Ave 21 wye design option.

BNSF Alternative

Sources of existing vibration along the unique portion of the BNSF Alternative include BNSF freight trains and Amtrak passenger trains. Project analysts measured vibration from the trains along the alignment and conducted vibration propagation testing, as previously discussed for the UPRR/SR 99 alignment. Measured overall ground-borne vibration levels for BNSF trains in Le Grand ranged from 72 VdB at 225 feet to 63 VdB at 350 feet from the tracks. The vibration levels from Amtrak trains in Le Grand were lower, at 65 VdB at 225 feet to 58 VdB at 350 feet from the tracks. Existing overall ground-borne vibration levels for BNSF trains in Madera ranged from 80 VdB at 50 feet to 74 VdB at 175 feet from the tracks; for Amtrak trains ground-borne vibration levels ranged from 77 VdB at 50 feet to 62 VdB at 140 feet from the tracks.

Wye Design Options

There are no significant existing sources of ground-borne vibration along either the Ave 24 or the Ave 21 wye design option.

Hybrid Alternative

The Hybrid Alternative alignment is a combination of the UPRR/SR 99 and BNSF alternatives. The alternative follows two different corridors depending on wye design option. For the Ave 24 Wye design option, the alignment of the Hybrid Alternative follows the UPRR/SR 99 alignment with the West Chowchilla design option from Merced to Chowchilla. From Chowchilla to Fresno, the alignment of the Hybrid Alternative follows the BNSF Alternative alignment with the Ave 24 Wye. With the Ave 21 Wye design option, the alignment of the Hybrid Alternative follows the UPRR/SR 99 alignment with the East Chowchilla design option from Merced to Chowchilla. From Chowchilla to Fresno, the alignment follows the BNSF Alternative alignment with the Ave 21 Wye. The vibration environments for these locations are discussed above under the UPRR/SR 99 and BNSF Alternative sections.

Wye Design Options

The Ave 24 Wye and the Ave 21 Wye are in a rural, unincorporated portion of Madera County. The vibration environments for these locations are discussed above under the UPRR/SR 99 and BNSF Alternative sections.

Heavy Maintenance Facility Alternatives

- **Castle Commerce Center**: Existing vibration and vibration propagation measurements conducted in Atwater are representative of the area near the Castle Commerce Center. The measured existing overall vibration levels for BNSF trains ranged from 81 VdB at 65 feet to 77 VdB at 115 feet from the tracks; for Amtrak trains overall vibration levels ranged from 74 VdB at 65 feet to 66 VdB at 115 feet from the tracks.
- **Harris–DeJager**: Vibration measurements along the UPRR in Chowchilla are representative of the existing vibration levels in the area of the proposed Harris-DeJager HMF site.
- **Fagundes**: There are no significant existing sources of ground-borne vibration near the proposed Fagundes HMF site.
- **Gordon-Shaw**: Vibration measurements along the UPRR in Madera are representative of the existing vibration levels in the area of the Gordon-Shaw HMF site.
- **Kojima Development**: Vibration measurements along the BNSF in Madera and Le Grand are representative of the existing vibration levels in the area of the Kojima Development HMF site.

3.4.5 Environmental Consequences

3.4.5.1 Overview of Operational Impacts

Table 3.4-12 summarizes the number of noise impacts by project alternative from conceptual HST operations and the HMFs. The highest number of moderate and severe noise impacts is associated with the UPRR/SR 99 Alternative. The numbers of moderate and severe noise impacts under the BNSF and Hybrid alternatives are lower than under the UPRR/SR 99 Alternative.

Table 3.4-12
Summary of Noise Impacts by Project Alternative from HST Operations and HMFs

HST Alternative	Total Number of Impacts Before Mitigation	
	Moderate	Severe
UPRR/SR 99	1,243 to 1,325 residential, 5 to 6 churches, 1 school, 1 hospital	787 to 884 residential, 1 to 2 churches, 1 park, 1 outdoor movie theater
BNSF	780 to 1,253 residential, 3 to 4 churches	420 to 468 residential, 1 park
Hybrid	796-915 residential, 3-4 churches	419-458 residential, 1 park
Impacts by Heavy Maintenance Facility Alternatives		
Castle Commerce Center	291	91
Harris–DeJager	0	0
Fagundes	0	0
Gordon–Shaw	0	0
Kojima Development	0	0
Source: Authority and FRA (2011).		

Most of the HMF sites do not have noise-sensitive receivers located close by. However, because there are noise-sensitive receivers in the vicinity of the lead track necessary for access to the Castle Commerce Center, moderate and severe noise impacts would result if this HMF location were selected.

There is one vibration impact projected for each of the BNSF Alternative Le Grand design options. There would be no vibration effects on sensitive receivers outside of the HST right-of-way from the UPRR/SR 99 or Hybrid Alternatives during operation. None of the HMF sites would result in vibration impacts.

3.4.5.2 No Project Alternative

Currently, many sources of noise and vibration exist throughout the HST corridor, as described in Section 3.4.4, Affected Environment. These sources, including the UPRR, BNSF, and SR 99, would continue to generate noise and vibration.

Chapter 2, Alternatives, describes the transportation construction projects that would be constructed by 2035 between Merced and Fresno without the HST System.

Freight trains currently operating along the UPRR and BNSF between Merced and Fresno would continue to operate without the HST System. Future freight traffic on privately owned railroads for the year 2035 is subject to commercial demands and cannot be determined to a level to conduct an assessment. According to the FRA Office of Safety (2010), train traffic on UPRR has maintained 20 to 24 trains per day since the recording began in 1970. The BNSF database shows that for the past 10 years, they have had about 20 to 24 trains, 12 of which have been Amtrak trains, whereas the FRA Office of Safety reports as high as 40 to 45 train movements in different parts of the Merced to Fresno Section. It seems that the number of freight trains on both corridors vary according to the economic conditions. But the variation has been historically only two to four trains per day difference. The number of trains is not anticipated to vary from this amount in the planning horizon. While there may be increases in freight volume, a 100% increase in volume would be required for a 3-dB increase in future freight noise levels. Because increases in freight volumes would likely be substantially below this, the noise increases would be minimal.

Caltrans will assess individually future highway improvement projects that may occur in the study area. Caltrans has plans to improve SR 99; however, with all of the planned structural and capacity improvements, Caltrans anticipates that urban areas along SR 99 will not meet acceptable operating standards in 2035. Non-urban areas will operate at a level of service (LOS) of D or better (Caltrans 2009). There may be increases in traffic volume; however, it would take a 100% increase in volume for a 3 dB increase in future traffic noise levels. The actual levels will be determined by the Caltrans study.

Without data, it cannot be determined if there would be any noise or vibration impacts in the future from these and other sources under the No Project Alternative. Any significant projects that might be included in the No Project Alternative would have a separate environmental assessment to determine noise or vibration impacts and potential mitigation measures, if required.

3.4.5.3 High-Speed Train Alternatives

Construction Period Impacts

Common Construction Noise Impacts

By using the FTA criteria provided in Table 3.4-1 and the noise projections in Table 3.4-13, and assuming that construction noise reduces by 6 dB for each doubling of distance from the center of the site, it is possible to estimate the screening distances for potential construction noise impact. These estimates suggest that the potential for construction noise impact would be minimal for commercial and industrial land use, with impact screening distances of 79 feet and 45 feet, respectively. For residential land use, the potential for temporary construction noise impact would be limited to locations within approximately 141 feet of the alignment. However, the potential for noise impact from nighttime construction could extend to residences as far as 446 feet, but the Authority will work to minimize this potential impact. These impacts would be temporary during construction (see Chapter 2, Alternatives). For residences within 141 feet of the alignment, or within 446 feet during nighttime, construction impacts would be moderate under NEPA and significant under CEQA. There is no construction noise impact projected for any of the HMF sites.

Table 3.4-13
Typical Equipment Noise for Rail Construction

Equipment Item	Typical Maximum Sound Level at 50 Feet (dBA)	Equipment Utilization Factor (%)	L_{eq} (dBA)
Air Compressor	81	50	78
Backhoe	80	40	76
Crane, Derrick	88	10	78
Bulldozer	85	40	81
Generator	81	80	80
Loader	85	40	81
Jackhammer	88	4	74
Shovel	82	40	78
Dump Truck	88	16	80
Total Workday L_{eq} at 50 feet (8-hour workday)			**89**
Source: (Authority and FRA 2011).			

Common Construction Vibration Impacts

During construction, some equipment may cause ground-borne vibration, most notably pile-driving equipment. Construction equipment can produce vibration levels at 25 feet that range from 58 VdB for a small bulldozer to 112 VdB for a pile driver. Table 3.4-14 provides the approximate distances within which receivers could experience construction-related vibration effects.

Table 3.4-14
Approximate Distances to Vibration Criterion-Level Contours

Land Use Category	Vibration Criterion Level (VdB)	Approximate Vibration Contour Distance (feet)
Category 1[a]	65	175
Category 2	72	130
Category 3	75	70

[a]See Table 3.4-4 for a description of the categories.
Source: Authority and FRA (2010).

Because there are receivers present within the distances identified in Table 3.4-14, with pile driving, there is potential for severe vibration impacts during construction that would be substantial under NEPA and significant under CEQA. Without pile driving, the impact would be moderate under NEPA and significant under CEQA. There would be no vibration impacts from construction at any of the proposed HMF sites.

Project Impacts

Severe and Moderate Noise Impacts

Project analysts assessed HST noise impacts for noise-sensitive land uses based on a comparison of existing noise levels with future noise levels from the project. Existing noise levels were measured and estimated near the proposed alignments in the Merced to Fresno Section. Existing noise along the proposed alternatives is dominated by traffic on SR 99 in some areas (for example, in Chowchilla, Madera, and Fresno), by freight trains along the UPRR or BNSF tracks in some areas (for example, in Le Grand), and by a combination of both traffic noise and freight train noise in other areas (for example, in Merced, Madera, and Fresno). Traffic on SR 99 tends to be continuous throughout day and night with a fairly steady noise level. Freight trains in this area are high noise-level events that average about 20 to 40 times per day (depending on location). The combination of the two types of sources results in higher existing noise levels than either one alone.

Project noise levels for comparison depend on factors such as number of trains per day, speed, and track configuration. The conceptual operations schedule shows that up to 272 trains per day would pass through Madera and Fresno, in contrast with about 100 per day in Merced in 2035. Fewer trains at lower speeds would result in lower noise levels, and combined with fewer noise-sensitive land uses, would result in fewer noise impacts north of the wye. The large number of homes along the alignment in Madera and Fresno, along with higher train speeds and greater number of trains, would result in many more noise impacts in the southern section. In rural areas with low existing noise levels and no building shielding, impacts occur at greater distances from the alignment. All alternatives would result in severe and moderate noise impacts from the project. In locations where train speeds and operations are high, severe noise impacts would be substantial under NEPA and significant under CEQA and moderate noise impacts would be moderate under NEPA and less than significant under CEQA. This evaluation is based on the information currently available. Project elements, such as the specific vehicle type, track structure and other elements, may change during engineering and design, resulting in changes to the noise assumptions and the results of the impact assessment. As project elements affecting noise either change or are refined, additional analyses will be conducted to reflect these changes.

The following sections summarize potential noise impacts for the UPRR/SR 99, BNSF, and Hybrid alternatives caused by operation of HSTs. The *Merced to Fresno Section Noise and Vibration Technical Report* (Authority and FRA 2011) provides more details regarding impacts.

UPRR/SR 99 Alternative

Figures 3.4-9 through 3.4-12 show the locations of noise impacts under the UPRR/SR 99 Alternative without mitigation during the design year (2035). Table 3.4-15 summarizes potential direct noise impacts related to operation of HSTs under the UPRR/SR 99 Alternative without mitigation during the design year (2035). HST noise impacts are assessed for noise-sensitive land uses based on a comparison of existing noise levels with future noise levels from the project. North of the wye there are fewer noise-sensitive areas and fewer trains than south of the wye. Consequently, there would be fewer noise impacts in areas of Merced and Chowchilla than in the southern sections of Madera and Fresno. Table 3.4-15 reports the total number of noise impacts projected to occur under all the design variations for the UPRR/SR 99 Alternative.

Table 3.4-15 indicates that for the Ave 24 Wye design options east of Chowchilla, severe noise impacts are projected at 861 residences, 1 church, 1 park, and 1 outdoor movie theater. For the Ave 24 Wye design option west of Chowchilla, severe noise impacts are projected at 884 residences, 2 churches, 1 park, and 1 outdoor movie theater. Under the Ave 21 Wye design option, severe noise impacts are projected at 787 residences, 1 church, 1 park, and 1 outdoor movie theater. The number of moderate impacts would vary among each of the design options.

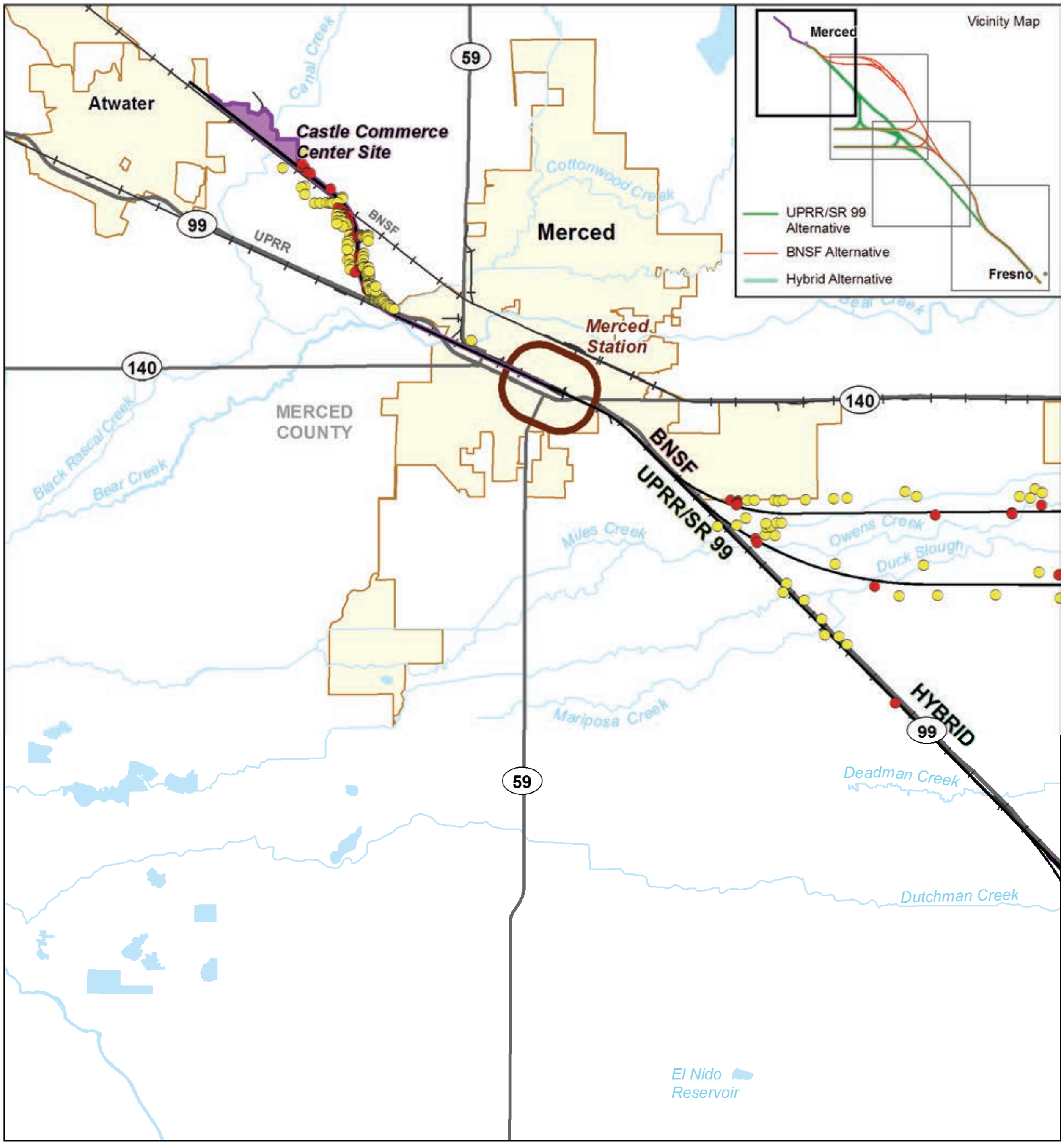
In the Merced vicinity, no severe noise impacts are projected to occur. Because of the relatively high existing noise levels in this urban area and the significantly fewer HST operations north of the wyes, project noise would not result in increases in noise sufficient to cause severe impacts.

In the Chowchilla vicinity with the East Chowchilla design option, severe noise impacts are projected to occur at 65 residences with the Ave 24 Wye design option and at 20 residences with the Ave 21 Wye design option. With the West Chowchilla design option, 155 residences and 1 church would experience severe noise impacts.

In the Madera vicinity, severe noise impacts are projected at 538 residences and 1 outdoor movie theater.

In the Fresno vicinity, severe noise impacts are projected to occur at 181 residences, 1 church, and Roeding Park.

With the Ave 24 Wye design option, severe noise impacts are projected at 77 residences in this area with the East Chowchilla design option and at 10 residences with the West Chowchilla design option, but with the Ave 21 Wye, severe noise impacts are projected at 48 residences in this area.



Source: HMMH, (2011). MF_EIS_NV_02-05_a Jun 14, 2011

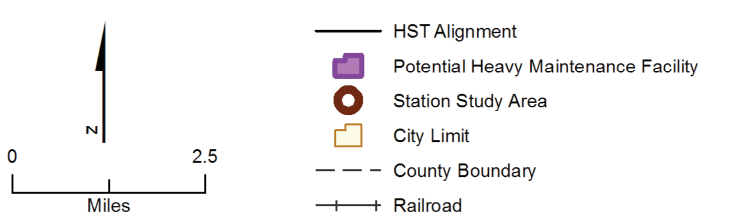


Figure 3.4-9
Noise Impacts in the Merced Project Vicinity

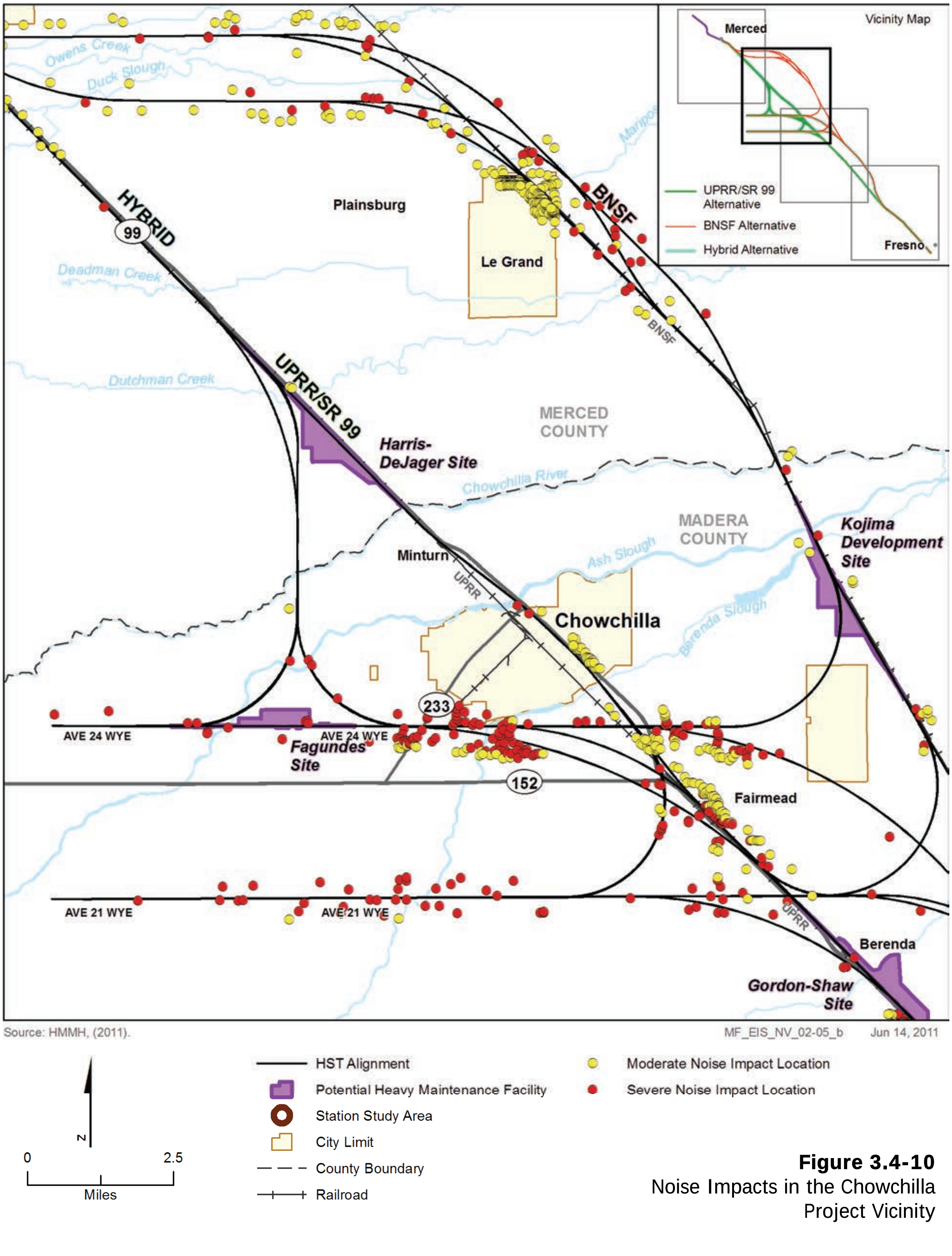
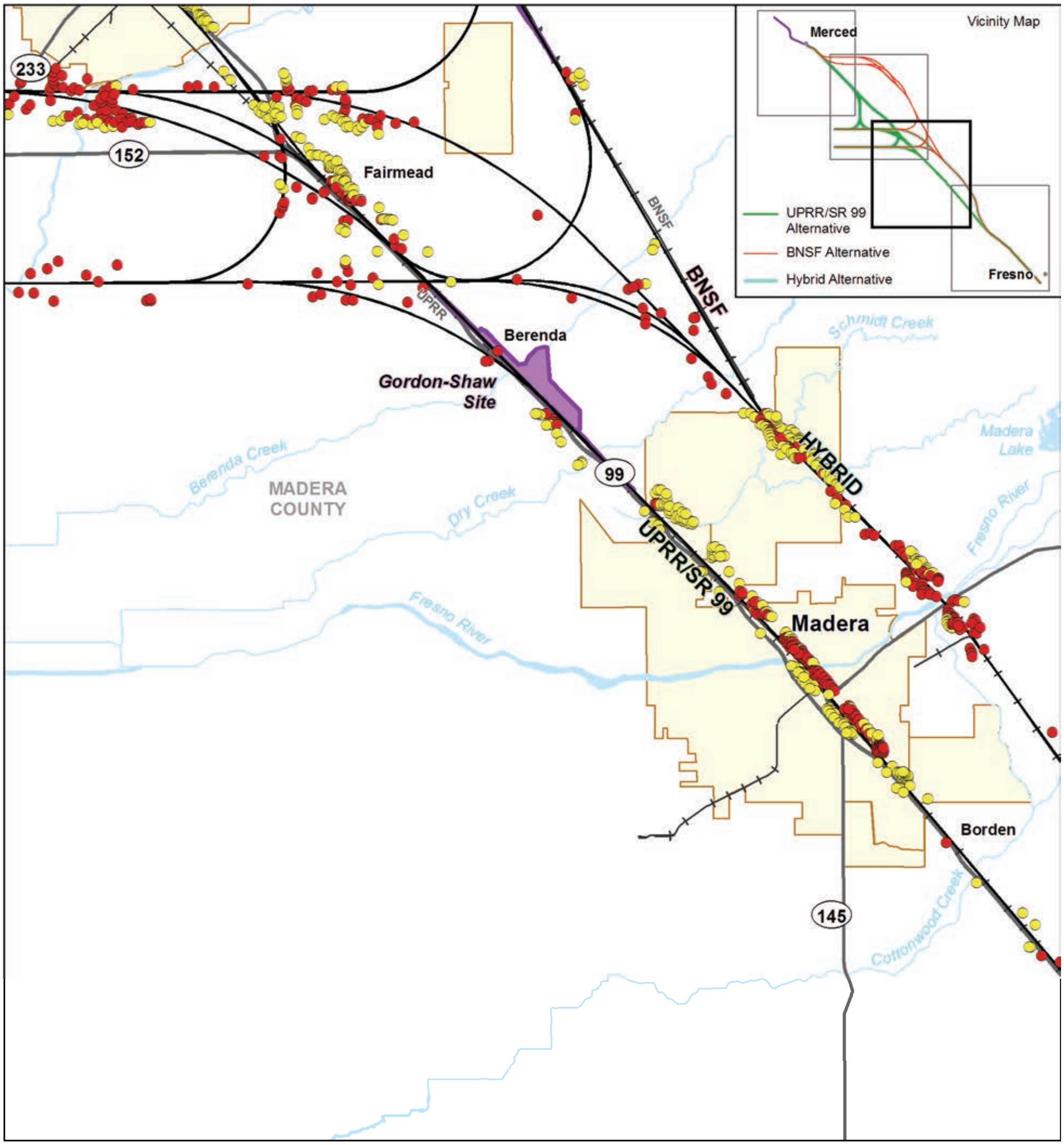


Figure 3.4-10
Noise Impacts in the Chowchilla Project Vicinity



Source: HMMH, (2011).

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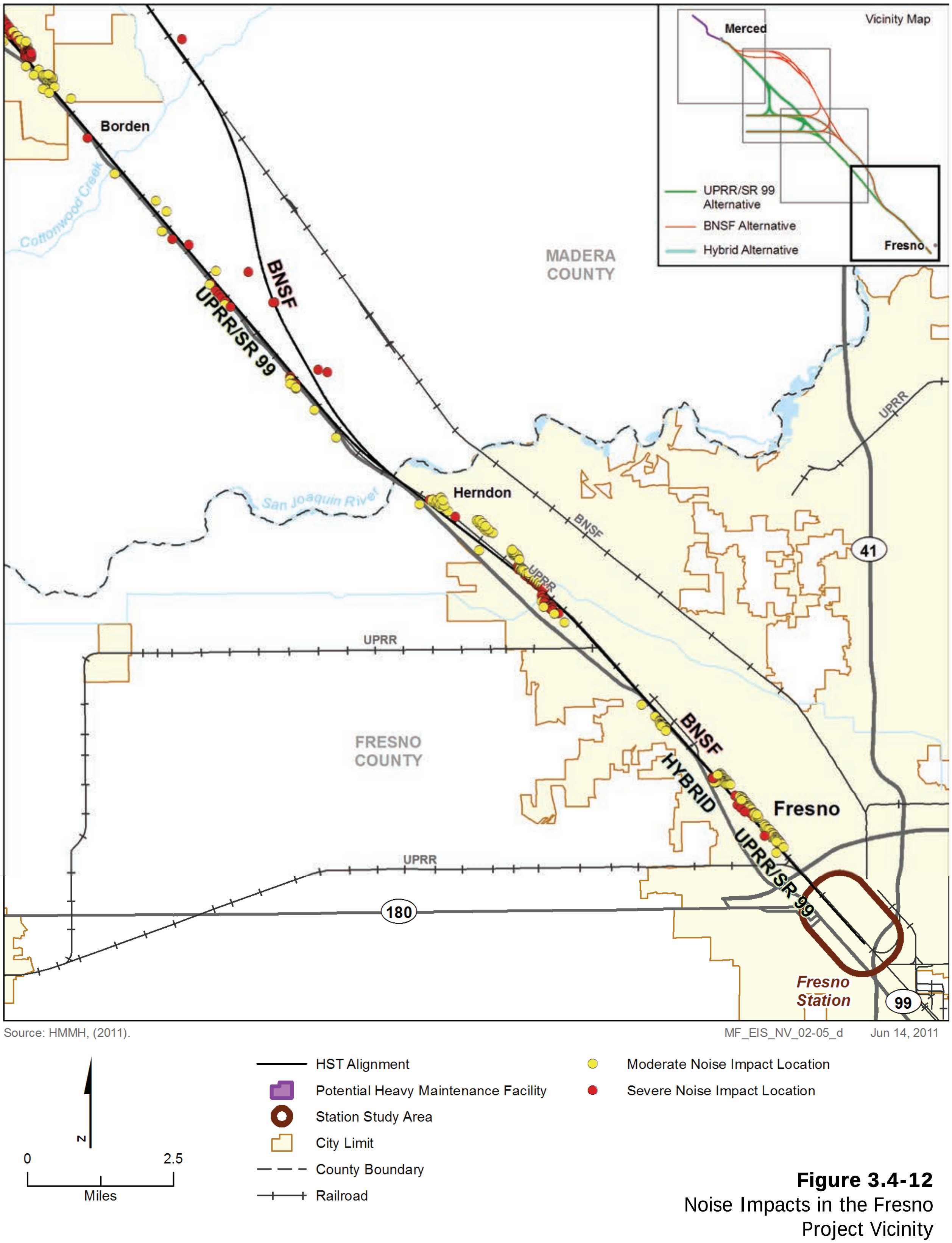
0 2.5
Miles

HST Alignment
Potential Heavy Maintenance Facility
Station Study Area
City Limit
County Boundary
Railroad
Moderate Noise Impact Location
Severe Noise Impact Location

Figure 3.4-11
Noise Impacts in the Madera Project Vicinity



Source: HMMH, (2011).

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Figure 3.4-12
Noise Impacts in the Fresno Project Vicinity

Table 3.4-15
Potential Noise Impacts under the UPRR/SR 99 Alternative without Mitigation for Design Year 2035

UPRR/SR 99 Alternative	Total Number of Impacts	
	Moderate	**Severe**
Impacts by Project Combination		
UPRR/SR 99 with West Chowchilla design option and Ave 24 Wye	1,243 residential, 5 churches, 1 school, 1 hospital	884 residential, 2 churches, 1 park, 1 outdoor movie theater
UPRR/SR 99 with East Chowchilla design option and Ave 24 Wye	1,302 residential, 6 churches, 1 school, 1 hospital	861 residential, 1 church, 1 park, 1 outdoor movie theater
UPRR/SR 99 with East Chowchilla design option and Ave 21 Wye	1,325 residential, 6 churches, 1 school, 1 hospital	787 residential, 1 church, 1 park, 1 outdoor movie theater
Range of Impacts under the UPRR/SR 99 Alternative	**1,243 to 1,325 residential, 5 to 6 churches, 1 school, 1 hospital**	**787 to 884 residential, 1 to 2 churches, 1 park, 1 outdoor movie theater**
Source: Authority and FRA (2010).		

BNSF Alternative

Table 3.4-16 summarizes potential direct noise impacts related to operation of HSTs under the BNSF Alternative during the design year (2035). The table shows the total number of noise impacts projected to occur under all of the BNSF Alternative design options. See Figures 3.4-9 through 3.4-12 for the locations of noise impacts under the BNSF Alternative without mitigation during the design year (2035).

Table 3.4-16
Potential Noise Impacts under the BNSF Alternative without Mitigation for Design Year 2035

BNSF Alternative	Total Number of Impacts	
	Moderate	**Severe**
Impacts by Project Combination		
BNSF north-south alignment with Ave 24 Wye	789 Residential; 3 Churches	440 Residential; 1 Park
BNSF north-south alignment with Ave 21 Wye	730 Residential; 3 Churches	403 Residential; 1 Park
Le Grand Design Options		
Mariposa Way	464 Residential, 1 Church	17
Mariposa Way East of Le Grand	50	25
Mission Ave	457	19
Mission Ave East of Le Grand	58	28

BNSF Alternative	**Total Number of Impacts**	
	Moderate	**Severe**
Impacts by Project Combination		
BNSF Alternative with Ave 24 Wye	839 to 1,253 Residential; 3 to 4 Churches	457 to 468 Residential; 1 Park
BNSF Alternative with Ave 21 Wye	780 to 1,194 Residential; 3 to 4 Churches	420 to 431 Residential; 1 Park
Range of Impacts under the BNSF Alternative	**780 to 1,253 Residential; 3 to 4 Churches**	**420 to 468 Residential; 1 Park**
Source: Authority and FRA (2011).		

Table 3.4-16 indicates that regardless of the design options between Merced and Le Grand, severe noise impacts are projected at approximately the same number of residences, ranging from 457 with the Mariposa Way design option to 468 with the Mission Ave East of Le Grand design option for the Ave 24 design options. In each case, severe impacts are also projected at one park. Under the 4 Ave 21 Wye design options, the number of severe noise impacts projected at residences would range from 420 with the Mariposa Way design option to 431 with the Mission Ave East of Le Grand option. In each case, severe impacts are also projected at one park.

The number of moderate noise impacts would vary among the design options.

In the Merced vicinity, no severe noise impacts are projected to occur within the City of Merced because there are already relatively high existing noise levels and significantly fewer HST operations north of the wyes. South of Merced to the Chowchilla River, severe noise impacts are projected at 17 residences with the Mariposa Way design option, 25 residences with the Mariposa Way East of Le Grand design option, 19 residences with the Mission Ave design option, and 28 residences with the Mission Ave East of Le Grand design option.

The Ave 24 Wye design option would experience severe noise impacts at 94 residences in this area, whereas with the Ave 21 Wye, severe noise impacts are projected at 59 residences.

In the Downtown Fresno Station vicinity, severe noise impacts are projected at 179 residences, and Roeding Park.

Hybrid Alternative

Table 3.4-17 summarizes all potential direct noise impacts related to operation of HSTs under the Hybrid Alternative during the design year (2035). See Figures 3.4-9 through 3.4-12 for the locations of noise impacts under the Hybrid Alternative without mitigation during the design year (2035).

Table 3.4-17 reports the total number of noise impacts projected to occur under all the design variations for the Hybrid Alternative. It indicates that under the Ave 24 Wye design option, severe noise impacts are projected at 458 residences and 1 park. Moderate noise impacts are projected at 796 residences and 3 churches. Under the Ave 21 Wye design option, severe noise impacts are projected at 419 residences and 1 park. Moderate impacts are projected at 915 residences and 4 churches.

Table 3.4-17
Potential Noise Impacts under the Hybrid Alternative
without Mitigation for Design Year 2035

Hybrid Alternative	Total Number of Impacts	
Impacts by Project Combination	Moderate	Severe
Hybrid Alignment with Ave 24 Wye	796 Residential 3 Churches	458 Residential 1 Park
Hybrid Alignment with Ave 21 Wye	915 residential, 4 churches	419 residential, 1 park
Impacts under the Hybrid Alternative	**796 to 915 residential, 3 to 4 churches**	**419 to 458 residential, 1 park**
Source: Authority and FRA (2011).		

In the Merced vicinity, no severe noise impacts are projected to occur. Because of the relatively high existing noise levels in this urban area and the significantly fewer HST operations north of the wyes, project noise would not result in increases sufficient to cause severe impacts. In the Chowchilla and Madera vicinities, severe noise impacts are projected to occur along the north-south alignment at 268 residences for the Ave 24 Wye design option and 188 residences for the Ave 21 Wye design option. Severe noise impacts are projected at 11 residences in this area along the Ave 24 Wye and 52 residences in this area along the Ave 21 Wye. In the Fresno vicinity, severe noise impacts are projected to occur at 179 residences and Roeding Park.

Heavy Maintenance Facility

The FTA guidance manual (FTA 2006) provided the methodology for a general noise assessment at the five HMF sites. The assessment used preliminary layouts for each HMF and information on probable HST movements into and out of the HMF. The noise modeling projections assumed 24 train movements during the nighttime and none during the daytime. The number of conceptual operations is based on assumptions regarding number of trains assigned to the HMF sites. Because the analysis assumes the trains are all moving during the nighttime, the assessment provides a conservative projection.

Direct noise impacts would occur at noise-sensitive receivers adjacent to the trackway leading to Castle Commerce Center, north of the proposed Downtown Merced Station. The noise modeling projections for the tracks assumed 24 total train movements into and out of the facility during the nighttime and none during the daytime. The model assumed all trains would travel at 150 mph along the maintenance facility lead trackway. The model used elevation data provided. Table 3.4-18 shows the projected noise impacts along the lead trackway to the Castle Commerce Center site. Figure 3.4-9 shows the location of the noise impacts from the Castle Commerce Center HMF site without mitigation during the design year (2035). These assumptions are consistent with Authority design and conceptual operations plans.

Based on the number of day and nighttime train movements and the number of tracks located in the HMF, the severe noise impacts identified in Table 3.4-18 would be substantial under NEPA and significant under CEQA, and moderate noise impacts would be moderate under NEPA and less than significant under CEQA.

For the other for HMF sites, projected noise levels would be higher than under current conditions but would remain below the FRA criteria and, therefore, there would be no noise impacts under NEPA because of HST operations at the other HMF sites. Under CEQA, the impact would be less than significant.

Table 3.4-18
Potential Noise Impacts at the HMFs without Mitigation for Full Operations Year 2035

HMF Alternative	Total Number of Impacts	
	Moderate	Severe
Castle Commerce Center	291	91
Harris–DeJager	0	0
Fagundes	0	0
Gordon–Shaw	0	0
Kojima Development	0	0
Source: Authority and FRA (2011).		

Annoyance from Onset of HST Pass-bys

There is considerable evidence that increased annoyance is likely to occur for train noise events with rapid onset rates. Because of this, the relationship of speed and distance was used to define locations where the onset rate for HST operations may cause surprise according to the FRA guidance manual (FRA 2005). The potential for increased annoyance for the most part is confined to an area very close to the tracks. In the Merced to Fresno Section, the maximum train speeds would be 220 mph. At this speed, the distance from the tracks within which surprise can occur would be 45 feet, which is within the project right-of-way; therefore, there would be no impact under CEQA and no impact under NEPA.

Noise Effects on Wildlife and Domestic Animals

FRA also addresses impacts on wildlife (mammals and birds) and domestic animals (livestock and poultry). Noise exposure limits for each are an SEL of 100 dBA from passing trains. The SEL represents a receiver's cumulative 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.

A screening assessment determined typical and maximum distances from the HST tracks at which this limit may be exceeded. 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, in each case the HST maximum operating speed of 220 mph was used, and no shielding from intervening structures or terrain was assumed.

Table 3.4-19 indicates that 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. In elevated guideway locations, a single-train pass-by SEL of 100 dBA would not occur beyond the edge of the structure, approximately 15 feet from the track centerline. This assumes the presence of a safety barrier on the edge of the guideways, 3 feet above the top of rail height, as detailed in typical cross sections.

For reference, Table 3.4-19 shows the screening distances for potential wildlife/domestic animal impacts from freight trains that currently use the UPRR and BNSF tracks. The distance to an impact for a freight train is 75 feet where the warning horn is not sounded and 400 feet where 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.

Table 3.4-19
Screening Distances for Effects on Wildlife and Domestic Animals

Track Location	Speed (mph)	SEL[a] (dBA)	Distance from Trackway Centerline (feet)
HST at-grade	220	100	100
HST 60-foot-high elevated structure	220	100	15[b]
Freight train, no horn noise	50	100	75
Freight train, sounding horn at grade crossing	50	100	400

[a] The SEL represents a receiver's cumulative 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.

[b] These projections assume a safety barrier on the edge of the aerial structure as shown in typical cross sections (see Chapter 2, Alternatives). The safety barrier is assumed to be 3 feet above the top of rail height and 15 feet from the track centerline.

Source: Authority and FRA (2011).

According to the screening distance information provided in Table 3.4-19, wildlife and domestic animals might be within the screening distance for an at-grade HST, i.e., within 100 feet in both directions from 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 100 feet wide in rural locations, wildlife and domestic animals would have to be within approximately 50 feet of the edge of the right-of-way to experience noise effects above the recommended threshold. The primary location where this could be an issue is where wildlife migration routes cross the HST right-of-way along at-grade locations. At locations adjacent to the UPRR, BNSF, or SR 99 where the existing noise is already high, there would be no impacts. However, in rural areas, such as along the Ave 24 Wye and Ave 21 Wye, there could be impacts. Section 3.7, Biological Resources and Wetlands, and Section 3.14, Agricultural Lands, discuss the assessment and findings for impacts on wildlife and domestic animals.

Vibration

There would be no vibration impacts under the UPRR/SR99 or Hybrid alternatives because of the limited propagation of vibration through the soils in the project corridor, the low vehicle input force, and the presence of elevated structures, which substantially attenuate vibration levels in heavily populated areas where vibration-sensitive receivers are primarily located. Projected vibration levels are lower than the impact threshold at the closest receivers for these HST alternatives and all proposed HMF sites. There would be two vibration impacts on the BNSF Alternative design options because of more efficient soil propagation that exists in Le Grand. Table 3.4-20 summarizes potential direct vibration impacts related to operation of HSTs under the BNSF Alternative during the design year (2035).

> **Vibration Impacts**
>
> HST projects typically generate significantly fewer vibration impacts as compared with noise impacts. Because of the low-vibration-generating HST technology and the elevated structures, vibration impacts would be limited to within approximately 45 to 50 feet of the HST corridor outside of Le Grand. Because the proposed corridor is 100 feet wide, there would be no structures which would be subjected to vibration impacts under any of the HST alternatives, except in Le Grand.

Table 3.4-20
Potential Vibration Impacts under the BNSF Alternative without Mitigation for Design Year 2035

BNSF Alternative	Total Number of Vibration Impacts
Impacts by Project Combination	
BNSF north-south alignment with Ave 24 Wye	0
BNSF north-south alignment with Ave 21 Wye	0
Le Grand Design Options	
Mission Ave	0
Mission Ave East of Le Grand	1
Mariposa Way	0
Mariposa Way East of Le Grand	1
Total BNSF Alternative Range of Impact	**0-1**

Most of the sensitive receptors that could experience vibration impacts on the Merced to Fresno corridor are located within the project right-of-way and would be relocated. There are two potential vibration impacts at residences in Le Grand for the BNSF Alternative that are not within the construction footprint. One impact would occur on the Mission Ave East of Le Grand design option and the other on the Mariposa Way East of Le Grand design option. Depending on the design option chosen, there would be a maximum of one potential vibration impact for the BNSF Alternative. Vibration effects at these locations are anticipated to be noticeable but are unlikely to result in property damage. These impacts would be substantial under NEPA and significant under CEQA. Figure 3.4-13 shows the location of the vibration impacts.

Traffic Noise

For the UPRR/SR 99, BNSF, and Hybrid alternatives, the project would require a relocation of SR 99 between Ashlan Avenue and Clinton Avenue to accommodate the HST tracks. Because this is a Type 1 project, as defined in Section 3.4.3.3, Noise Criteria – Traffic, noise mitigation must be evaluated for SR 99 in this area. In addition, because this shift in SR 99 is related to the project, the potential impacts associated with this shift have been evaluated as a part of the HST project. The proposed change in SR 99 would shift the roadway approximately 80 feet to the west, closer to a number of residences. The project also would include the addition of an auxiliary lane in each direction.

At this Draft EIR/EIS stage of the project, there is not sufficient engineering information available to conduct a detailed noise assessment for traffic impacts. However, the existing noise levels at the residences to the west of SR 99 currently exceed the Caltrans noise abatement criteria discussed in Section 3.4.3.3. The proposed changes would shift SR 99 closer to the residences. This would result in increased noise levels at all residences to the west of SR 99, which already exceed the Caltrans noise abatement criteria, which would result in an impact that would be substantial under NEPA and significant under CEQA.

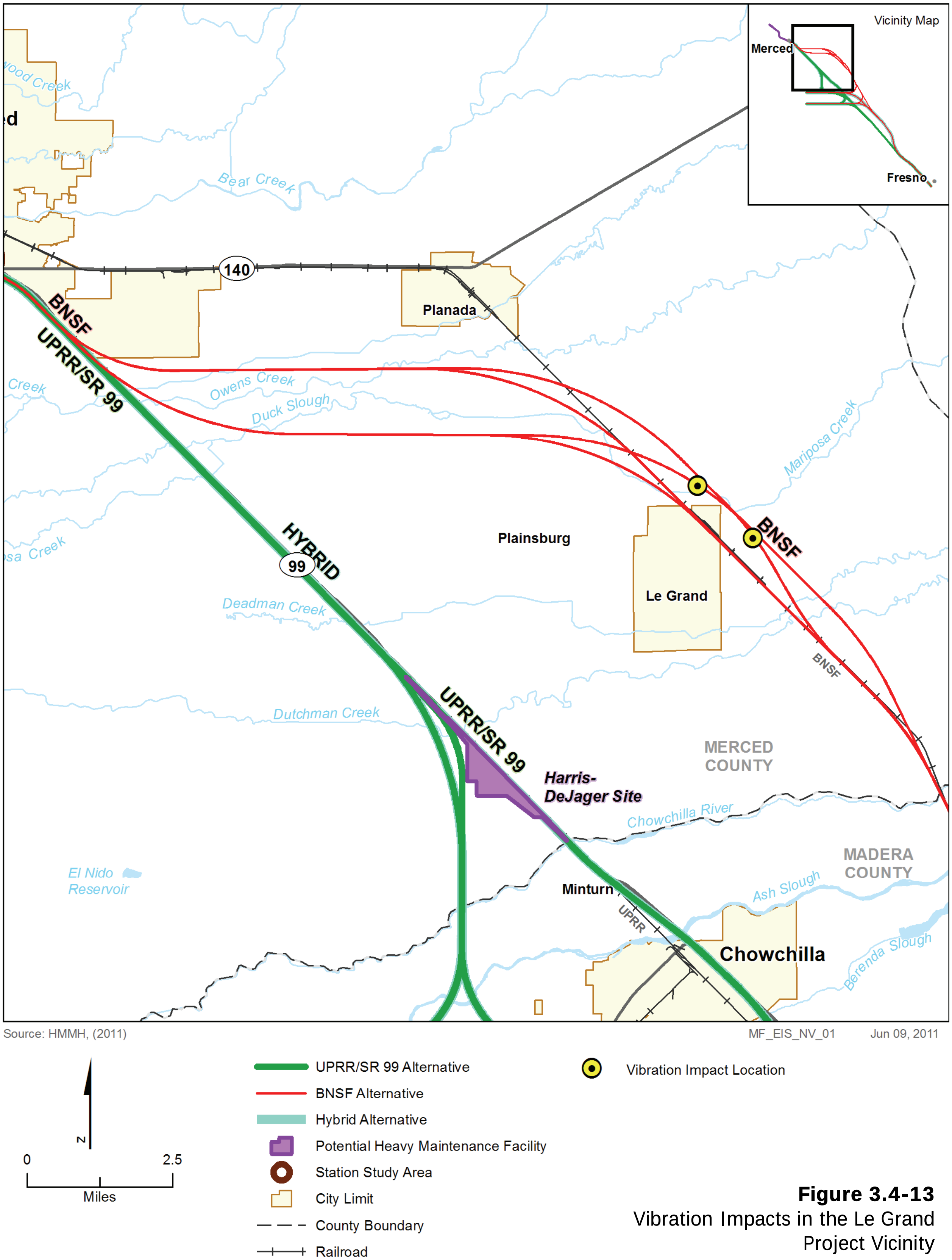


Figure 3.4-13
Vibration Impacts in the Le Grand
Project Vicinity

3.4.6 Project Design Features

The Authority and the FRA have considered avoidance and minimization measures consistent with the Statewide and Bay Area to Central Valley Program EIR/EIS commitments. FTA and FRA have guidelines that will be followed during construction.

3.4.7 Mitigation Measures

In addition, the following mitigation measures are available to compensate for impacts that cannot be minimized or avoided. The Authority has developed proposed Noise and Vibration Mitigation Guidelines that identify criteria by which noise and vibration mitigation would be deemed effective. The proposed Noise and Vibration Mitigation Guidelines are included as Appendix 3.4-A.

3.4.7.1 Construction Period

N&V-MM#1: Construction Noise Mitigation Measures. Monitor construction noise to verify compliance with the limits. Provide the contractor the flexibility to meet the FTA construction noise limits in the most efficient and cost-effective manner. The contractor would have the flexibility of either prohibiting certain noise-generating activities during nighttime hours or providing additional noise control measures to meet the noise limits. To meet required noise limits, the following noise control mitigation measures will be implemented as necessary, for nighttime and daytime:

- Install a temporary construction site sound barrier near a noise source.
- Avoid nighttime construction in residential neighborhoods.
- Locate stationary construction equipment as far as possible from noise-sensitive sites.
- Re-route construction-related truck traffic along roadways that will cause the least disturbance to residents.
- During nighttime work, use smart back-up alarms, which automatically adjust the alarm level based on the background noise level, or switch off back-up alarms and replace with spotters.
- Use low-noise emission equipment.
- Implement noise-deadening measures for truck loading and operations.
- Monitor and maintain equipment to meet noise limits.
- Line or cover storage bins, conveyors, and chutes with sound-deadening material.
- Use acoustic enclosures, shields, or shrouds for equipment and facilities.
- Use high-grade engine exhaust silencers and engine-casing sound insulation.
- Prohibit aboveground jackhammering and impact pile driving during nighttime hours.
- Minimize the use of generators to power equipment.
- Limit use of public address systems.
- Grade surface irregularities on construction sites.
- Use moveable sound barriers at the source of the construction activity.
- Limit or avoid certain noisy activities during nighttime hours.

To mitigate noise related to pile driving, the use of an augur to install the piles instead of a pile driver would reduce noise levels substantially. If pile driving is necessary, limit the time of day that the activity can occur.

N&V-MM#2: **Construction Vibration Mitigation Measures**. Building damage from construction vibration is only anticipated from impact pile driving at very close distances to buildings. If piling is more than 25 to 50 feet from buildings, or if alternative methods such as push piling or augur piling can be used, damage from construction vibration is not expected to occur. Other sources of construction vibration do not generate high enough vibration levels for damage to occur. Typically, once a construction scenario has been established, preconstruction surveys are conducted at locations within 50 feet of piling to document the existing condition of buildings in case damage is reported during or after construction. Damaged buildings would be repaired or compensation paid.

3.4.7.2 Project

Noise

N&V-MM#3: Implement Proposed California High-Speed Train Project Noise and Vibration Mitigation Guidelines. Figures 3.4-14 through 3.4-17 show the locations where the noise mitigation guidelines would be applied. Various options exist to address the potentially severe noise effects from HSTs. With input from local jurisdictions and balancing technological factors, such as structural and seismic safety, cost, number of affected receptors, and effectiveness, mitigation measures would be selected and implemented. For example, where moderate increases in noise affect receptors, noise-reducing measures could be implemented, even though not required. Conversely, in rural areas devoid of receptors where severe noise effects are anticipated, it might be appropriate and acceptable not to apply any noise-reducing treatments. The noise guidelines include the following mitigation measures:

- Install sound barriers. Depending on the height and location relative to the tracks, sound barriers can achieve between 5 and 15 dB of noise reduction. The primary requirements for an effective sound barrier are that the barrier must (1) be high enough and long enough to break the line-of-sight between the sound source and the receiver, (2) be of an impervious material with a minimum surface density of 4 pounds per square foot, and (3) not have any gaps or holes between the panels or at the bottom. Because many materials meet these requirements, aesthetics, durability, cost, and maintenance considerations usually determine the selection of materials for sound barriers (examples are shown in Figure 3.4-18 below). Depending on the situation, sound barriers can become visually intrusive. Typically, the sound barriers style is selected with input from the local jurisdiction to reduce the visual effect of barriers on adjacent lands uses. For example, sound barriers could be solid or transparent, of various colors, materials, and surface treatments.

  The maximum sound barrier height would be 14 feet for at-grade sections; however, all sound barriers would be designed to be as low as possible while still achieving a substantial noise reduction. Berm and berm/wall combinations are the preferred types of sound barriers where space and other environmental constraints permit. On aerial structures, the maximum sound barrier height would also be 14 feet, but barrier material would be limited by engineering weight restrictions for barriers on the structure. Sound barriers on the aerial structure should still be designed to be as low as possible while still achieving a substantial noise reduction. Sound barriers on aerial structures and at-grade could consist of solid, semitransparent, and transparent materials.

- Work with the communities to determine how the use and height of sound barriers would be determined using jointly developed performance criteria. Other solutions may result in higher numbers of residual impacts than reported herein. Options may be to reduce the height of sound barriers and combine barriers with sound insulation or to accept higher than the FRA's current noise thresholds.

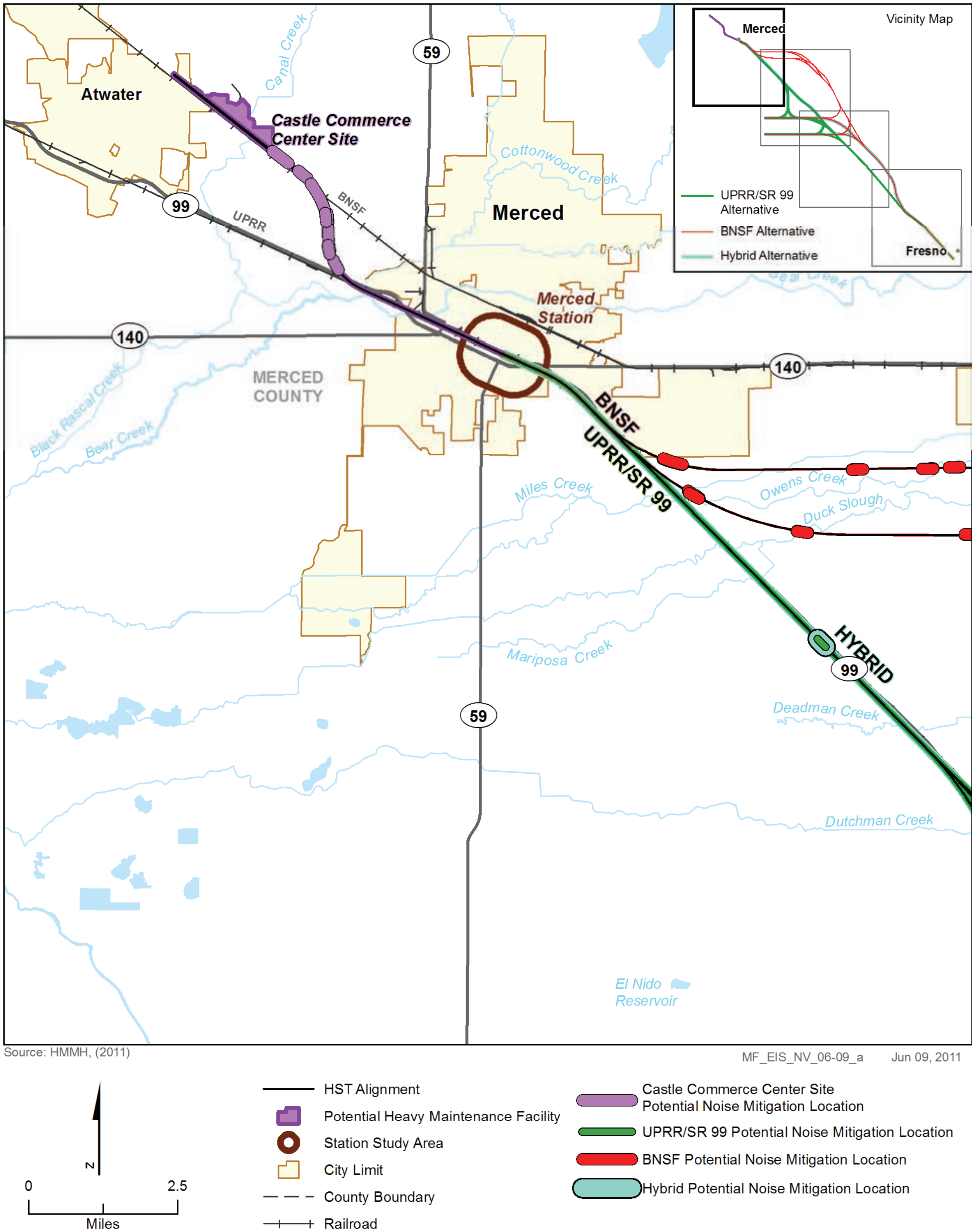


Figure 3.4-14
Potential Noise Mitigation Locations in the Merced Project Vicinity

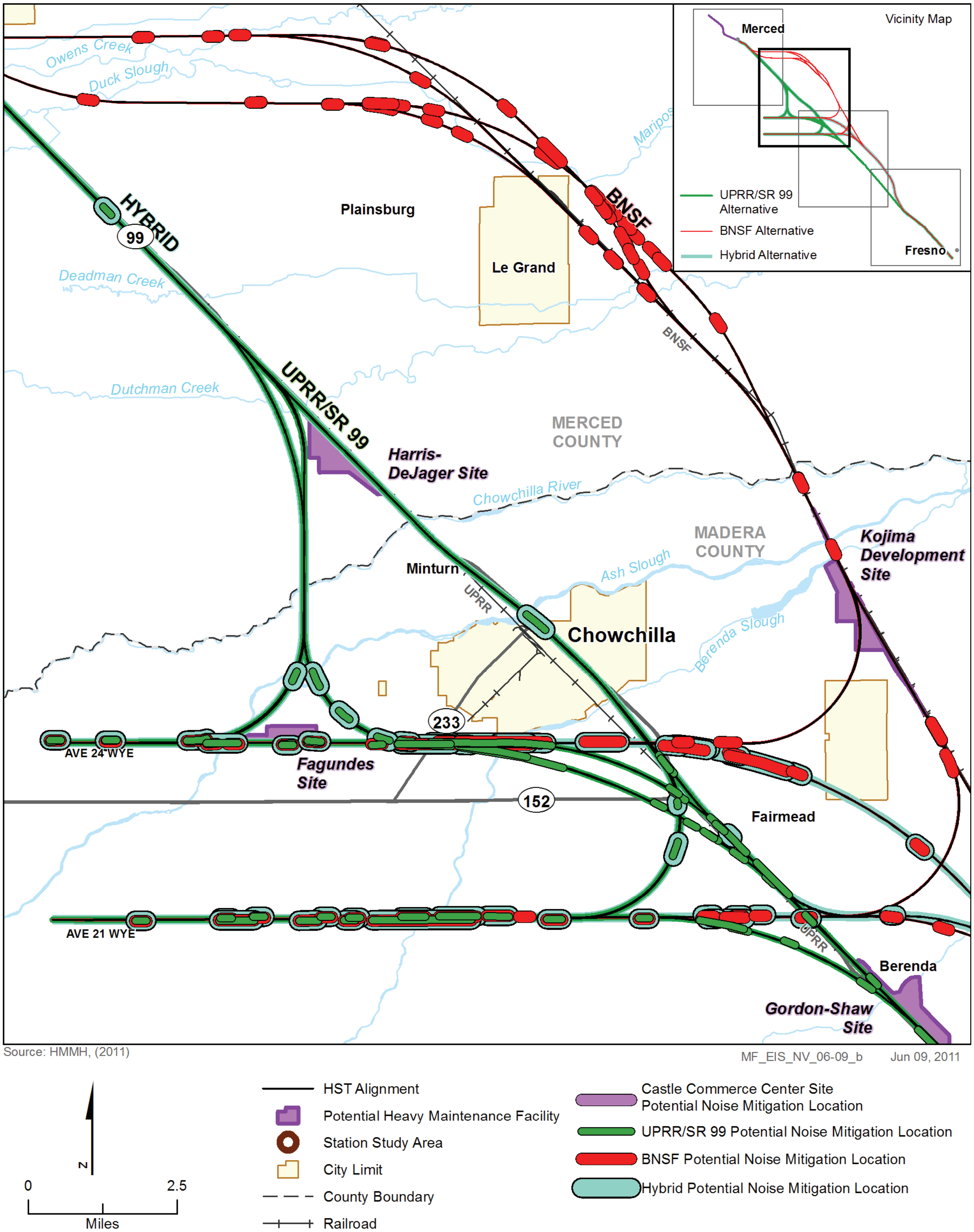


Figure 3.4-15
Potential Noise Mitigation Locations in the Chowchilla Project Vicinity

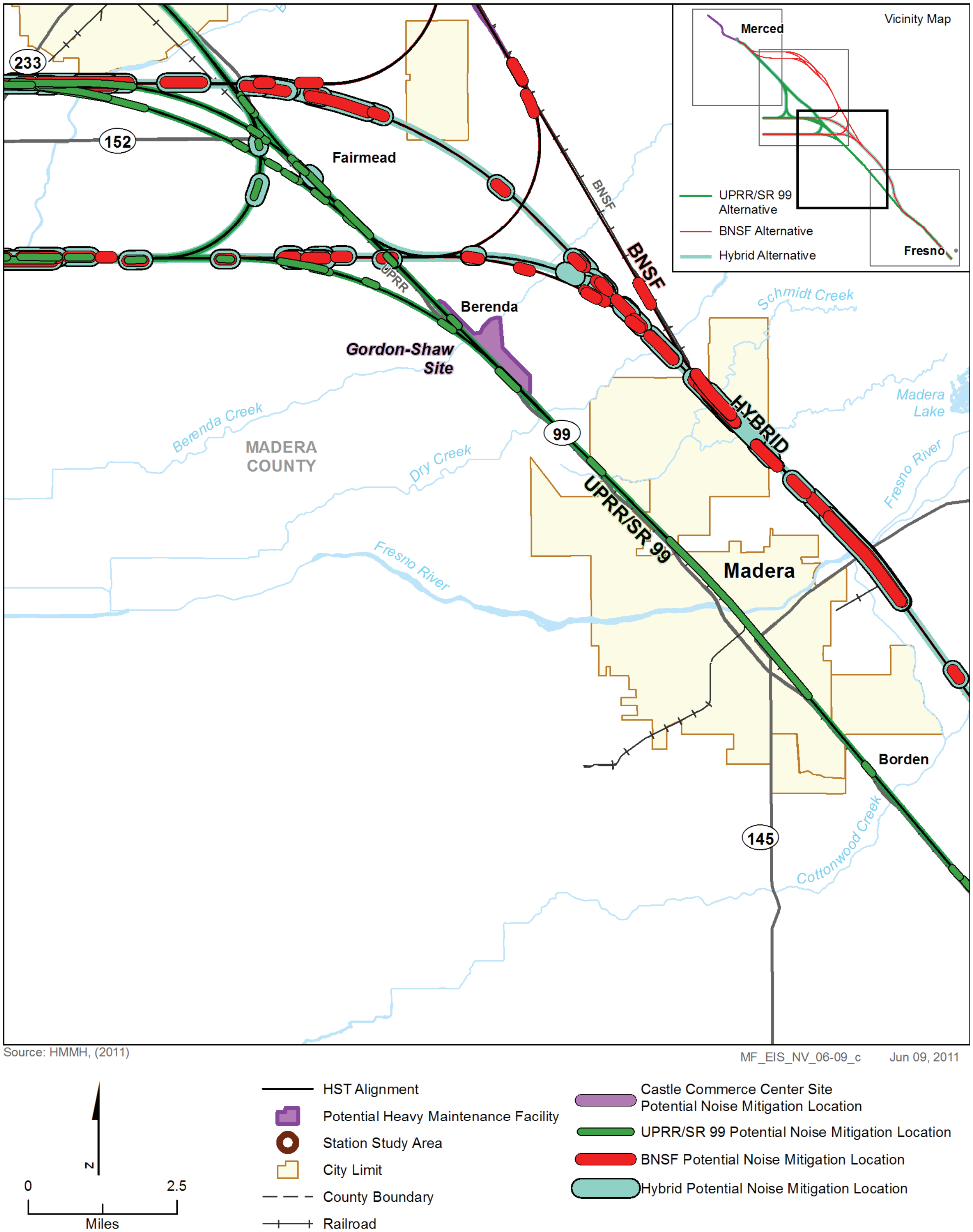


Figure 3.4-16
Potential Noise Mitigation Locations in the Madera Project Vicinity

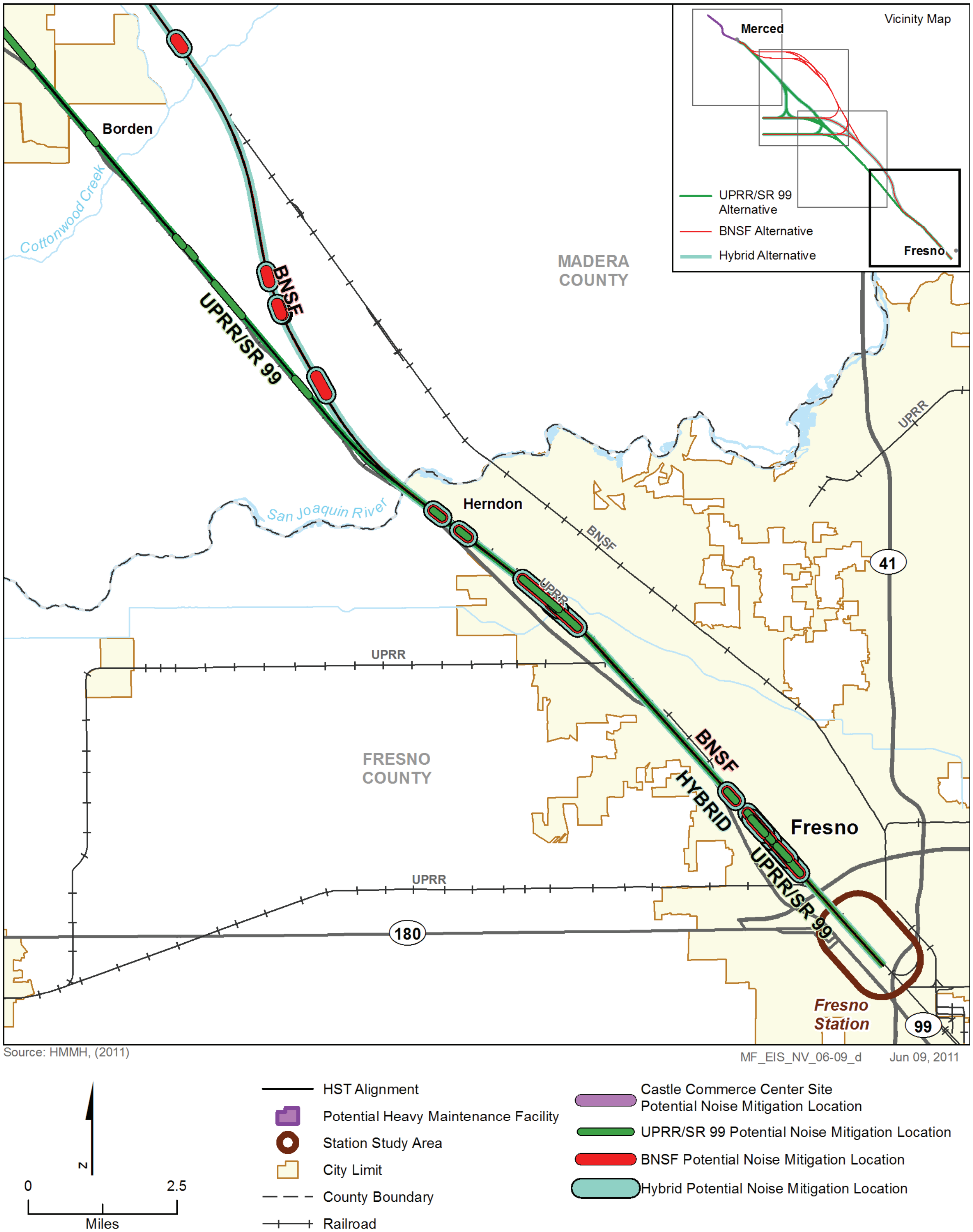


Figure 3.4-17
Potential Noise Mitigation Locations in the Fresno Project Vicinity

(a) Denver, Colorado

(b) Slovenia, Italy

(c) Sha Tin, Hong Kong

(d) Loire Valley, France

Figure 3.4-18
Examples of Sound Barriers for Rail Corridors
(Photographs courtesy of Harris Miller Miller & Hanson Inc.)

- Install building sound insulation. Sound insulation of residences and institutional buildings to improve the outdoor-to-indoor noise reduction is a mitigation measure that can be provided when the use of sound barriers is not feasible in providing a reasonable level (5 to 7 dB) of noise reduction. Although this approach has no effect on noise in exterior areas, it may be the best choice for sites where sound barriers are not feasible or desirable and for buildings where indoor sensitivity is of most concern. Substantial improvements in building sound insulation (on the order of 5 to 10 dB) can often be achieved by adding an extra layer of glazing to windows, by sealing holes in exterior surfaces that act as sound leaks, and by providing forced ventilation and air conditioning so that windows do not need to be opened. Establish performance criteria to balance existing noise events and ambient roadway noise conditions as factors for determining mitigation measures.

- Acquire easements on properties severely affected by noise. Another option for mitigating noise impacts is for the Authority to acquire easements on residences likely to be affected by HST operations in which the homeowners would accept the future noise conditions. This approach is usually taken only in isolated cases where other mitigation options are infeasible, impractical, or too costly.

Tables 3.4-21 through 3.4-24 show the number and length of sound barriers that would be cost effective for the Merced to Fresno Section alternatives based on implementation of the noise mitigation guidelines. Figures 3.4-19 through 3.4-22 show the locations of potential sound barriers along the project alternatives.

Table 3.4-21
Potential UPRR/SR 99 Alternative Sound Barriers

# of Cost-Effective Barriers	Total Length of All Barriers (ft)	Number of Severe Impacts Eliminated[1]	Number of Severe Impacts Remaining
4	30,100	702	0
Note: With the sound barrier, the noise effect is reduced from a severe to a moderate level.			

Table 3.4-22
Potential BNSF Alternative Sound Barriers

# of Cost-Effective Barriers	Total Length of All Barriers (ft)	Number of Severe Impacts Eliminated[1]	Number of Severe Impacts Remaining
5	23,000	139	0
Note: With the sound barrier, the noise effect is reduced from a severe to a moderate level.			

Table 3.4-23
Potential Hybrid Alternative Sound Barriers

# of Cost Effective-Barriers	Total Length of All Barriers (ft)	Number of Severe Impacts Eliminated[1]	Number of Severe Impacts Remaining
5	26,700	159	0
Note: With the sound barrier, the noise effect is reduced from a severe to a moderate level.			

Table 3.4-24
Potential Castle Commerce Center Sound Barriers

# of Cost Effective Barriers	Total Length of All Barriers (ft)	Number of Severe Impacts Eliminated[1]	Number of Residual Impacts Remaining
3	5,600	69	0
Note: With the sound barrier, the noise effect is reduced from a severe to a moderate level.			

Table 3.4-25 shows the number of severe effects that would remain because a sound barrier is not cost effective. These residences might be treated with sound insulation that would reduce indoor noise impacts. When receptors are covered by an easement, the noise effects would remain severe.

Table 3.4-25
Severe Effects Remaining at Locations without Sound Barriers

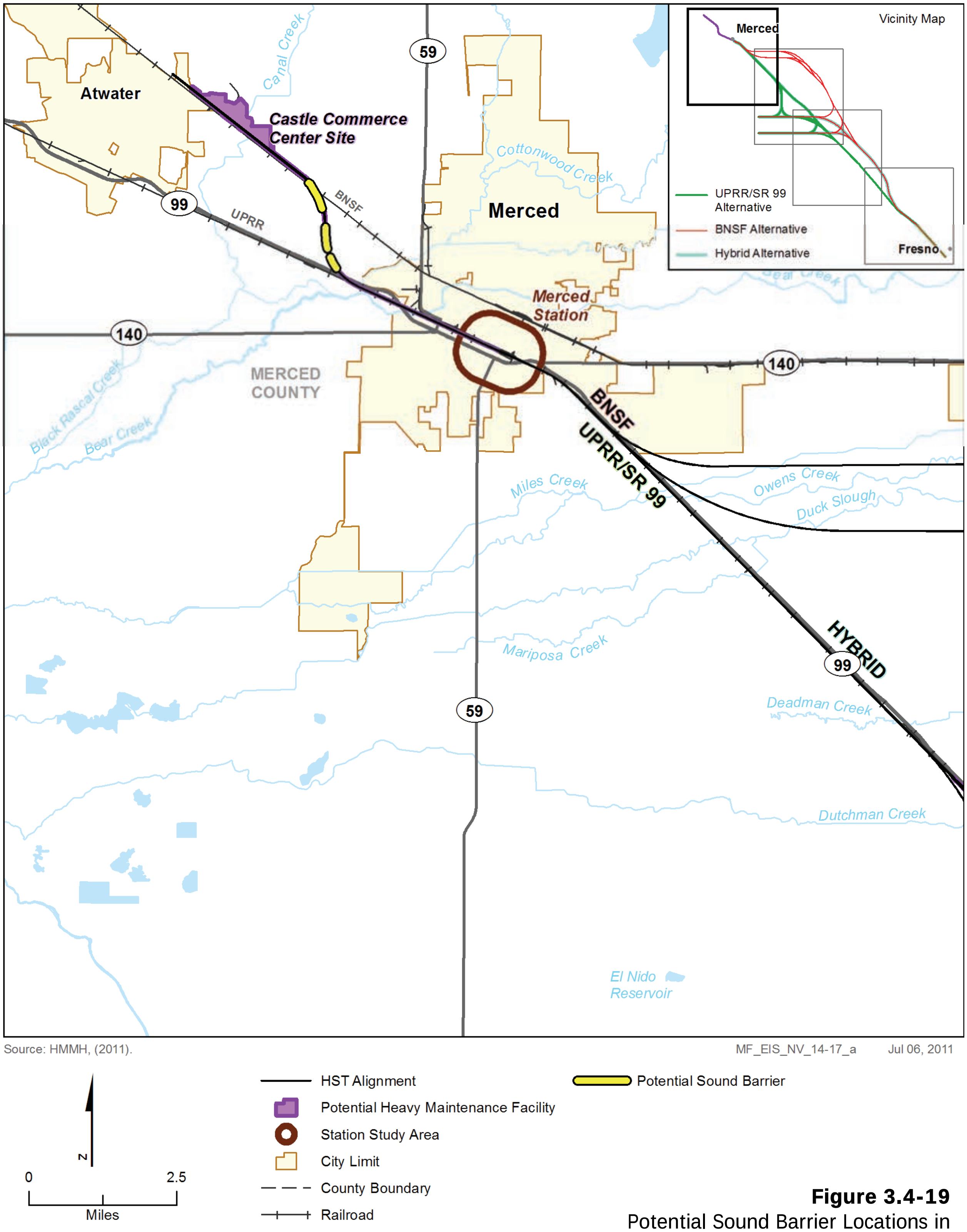
Alternative	Number of Severe Effects
UPRR/SR 99 Alternative	204 to 238
BNSF Alternative	313 to 363
Hybrid Alternative	304 to 341
Note: Ranges reflect variation due to design options.	

In addition, severe noise impact has been identified at Roeding Park for all three project alternatives. Mitigation options for Roeding Park are discussed in Section 3.15, Parks, Recreation, and Open Space, and follow the HST noise and vibration mitigation guidelines.

N&V-MM#4: Vehicle Noise Specification. In the procurement of an HST vehicle technology, the project can set performance limits for noise levels in order to reduce community noise impacts throughout the corridor. Depending on the available technology, this could significantly reduce the number of impacts throughout the corridor.

N&V-MM#5: Special Trackwork at Crossovers and Turnouts. Because the impacts of HST wheels over rail gaps at turnouts increases HST noise by approximately 6 dB over typical operations, turnouts can be a major source of noise impact. If the turnouts cannot be moved from sensitive areas, the project can use special types of trackwork that eliminate the gap.

N&V-MM#6: Additional Noise Analysis Following Final Design. If final design or final vehicle specifications results in changes to the assumptions underlying the noise analysis, reassess noise impacts and recommendations for mitigation and provide supplemental environmental documentation, as required by CEQA and NEPA.



Source: HMMH, (2011).

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Figure 3.4-19
Potential Sound Barrier Locations in the Merced Project Vicinity

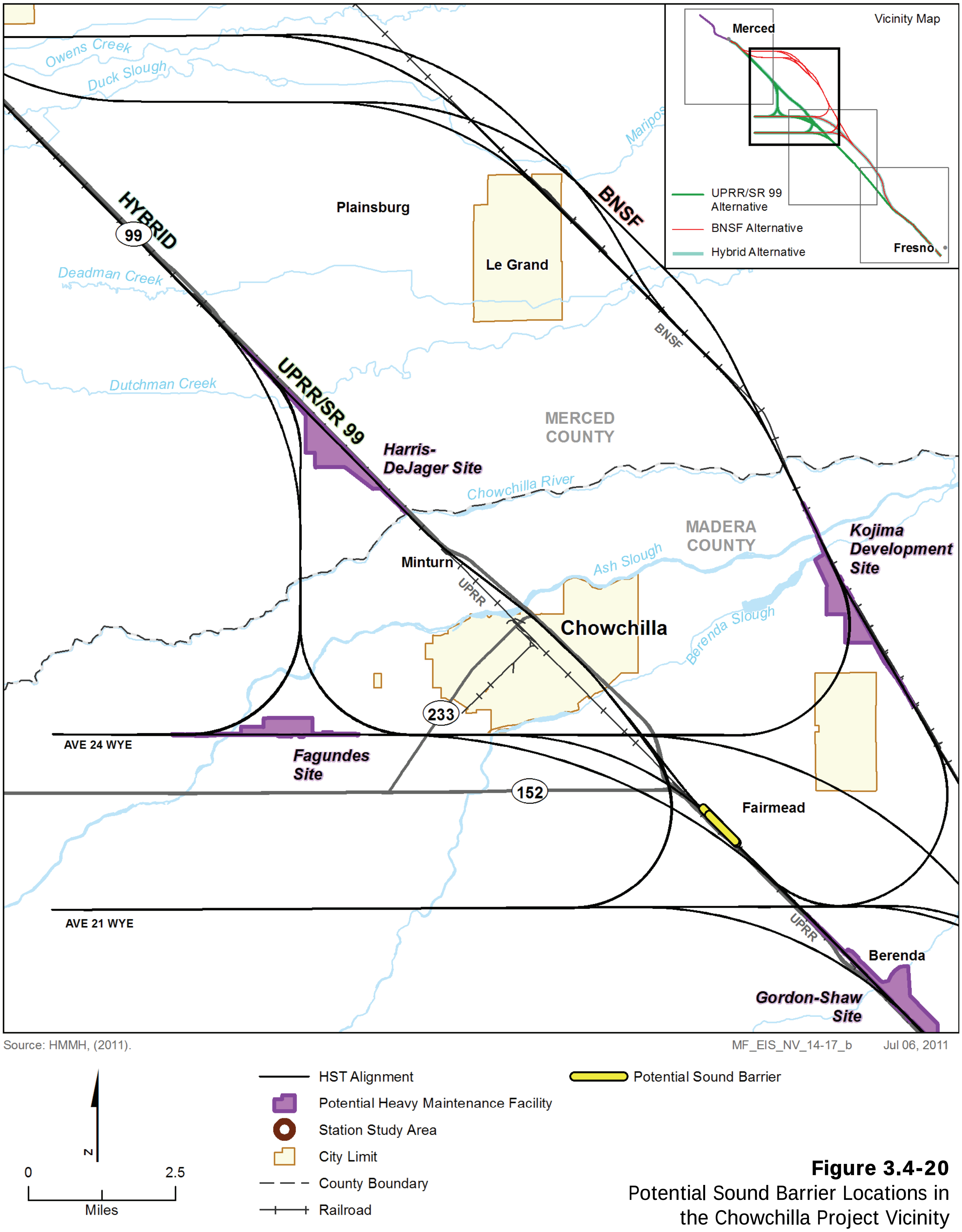

Figure 3.4-20
Potential Sound Barrier Locations in the Chowchilla Project Vicinity

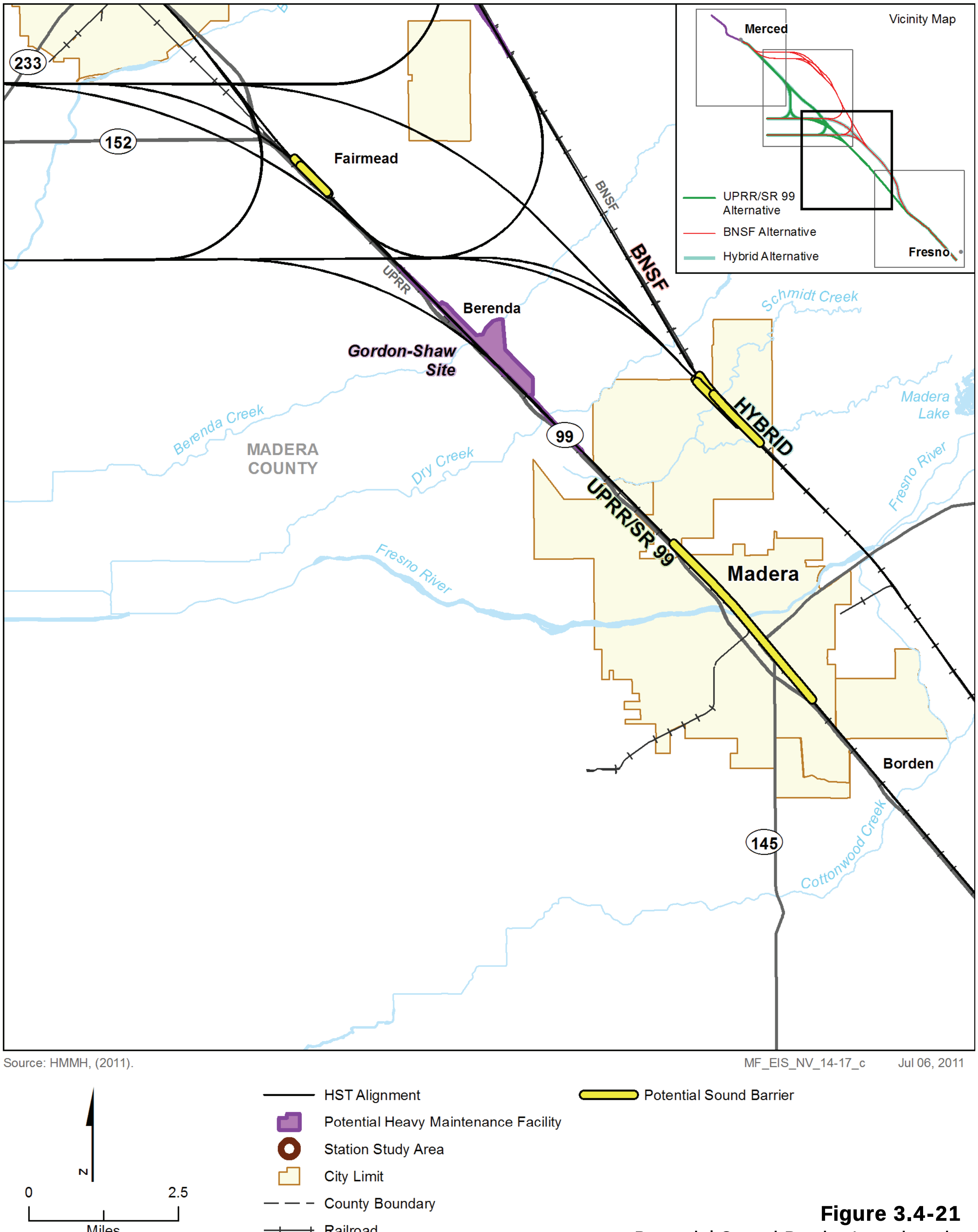

Figure 3.4-21
Potential Sound Barrier Locations in the Madera Project Vicinity

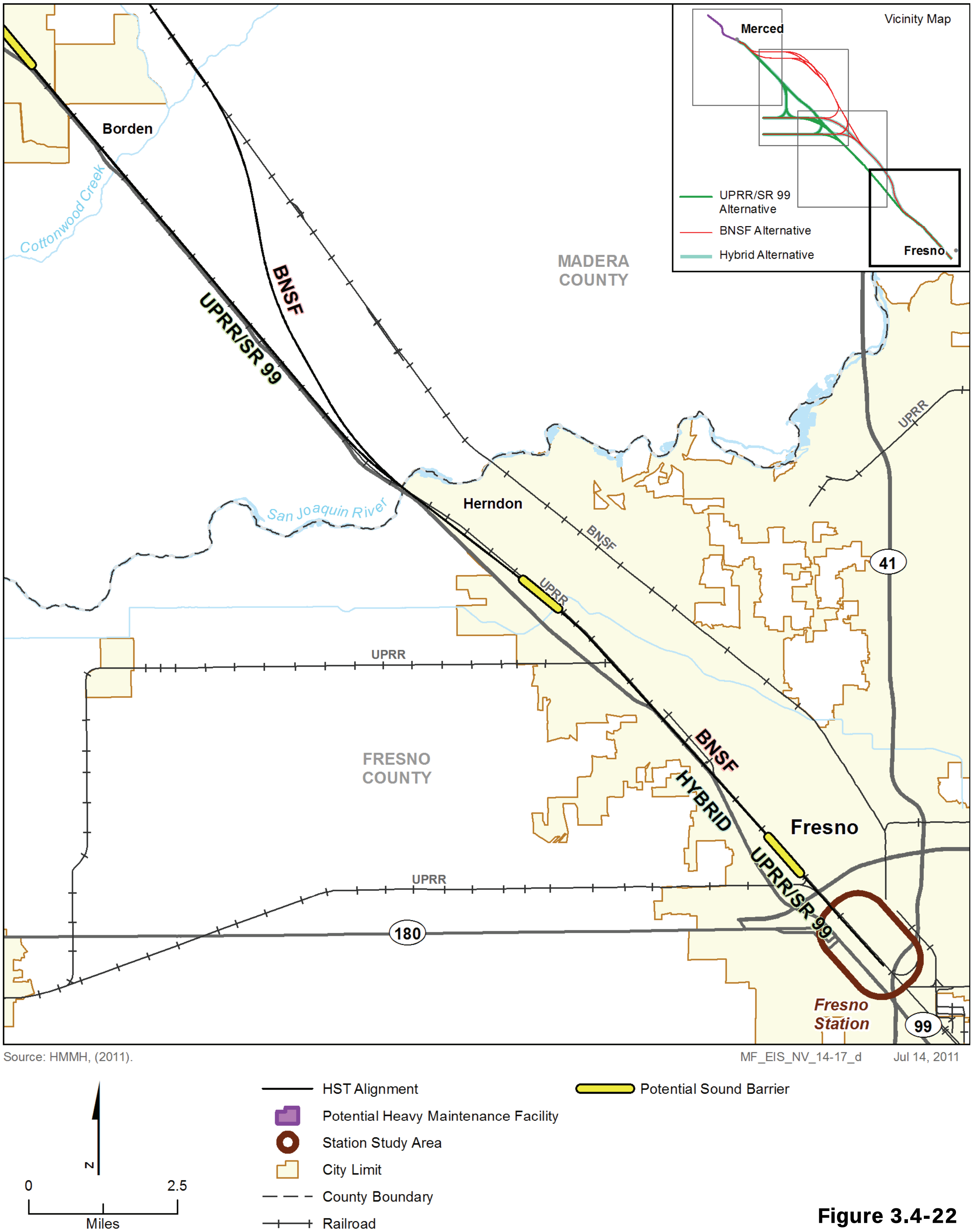

Figure 3.4-22
Potential Sound Barrier Locations in the Fresno Project Vicinity

Vibration

N&V-MM#7: Implement Proposed California High-Speed Train Project Noise and Vibration Mitigation Guidelines. Implement vibration-reducing measures such as those listed in Table 3.4-26. The table lists where the mitigation procedure would be applied, such as at the source, sensitive receiver, or along the propagation path from the source to the sensitive receiver.

Table 3.4-26
Potential Vibration Mitigation Procedures and Descriptions

Mitigation Procedure	Location of Mitigation	Description
Location and Design of Special Trackwork	Source	Careful review of crossover and turnout locations during the preliminary engineering stage. When feasible, relocate special trackwork to a less vibration-sensitive area. Installation of spring frogs eliminates gaps at crossovers and helps reduce vibration levels.
Vehicle Suspension	Source	Rail vehicle should have low unsprung weight, soft primary suspension, minimum metal-on-metal contact between moving parts of the truck, and smooth wheels that are perfectly round.
Special Track Support Systems	Source	Floating slabs, resiliently supported ties, high resilience fasteners and ballast mats all help reduce vibration levels from track support system.
Building Modifications	Receiver	For existing buildings, if vibration-sensitive equipment is affected by train vibration, the floor upon which the vibration-sensitive equipment is located could be stiffened and isolated from the remainder of the building. For new buildings, the building foundation should be supported by elastomer pads similar to bridge bearing pads.
Trenches	Along Vibration Propagation Path	A trench can be an effective vibration barrier if it changes the propagation characteristics of the soil. It can be open or solid. Open trenches can be filled with materials such as styrofoam. Solid barriers can be constructed with sheet piling, rows of drilled shafts filled with either concrete or a mixture of soil and lime, or concrete poured into a trench.
Buffer Zones	Receiver	Negotiate a vibration easement from the affected property owners or expand rail right-of-way.

Secondary Impacts

Secondary impacts could potentially occur at the locations where the project would install sound barriers. The changes to visual and aesthetic qualities and the existing environment that might occur because of the installation of these barriers are discussed in Section 3.16, Aesthetics and Visual Resources, but these changes are not assessed in site-specific locations because of uncertainty about the locations of these barriers, their heights, and their applications. The project design will incorporate communities' input on the appearance of the sound barriers to reduce secondary impacts. Section 3.15, Parks, Recreation, and Open Space, discusses impacts of installation of a sound barrier at Roeding Park. Sound barriers would not be additional obstacles to wildlife movement because they would be installed inside the fenced HST right-of-way.

Small localized effects could occur from digging a trench to protect the residence that would be affected by vibration.

3.4.8 NEPA Impacts Summary

Construction noise and vibration impacts could be substantial for all alternatives. Substantial operational noise impacts would occur for all alternatives and with the Castle Commerce Center HMF site. Substantial vibration impacts are projected for the BNSF Le Grand design options where vibration effects would be noticeable but are not anticipated to result in property damage. Mitigation at these locations might not feasible. Operations vibration impacts are not projected to exceed the threshold outside the right-of-way along the UPRR/SR 99 and Hybrid alternatives and therefore would be no impact. There would be no impacts for annoyance from HST pass-bys, and the traffic noise impacts would be substantial.

With sound barriers as mitigation, the number of substantial noise impacts could be reduced as the barriers would shield HST noise. With full implementation of the guidelines most substantial noise impacts would be eliminated. Severe noise effects would remain for some receptors because they are located outside of the area where the barrier is fully effective or the sound barrier does not fully mitigate the effect (i.e., noise is reduced by 5 dB but not below the severe threshold). Furthermore, severe noise effects would remain for receptors mitigated only with indoor sound insulation or when covered by noise easements.

3.4.9 CEQA Significance Conclusions

Table 3.4-27 summarizes noise- and vibration-related impacts, associated mitigation measures, and the level of significance after mitigation.

After mitigation, there could be a significant impact under CEQA because some noise-sensitive receivers might still experience operational noise levels that are considered severe even after installation of sound barriers. Also, in collaboration with the communities, some severe noise effects may not be mitigated if barriers that would fully mitigate impacts are undesirable because of their visual impacts.

Table 3.4-27
Summary of Significant Noise and Vibration Impacts and Mitigation Measures

Impact	CEQA Level of Significance before Mitigation	Mitigation Measure	CEQA Level of Significance after Mitigation
Construction Period			
N&V#1: Construction Noise	Significant	**N&V-MM#1:** Construction noise mitigation measures.	Less than significant
N&V#2: Construction Vibration	Significant	**N&V-MM#2:** Construction vibration mitigation measures.	Less than significant
Project			
N&V#3: Severe Operational Noise Impacts	Significant	**N&V-MM#3:** Implement noise and vibration mitigation guidelines; **N&V-MM#4:** Vehicle noise specification; **N&V-MM#5:** Special trackwork at crossovers and turnouts. **N&V-MM#6:** Additional noise analysis following final design.	Significant in some locations as decided in coordination with local communities or where sound barriers are not fully effective Less than significant where fully mitigated

Impact	CEQA Level of Significance before Mitigation	Mitigation Measure	CEQA Level of Significance after Mitigation
N&V#4: Operational Vibration Impacts	Significant	**N&V-MM#7:** Implement noise and vibration mitigation guidelines	Significant if mitigation is not feasible