CALIFORNIA HIGH-SPEED TRAIN

Program Environmental Impact Report/Environmental Impact Statement

Bay Area to Merced

NOISE & VIBRATION TECHNICAL EVALUATION

Prepared for:

California High-Speed Rail Authority

U.S. Department of Transportation
Federal Railroad Administration

January 2004

CALIFORNIA HIGH SPEED RAIL AUTHORITY

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CALIFORNIA HIGH-SPEED TRAIN PROGRAM EIR/EIS

Bay Area to Merced Noise & Vibration Technical Evaluation

Prepared by:

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ACRONYMS

AUTHORITY	CALIFORNIA HIGH-SPEED RAIL
CEQA	CALIFORNIA ENVIRONMENTAL QUALITY ACT
COG	COUNCIL OF GOVERNMENTS
EIR	ENVIRONMENTAL IMPACT REPORT
EIS	ENVIRONMENTAL IMPACT STATEMENT
EPA	ENVIRONMENTAL PROTECTION AGENCY
FAA	FEDERAL AVIATION ADMINISTRATION
FHWA	FEDERAL HIGHWAY ADMINISTRATION
FRA	FEDERAL RAILROAD ADMINISTRATION
FTA	FEDERAL TRANSIT ADMINISTRATION
GIS	GEOGRAPHIC INFORMATION SYSTEM
HSR	HIGH SPEED RAIL
HST	HIGH SPEED TRAINS
HUD	DEPARTMENT OF HOUSING & URBAN DEVELOPMENT
IM	IMPACT METRIC
IR	IMPACT RATING
MTA	METROPOLITAN TRANSPORTATION AUTHORITY
MU	MIXED USE (COMMERCIAL AND RESIDENTIAL LAND USE)
NEPA	NATIONAL ENVIRONMENTAL POLICY ACT
RTP	REGIONAL TRANSPORTATION PLAN
TNM	TRAFFIC NOISE MODEL
USACE	U.S. CORPS OF ENGINEERS

1.0 INTRODUCTION

The California High-Speed Rail Authority (Authority) was created by the Legislature in 1996 to develop a plan for the construction, operation, and financing of a statewide, intercity high-speed passenger train system.[1] After completing a number of initial studies over the past six years to assess the feasibility of a high-speed train system in California and to evaluate the potential ridership for a variety of alternative corridors and station areas, the Authority recommended the evaluation of a proposed high-speed train system as the logical next step in the development of California's transportation infrastructure. The Authority does not have responsibility for other intercity transportation systems or facilities, such as expanded highways, or improvements to airports or passenger rail or transit used for intercity trips.

The Authority adopted a *Final Business Plan* in June 2000, which reviewed the economic feasibility of a 1,127-kilometer-long (700-mile-long) high-speed train system. This system would be capable of speeds in excess of 321.8 kilometers per hour (200 miles per hour [mph]) on a dedicated, fully grade-separated track with state-of-the-art safety, signaling, and automated train control systems. The system described would connect and serve the major metropolitan areas of California, extending from Sacramento and the San Francisco Bay Area, through the Central Valley, to Los Angeles and San Diego. The high-speed train system is projected to carry a minimum of 42 million passengers annually (32 million intercity trips and 10 million commuter trips) by the year 2020.

Following the adoption of the Business Plan, the appropriate next step for the Authority to take in the pursuit of a high-speed train system is to satisfy the environmental review process required by federal and state laws which will in turn enable public agencies to select and approve a high speed rail system, define mitigation strategies, obtain necessary approvals, and obtain financial assistance necessary to implement a high speed rail system. For example, the Federal Railroad Administration (FRA) may be requested by the Authority to issue a *Rule of Particular Applicability*, which establishes safety standards for the high-speed train system for speeds over 200 mph, and for the potential shared use of rail corridors.

The Authority is both the project sponsor and the lead agency for purposes of the California Environmental Quality Act (CEQA) requirements. The Authority has determined that a Program Environmental Impact Report (EIR) is the appropriate CEQA document for the project at this conceptual stage of planning and decision-making, which would include selecting a preferred corridor and station locations for future right-of-way preservation and identifying potential phasing options. No permits are being sought for this phase of environmental review. Later stages of project development would include project-specific detailed environmental documents to assess the potential impacts of the alternative alignments and stations in those segments of the system that are ready for implementation.

The decisions of federal agencies, particularly the FRA related to high-speed train systems, would constitute major federal actions regarding environmental review under the National Environmental Policy Act (NEPA). NEPA requires federal agencies to prepare an Environmental Impact Statement (EIS) if the proposed action has the potential to cause significant environmental impacts. The proposed action in California warrants the preparation of a Tier 1 Program-level EIS under NEPA, due to the nature and scope of the comprehensive high-speed train system proposed by the Authority, the need to narrow the range of alternatives, and the need to protect/preserve right-of-way in the future. FRA is the federal lead agency for the preparation of the Program EIS, and the Federal Highway Administration (FHWA), the U.S. Environmental Protection Agency (EPA), the U.S. Corps of Engineers (USACE), the Federal Aviation Administration (FAA), the U.S. Fish and Wildlife Service (USFWS), and the Federal Transit Administration (FTA) are cooperating federal agencies for the EIS.

[1] Chapter 796 of the Statutes of 1996; SB 1420, Kopp and Costa

A combined Program EIR/EIS is to be prepared under the supervision and direction of the FRA and the Authority in conjunction with the federal cooperating agencies. It is intended that other federal, state, regional, and local agencies will use the Program EIR/EIS in reviewing the proposed program and developing feasible and practicable programmatic mitigation strategies and analysis expectations for the Tier 2 detailed environmental review process which would be expected to follow any approval of a high speed train system.

The statewide high-speed train system has been divided into five regions for study: Bay Area-Merced, Sacramento-Bakersfield, Bakersfield-Los Angeles, Los Angeles-San Diego via the Inland Empire, and Los Angeles-Orange County-San Diego. This Noise and Vibration Technical Evaluation for Bay Area – Merced Corridor is one of five such reports being prepared for each of the regions on the topic, and it is one of fifteen technical reports for this region. This report will be summarized in the Program EIR/EIS and it will be part of the administrative record supporting the environmental review of alternatives.

1.1 ALTERNATIVES

1.1.1. No- Project Alternative

The No-Project Alternative serves as the baseline for comparison of the Modal and High-Speed Train Alternatives. The No-Project Alternative represents the state's transportation system (highway, air, and conventional rail) as it existed in 1999-2000, and as it would be after completion of programs or projects currently programmed for implementation and projects with funding expected by 2020 (Figure 1). The No-Project Alternative addresses the geographic area serving the same intercity travel market as the proposed high-speed train (generally from Sacramento and the San Francisco Bay Area, through the Central Valley, to Los Angeles and San Diego). The No-Project Alternative satisfies the statutory requirements under CEQA and NEPA for an alternative that does not include any new action or project beyond what is already committed.

The No-Project Alternative defines the existing and future statewide intercity transportation system based on programmed and funded (already in funded programs/financially constrained plans) improvements to the intercity transportation system through 2020, according to the following sources of information:

- State Transportation Improvement Program (STIP)
- Regional Transportation Plans (RTPs) for all modes of travel
- Airport plans
- Intercity passenger rail plans (California Rail Plan 2001-2010, Amtrak Five- and Twenty-year Plans)

As with all of the alternatives, the No-Project Alternative will be assessed against the purpose and need topics/objectives for congestion, safety, air pollution, reliability, and travel times.

Figure 1
No-Project Alternative – California Transportation System (Present to 2020)

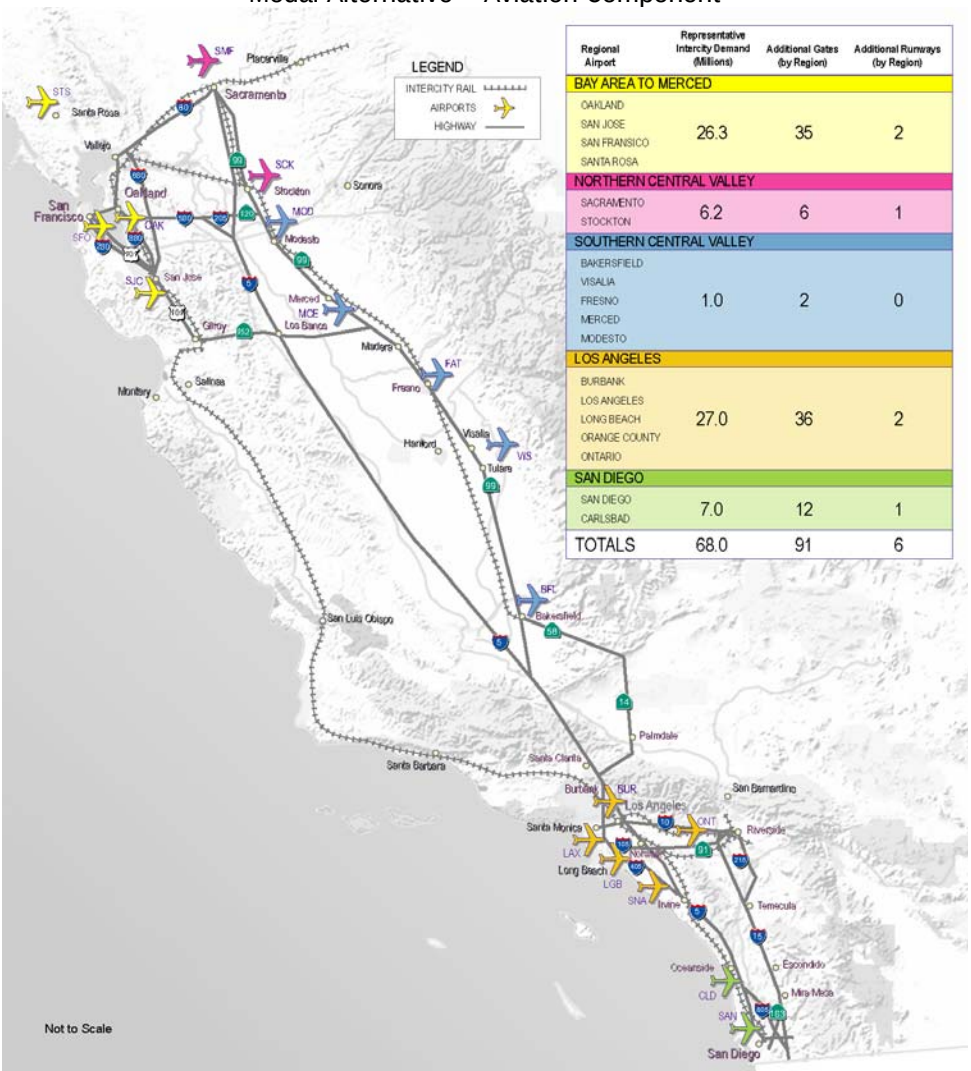
1.1.2 Modal Alternative

There are currently only three main options for intercity travel between the major urban areas of San Diego, Los Angeles, the Central Valley, San Jose, Oakland/San Francisco, and Sacramento: vehicles on the interstate highway system and state highways, commercial airlines serving airports between San Diego and Sacramento and the Bay Area, and conventional passenger trains (Amtrak, etc.) on freight and/or commuter rail tracks. The Modal Alternative consists of expansion of highways (Figure 2), airports (Figure 3), and intercity and commuter rail systems serving the markets identified for the High-Speed

Train Alternative. The Modal Alternative uses the same inter-city travel demand (not capacity) assumed under the high-end sensitivity analysis completed for the high-speed train ridership in 2020. This same travel demand is assigned to the highways and airports and passenger rail described under the No-Project Alternative, and the additional improvements or expansion of facilities is assumed to meet the demand, regardless of funding potential and without high-speed train service as part of the system.

Figure 2
Modal Alternative – Highway Component

Figure 3
Modal Alternative – Aviation Component



Regional Airport	Representative Intercity Demand (Millions)	Additional Gates (by Region)	Additional Runways (by Region)
BAY AREA TO MERCED			
OAKLAND SAN JOSE SAN FRANSICO SANTA ROSA	26.3	35	2
NORTHERN CENTRAL VALLEY			
SACRAMENTO STOCKTON	6.2	6	1
SOUTHERN CENTRAL VALLEY			
BAKERSFIELD VISALIA FRESNO MERCED MODESTO	1.0	2	0
LOS ANGELES			
BURBANK LOS ANGELES LONG BEACH ORANGE COUNTY ONTARIO	27.0	36	2
SAN DIEGO			
SAN DIEGO CARLSBAD	7.0	12	1
TOTALS	68.0	91	6

1.1.3 High-Speed Train Alternative

The Authority has defined a statewide high-speed train system capable of speeds in excess of 200 miles per hour (mph) (320 kilometers per hour [km/h]) on dedicated, fully grade-separated tracks, with state-of-the-art safety, signaling, and automated train control systems. State of the art high-speed steel-wheel-on-steel-rail technology is being considered for the system that would serve the major metropolitan centers of California, extending from Sacramento and the San Francisco Bay Area, through the Central Valley, to Los Angeles and San Diego (Figure 4).

The High-Speed Train Alternative includes several corridor and station options. A steel-wheel on steel-rail, electrified train, primarily on exclusive right-of-way with small portions of the route on shared track with other rail is planned. Conventional "non-electric" improvements are also being considered along the existing LOSSAN rail corridor from Los Angeles to San Diego. The train track would be either at-grade, in an open trench or tunnel, or on an elevated guideway, depending on terrain and physical constraints.

For purposes of comparative analysis the HST corridors will be described from station-to-station within each region, except where a by-pass option is considered when the point of departure from the corridor will define the end of the corridor segment. Segment and subsegment labels and civil station numbers taken from the project plans and data are also used to identify corridor locations.

Figure 4
High-Speed Train Alternative – Overview and Areas Served

2.0 BASELINE/AFFECTED ENVIRONMENT

2.1 STUDY AREA

The Study Area for noise and vibration assessment is defined by the screening distances established by FRA and FTA for rail and highway corridors. In all cases, the areas are confined to within 1000 feet from the center of the proposed corridor. For airport noise, the area is confined to within the Ldn 65 noise contour established for the particular airport. This is the extent of area where a change in noise would be most noticeable to receivers, and new projects could begin to dominate the noise environment.

2.2 GENERAL DESCRIPTION OF REGIONAL NOISE & VIBRATION ENVIRONMENTS

Regional noise and vibration environments are generally dominated by transportation-related sources, including vehicle traffic on freeways, highways, and other major roads, existing passenger and freight rail operations, and aviation sources, including civilian and military.

Noise contours for major road and rail corridors are required by the State of California to be part of community (city and county) General Plan documents. Contours for road and rail corridors can also be estimated using Table 5-7 of the FTA *Transit Noise and Vibration Impact Assessment* Manual. In this study, existing noise contours for the No-Project Alternative and Representative Cases (typologies) were estimated according to the FTA procedures because of the high number of communities involved. The FTA procedures also allow noise contour estimation based on the local population density, and this method was also used in this study, particularly for Representative Cases at portions of the HST Alternative that would be new corridors.

Near airports, regional noise environments will be dominated by aircraft operations. Major civil and military airports are required to produce noise contour maps to assist local agencies with land development and zoning. Operational growth at a particular airport may also be studied from a noise basis using noise contour maps if such data are available. The 65 Ldn contour is typically considered to be the transition between aviation and vehicle traffic dominated noise environments, although aircraft flyovers can remain a measurable part of the local noise environment outside of the 65 Ldn airport noise contour.

2.3 SENSITIVE NOISE & VIBRATION LAND USE LOCATIONS

The screening study includes residential, institutional, and park areas as noise and vibration sensitive land uses. All residential zones within the screening distances defined for highways and HST corridors were included in the study. Institutional locations for the study included schools, hospitals, and historic structures within the screening distances. All sensitive land use locations were determined from GIS data and project plans for the region.

2.4 REPRESENTATIVE NOISE & VIBRATION TYPOLOGIES IN REGION

Representative land use typologies for the region were selected from residential, institutional, and park uses within the study screening areas for the HST Alternative. For the Bay Area to Merced region, the land use typologies selected for individual study are as follows:

Table 2.4.1 Representative Typology Cases for Region

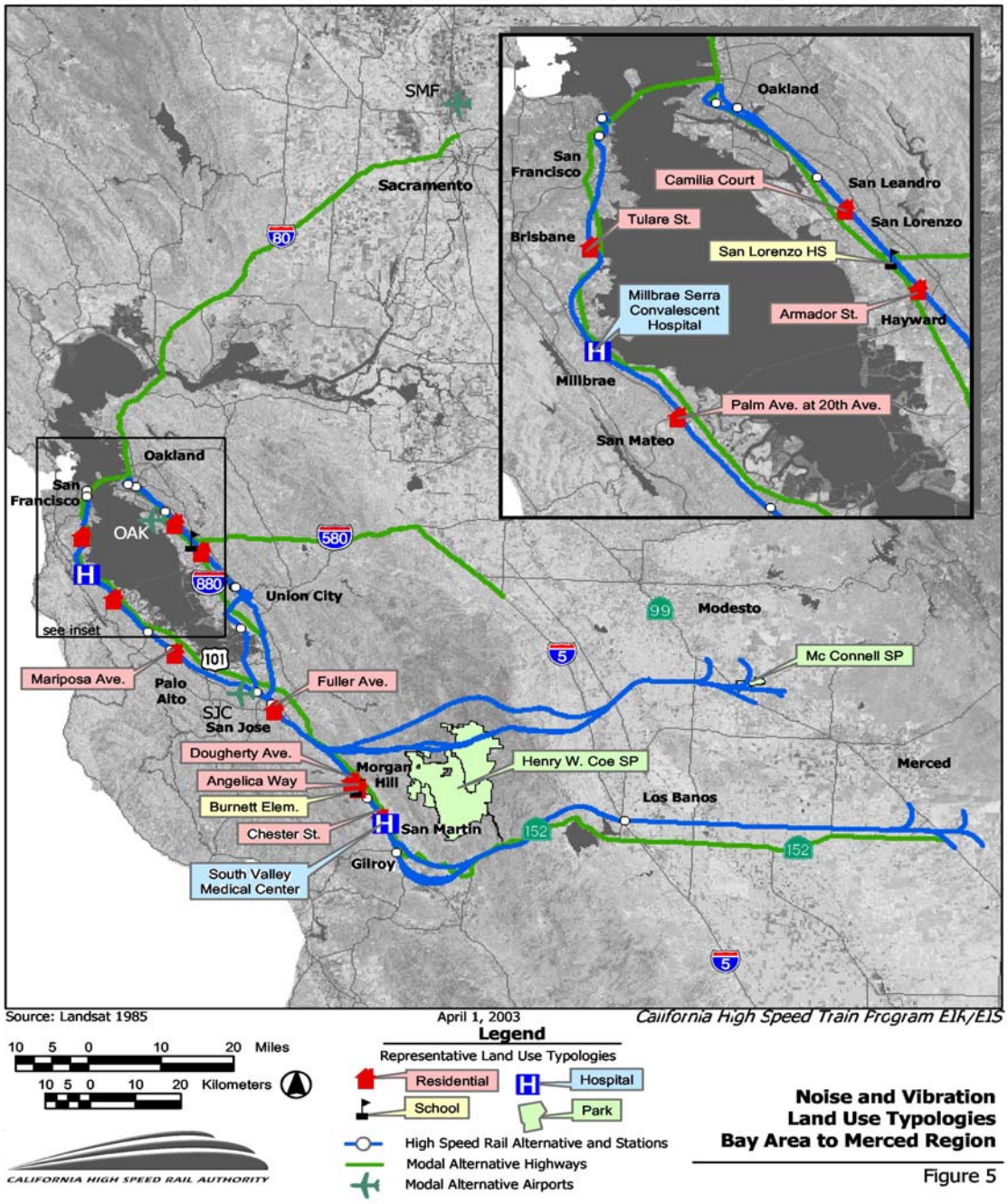
Bay Area - Merced

Alignment/Segment	Description	City/County	Land Use Type	Distance from Alignment (ft)*
SF to SJ	Tulare Street	Brisbane	Residential	450
SF to SJ	Palm Ave. @ 20th Avenue	San Mateo	Residential	200
SF to SJ	Mariposa Avenue	Palo Alto	Residential	70
Oak to SJ	Camellia Court	San Leandro	Residential	80
Oak to SJ	Amador Street	Hayward	Residential	300
SJ to Merced	Fuller Avenue	San Jose	Residential	60
SJ to Merced	Dougherty Avenue	San Jose	Residential	790
SJ to Merced	Angelica Way	Morgan Hill	Residential	340
SJ to Merced	Chester Street	San Martin	Residential	200
SF to SJ	Millbrae Serra Convalescent Hospital	Millbrae	Hospital	100
SJ to Merced	South Valley Medical Center	San Martin	Hospital	330
Oak to SJ	San Lorenzo High School	San Lorenzo	School	140
SJ to Merced	Burnett Elementary School	Morgan Hill	School	190
SJ to Merced	McConnell State Park (middle of park)	Santa Clara Co.	Park	50
SJ to Merced	Henry W. Coe State Park	Merced Co.	Park	50

* Measured from centerline of alignment

The geographic locations for the representative cases indicated in Table 2.4.1 are shown in Figure 5. The northern portion of the Bay Area to Merced region corridor is densely developed. Along the San Francisco Peninsula, there is extensive residential land use along the existing Caltrain alignment. There is also much commercial and light industry land use along this portion of the alignment, in particular in city centers.

In the East Bay, the area is also densely populated along the I-880 corridor. The San Jose area is similarly populated along the alignment until the southern end of the city. South of San Jose there are scattered suburban residential developments, with a gradual transition to a more rural setting. There is residential land use in Morgan Hill, San Martin and Gilroy, but outside these towns the land is primarily agricultural.



Noise and Vibration
Land Use Typologies
Bay Area to Merced Region

Figure 5

Typical residential land use typologies have been selected from each of these areas using the GIS data from which were chosen representative cases within the noise screening distances. Representative cases of hospitals, schools and parkland which might be impacted by the HST alternative of the project have also been selected, using GIS data within the screening distances.

Ambient noise in the Bay Area to Merced region has been estimated using data in the Noise Element from the General Plan for cities and counties in the region and general methods provided by FRA and FTA for estimating noise. The ambient noise in the northern portion of the region is dominated by motor vehicle traffic in densely populated areas and along freeways. Along the San Francisco Peninsula, the existing Caltrain passenger service contributes to the ambient there. In the East Bay, existing Amtrak passenger service and freight rail contribute to the ambient. In southern San Jose and as far as Gilroy, to the south, Caltrain, Amtrak, and freight rail contribute to the ambient.

In the urban areas and suburban areas of the East Bay, San Francisco Peninsula and San Jose, the ambient noise ranges from L_{dn} 57 to 66. In the areas close to the international airports at San Francisco (SFO), Oakland (OAK), and San Jose (SJC), the ambient levels are over L_{dn} 70. In the more rural areas of the region, the ambient noise ranges from 52 to 57. Henry Coe State Park is characterized by a low ambient noise environment of approximately L_{eq} 40 dBA, being in a remote location and removed from transportation noise sources.

Where there is an existing railroad alignment, groundborne vibration may be part of the existing ambient conditions beyond 50 ft. from the tracks. This is particularly true for freight railroad, or where passenger trains operate at speeds over 40 mph. Ambient vibration conditions would be determined in the Tier 2 analysis.

3.0 EVALUATION METHODOLOGY FOR NOISE & VIBRATION

3.1 CHARACTERISTICS OF HST NOISE & VIBRATION

High-speed trains have similar noise and vibration characteristics to conventional trains with some unique features resulting from the higher speed of travel. The HST is expected to be a steel-wheel, steel-rail electrically-powered train operating on its own tracks in an exclusive right-of-way. Because there will be no highway grade crossings, the annoying sounds of the train horn and warning bells will be eliminated. The use of electrical power cars eliminates the rumble associated with diesel-powered locomotives. All of the above factors allow HST to generate lower noise levels than conventional trains at speeds with which most people are familiar. At higher speeds, however, HST shows a noise increase over conventional trains due to aerodynamic effects. A mitigating factor is that the high speeds enable HST noise to occur for a relatively short duration (a few seconds at the highest speeds).

Vibration of the ground caused by the pass-by of the HST is similar to that caused by conventional steel wheel/steel rail trains. The same speed-dependent vibration generation mechanisms are present in each type of train. Holding down the vibration levels associated with the HST are the new track construction and smooth track and wheel surfaces resulting from high maintenance standards required for high speed operation.

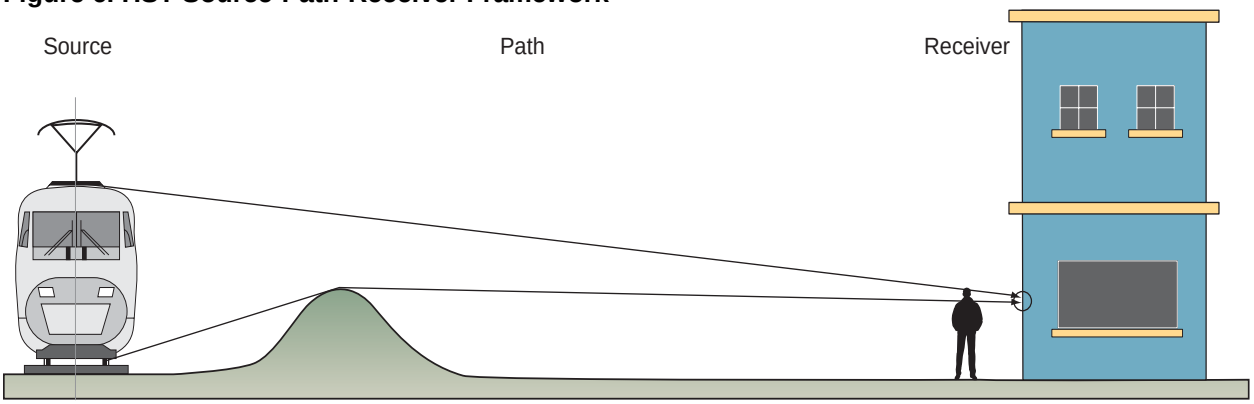
This section provides a description of the noise and vibration effects associated with HST.

3.1.1 Elements of Noise Environment Associated with HST

Noise from HST is expressed in terms of a Source-Path-Receiver framework as illustrated in Figure 6. The source of noise is the train moving on its tracks. The path describes the intervening course between

the source and the receiver wherein the noise levels are reduced by distance, topographical and man-made obstacles, atmospheric effects and other factors. Finally, at each receiver, the noise from all sources combines and is the noise environment at that location.

Figure 6. HST Source-Path-Receiver Framework



3.1.2 Noise Sources on HST and Conventional Trains.

The total noise generated by a train consists of several individual noise-generating mechanisms, each with its own characteristics, including location, intensity, frequency content, directivity and speed dependence. The distribution of noise sources on a typical HST is shown in Figure 7. These noise sources can be grouped into three categories according to the speed of the train.

Noise Sources at Low Speeds. For low speeds, below about 40 mph, noise emissions are dominated by the propulsion units, cooling fans, and undercar and top-of-car auxiliary equipment such as compressors and air conditioning units. HST will be electrically powered whereas conventional trains are usually diesel powered, a major difference in noise emission levels at low speed. Cooling fan noise is similar on all trains, but missing from the HST will be the low-frequency noise generated by the diesel exhaust that people associate with freight and commuter trains. Sources of HST noise occur both low and high on the body of the train. For example cooling fans and auxiliary systems can be located both on top and underneath the coaches and power cars. Traction motors on the power cars are low down near the wheels. Below 40 mph, noise levels increase only slightly with speed increases, typically following a relationship of 10 times the logarithm of the train speed.

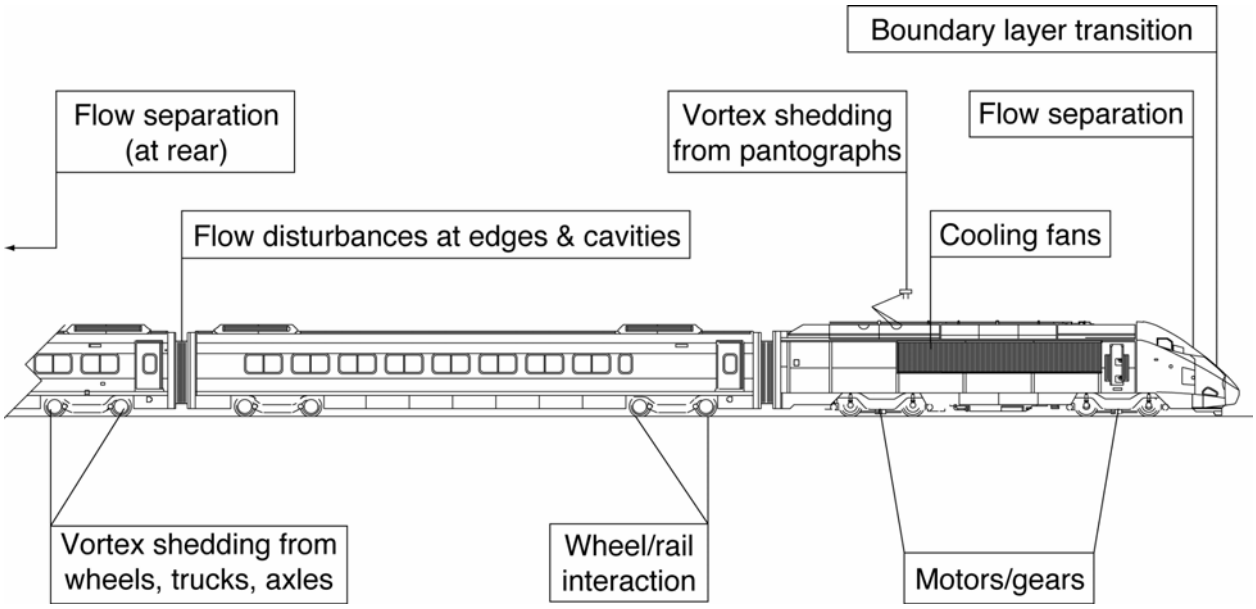
Noise Sources at Medium Speeds. In the speed range from 60 mph to about 150 mph, mechanical noise resulting from wheel/rail interactions and structural vibrations dominate the noise emission from trains. Conventional trains seldom exceed 125 mph, so this speed range which represents a medium range for HST actually represents the top end of noise characteristics for trains with which most people are familiar. Wheel/rail interaction is the source of the rolling noise radiated by steel wheels and rails on both HST and conventional trains. Rolling noise is caused by roughness and unevenness in the running surfaces and emanates from just above the track level. Consequently, this source is low to the ground and easy to shield with noise barriers for at-grade operations. When a train runs on a bridge or an elevated structure, the noise becomes a combination of wheel/rail noise and structure-borne noise. Structure-borne noise comes from many elements of the structure, but is generally concentrated on the area near the point of wheel/rail contact. Speed has a strong influence on noise in the medium speed range, usually about 30 times the logarithm of train speed.

Noise Sources at High Speeds. Above approximately 170 mph, aerodynamic noise sources tend to dominate the radiated noise from HST. Conventional trains are not capable of attaining such speeds. Aerodynamic noise is generated from solid elements of the train body moving rapidly through the air. The motion causes air to flow around components and separate from the train in an unsteady way, especially in the areas around the wheels, the gaps between coaches, and the pantograph (the telescopic structure that picks up electrical current from the overhead wires). Unsteady flow causes aerodynamic noise which increases very rapidly with speed, typically 60 to 70 times the logarithm of speed.

HST noise in the transition speeds between each of the three foregoing ranges is a combination of the sources in each range, with no clear dominant source.

Sources at all Speeds: Horns and Bells. Horns are an example of a train noise source that is meant to be the dominant noise source at any speed. Audible warnings at grade crossings, including train horns and warning bells, are a common feature of conventional trains. These noise sources often prove to be a source of annoyance to people living in the vicinity of railroad tracks. In the case of HST, however, these sources are absent except in the case of emergencies because grade crossings are eliminated for reasons of safety. Elimination of horns and bells at grade crossings is a clear noise benefit associated with the implementation of HST.

Figure 7. Noise Sources on HST



3.1.3 Noise Propagation from Trains

Sound from a train reduces in level in its path to nearby receivers due to a number of natural and environmental factors, including:

Divergence – Sound reduces by spreading in all directions.

Absorption – Sound gets absorbed by the air and the ground.

Refraction – Wind and temperature gradients change the direction of sound waves.

Natural Shielding – Topographical features (hills) interfere with sound waves.

Man-made Shielding -- Noise barriers and buildings interfere with sound waves.

Most of these effects occur in nature and provide a gradual and predictable reduction of noise with distance in open areas. A typical natural reduction would be 5 to 6 dB per doubling of distance starting from about 100 feet from the tracks. In contrast, for built-up areas and locations where mitigation is applied, the man-made shielding by buildings and noise barriers provides significant reductions of noise in a short distance. A typical reduction by man-made shielding is 5 to 10 dB in the shadow of the structure. Specially designed noise barriers for HST can achieve somewhat greater noise reductions.

3.1.4 Noise Perception at the Receiver.

When train noise reaches the receiver, whether it be a person outdoors in the garden or someone indoors sleeping, it combines with other sounds in the environment and may or may not stand out in comparison. The distant sources may include traffic, aircraft, industrial activities, animal sounds or wind in the trees. These distant sources create a background noise in which no particular source is identifiable, but is fairly constant from moment to moment and varies slowly from hour to hour. Superimposed on this slowly-varying background noise is a succession of identifiable noisy events of relatively brief duration. Examples include the passby of a train, the overflight of an airplane, or the screeching of brakes. These single events may be loud enough to dominate the noise environment at a location for a short time, and when added to everything else, can be responsible for annoyance.

The highest noise level reached during a single event is called the “maximum level” (Lmax). Lmax is used to provide information on how loud is the noise from a train passby, for example. Some typical Lmax’s are shown in Figure 8.

Despite the usefulness of the Lmax in describing a single event, there are better measures for assessing the noise environment containing many such events of varying duration in a fluctuating noise environment. The primary descriptor used for HST environmental assessment is Day-Night Sound Level (Ldn), which describes a receiver’s cumulative noise exposure from all noise events that occur in a 24-hour period, with events between 10 pm and 7 am increased by 10 decibels to account for greater nighttime sensitivity to noise. The Ldn is used to describe the general noise environment in a location – the so-called “noise climate.” The descriptor is a computed number, not one to be read moment to moment on a meter. Its magnitude is related to the general noisiness of an area. The U.S. Environmental Protection Agency (EPA) developed the Ldn descriptor and now most Federal agencies, including the FRA and Federal Transit Administration (FTA), use it to evaluate noise impacts.

Along highway and rail corridors where the noise sources run for 24-hours a day and 7 days a week, the Ldn is considered the best descriptor of the noise environment. Freeway noise tends to be continuous, with sources extending out in the distance in both directions. This type of source is characterized as a “line source,” a term that defines the way the sound propagates away from the highway. HST and railroad noise is a bit different in character. Rather than a continuous line source like highway traffic, rail traffic is described as a “truncated line source,” where trains pass by only periodically. The sound propagation from a rail line differs from that of the highway.

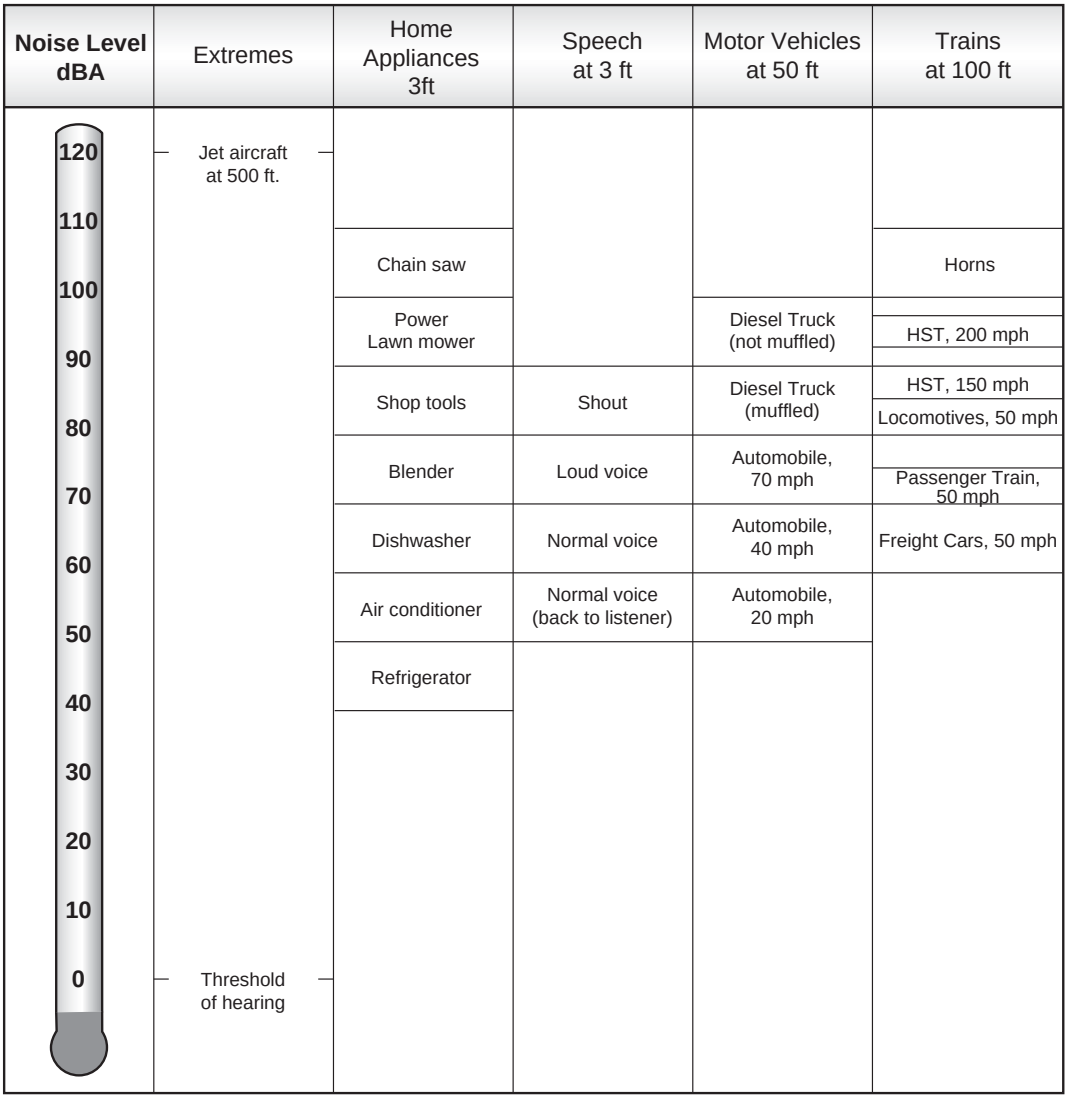
A comparison of Ldn associated with surface transportation sources at various distances is shown in Figure 9. The example is based on rural areas adjacent to a typical 4-lane freeway[2], a moderately busy freight railroad[3], and the HST at 180 mph in a segment between Merced and Sacramento[4]. In general, the HST noise falls off more rapidly with respect to distance than that from a busy freeway.

[2] Freeway, 4 lanes, 1885 vehicles/hour/lane, 65 mph, 2% medium trucks, 3% heavy trucks.

[3] Freight trains with 2 locomotives, 40 cars, 60 mph, 10 daytime, 3 nighttime.

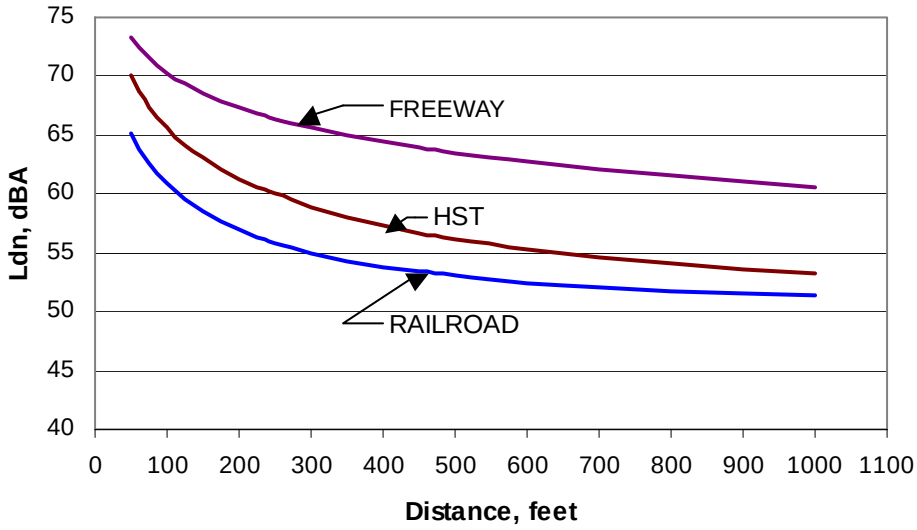
The way people react to noise in their environment has been studied extensively by researchers throughout the world. As a result of these studies, noise impact criteria have been adopted by FRA and other federal agencies based on the contribution of the noise from a source like HST to the existing environment. FRA bases noise impact criteria on the increase in Ldn (for buildings with nighttime occupancy) or increase in Leq (for institutional) buildings caused by the project. Criteria are discussed in Section 3.2.

Figure 8. Typical Lmax Values



[4] HST, 180 mph, 67 daytime, 5 nighttime.

Figure 9 Example of Noise Exposure vs. Distance for Transportation Modes



3.1.5 Vibration from HST

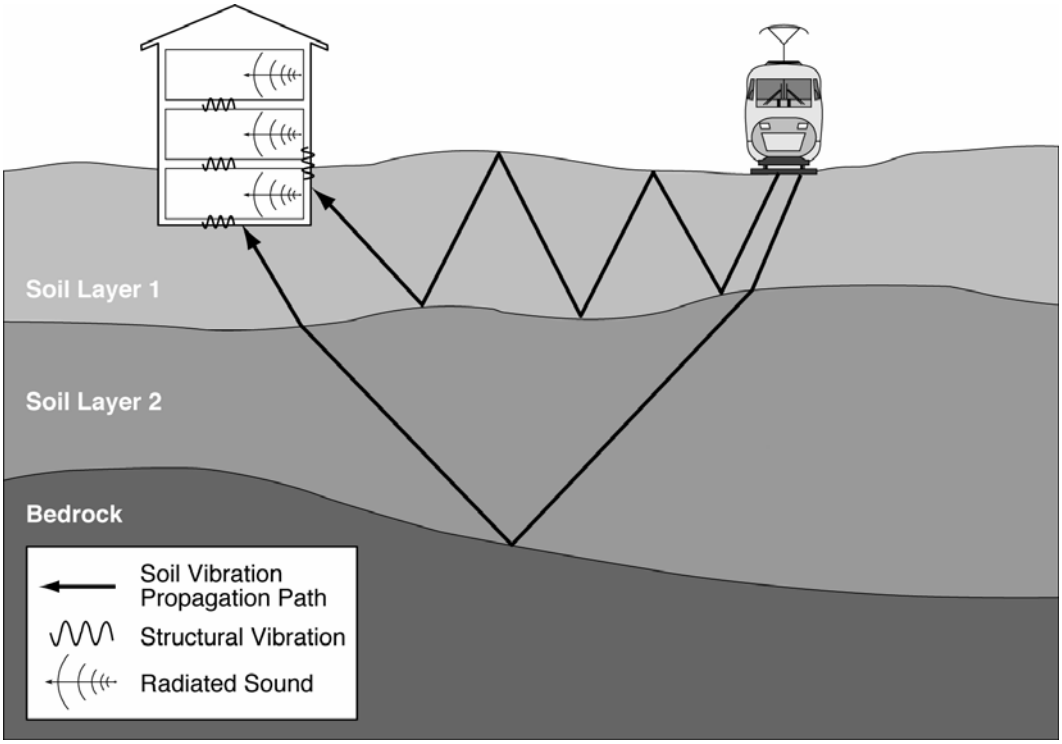
Ground-borne vibration from trains refers to the fluctuating motion experienced by people on the ground and in buildings near railroad tracks. In general, people are not exposed to vibration levels from outside sources that they can feel in their everyday lives. They slam their doors and a wall may shake, or drop something heavy and feel the floor shake, but when an outside source like a train causes their homes to shake, they become concerned. The effects of ground-borne vibration in a building close to a source of vibration may include perceptible movement of the floors, rattling of windows, shaking of items on shelves or hanging on walls, and rumbling sounds. None of these effects is great enough to cause damage, but could result in annoyance if repeated many times per day.

As is the case with noise, ground-borne vibration can be considered to follow a Source-Path-Receiver Framework, as shown in Figure 10. The Source of vibration is the train wheels rolling on the rails. They create vibration energy that gets transmitted through the track support system into the trackbed or track structure. The amount of energy that is transmitted into the track structure depends strongly on factors such as how smooth the wheels and rails are and the details of the vehicles and tracks. Vibration levels from conventional trains and from HST have been measured and documented by FRA in the guidance manual. As in the case of noise, speed makes a difference: vibration levels increase according to a 20 times the logarithm of speed relationship.

The Path of vibration involves the ground between the source and a nearby building. The vibration of the track or structure excites the adjacent ground, creating vibration waves that propagate through the various soil and rock strata to the foundations of nearby buildings. Ground-borne vibration propagation characteristics vary considerably among the different ground types found in a region. FRA's guidance manual provides a generic method for estimating propagation effects for Tier 1 and a more detailed method for Tier 2 assessments.

The Receiver of vibration is the building. Vibrations propagate from the foundation throughout the building structure, causing floors, walls and other building elements to vibrate. Vibration impact criteria have been adopted by FRA based on people's annoyance from repeated exposure to ground-borne vibrations from trains. These criteria are discussed in Section 3.2.

Figure 10. Vibration Propagation from HST



3.2 CRITERIA FOR NOISE & VIBRATION IMPACT

Criteria for HST noise and vibration impact assessment have been established by the FRA based on activity interference and annoyance ratings developed by the EPA. These criteria provide the basis for the screening procedures used in the programmatic assessment.[5]

HST Noise. FRA's noise criteria are ambient-based such that a project's noise is compared with existing conditions to provide an assessment of the effect of the potential change in noise environment on various land uses in the transportation corridor. They incorporate elements of both "relative" and "absolute" limits in assessment of project noise levels. Relative criteria are based on expected annoyance due to the change in the noise environment caused by the HST. Absolute criteria are based on activity interference caused by the HST alone.

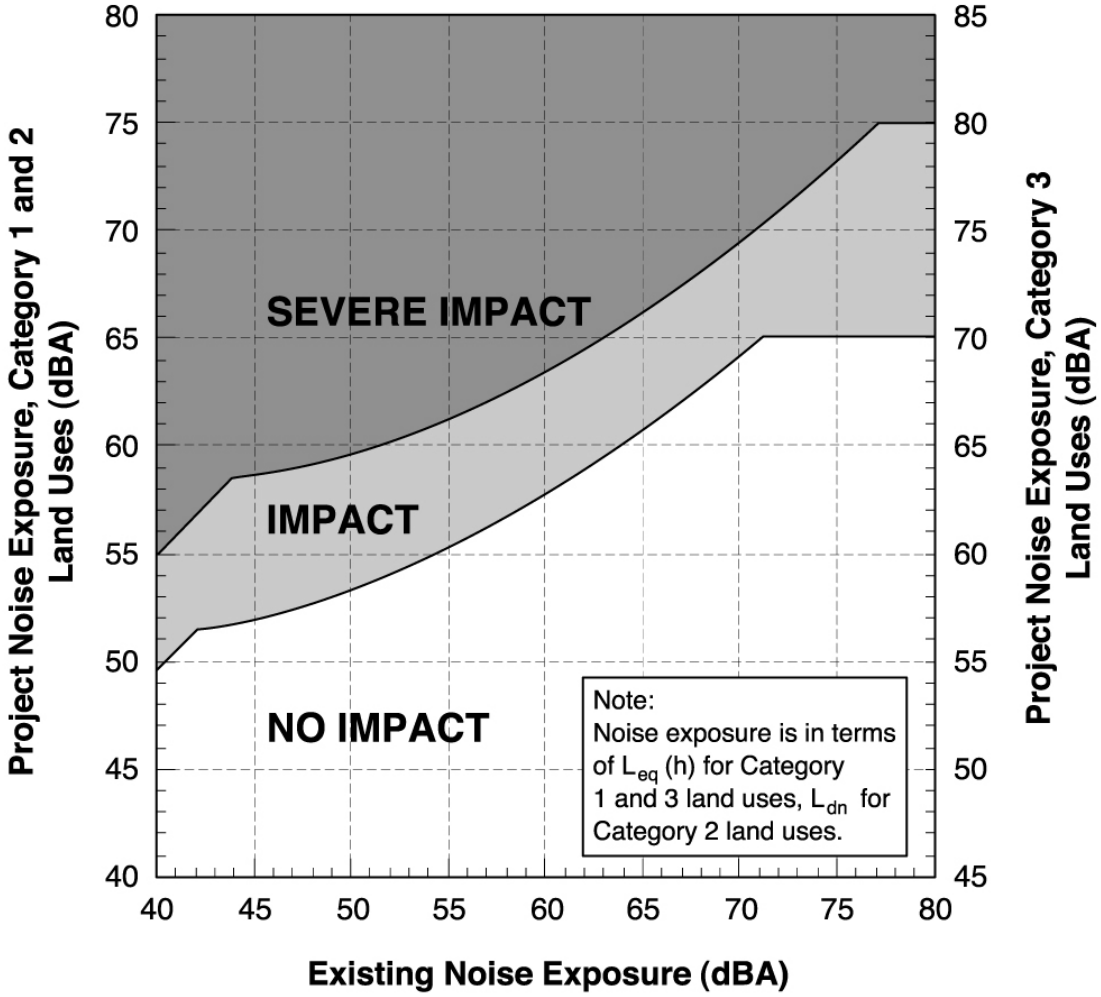
The metric used for noise impact assessment is the day-night sound level (Ldn) in dBA for residential land uses, Land Use Category 1, including buildings where people sleep (hospitals, hotels, motels). The hourly equivalent sound level (Leq) in dBA is applied during hours of active use in parks (Land Use Category 2) and institutional uses (Land Use Category 3 -- churches, libraries, schools).

Changes in noise over existing conditions are categorized into three levels of effect by FRA: No Impact, Impact and Severe Impact, as shown in Figure 11. The project noise level is compared to the existing ambient noise level prior to the introduction of the project. The intersection of the two levels on the

[5] U.S. Department of Transportation, Federal Railroad Administration. "High Speed Ground Transportation Noise and Vibration Impact Assessment," (see FRA website).

graph is an indicator of the degree of impact. Below the threshold of Impact the project is considered to have no noise impact since, on the average, the introduction of the project will result in an insignificant increase in the number of people highly annoyed by the new noise source. For Severe Impact, a significant percentage of the people exposed to the noise would be highly annoyed by the new noise source. Impact is assessed when the HST's noise level would be noticeable but would not be sufficient to cause strong, adverse reactions from the community. Upper limits are imposed in the FRA criteria to account for high noise levels judged to interfere with human activities.

Figure 11 Noise Impact Criteria for High Speed Rail Projects



HST Vibration. FRA's vibration criteria are based on research documenting people's reactions to various levels of building vibrations induced by rail systems. The research, combined with national and international standards related to human exposure to vibration provides the foundation for predicting annoyance from ground-borne vibration in residential areas that would be caused by the HST. The criteria shown in Table 3.2.1 are based on the expected maximum vibration level caused by an average passby of the HST at site-specific locations.

The metric used for vibration impact assessment is the one-second average root-mean-square velocity level (Lv) in VdB. For frequent events, e.g., more than 70 HST passbys per day, the criterion for residential land use is 72 VdB.

Table 3.2.1 Ground-Borne Vibration Impact Criteria

Land Use Category	Ground-Borne Vibration Impact Levels (VdB re 1 micro inch/sec)	
	Frequent Events[1]	Infrequent Events[2]
Category 1: Buildings where low ambient vibration is essential for interior operations.	65[3]	65[3]
Category 2: Residences and buildings where people normally sleep	72	80
Category 3: Institutional land uses with primarily daytime use.	75	83

Notes:
1. "Frequent Events" are defined as more then 70 vibration events per day. Most rapid transit projects fall into this category.
2. "Infrequent Events" is defined as fewer than 70 vibration events per day. This category includes most commuter rail systems
3. 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 acceptable vibrations levels. Ensuring lower vibration levels in a building often requires special design of the HVAC (heating/air conditioning) systems and stiffened floors.

Modal and No-Project Alternative Noise and Vibration Criteria. The alternatives to HST include railroad, highway, and aviation components, each of which has criteria established by the corresponding transportation departments concerned with those modes.. Railroad noise and vibration criteria have been established by FTA for commuter trains and can be applied to the speeds attained by usual intercity operations; highway noise criteria have been established by FHWA; and aviation noise criteria have been established by FAA. It is to be noted that neither of the latter agencies have vibration criteria. Although each agency has a different approach, it is possible to link the noise impact assessments obtained from the various methods by a commonality of annoyance relationships quantified by the US EPA and noise standards adopted by the US HUD.

Railroad noise and vibration criteria developed by FTA are actually the original criteria adopted by FRA. Since they are identical to those used for HST, these criteria will be used for all rail operations in the Modal and No-Project Alternatives.

Aviation noise can be assessed using the Ldn metric, and noise impact occurs where Ldn exceeds 65 dBA, according to FAA. Noise contours around airports are routinely developed to identify the area exposed to noise levels in excess of the impact threshold. Some airports have noise contours for future planned airport operations. However, noise contours are not available for the Modal Alternative and consequently could not be used to assess the potential impacts of the aviation mode in the Modal Alternative. It was not possible to obtain noise contours for the No-Project Alternative. Consequently the potential noise impacts associated with the aviation component of these two alternatives is not included. Vibration is assumed not to be an issue with aviation.

Highway noise metrics used by FHWA are slightly different from the other modes. Highway noise impact is based on the traffic equivalent noise level (Leq) during one hour of the day -- the hour with the worst

impact on a regular basis. For adding to the potential impacts of other modes and subsequent comparison with HST, the hourly Leq can be used to develop an estimate of Ldn in communities along the highway corridors.

3.3 SCREENING PROCEDURE FOR PROGRAMMATIC ASSESSMENT

Noise Screening for HST Alternative. FRA has developed a screening method for application early in the HST development, before many details of the system have been defined. Distances from the center of the corridor are provided to encompass all potentially impacted locations. The purpose is to provide an indication whether any noise-sensitive receivers are close enough to the proposed alignments for noise impact to be possible, and it identifies locations where the HST has little possibility of noise impact. The method is used for making a general comparison of potential impacts for different corridors. It is also a key element in the identification of locations for subsequent analysis in Tier 2 where the greater refinement in the detailed analysis is used to focus in on the actual impacts. Correspondingly, screening identifies locations where no additional noise studies need be conducted.

The FRA screening procedure takes account of the noise impact criteria, the type of corridor, and the ambient noise conditions in typical communities. Distances are developed from detailed noise models based on noise emissions of typical steel-wheel/steel-rail high-speed trains, expected maximum operation levels and speeds, along with the noise-sensitivity of residential land use. The FRA screening procedure is considered to be appropriate for HST speeds from 125 mph to 210 mph. FRA's screening method is not intended for use at speeds less than 125 mph, or for areas near stations. However, FTA has developed a screening method that is consistent with the FRA method, and will be used for these conditions.

The screening distances differentiate among areas according to their estimated existing ambient noise. "Urban" and "Noisy Suburban" areas are grouped together. These areas are assumed to have ambient noise levels greater than 60 Ldn. Similarly, "Quiet Suburban" and "Rural" areas are grouped as areas where ambient noise levels are less than 55 Ldn. For developed land with Ldn between 55 and 60, the classification is dependant on other factors such as proximity of major transportation facilities and density of population.

Table 3.3.1 Noise Screening Distances for HST Alternative

Speed (mph)	Type of Corridor	Land Use - Ambient	Distance† (ft)
≥ 125	Existing Rail	Urban/Noisy Suburban	450
		Quiet Suburban/Rural	900
	Existing Highway	Urban/Noisy Suburban	450
		Quiet Suburban/Rural	700
	New Rail	Urban/Noisy Suburban	450
		Quiet Suburban/Rural	900
< 125	Any	Urban/Noisy Suburban	375
		Quiet Suburban/Rural	750
Station§	Any	Urban/Noisy Suburban	225
		Quiet Suburban/Rural	450

† Measured from centerline of track
§ For a distance of 1/4 mile in either direction from center of station

Vibration Screening for HST Alternative. FRA also provides a screening method for HST vibration levels. The method is similar to that for noise, except it assumes typical ground propagation conditions. Vibration propagation is site-specific depending on the soil conditions. Although it is not possible to

account for this in a Tier 1 analysis, this has been addressed in the typology analyses. The FRA screening distances are shown below:

Table 3.3.2 Vibration Screening Distances for HST Alternative

Speed (mph)	Receptor Type	Distance† (ft)
≥125	Special Facilities (e.g. concert halls, research)	750
	Residential	220
	Institutional (e.g., schools, public buildings)	160
< 125	Category 1 (e.g., concert halls, research)	600
	Category 2 (e.g., residences, theaters, auditoria)	200
	Category 3 (e.g., schools, public buildings)	120

† Measured from centerline of track

Modal and No-Project Alternatives. The railroad noise component of the alternatives is screened according to the FRA/FTA methods described above. Screening distances for highways are calculated for various roadway types according to the number of lanes, using the authorized FHWA traffic noise model to determine the distance to where the 65 Leq noise contour is reached. Highway noise screening distances are shown below:

Table 3.3.3 Noise Screening Distances for Highways

Number of Lanes	Distance† (ft)
2	242
4	335
6	390
8	455
10	510
12	580
14	640
16	715

† Measured from centerline of highway

3.4 SUBSEQUENT ANALYSIS IN TIER 2

Locations identified as potentially impacted by noise and vibration in the screening procedure will be revisited with a more detailed assessment in Tier 2 analysis. FRA provides procedures for a general assessment to refine the noise impact areas, followed by a detailed analysis to develop mitigation for impacted areas.

3.5 PARAMETERS FOR COMPARING ALTERNATIVES

The screening procedures described above are designed to provide distances from the center of a corridor, or area enclosed by contours. However, noise and vibration impacts relate to the number of people who are likely to be annoyed by activity interference. The areas defined by the screening distances along the alignments, together with available population density information in GIS format,

provide a measure of the number of people impacted by HST and the other alternatives. Consequently, people impacted will be the base parameter for comparing the alternatives.

Rating the severity of impacts by "High," "Medium," or "Low" requires an assessment of how many people are exposed to impact-level noise and vibration. Consequently, a metric describing the relative magnitude of impact has been developed. For this screening study, an Impact Metric (IM) and Impact Rating (IR) have been defined as follows:

Impact Metric (IM) = (#Res. Population Impacts/Mile) + 0.3 x (#MU Population Impacts/Mile) + (l00 x # Hospitals)/Mile + (250 x # Schools)/Mile

Noise Rating Scheme (IR): High (H) = IM > 200; Medium (M) = 80 < IM <200; Low (L) = IM < 80

Vibration Rating Scheme (IR): High (H) = IM >100; Medium (M) = 40 < IM < 100; Low (L) = IM < 40

Implications of the Rating Scheme for noise as defined in this manner are that a moderate impact of only Low (L) with IM less than 80 corresponds to a residential impact of 4 people per house and 20 houses per mile (520 feet between houses for development on both sides of the alignment), and no institutional potential impacts (hospitals, schools). Institutional impacts, because of their higher occupancy add substantially to the severity of impact.

4.0 NOISE IMPACTS

4.1 NO-PROJECT ALTERNATIVE

The No-Project Alternative, potential noise impacts associated with existing highways only were obtained from the screening analysis. Because of limited or nonexistent information, potential impacts for expected future (2020) rail and aviation conditions were not included in the impact tabulations. Therefore the comparison between the No-Project Alternative and the HST Alternative is somewhat conservative in that the No-Project Alternative potential impacts are underestimated.

4.2 MODAL ALTERNATIVE

Potential noise impacts for the Modal Alternative associated with highway expansions and airport improvements were obtained from screening analyses. These potential impacts can be used to compare with the overall results of the No-Project Alternative potential highway impacts and potential HST impacts. Complete aviation data for the Modal Alternative is not available for this study, but where data were available an assessment of impact was made. The aviation component will increase the number people impacted and the degree of impact for the Modal Alternative. From the data available, it would appear that the number of people potentially impacted by the aviation component is small in comparison with the highway component. However, where available the potential airport impacts were combined with the highway component for comparison between the Modal Alternative and the HST Alternative.

4.3 HIGH-SPEED TRAIN ALTERNATIVE

HST noise typologies were analyzed using the General Assessment method provided by the FRA. Representative Cases were chosen to show, in more detail than is possible with the screening analysis, a range of impact levels that are likely to be encountered in the Tier 2 impact evaluation. Potential impacts for the entire HST Alternative were obtained from the screening analysis. The results of the screening analysis can be used to compare potential impacts between regional alignment options and between the potential highway impacts of the Modal Alternative and No-Project Alternative. Residential, park, and

institutional noise impact summaries are based upon the GIS land use and location data made available for the screening study and the corresponding screening distances used for each alignment segment.

4.4 NOISE TYPOLOGIES FOR HST

The results of the HST Representative Case noise typology studies are shown in Table 4.4.1 and 4.4.2 below. Table 4.4.1 includes residences and hospitals where there is occupancy both night and day and people generally sleep. Table 4.4.2 includes schools and parks with primarily daytime usage. The Representative Cases illustrate the typologies that exist throughout the Bay Area to Merced portion of this Rail Alternative. The FRA criteria, as described in Section 3.2, define three levels of noise impact: "no impact" (NI), "impact" (I), and "severe impact" (SI). Severe impact is normally associated with a Significant Impact as defined by CEQA, whereas an "impact" is usually not considered a significant impact, but worthy of consideration for mitigation based on a detailed cost/benefit analysis.

Reviewing Table 4.4.1, it can be seen that along the SF Peninsula corridor, the potential HST noise impacts to residences vary from NI to SI before applying standard noise reduction for typical mitigation as provided in the FRA manual. The noise impact to the Millbrae Serra Convalescent Hospital is indicated to be an SI before mitigation. Applying standard noise reduction, the potential residential and institutional noise impacts can be reduced to either NI or I. Such mitigation would consist of noise walls constructed approximately 30 to 50 feet from the centerline of the nearest track to the sensitive land use. The wall height necessary to mitigate these situations would normally be in the range of 8 to 12 feet high and would depend on the particular circumstances of each situation requiring noise mitigation.

Along the East Bay corridor, the potential HST noise impacts to residences are indicated to be SI for one and I for the other. After applying standard mitigation, the potential impacts are reduced to I for the latter on Amador Street, but the residences on Camillia Court are indicated as requiring more than the standard mitigation. More detailed noise analysis of the latter residences indicate that a noise wall of from 14 to 16 feet high may be required to mitigate to a level of I. For San Lorenzo High School, the impact level is I before mitigation and NI after mitigation.

In the San Jose to Merced segment of the regional alignment, the potential noise impacts to residences range from SI to I before mitigation. With standard mitigation, these potential impacts are reduced to either I or NI, except in case of the residences on Chester Street, which was analyzed in greater detail. In this particular case, the analysis indicates a noise wall may need to be from 14 to 16 feet high to mitigate to an impact level of I.

Also in the San Jose to Merced portion of the alignment, the South Valley Medical Center is indicated as being impacted at a level of SI before mitigation. Standard mitigation does not appear to be sufficient and this situation was also analyzed in greater detail. Further analysis of the South Valley Medical Center indicates a noise wall in the range of 12 to 14 feet high is sufficient to reduce the impact level to I. The Burnett Elementary School is shown to have an impact level of I before mitigation and NI after mitigation. The two parks in this portion of the region are also both seen to have an impact level of SI before mitigation and after applying standard mitigation. Further analysis indicates that noise walls in the range of from 12 to 14 feet high appear to reduce the impact level to I.

Table 4.4.1 Typology Analysis Table – Potential Residential and Hospital Noise Impacts
Bay Area to Merced

ALIGNMENT SEGMENT	DESCRIPTION	CITY/ COUNTY	CORRIDOR TYPE	DISTANCE (ft)*	SPEED (mph)	EXISTING Ldn	PROJECT Ldn	IMPACT LEVEL**	IMPACT TYPE AFTER MITIG.
SF to SJ	Tulare Street	Brisbane	Existing Rail	450	100	60	57	NI	--
SF to SJ	Palm Ave. at 20th Avenue	San Mateo	Existing Rail	200	121	61	64	SI	NI
SF to SJ	Mariposa Avenue	Palo Alto	Existing Rail	70	125	66	71	SI	I
Oak to SJ	Camellia Court	San Leandro	Existing Rail	80	170	65	72	SI	I†
Oak to SJ	Amador Street	Hayward	Existing Rail	300	148	60	63	I	NI
SJ to Merced	Fuller Avenue	San Jose	Existing Rail	60	74	65	68	SI	NI
SJ to Merced	Dougherty Avenue	San Jose	Existing Rail	790	175	52	58	I	NI
SJ to Merced	Angelica Way	Morgan Hill	Existing Rail	340	200	57	66	SI	I
SJ to Merced	Chester Street	San Martin	Existing Rail	200	200	57	70	SI	I†
SF to SJ	Millbrae Serra Convalescent Hospital	Millbrae	Existing Rail	100	125	64	69	SI	NI
SJ to Merced	South Valley Medical Center	San Martin	Existing Rail	330	200	55	67	SI	I††

* Measured from centerline of alignment.
** NI = No Impact, I = Impact, SI = Severe Impact
† Detailed noise analysis indicates a 14 to 16 ft high noise wall may be needed.
†† Detailed noise analysis indicates a 12 to 14 ft. high noise wall may be needed

Table 4.4.2 Typology Analysis Table – Potential School and Park Noise Impacts
Bay Area to Merced

ALIGNMENT SEGMENT	DESCRIPTION	CITY/ COUNTY	CORRIDOR TYPE	DISTANCE (ft)*	SPEED (mph)	EXISTING Daytime Leq	PROJECT Daytime Leq	IMPACT TYPE**	IMPACT TYPE AFTER MITIG.
Oak to SJ	San Lorenzo High School	San Lorenzo	Existing Rail	140	160	62	67	I	NI
SJ to Merced	Burnett Elementary School	Morgan Hill	Existing Rail	190	200	64	69	I	NI
SJ to Merced	McConnell State Park (middle of park)	Santa Clara	New Rail	50	200	50	78	SI	I†
SJ to Merced	Henry W. Coe State Park	Merced	New Rail	50	150	40	73	SI	I†

* Measured from centerline of alignment
** NI = No Impact, I = Impact, SI = Severe Impact
† Detailed noise analysis indicates a 12 to 14 ft high noise wall may be needed

4.5 NOISE SCREENING ANALYSIS

The screening analyses were performed for the No-Project, the Modal and the HST Alternatives. The analyses were accomplished using available GIS data for land use and alignment geometry. The land use along rail and highway alignments were "buffered" using the screening distances presented in Section 3.3. For airports, the screening distance is the distance to the existing CNEL 65 noise contour. The screening analyses for airports determined the number of people currently impacted. The number of people impacted by the Modal Alternative was determined using an "area equivalent" method approved by the FAA. The area equivalent method estimates that for every 1 dBA increase, the population impacted increases by 17%. The increase in noise level was estimated by the growth in demand forecast for each airport. The number of people potentially impacted within the noise buffers was determined using GIS census data.

There are two types of residential land use in the GIS database: strictly residential and mixed use (MU). The former is referred to as Anderson Land Use category 11, and the latter as Anderson Land Use category 16. Anderson Land Use category 16 applies to mixed use land (e.g., commercial and high density residential) where the residential component is typically 30% of the total. This latter fact was used in determining the impact metric (IM) described in Section 3.3.

The impact rating (IR) for each segment is indicated as being either L, M or H. The IR designates the degree of impact based on the number of people impacted per mile of alignment based on the metric thresholds presented in Section 3.3. Figure 12 indicates the results of the screening analysis for the No-Project and Modal Alternatives with the highway alignments color coded to show whether the rating is H, M, or L. Similar results of the HST screening analysis are indicated in Figure 13. The highest impact ratings are seen to coincide with the more densely populated areas of the SF Peninsula, the East Bay and San Jose.

Table 4.5.1 presents the detailed results of the screening analyses for the three project alternatives. In addition to potential residential land use impact, potential impacts to schools, hospitals and parks are also included. For hospitals and schools, the number of potentially impacted locations is indicated. Where parks are potentially impacted, the amount of acreage within the screening distances is indicated.

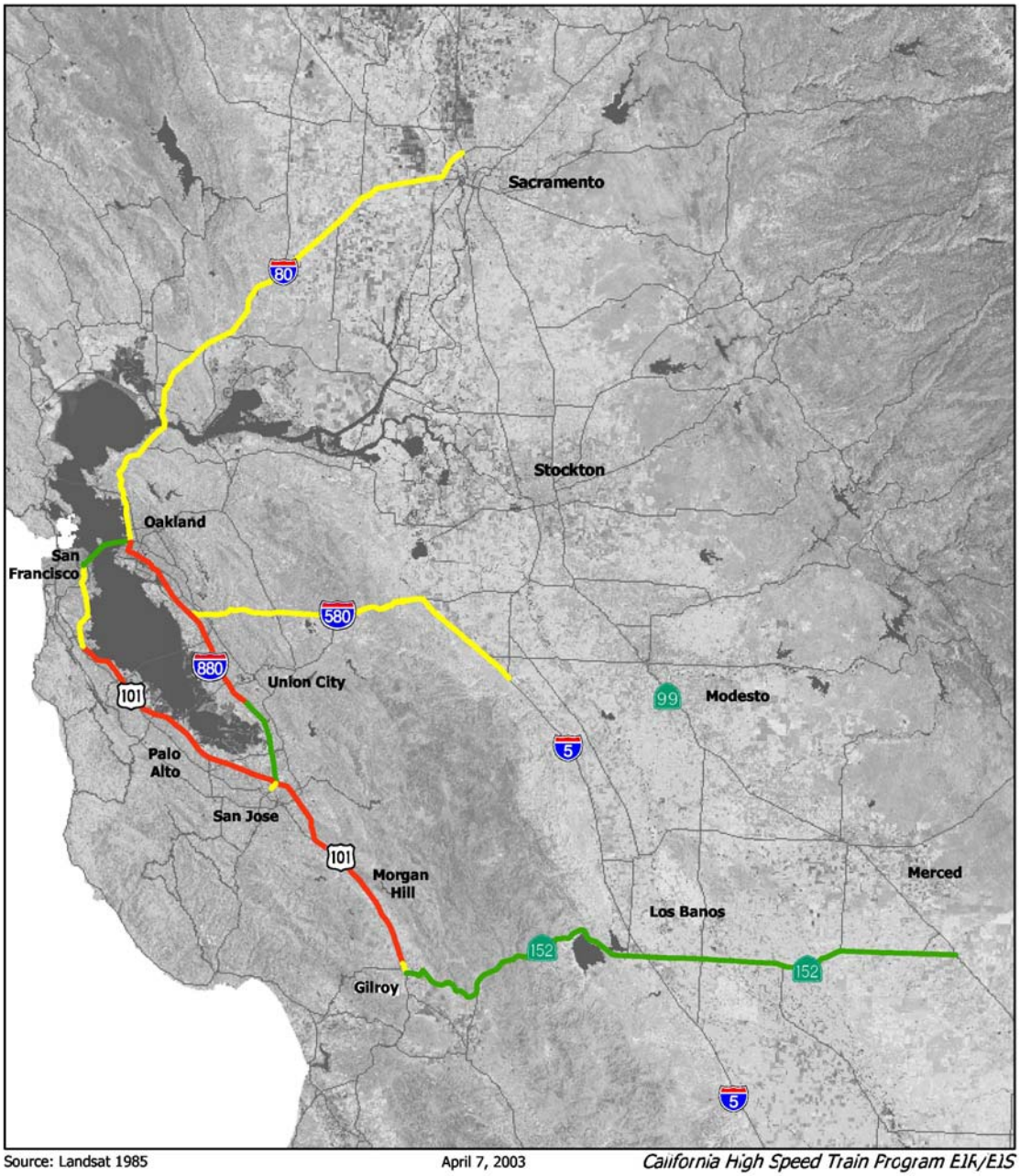
Under the No-Project Alternative (see Figure 12), the IR for the various highway segments ranges from L to H. Two areas of H impact are the I-880 corridor from I-238 to Fremont/Newark and the US-101 corridor from SFO to Gilroy. These same trends are also seen for the Modal Alternative. This result is not unexpected considering the close proximity of residential land along these alignments. What is different between the two alternatives is that the number of people impacted increases with the Modal Alternative and consequently the IM, although not enough to change the IR.

The HST Alternative (see Figure 13) is indicated to have potential impacts which are H along the SF Peninsula and East Bay corridors as would be expected considering the close proximity of residential land use and other sensitive land use. From San Jose to Merced the Gilroy Option has the highest impact of all the options, whereas the tunnel options all have similar potential impacts. Overall the HST Alternative has IRs which range from L to H depending primarily on the proximity and density of residential population, but also on the speed of the train. The noise Typology study results are seen to reflect the same general trend as the screening analysis results. Where population is dense and close to the alignment, potential impacts are higher and more substantial and conversely where the alignment passes through less densely populated areas such as in the southern and eastern portion of the region, the potential impacts are less and not as substantial.

Figure 14 indicates the two combinations of HST segments which produce the least and the greatest potential impacts based on the results of the screening analysis. The primary factor used to select the

segments for each combination was the number of people potentially impacted. In most cases the HST segment with the greatest impact would be the longest segment with the highest IR and conversely the segment with the least impact would be the shortest segment with the lowest IR. In most cases this is true, but because the IR represents a range of values of the IM, cases arise where, because of the density of population, a shorter segment can have a greater potential impact than a longer segment.

The HST alignment with the least potential noise impacts consists of the San Francisco to San Jose segment, with the Tunnel Under Henry Coe Park segment. The HST alignment with the greatest potential for noise impact consists of the East Bay Coast Line Option and the Gilroy Option in the southern portion of the region.



Source: Landsat 1985

April 7, 2003

California High Speed Train Program EIR/EIS

10 5 0 10 20 Miles

10 5 0 10 20 Kilometers

CALIFORNIA HIGH SPEED RAIL AUTHORITY

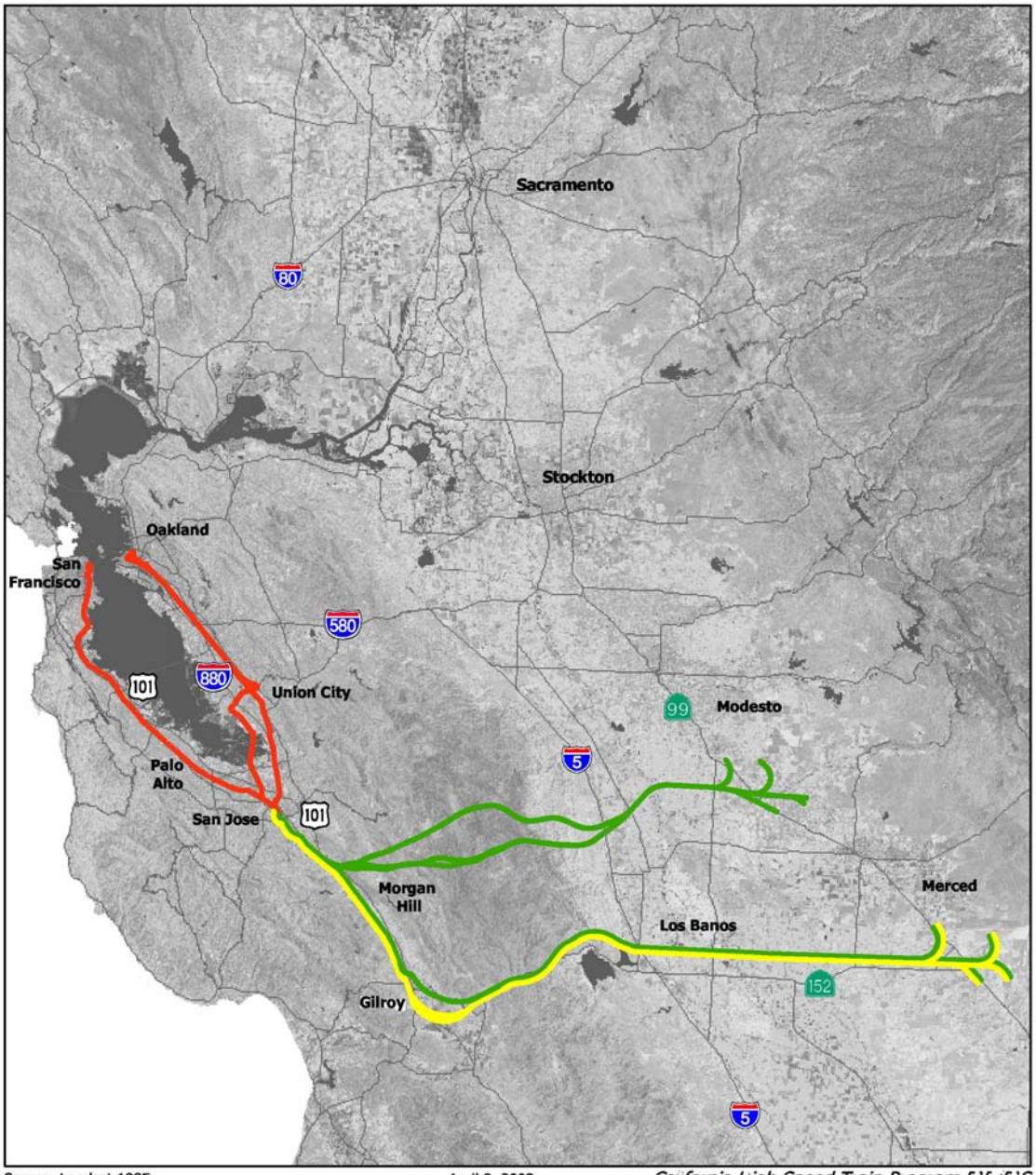
Legend

No-Build and Modal Alternatives
Highways - Noise Impacts

- High
- Medium
- Low

Noise Impacts
No-Build and Modal Alternatives
Bay Area to Merced Region

Figure 12



Source: Landsat 1985

April 8, 2003

California High Speed Train Program EIR/EIS

10 5 0 10 20 Miles

10 5 0 10 20 Kilometers

CALIFORNIA HIGH SPEED RAIL AUTHORITY

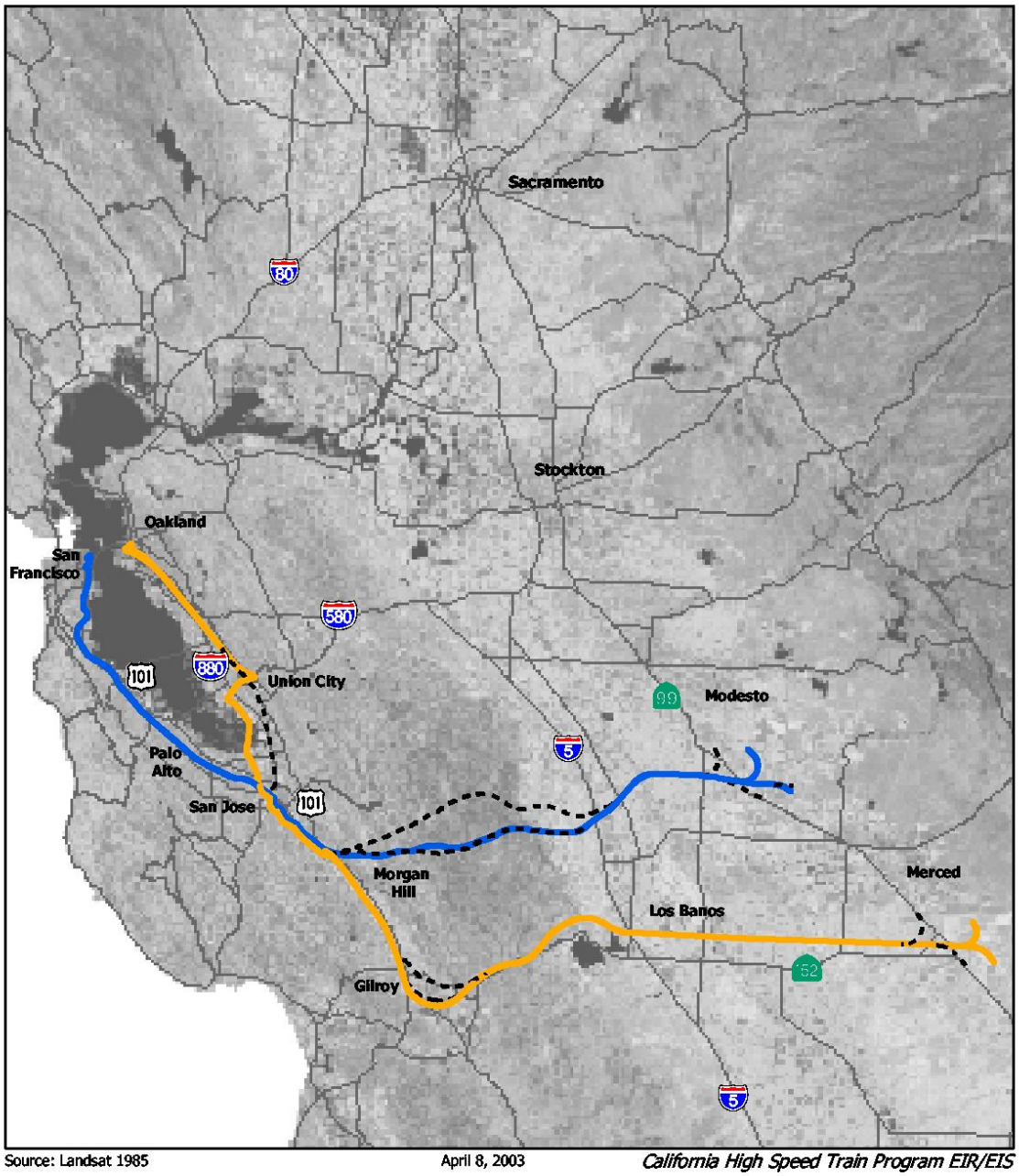
Legend

High Speed Rail Alternative Noise Impacts

- High
- Medium
- Low

Noise Impacts
High Speed Rail Alternative
Bay Area to Merced Region

Figure 13



Source: Landsat 1985 April 8, 2003 *California High Speed Train Program EIR/EIS*

10 5 0 10 20 Miles

10 5 0 10 20 Kilometers

CALIFORNIA HIGH SPEED RAIL AUTHORITY

Legend

High Speed Rail Alternative
Potential Noise Impacts

- Least
- Greatest
- Other Routes

Routes with Least and Greatest Potential Noise Impacts High Speed Rail Alternative Bay Area to Merced Region

Figure 14

Table 4.5.1 Analysis/Comparison Table – Potential Noise Impacts
Bay Area to Merced

	Residential (no. of people)	MU* (no. of people)	Parkland (acres)	Institution		Impact Rating (H,M,L)
				Schools	Hospitals	
No-Project						
Fremont/Newark to US-101	762	20	0	0	0	L
Gilroy to SR-152	268	0	0	0	0	M
I-238 to Fremont/Newark	10372	0	0	1	0	H
I-5 to SR-99	69	0	0	0	0	L
I-80 to I-238	4167	0	3	2	0	H
I-880 to I-5 (Sacramento)	5928	0	1	6	0	M
I-880 to I-5 (via I-238)	3818	1	0	3	0	M
Redwood City to I-880	6836	37	0	1	0	H
SFO to Redwood City	3247	12	1	0	0	H
San Francisco to I-880	31	1	51	2	0	L
San Francisco to San Francisco Airport (SFO)	920	32	0	0	1	M
San Jose to Gilroy	6895	13	0	1	0	H
US 101 to San Jose	140	0	0	0	0	M
US-101 to I-5	8	0	604	3	0	L
Modal						
Fremont/Newark to US-101	984	24	0	0	0	L
Gilroy to SR-152	270	0	0	0	0	M
I-238 to Fremont/Newark	11797	0	0	3	0	H
I-5 to SR-99	106	0	0	0	0	L
I-80 to I-238	4746	0	4	2	0	H
I-880 to I-5 (Sacramento)	6982	0	2	7	0	M
I-880 to I-5 (via I-238)	4183	1	0	3	0	M
Redwood City to I-880	7848	40	0	1	0	H
SFO to Redwood City	3823	13	1	0	0	H
San Francisco to I-880	31	1	71	2	0	L
San Francisco to San Francisco Airport (SFO)	980	32	0	1	1	M
San Jose to Gilroy	8307	15	0	1	0	H
US 101 to San Jose	156	0	0	0	0	M
US-101 to I-5	10	1	814	3	0	L
HST Corridor Options						
San Jose to San Francisco						
San Jose to San Francisco	11129	223	0	3	1	H

San Jose to Oakland						
Coastline Option	15741	283	0	3	0	H
I-880 Option	13339	259	0	3	0	H
San Jose to Merced						
Northern Tunnel Option	5583	54	1086	2	0	L
Tunnel Under Park Option	5584	54	1110	2	0	L
Minimize Tunnel Option	5584	54	2730	2	0	L
Gilroy Bypass Option	7977	60	39	5	1	L
Gilroy Option	10361	71	39	6	1	M

*Mixed Use

4.6 FOCUSED NOISE STUDY

The Bay Area to Merced rail alternative would result in improvements to existing rail service along the San Francisco Peninsula. One of the improvements would be to increase the number of grade separations for the existing rail alignment used by Caltrain. Currently there are numerous grade crossings along this rail alignment. Caltrain is required by the California PUC, as are freight trains, to sound their warning horn as a safety measure, unless there is a separated grade crossing. As most community members know, the warning horns are loud. After much community prompting, the Caltrain service now uses the lowest horn level allowable by law. The horn sound used by Caltrain is still loud in comparison to other community sounds. This is necessary in order for the horn to be heard and be an adequate warning device.

Recently some of the grade crossings have been grade separated, such as at Holly Street in San Carlos. The implementation of grade separations on the Peninsula would substantially reduce the need for warning horns. This would have a positive impact on the noise environment in the communities along the Peninsula. To assess this effect, an analysis was performed in which a representative case was analyzed with and without the use of horns to estimate the potential benefit of grade separating the existing Caltrain alignment on the Peninsula.

To illustrate this benefit, an example was selected for analysis. The grade crossing at Meadow Drive in Palo Alto was analyzed. The noise model used to determine the impact for the horn noise is the FRA horn noise model. The level of train service used in the noise model is the existing Caltrain service. The noise model without horn sounding (i.e., grade separation), is the FTA noise model for commuter trains. The results of the two analyses were compared to determine the difference in the number of people impacted.

For the purpose of this analysis, the residential land, within the L_{dn} 65 contour, was assumed to be impacted by noise. The distance from the rail alignment to the L_{dn} 65 contour was determined from the two noise models. The distance in each case was used as a screening distance. The length of alignment considered was ½ mile long corresponding to a distance of ¼ mile in each direction from the crossing that trains are required to sound their horn. The existing alignment was buffered using GIS, and the GIS database for residential land, which was used in the general noise screening analysis, was used to determine the number of people impacted.

The results, of this focused analysis of the horn noise issue, using Meadow Avenue as an example are that a significant benefit would occur. The benefit to be gained from eliminating the need for sounding warning horns, where grade crossings are replaced with grade separations, as in the case of Meadow Avenue, are that 177 people are currently impacted by the horn sounding, whereas only 34 people would be impacted with a grade separation. This is an 81% reduction in the number of people impacted. Each new grade separation would produce different results, which would depend on the local population

density and proximity of residences and other sensitive land use to the current grade crossings, but this example illustrates the magnitude of change to be expected.

5.0 VIBRATION IMPACTS

5.1 NO-PROJECT ALTERNATIVE

Vibration impacts are assumed to be non-existent for highway and airport modes.

5.2 MODAL ALTERNATIVE

Vibration impacts are assumed to be non-existent for highway and airport modes

5.3 HIGH-SPEED TRAIN ALTERNATIVE

HST Alternative entries in the Analysis/Comparison Table above can be used to compare potential impacts between regional alignment options. Residential, park, and institutional impact summaries in the Analysis/Comparison Table are based upon the GIS land use and location data made available for the screening study and the corresponding screening distances used in each alignment portion. Please see the Appendix for a list of the individual screening distances used, and the length of alignment to which each screening distance applies.

5.4 VIBRATION TYPOLOGIES

The results of the Special Case land use typology vibration studies are shown in the Typology Analysis Table below. The Special Cases shown are representative of the typologies that exist throughout the Bay Area to Merced portion of the HST Alternative. Special Cases were chosen to show a range of the impact levels that are likely to be encountered in Tier 2 analyses, and to address historical locations that have already been identified by others as a significant concern.

The results of the typology analyses using the FRA criteria for assessing potential vibration impacts are indicated in Table 5.4.1. Of the thirteen cases analyzed, five of them are indicated as being possibly impacted by groundborne vibration. The closer the building is to the alignment, the greater the likelihood of impact. At 80 ft from the alignment, as in the case of the residence in San Leandro, the projected vibration level is 79 dBV or 7 dBV greater than the criterion.

Speed of the train can also be seen to play an important factor in the level of vibration. In the case of the residence in San Jose on Fuller Avenue, at 60 ft away the vibration is less because of a much lower speed of 74 mph. Where the speed is much higher the distance impact can occur extends out to greater distances as in the case of residence in San Martin at 200 ft away, where the train speed is 200mph. In this instance the projected vibration is slightly over the criterion by 3 dBV.

The typology vibration analyses would seem to indicate that beyond about 200 ft from the alignment vibration would be low enough not to result in impact. This is consistent with the screening distance of 200 ft used for most of the Bay Area to Merced alignment segments. However, groundborne vibration is very site-specific, and actual vibration levels from HST will be determined and evaluated in more detail in the Tier 2 analysis. These future investigations would measure the local response of the soil strata along the alignment(s) chosen for further impact assessment. Specific HST technology would be evaluated and the characteristics of such systems would be directly taken into account in the analyses.

Mitigation of groundborne vibration can be achieved using special systems that reduce vibration transmitted into the ground below the tracks. Available technology for reducing HST groundborne vibration relies on special track support systems, which are discussed in more detail in Section 6 under mitigation strategies. Specific mitigation for portions of the HST alignment which are indicated as requiring groundborne vibration mitigation will be developed in the Engineering Phase of the project.

Table 5.4.1 Typology Analysis Table – Potential Vibration Impacts
Bay Area to Merced

ALIGNMENT SEGMENT	LAND USE/DESCRIPTION	CITY/ COUNTY	CORRIDOR TYPE	DISTANCE (ft)	SPEED (mph)	MAX. ALLOWED (dBV)	PROJECT (dBV)	IMPACT? YES/no
SF to SJ	Tulare St.	Brisbane	Existing Rail	450	100	72	61	no
SF to SJ	Palm Ave. at 20th Ave.	San Mateo	Existing Rail	200	121	72	70	no
SF to SJ	Mariposa Ave.	Palo Alto	Existing Rail	70	125	72	77	YES
Oak to SJ	Camellia Ct.	San Leandro	Existing Rail	80	170	72	79	YES
Oak to SJ	Amador St.	Hayward	Existing Rail	300	148	72	69	no
SJ to Merced	Fuller Ave.	San Jose	Existing Rail	60	74	72	73	YES
SJ to Merced	Dougherty Ave.	San Jose	Existing Rail	790	175	72	57	no
SJ to Merced	Angelica Way	Morgan Hill	Existing Rail	340	200	72	70	no
SJ to Merced	Chester St.	San Martin	Existing Rail	200	200	72	75	YES
SF to SJ	Millbrae Serra Convalescent Hospital	Millbrae	Existing Rail	100	125	72	76	YES
SJ to Merced	South Valley Medical Center	San Martin	Existing Rail	330	200	72	70	no
Oak to SJ	San Lorenzo High School	San Lorenzo	Existing Rail	140	160	75	75	no
SJ to Merced	Burnett Elementary School	Morgan Hill	Existing Rail	190	200	75	75	no

5.5 VIBRATION SCREENING ANALYSIS

The vibration screening analysis was performed only for the HST, because the No-Project and Modal Alternatives are assumed to have no associated potential vibration impacts. Table 5.5.1 presents the detailed results of the vibration screening analysis for the HST Alternative. Both the SF Peninsula corridor and the East Bay corridors are indicated as having H IRs, as would be expected because of the density of population along these two alignments. One hospital, is indicated as being within the screening distance along this alignment. South of San Jose the IR is an L. Two schools are within the screening distance in this segment.

Table 5.5.1 Analysis/Comparison Table – Potential Vibration Impacts
Bay Area to Merced

	Residential (no. of people)	MU (no. of people)	Institutional		Impact Rating (H,M,L)
			Schools	Hospitals	
No-Project*					
Modal*					
HST Corridor Options					
San Jose to San Francisco					
San Jose to San Francisco	8714	71	0	1	H
San Jose to Oakland					
Coastline Option	8200	0	0	0	H
I-880 Option	7560	68	0	0	H
San Jose to Merced					
Northern Tunnel Option	2888	0	2	0	L
Tunnel Under park Option	2854	0	2	0	L
Minimize Tunnel Option	2856	0	2	0	L
Gilroy Bypass Option	3264	0	0	0	L
Gilroy Option	3794	0	0	0	L

* Vibration impacts are assumed to be non-existent for highway and airport modes

6.0 REFERENCES

PUBLICATIONS

Federal Aviation Administration Noise Standards, Tital 14, Code of Federal Regulation, Chap. 1, Part 36, 34 fed Reg. 1864, November 1969

Federal Highway Administration, *FHWA Highway Traffic Noise Model (Version 2.0 Addendum)*, May 2002

Federal Highway Administration, *FHWA Highway Traffic Noise Prediction* Model, FHWA-RD-77-108, December 1978

Federal Railroad Administration, *High-Speed Ground Transportation Noise and Vibration Impact Assessment: Final Draft*, Report No. 293630-1, December 1998.

Federal Transit Administration, *Transit Noise and Vibration Impact* Assessment, Report No. PB96-1721135. April 1995.

GIS DATA

Land Use, CAHSR Alignment, Highway Alignment – Provided by regional team.

Parks, Population Density, Schools, Hospitals – ESRI Data & Maps Media Kits 2002, ESRI, 380 New York Street, Redlands, CA

OTHER MATERIALS

Aerial Photos, Plan & Profile Drawings, and Alignment Sections – Provided by regional team

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APPENDIX A

Detailed Analysis/Comparison Table
Potential CAHSR Noise Impacts
Bay Area to Merced Region

SEGMENT_ID	miles	# of noise Ander 11 people	People/mile	# of noise Ander 16 people	People/mile	# of Hospitals	# of schools	Severit Metric	Rating	Rating		
NO-PROJECT										L	M	H
Fremont/Newark to US-101	12.4	762	61	20	2	0	0	62	L	12.4		
Gilroy to SR-152	1.4	268	185	0	-	0	0	185	M		1.4	
I-238 to Fremont/Newark	14.5	10372	717	0	-	0	1	735	H			14.5
I-5 to SR-99	42.8	69	2	0	-	0	0	2	L	42.8		
I-580/SR-120 to SR-152	52.4	0	-	0	-	0	1	5	L	52.4		
I-80 to I-238	13.8	4167	301	0	-	0	2	337	H			13.8
I-80 to Stockton	50.6	7900	156	0	-	0	0	156	M		50.6	
I-880 to I-5 (Sacramento)	86.7	5928	68	0	-	0	6	86	M		86.7	
I-880 to I-5 (via I-238)	52.7	3818	72	1	0	0	3	87	M		52.7	
Merced to SR-152	21.5	640	30	0	-	0	0	30	L	21.5		
Modesto to Merced	39.0	447	11	138	4	0	2	25	L	39.0		
Redwood City to I-880	19.7	6836	348	37	2	0	1	361	H			19.7
SFO to Redwood City	13.8	3247	236	12	1	0	0	236	H			13.8
SR-120 to Modesto	14.5	160	11	36	2	0	0	12	L	14.5		
SR-152 to Fresno	23.4	0	-	0	-	0	3	32	L	23.4		
SR-152 to SR-99	20.5	0	-	0	-	0	0	-	L	20.5		
Sacramento to SR-120	62.6	8509	136	0	-	1	4	153	M		62.6	

San Francisco to I-880	9.2	31	3	1	0	0	2	58	L		9.2		
San Francisco to San Francisco Airport (SFO)	11.3	920	82	32	3	1	0	91	M			11.3	
San Jose to Gilroy	31.2	6895	221	13	0	0	1	229	H				31.2
Stockton to I-580/SR-120	25.8	774	30	0	-	0	0	30	L		25.8		
US 101 to San Jose	0.9	140	159	0	-	0	0	159	M			0.9	
US-101 to I-5	40.8	8	0	0	-	0	3	19	L		40.8		
										Total(mi)	302.3	266.1	92.9
MODAL													
Fremont/Newark to US-101	12.4	984	79	24	2	0	0	80	L		12.4		
Gilroy to SR-152	1.4	270	186	0	-	0	0	186	M			1.4	
I-238 to Fremont/Newark	14.5	11797	816	0	-	0	3	868	H				14.5
I-5 to SR-99	42.8	106	2	0	-	0	0	2	L		42.8		
I-580/SR-120 to SR-152	52.4	0	-	0	-	0	1	5	L		52.4		
I-80 to I-238	13.8	4746	343	0	-	0	2	379	H				13.8
I-80 to Stockton	50.6	9291	184	0	-	0	0	184	M			50.6	
I-880 to I-5 (Sacramento)	86.7	6982	81	0	-	0	7	101	M			86.7	
I-880 to I-5 (via I-238)	52.7	4183	79	1	0	0	3	94	M			52.7	
Merced to SR-152	21.5	732	34	0	-	0	0	34	L		21.5		
Modesto to Merced	39.0	554	14	179	5	0	2	28	L		39.0		
Redwood City to I-880	19.7	7848	399	40	2	0	1	413	H				19.7
SFO to Redwood City	13.8	3823	277	13	1	0	0	278	H				13.8
SR-120 to Modesto	14.5	202	14	54	4	0	0	15	L		14.5		
SR-152 to Fresno	23.4	0	-	0	-	1	3	36	L		23.4		
SR-152 to SR-99	20.5	0	-	0	-	0	0	-	L		20.5		
Sacramento to SR-120	62.6	9980	159	0	-	1	5	181	M			62.6	
San Francisco to I-880	9.2	31	3	1	0	0	2	58	L		9.2		
San Francisco to San Francisco Airport (SFO)	11.3	980	87	32	3	1	1	119	M			11.3	
San Jose to Gilroy	31.2	8307	266	15	0	0	1	275	H				31.2
Stockton to I-580/SR-120	25.8	943	37	0	-	0	0	37	L		25.8		
US 101 to San Jose	0.9	156	177	0	-	0	0	177	M			0.9	
US-101 to I-5	40.8	10	0	1	0	0	3	19	L		40.8		
										Total(mi)	302.3	266.1	92.9

HST CORRIDOR OPTIONS											Greatest			Least			# People Impacted
											L	M	H	L	M	H	
San Jose to San Francisco	50.0	11129	223	155	3	1	3	241	H							50.0	12025.5
Coastline Option	55.7	15741	283	0	-	0	3	296	H				55.7				16491.0
I-880 Option	51.5	13339	259	273	5	0	3	275	H								14170.9
Northern Tunnel Option	104	5583	54	20	0	0	2	59	L								6089.0
Tunnel Under Park Option	103.2	5584	54	20	0	0	2	59	L					103.2			6090.0
Minimize Tunnel Option	104.3	5584	54	20	0	0	2	58	L								6090.0
Gilroy Bypass Option	132.3	7977	60	45	0	1	5	71	L								9340.5
Gilroy Option	146.6	10361	71	45	0	1	6	82	M			146.6					11974.5
										Total(mi)	0.0	146.6	55.7	103.2	0.0	50.0	

Detailed Analysis/Comparison Table
Potential CAHSR Vibration Impacts
Bay Area to Merced Region

SEGMENT_ID	miles	# of noise Ander 11 people	People/mile	# of noise Ander 16 people	People/mile	# of Hospitals	# of schools	Severit Metric	Rating	Greatest	Least	# People Impacted
HST CORRIDOR OPTIONS												
San Jose to San Francisco	50.0	8714	174	155	3	1	3	192	H	50		9610.5
Coastline Option	55.7	8200	147	0	-	0	3	161	H			8950.0
I-880 Option	51.5	7560	147	273	5	0	3	163	H		51.5	8391.9
Northern Tunnel Option	104	2888	28	20	0	0	2	33	L			3394.0
Tunnel Under Park Option	103.2	2854	28	20	0	0	2	33	L		103.2	3360.0
Minimize Tunnel Option	104.3	2856	27	20	0	0	2	32	L			3362.0
Gilroy Bypass Option	132.3	3264	25	45	0	1	5	35	L			4627.5
Gilroy Option	146.6	3794	26	45	0	1	6	37	L	146.6		5407.5

California High Speed Rail

Bay Area to Merced - Typology Analysis

Noise Impact Analysis - NO MITIGATIONS

Coaches Length (ft)	82	
Num Coaches	15	
Power unit Length (ft)	82	
# powers units	1	
Total length PU	82	0
Train Length (ft)	1312	0

Num.	Landuse	Community	Location and/or Description	Corridor Type	Civil Station
1	Residential	Brisbane	Tulare St.	Existing Rail	Sta. 16+950SF to SJ
2	Residential	San Mateo	Palm Ave. at 20th Ave.	Existing Rail	Sta. 37+050SF to SJ
3	Residential	Palo Alto	Mariposa Ave.	Existing Rail	Sta. 56+190SF to SJ
4	Residential	San Leandro	Camellia Ct.	Existing Rail	Sta. 63+800Oak to SJ
5	Residential	Hayward	Armador St.	Existing Rail	Sta. 73+270Oak to SJ
6	Residential	San Jose	Fuller Ave.	Existing Rail	118+460SJ to Merced
7	Residential	San Jose	Dougherty Ave.	Existing Rail	143+700SJ to Merced
8	Residential	Morgan Hill	Angelica Way	Existing Rail	Sta. 145+550SJ to Merced
9	Residential	San Martin	Chester St.	Existing Rail	Sta. 18+450SJ to Merced
10	Hospital	Millbrae	Millbrae Serra Convalescent Hospital	Existing Rail	Sta. 27+750SF to SJ
11	Hospital	San Martin	South Valley Medical Center	Existing Rail	Sta. 19+850
12	School	San Lorenzo	San Lorenzo High School	Existing Rail	Sta. 69+750Oak to SJ
13	School	Morgan Hill	Burnett Elementary School	Existing Rail	Sta. 145+280
14	Park	n.a.	McConnell State Park(middle of park)	New Rail	Sta. 160+700
15	Park	n.a.	Henry W. Coe State Park	New Rail	Sta 36+000Min. Tun. Op.

California High Speed Rail

Bay Area to Merced - Typology Analysis

Noise Impact Analysis - NO MITIGATIONS (continued)

ag =at grade
sc =shallow cut
dc =deep cut
as =aerial structure
emb =embankment

	TOTAL # TRAINS One/Direction			
	7 to 22		22 to 7	
	NB	SB	NB	SB
Gold LIne	0	0	0	0
Green Line	16	14	2	4
Blue Line	45	43	3	5
total trains both direct.	118		14	
train/hr	7.9		1.6	

Train Speed (mph)	Distance to Alignment (ft)	Existing Ambient (Ldn/Leqday)	FRA Landuse Category	Alignment Geometry		Speed Regime	Reference SEL	Speed Coefficient K	Reference Speed	Reference Length
100	450	60	2	ag		2	93.0	17	90	634
121	200	61	2	ag		2	93.0	17	90	634
125	70	66	2	ag		2	93.0	17	90	634
170	80	65	2	ag		3	99.0	47	180	73
148	300	60	2	ag		2	93.0	17	90	634
74	60	65	2	ag		2	93.0	17	90	634
175	790	52	2	ag		3	99.0	47	180	73
200	340	57	2	ag		3	99.0	47	180	73
200	200	57	2	ag		3	99.0	47	180	73
125	100	64	2	ag		2	93.0	17	90	634
200	330	55	2	ag		3	99.0	47	180	73
160	140	62	3	ag		2	93.0	17	90	634
200	190	64	3	ag		3	99.0	47	180	73
200	50	50	3	ag		3	99.0	47	180	73
150	50	40	3	ag		2	93.0	17	90	634

California High Speed Rail

Bay Area to Merced - Typology Analysis

Noise Impact Analysis - NO MITIGATIONS (continued)

Shielding Correction	SEL @ 50ft	Leqday @ 50ft	Leqnight @ 50ft	Ldn @ 50 ft	Project Ldn/Leq @ Receiver	No Mitigation Impact
0	96.9	70	63	72	57	NI
0	98.3	72	65	73	64	SI
0	98.6	72	65	73	71	SI
0	100.8	74	67	76	72	SI
0	99.8	73	66	75	63	I
0	94.7	68	61	69	68	SI
0	101.4	75	68	76	58	I
0	104.2	78	70	79	66	SI
0	104.2	78	70	79	70	SI
0	98.6	72	65	73	69	SI
0	104.2	78	70	79	67	SI
0	100.4	74	67	75	67	I
0	104.2	78	70	79	69	I
0	104.2	78	70	79	78	SI
0	99.9	73	66	75	73	SI

California High Speed Rail

Bay Area to Merced - Typology Analysis

Noise Impact Analysis - MITIGATED

Coaches Length (ft)	82
Num Coaches	15
Power unit Length (ft)	82
# powers units	1
Total length PU	82
Train Length (ft)	1312

Num.	Landuse	Community	Location and/or Description	Corridor Type	Civil Station
1	Residential	Brisbane	Tulare St.	Existing Rail	Sta. 16+950SF to SJ
2	Residential	San Mateo	Palm Ave. at 20th Ave.	Existing Rail	Sta. 37+050SF to SJ
3	Residential	Palo Alto	Mariposa Ave.	Existing Rail	Sta. 56+190SF to SJ
4	Residential	San Leandro	Camellia Ct.	Existing Rail	Sta. 63+800Oak to SJ
5	Residential	Hayward	Armador St.	Existing Rail	Sta. 73+270Oak to SJ
6	Residential	San Jose	Fuller Ave.	Existing Rail	118+460SJ to Merced
7	Residential	San Jose	Dougherty Ave.	Existing Rail	143+700SJ to Merced
8	Residential	Morgan Hill	Angelica Way	Existing Rail	Sta. 145+550SJ to Merced
9	Residential	San Martin	Chester St.	Existing Rail	Sta. 18+450SJ to Merced
10	Hospital	Millbrae	Millbrae Serra Convalescent Hospital	Existing Rail	Sta. 27+750SF to SJ
11	Hospital	San Martin	South Valley Medical Center	Existing Rail	Sta. 19+850
12	School	San Lorenzo	San Lorenzo High School	Existing Rail	Sta. 69+750Oak to SJ
13	School	Morgan Hill	Burnett Elementary School	Existing Rail	Sta. 145+280
14	Park	n.a.	McConnell State Park(middle of park)	New Rail	Sta. 160+700
15	Park	n.a.	Henry W. Coe State Park	New Rail	Sta 36+000Min. Tun. Op.

California High Speed Rail

Bay Area to Merced - Typology Analysis

Noise Impact Analysis - MITIGATED (Continued)

ag =at grade
sc =shallow cut
dc =deep cut
as =aerial structure
emb =embankment
nb =noise barrier

	TOTAL # TRAINS One/Direction			
	7 to 22		22 to 7	
	NB	SB	NB	SB
Gold LIne	0	0	0	0
Green Line	16	14	2	4
Blue Line	45	43	3	5
total trains both direct.	118		14	
train/hr	7.9		1.6	

Train Speed (mph)	Distance to Alignment (ft)	Existing Ambient (Ldn/Leqday)	FRA Landuse Category	Alignment Geometry		Speed Regime	Reference SEL	Speed Coefficient K	Reference Speed	Reference Length
100	450	60	2	nb		2				
121	200	61	2	nb		2	93.0	17	90	634
125	70	66	2	nb		2	93.0	17	90	634
170	80	65	2	nb		3	99.0	47	180	73
148	300	60	2	nb		2	93.0	17	90	634
74	60	65	2	nb		2	93.0	17	90	634
175	790	52	2	nb		3	99.0	47	180	73
200	340	57	2	nb		3	99.0	47	180	73
200	200	57	2	nb		3	99.0	47	180	73
125	100	64	2	nb		2	93.0	17	90	634
200	330	55	2	nb		3	99.0	47	180	73
160	140	62	3	nb		2	93.0	17	90	634
200	190	64	3	nb		3	99.0	47	180	73
200	50	50	3	nb		3	99.0	47	180	73
150	50	40	3	nb		2	93.0	17	90	634

California High Speed Rail

Bay Area to Merced - Typology Analysis

Noise Impact Analysis - MITIGATED (Continued)

Shielding Correction	SEL @ 50ft	Leqday @ 50ft	Leqnight @ 50ft	Ldn @ 50 ft	Project Ldn/Leq @ Receiver	Mitigation Impact
						N/A
-10	98.3	61.7	54.7	63	54	NI
-10	98.6	61.9	54.9	63	61	I
-5	100.8	69.2	62.2	71	67	SI
-10	99.8	63.2	56.1	65	53	NI
-10	94.7	58.1	51.0	59	58	NI
-5	101.4	69.8	62.7	71	53	NI
-5	104.2	72.5	65.5	74	61	I
-5	104.2	72.5	65.5	74	65	SI
-10	98.6	61.9	54.9	63	59	NI
-5	104.2	72.5	65.5	74	62	SI
-10	100.4	63.8	56.7	65	57	NI
-5	104.2	72.5	65.5	74	64	NI
-5	104.2	72.5	65.5	74	73	SI
-10	99.9	63.3	56.2	65	63	SI

California High Speed Rail

Bay Area to Merced

Groundborne Vibration Predictions

Num.	Landuse	Community	Location and/or Description	Corridor Type	Civil Station	Train Speed (mph)	Distance to Alignment (ft)	FRA Landuse Category	Max. Allowed Vib	**OA**	IMPACT?
1	Residential	Brisbane	Tulare St.	Existing	Sta. 16+950SF to SJ	100	450	2	72	**61**	**NO**
2	Residential	San Mateo	Palm Ave. at 20th Ave.	Existing	Sta. 37+050SF to SJ	121	200	2	72	**70**	**NO**
3	Residential	Palo Alto	Mariposa Ave.	Existing	Sta. 56+190SF to SJ	125	70	2	72	**77**	**YES**
4	Residential	San Leandro	Camellia Ct.	Existing	Sta. 63+800Oak to SJ	170	80	2	72	**79**	**YES**
5	Residential	Hayward	Armador St.	Existing	Sta. 73+270Oak to SJ	148	300	2	72	**69**	**NO**
6	Residential	San Jose	Fuller Ave.	Existing	118+460SJ to Merced	74	60	2	72	**73**	**YES**
7	Residential	San Jose	Dougherty Ave.	Existing	143+700SJ to Merced	175	790	2	72	**57**	**NO**
8	Residential	Morgan Hill	Angelica Way	Existing	Sta. 145+550SJ to Merced	200	340	2	72	**70**	**NO**
9	Residential	San Martin	Chester St.	Existing	Sta. 18+450SJ to Merced	200	200	2	72	**75**	**YES**
10	Hospital	Millbrae	Millbrae Serra Convalescent Hospital	Existing	Sta. 27+750SF to SJ	125	100	2	72	**76**	**YES**
11	Hospital	San Martin	South Valley Medical Center	Existing	Sta. 19+850	200	330	2	72	**70**	**NO**
12	School	San Lorenzo	San Lorenzo High School	Existing	Sta. 69+750Oak to SJ	160	140	3	75	**75**	**YES**
13	School	Morgan Hill	Burnett Elementary School	Existing	Sta. 145+280	200	190	3	75	**75**	**NO**
14	Park	n.a.	McConnell State Park(middle of park)	Existing	Sta. 160+700	200	50	3	75	**83**	**YES**
15	Park	n.a.	Henry W. Coe State Park	Existing	Sta 36+000Min. Tun. Op.	150	50	3	75	**80**	**YES**

California High Speed Rail

Bay Area to Merced

Groundborne Vibration Predictions (continued)

PREDICTED VIBRATION LEVELS*

1/3OB	6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200	250	315	400
61	28	37	44	46	61	61	49	43	38	41	37	33	32	32	(8)	(26)	(26)	(23)	(21)
70	31	42	49	52	67	70	59	54	49	52	48	41	41	41	0	(17)	(20)	(19)	(19)
76	33	44	51	56	72	76	67	64	62	65	62	58	58	58	18	0	(3)	(4)	(8)
76	33	43	50	55	72	76	66	63	60	63	60	56	55	56	16	(2)	(6)	(7)	(10)
66	31	40	46	49	64	66	54	49	43	46	42	38	36	37	(4)	(21)	(23)	(21)	(20)
77	34	44	51	56	72	77	67	65	63	67	64	61	60	61	20	3	(1)	(2)	(6)
53	25	33	38	40	52	53	39	34	29	32	29	25	24	24	(16)	(32)	(30)	(24)	(21)
65	30	39	45	49	63	65	53	47	42	45	41	36	35	36	(5)	(22)	(24)	(22)	(20)
70	31	42	49	52	67	70	59	54	49	52	48	41	41	41	0	(17)	(20)	(19)	(19)
75	32	43	50	55	71	75	65	61	58	60	56	52	51	52	11	(6)	(10)	(11)	(13)
65	30	39	45	49	64	65	53	47	42	45	41	36	35	36	(5)	(22)	(24)	(21)	(20)
72	32	42	49	54	70	72	62	58	54	57	52	46	46	46	6	(12)	(15)	(15)	(16)
70	31	42	49	53	67	70	59	55	50	52	49	42	42	41	1	(16)	(19)	(19)	(19)
77	34	44	51	56	73	77	68	66	64	68	66	63	62	63	23	5	1	0	(4)
77	34	44	51	56	73	77	68	66	64	68	66	63	62	63	23	5	1	0	(4)

California High Speed Rail

Bay Area to Merced

Groundborne Vibration Predictions (continued)

FORCE DENSITY LEVEL

6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200	250	315	400
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33
14	21	25	27	41	43	32	28	25	29	27	24	25	30	13	13	21	29	33

California High Speed Rail

Bay Area to Merced

Groundborne Vibration Predictions (continued)

LINE SOURCE REPONSE

2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
6.3	8	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160	200	250	315	400
14	16	19	19	20	18	17	15	13	12	10	9	7	2	(21)	(39)	(47)	(52)	(54)
17	21	24	25	26	27	27	26	24	23	21	17	16	11	(13)	(30)	(41)	(48)	(52)
19	23	26	29	31	33	35	36	37	36	35	34	33	28	5	(13)	(24)	(33)	(41)
19	22	25	28	31	33	34	35	35	34	33	32	30	26	3	(15)	(27)	(36)	(43)
17	19	21	22	23	23	22	21	18	17	15	14	11	7	(17)	(34)	(44)	(50)	(53)
20	23	26	29	31	34	35	37	38	38	37	37	35	31	7	(10)	(22)	(31)	(39)
11	12	13	13	11	10	7	6	4	3	2	1	(1)	(6)	(29)	(45)	(51)	(53)	(54)
16	18	20	22	22	22	21	19	17	16	14	12	10	6	(18)	(35)	(45)	(51)	(53)
17	21	24	25	26	27	27	26	24	23	21	17	16	11	(13)	(30)	(41)	(48)	(52)
18	22	25	28	30	32	33	33	33	31	29	28	26	22	(2)	(19)	(31)	(40)	(46)
16	18	20	22	23	22	21	19	17	16	14	12	10	6	(18)	(35)	(45)	(50)	(53)
18	21	24	27	29	29	30	30	29	28	25	22	21	16	(7)	(25)	(36)	(44)	(49)
17	21	24	26	26	27	27	27	25	23	22	18	17	11	(12)	(29)	(40)	(48)	(52)
20	23	26	29	32	34	36	38	39	39	39	39	37	33	10	(8)	(20)	(29)	(37)
20	23	26	29	32	34	36	38	39	39	39	39	37	33	10	(8)	(20)	(29)	(37)

Exec Summary Charts

Region: Bay Area to Merced - Potential Noise Impacts - Impact Rating

Alternative	Align. Length (mi) L rating	Align. Length (mi) M rating	Align. Length (mi) H rating	Align. Length (mi) Total
No-Project	302.3	266.1	92.9	661.3
Modal	302.3	266.1	92.9	661.3
HST - Least	103.2	0.0	50.0	153.2
HST - Greatest	0.0	146.6	55.7	202.3

Exec Summary Charts

Region: Bay Area to Merced - Potential Vibration Impacts - Impact Rating

Alternative	Align. Length (mi) L rating	Align. Length (mi) M rating	Align. Length (mi) H rating	Align. Length (mi) Total
No-Project	0.0	0.0	0.0	0.0
Modal	0.0	0.0	0.0	0.0
HST - Least	103.2	0.0	50.0	153.2
HST - Greatest	146.6	0.0	55.7	202.3

FRA Grade Crossing Noise Model

User Input	
Noise Situation (Pick from List)	1
Horn Lmax (dBA) @ 100 feet	96
Horn Location on Locomotive(Pick from List)	2
Non Train Noise Environment (pick from list)	3
Shielding (Pick from List)	6
Length of Impact Area (pick from list)	1
Existing Train Speed (mph)	50
Future Train Speed (mph)	50
Number of Existing Trains in one Direction	37
Number of Future Trains in one Direction	37
Existing Number of Day Trains (7 am to 10 p.m.)	23.125
Future Number of Day Trains (7 am to 10 p.m.)	23.125
Existing Number of Night Trains (10 p.m. to 7 am)	13.875
Future Number of Night Trains (10 p.m. to 7 am)	13.875
Existing Average Number of Cars	5
Future Average Number of Cars	5
Existing Average Number of Locomotives	1
Future Average Number of Locomotives	1

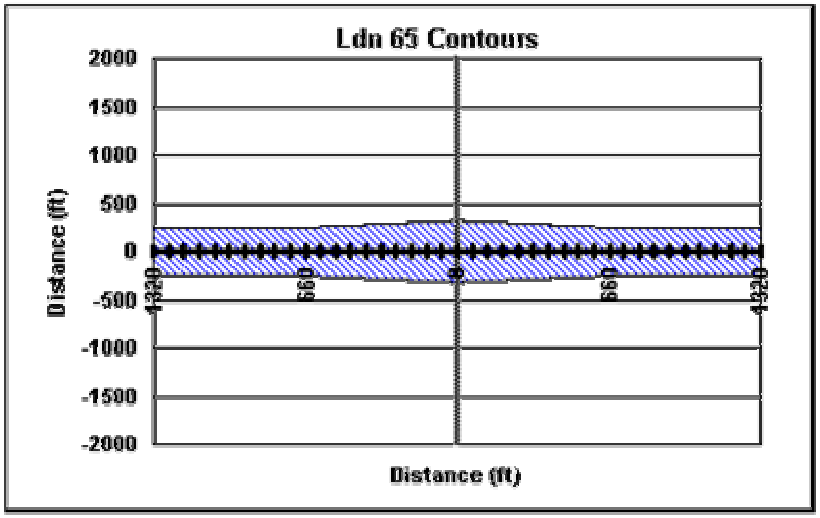
Noise Situation	
Horns Existing and Future	1
Horns in Future Only	2
No Horns Existing and Future	3

Horn Location on Locomotive			
National Average (50% front, 50% middle)			1
All Front Mounted			2
All Middle Mounted			3
User Defined	80	% front mounted horns	4

Non Train Noise Environment			
Urban			1
Suburban			2
Rural			3
User Defined Ldn =	50	dBA	4

Shielding	
Dense Urban	1
Light Urban	2
Dense Suburban	3
Light Suburban	4
Rural	5
No Shielding	6

Length of Impact Area	
1/4 mile	1
20 seconds	2
15 seconds	3

Ldn 65 Contours Numeric Output (in feet)	
Existing 65 Ldn Contour at X-ing	319
Future 65 Ldn Contour at X-ing	319
Existing 65 Ldn Contour at 1/2 zone length	249
Future 65 Ldn Contour at 1/2 zone length	249
Zone Length	1320
1/2 Zone Length	660

Impact Zones Numeric Output (in feet)	
Impact Distance at X-ing	0
Severe Impact Distance at X-ing	0
Impact Distance at 1/2 zone length	0
Severe Impact Distance at 1/2 zone length	0
Zone Length	1320
1/2 Zone Length	660