CALIFORNIA HIGH-SPEED TRAIN

Program Environmental Impact Report/Environmental Impact Statement

Sacramento to Bakersfield

NOISE & VIBRATION TECHNICAL EVALUATION

January 2004

Prepared for:

California High-Speed Rail Authority

U.S. Department of Transportation
Federal Railroad Administration

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CALIFORNIA HIGH-SPEED TRAIN PROGRAM EIR/EIS

Sacramento to Bakersfield
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
USFWS	U.S. FISH AND WILDLIFE SERVICE

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 Federal Railroad Administration (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 the Sacramento to Bakersfield region 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)

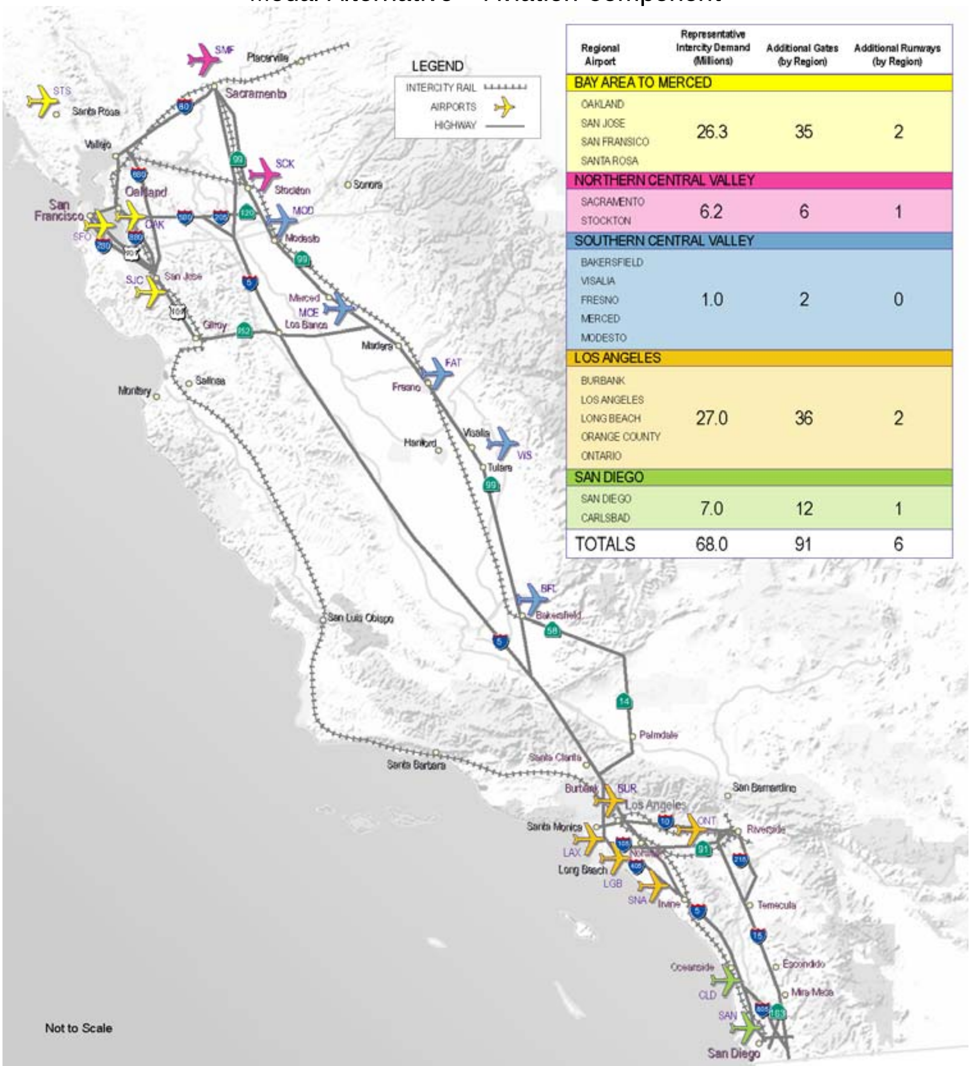
1.1.2 Modal Alternative

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 Sacramento to Bakersfield Corridor, the land use typologies selected for individual study are as follows:

Table 2.4.1 Representative Typology Cases for Region

Sacramento to Bakersfield

Alignment/Segment	Description	City/County	Land Use Type	Distance (ft)*
UPRR \ UP3	Amador Ave & Railroad	Sacramento	Residential	320
BNSF \ BN4	End of Lacey	Wilton	Residential	430
UPRR \ UP4 50+000	Twin Cities & Midway	Galt	Residential	260
UPRR \ UP592+000	Aurora & 5th St.	Stockton	Residential	50
UPRR LOOPS / CON \ UPC10	Garfield & Shaw	Fresno	Residential	110
BNSF LOOPS / CON \ BNC8	Cherry Ave & South	Easton	Residential	780
BNSF \ BN22	Gardner & Brokaw	Corcoran	Residential	50
UPRR \ UP21	Along Hamlin	Tripton	Residential	260
BNSF \ BN24	Jenkins near Hageman	Rosedale	Residential	780
UPRR \ UP11	Merced Medical Center	Merced	Hospital	375
UPRR \ UP13	Madera Community Hospital	Madera	Hospital	780
BNSF \ BN5	Greenwood School (Historical)	Morada	School	80
BNSF \ BN15	Madera Community College	Madera	School	440
UPRR \ UP9	Mc Connel State Park	Livingston	Park	50
UPRR \ UP6	Mayor's Park	Manteca	Park	50

* Distance from the alignment centerline

The Sacramento to Bakersfield corridor follows two major railroad alignments, the Union Pacific Rail Road (UPRR) and the Burlington North Santa Fe (BNSF) railroad. Most of the Sacramento to Bakersfield corridor following UPRR also runs parallel to the State Route 99. In general, the proposed UPRR alignment is more developed than the one following BNSF.

The top most northern and the southern regions, Sacramento County and Bakersfield Metropolitan Area, represent the two zones most densely populated. The land use along the corridor corresponds to a quiet suburban or rural area, changing into an urban or noisy suburban area primarily inside of the city and town limits such as Fresno and Merced. Due to the proximity of the existing UP railroad and SR 99 to the proposed Sacramento to Bakersfield alignment, the non-developed or low densely populated environments, are also noisy.

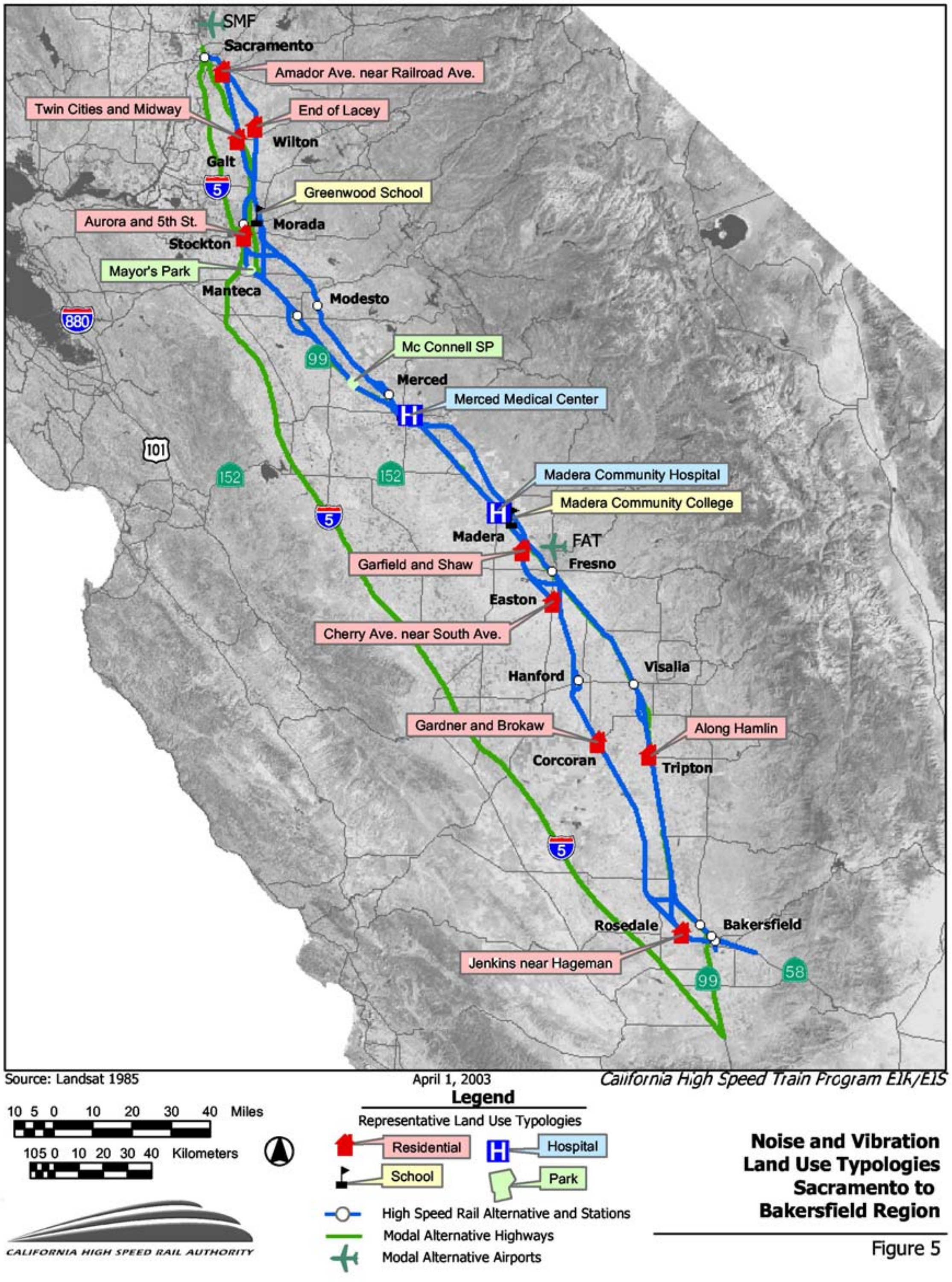
The non-residential, rural and quiet suburban areas along the Sacramento to Bakersfield corridor, correspond primarily to agricultural land use. There are some considerable commercial and industrial areas next to the proposed alignment, but only within the boundaries the towns and cities, outside this boundaries the land is mostly agricultural.

As the corridor follows an existing rail alignment, the ambient noise levels in this region are dominated by train noise from freight and passenger trains. The second most important noise sources are motor vehicles on SR 99. Ambient levels are between L_{dn} 50 to 58 dBA for rural and quiet suburban and L_{dn} 60 to 68 dBA for noisy suburban urban areas.

The ambient levels have been estimated using the Noise Element from the General Plan for the cities and counties in the region and the general method provided by FRA and FTA for noise estimation.

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.

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.



Noise and Vibration Land Use Typologies Sacramento to Bakersfield Region

Figure 5

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).

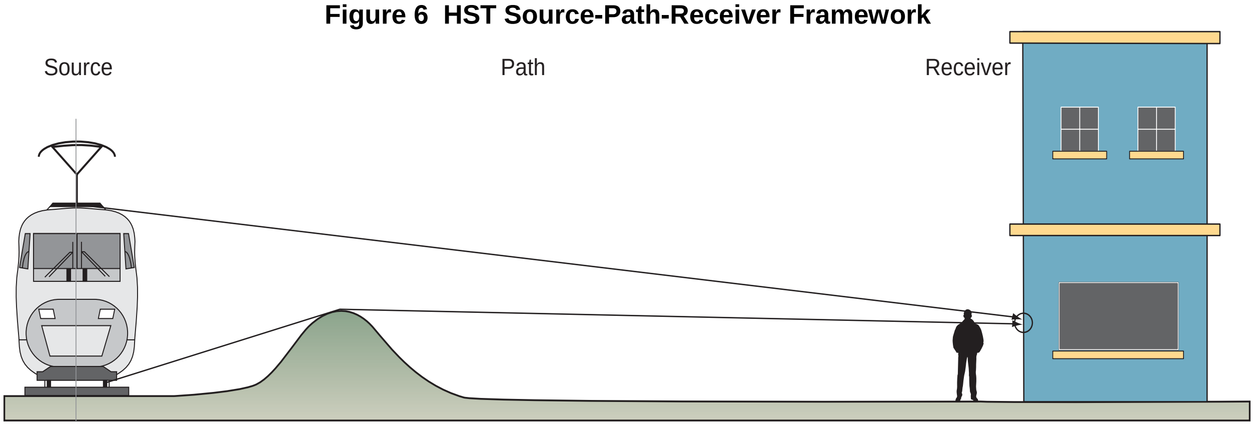
Vibration of the ground caused by the pass-by of the HST is similar to that caused by conventional steel wheel/steel rail trains. The same speed-dependent vibration generation mechanisms are present in each type of train. Holding down the vibration levels associated with the HST are the new track construction 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.

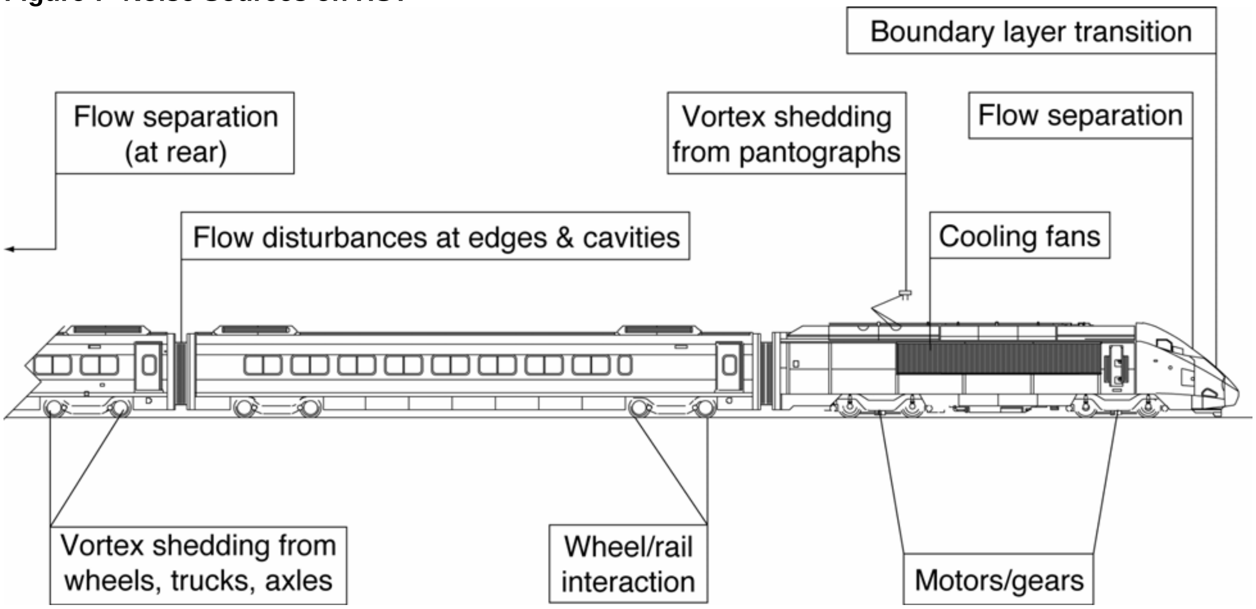
Noise Sources at Medium Speeds. In the speed range from 60 mph to about 150 mph, mechanical noise resulting from wheel/rail interactions and structural vibrations dominate the noise emission from trains. Conventional trains seldom exceed 125 mph, so this speed range which represents a medium range for 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.

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.

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

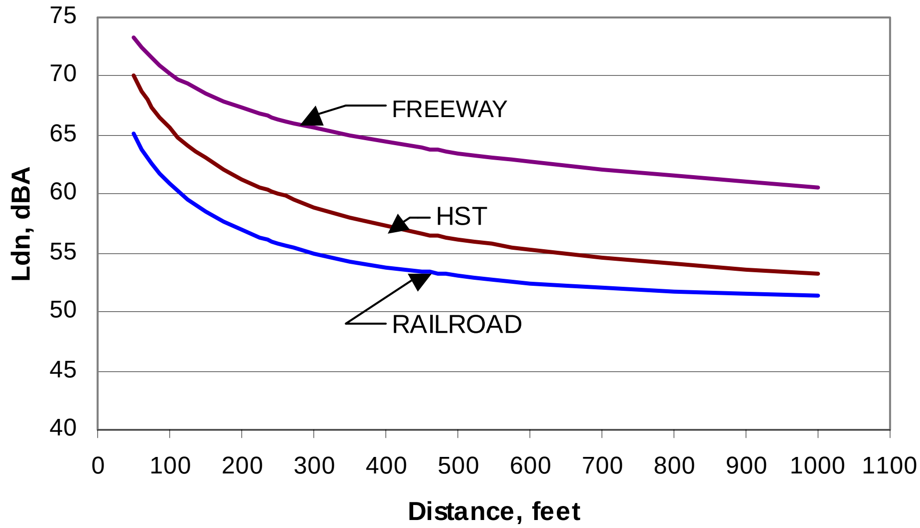
[3] Freight trains with 2 locomotives, 40 cars, 60 mph, 10 daytime, 3 nighttime.

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

Figure 8 Typical Lmax Values

Noise Level dBA	Extremes	Home Appliances 3ft	Speech at 3 ft	Motor Vehicles at 50 ft	Trains at 100 ft
120	Jet aircraft at 500 ft.				
110					
100		Chain saw			Horns
90		Power Lawn mower		Diesel Truck (not muffled)	HST, 200 mph
80		Shop tools	Shout	Diesel Truck (muffled)	HST, 150 mph Locomotives, 50 mph
70		Blender	Loud voice	Automobile, 70 mph	Passenger Train, 50 mph
60		Dishwasher	Normal voice	Automobile, 40 mph	Freight Cars, 50 mph
50		Air conditioner	Normal voice (back to listener)	Automobile, 20 mph	
40		Refrigerator			
30					
20					
10					
0	Threshold of hearing				

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



3.1.5 Vibration from HST

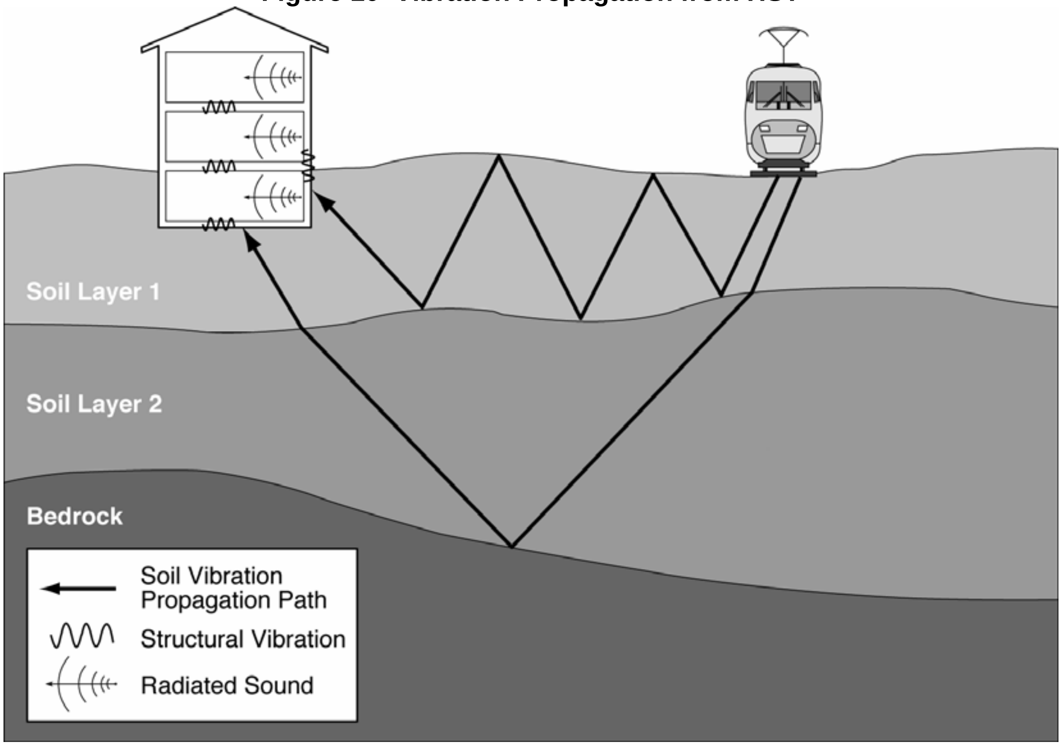
Ground-borne vibration from trains refers to the fluctuating motion experienced by people on the ground and in buildings near railroad tracks. In general, people are not exposed to vibration levels from outside sources that they can feel in their everyday lives. They slam their doors and a wall may shake, 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 US Environmental Protection Agency. 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.

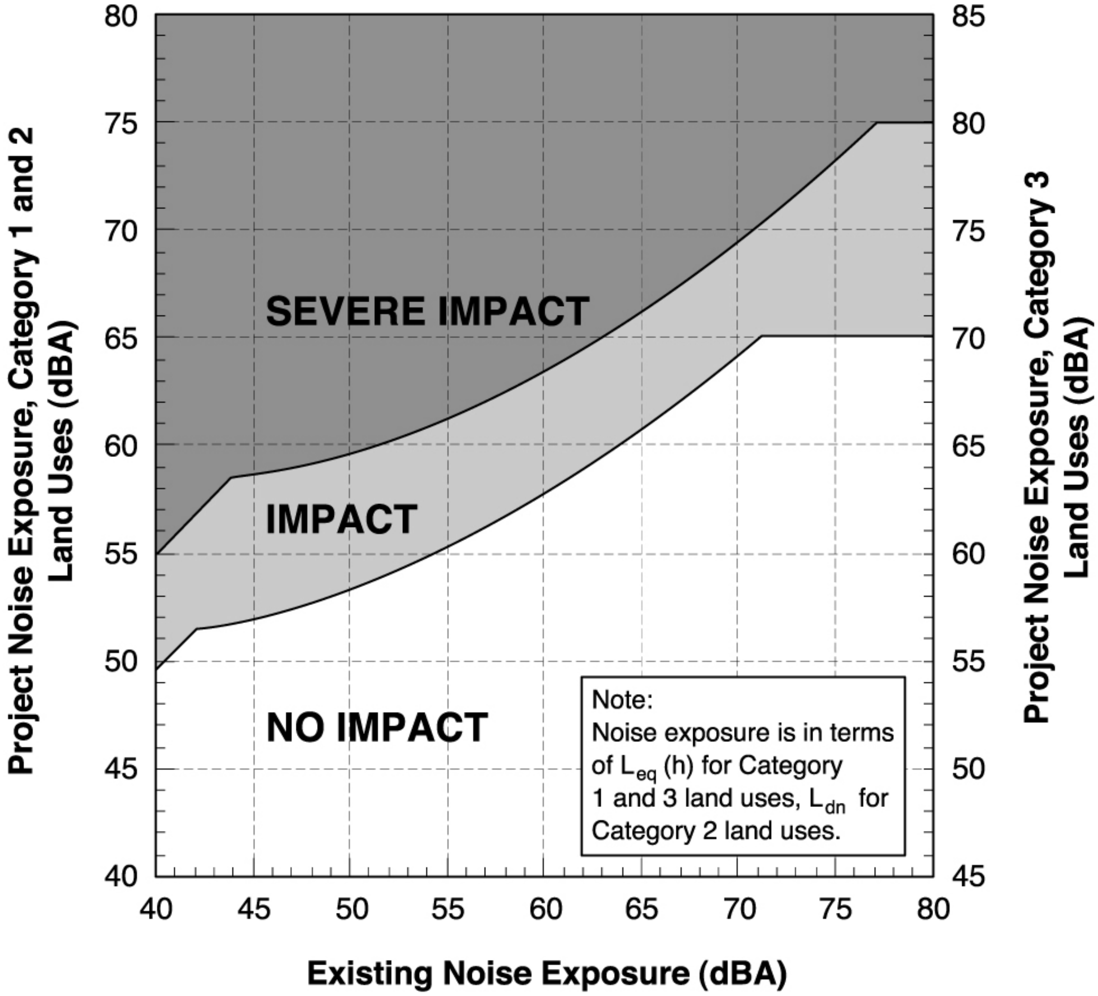
The metric used for noise impact assessment is the day-night sound level (Ldn) in dBA for residential land uses, Land Use Category 1, including buildings where people sleep (hospitals, hotels, motels). The hourly equivalent sound level (Leq) in dBA is applied during hours of active use in parks (Land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

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

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 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 potential 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)
$\geq$ 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 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 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 highway potential impacts and potential HST impacts. Complete aviation data for the Modal Alternative is not available for this study, but where data is available an assessment of potential impacts 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 from the entire HST Alternative were obtained from the screening analysis. The results of the screening analysis can be used to compare impacts between regional alignment options and the highway impacts between 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 range of typologies that exist throughout the Sacramento to Bakersfield portion of the HST 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, within the northern portion of the region there are six residential land use typology cases analyzed. In Sacramento on Amador Avenue, the potential HST noise impacts to the residences analyzed are SI before applying noise reduction for standard mitigation as provided in the FRA manual. Standard noise reduction for these receptors is sufficient to reduce the impact to a level I. For the residences in Wilton on Lacey Street and the residences in Galt on Twin Cities Street, the impact level, as indicated in Table 4.4.1, is I before mitigation. In the case of the former, the impact level can be reduced, but the impact is still at a level I with a standard noise wall, whereas for the latter, standard noise mitigation reduces the impact level to NI. The Greenwood School (an historical structure) in Morada is seen to have a noise impact level, as indicated in Table 4.4.2, of SI. This is reduced to a level I with typical noise reduction provided by standard noise wall. In Stockton, the residences on Aurora Street are impacted at a level SI before mitigation. The level of impact with a standard noise wall is NI. In Manteca, Mayor’s Park is impacted at a level I and with a standard noise wall this is reduced to a level NI.

Along the HST corridor in the central part of the San Joaquin Valley, the UP rail alignment passes through cities and towns, whereas the BNSF rail alignment tends to go around populated areas. Near Livingston, McConnel State Park would be directly adjacent to the alignment and would be impacted at a level SI before mitigation. With a standard noise wall this is reduced to a level I. The Merced Medical Center is impacted at a level SI before mitigation and with a standard noise wall this is reduced to level I. The Madera Community College is at some distance (780 ft) from the proposed alignment and the noise impact level is I.

In Fresno, the potential noise impact to residences on Garfield Street were analyzed, and found to be at a level SI. A standard noise wall was indicated as being insufficient to reduce this to a level I. More detailed noise analysis indicates that a noise wall, between 14 and 16 feet high, would reduce the impact level to these residences. However, more substantial noise mitigation is indicated to be necessary. When the train speed at this location is reduced to less than 200mph (i.e., approximately 190mph), the analysis indicates a noise reduction with the higher noise wall to an impact level of I. In Easton, the residences on Cherry Avenue analyzed for noise are indicated to have an impact level of SI before mitigation. For these receptors, a standard noise wall is sufficient to mitigate to an impact level of I.

In Corcoran and Tripton in the southern portion of the region, the HST potential noise impacts to residences are indicated to be SI before mitigation. Applying standard mitigation, does not reduce the impacts to a level I. More detailed noise analysis indicates that a noise wall, between 14 and 16 feet high, would reduce the impact level to these residences. However, further mitigation is indicated to be necessary for the residences in Corcoran. When the train speed is reduced to approximately 200mph, the analysis indicates a noise reduction with the higher noise wall to an impact level of I for these residences. The residences in Rosedale are at some distance (780 ft) from the alignment, and the noise impact level is I before mitigation and NI with standard noise mitigation.

Table 4.4.1 Typology Analysis Table – Potential Residential and Hospital Noise Impacts Sacramento to Bakersfield

ALIGNMENT SEGMENT	DESCRIPTION	CITY/ COUNTY	CORRIDOR TYPE	DISTANCE (ft)*	SPEED (mph)	EXISTING Ldn	PROJECT Ldn	IMPACT TYPE**	IMPACT TYPE AFTER MITIG.
UPRR \ UP3	Amador Avenue & Railroad	Sacramento	Exist. Rail	320	198	59	65	SI	I
BNSF \ BN4	End of Lacey	Wilton	Exist. Rail	430	207	50	59	I	I
UPRR \ UP4	Twin Cities & Midway	Galt	Exist. Rail	260	200	65	65	I	NI
UPRR \ UP5	Aurora & 5th Street	Stockton	Exist. Rail	50	148	67	71	SI	NI
UPRR LOOP/CON \ UPC10	Garfield & Shaw	Fresno	New	110	207	65	76	SI	I†
BNSF LOOP/CON \ BNC8	Cherry Ave & South	Easton	New	780	207	50	61	SI	I
BNSF \ BN22	Gardner & Brokaw	Corcoran	Exist. Rail	50	207	54	81	SI	I††
UPRR \ UP21	Along Hamlin	Tripton	Exist. Rail	260	207	60	68	SI	I††
UPRR \ UP21	Jenkins near Hageman	Rosedale	Exist. Rail	780	207	58	61	I	NI
UPRR \ UP11	Merced Medical Center	Merced	Exist. Rail	375	207	56	63	SI	I
UPRR \ UP13	Madera Community Hospital	Madera	Exist. Rail	780	207	56	61	I	NI

*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 14 to 16 ft high noise wall may be needed and a possible speed reduction to about 200 mph

**Table 4.4.2 Typology Analysis Table – Potential Institutional Noise Impacts
Sacramento to Bakersfield**

ALIGNMENT/ SEGMENT	DESCRIPTION	CITY/ COUNTY	CORRIDOR TYPE	DISTANCE (ft)*	SPEED (mph)	EXISTING Leq	PROJECT Leq	IMPACT TYPE**	IMPACT TYPE AFTER MITIG.
BNSF \ BN5	Greenwood School (Historical)	Morada	New	80	207	60	73	SI	I
BNSF \ BN15	Madera Community College	Madera	Exist. Rail	440	207	53	64	I	I
UPRR \ UP9	Mc Connel State Park	Livingston	Exist. Rail	50	207	67	78	SI	I
UPRR \ UP6	Mayor's Park	Manteca	Exist. Rail	50	161	67	71	I	NI

* Measured from centerline of alignment.
** NI = No Impact, I = Impact, SI = Severe Impact

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 for all three Alternatives are seen to coincide with the more densely populated areas such as found in the cities and towns in the San Joaquin Valley. Outside these areas, the land is primarily agricultural with very low population density and therefore lower impacts.

Table 4.5.1 presents the detailed results of the screening analyses for the three project alternatives. In addition to potential residential land use 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.

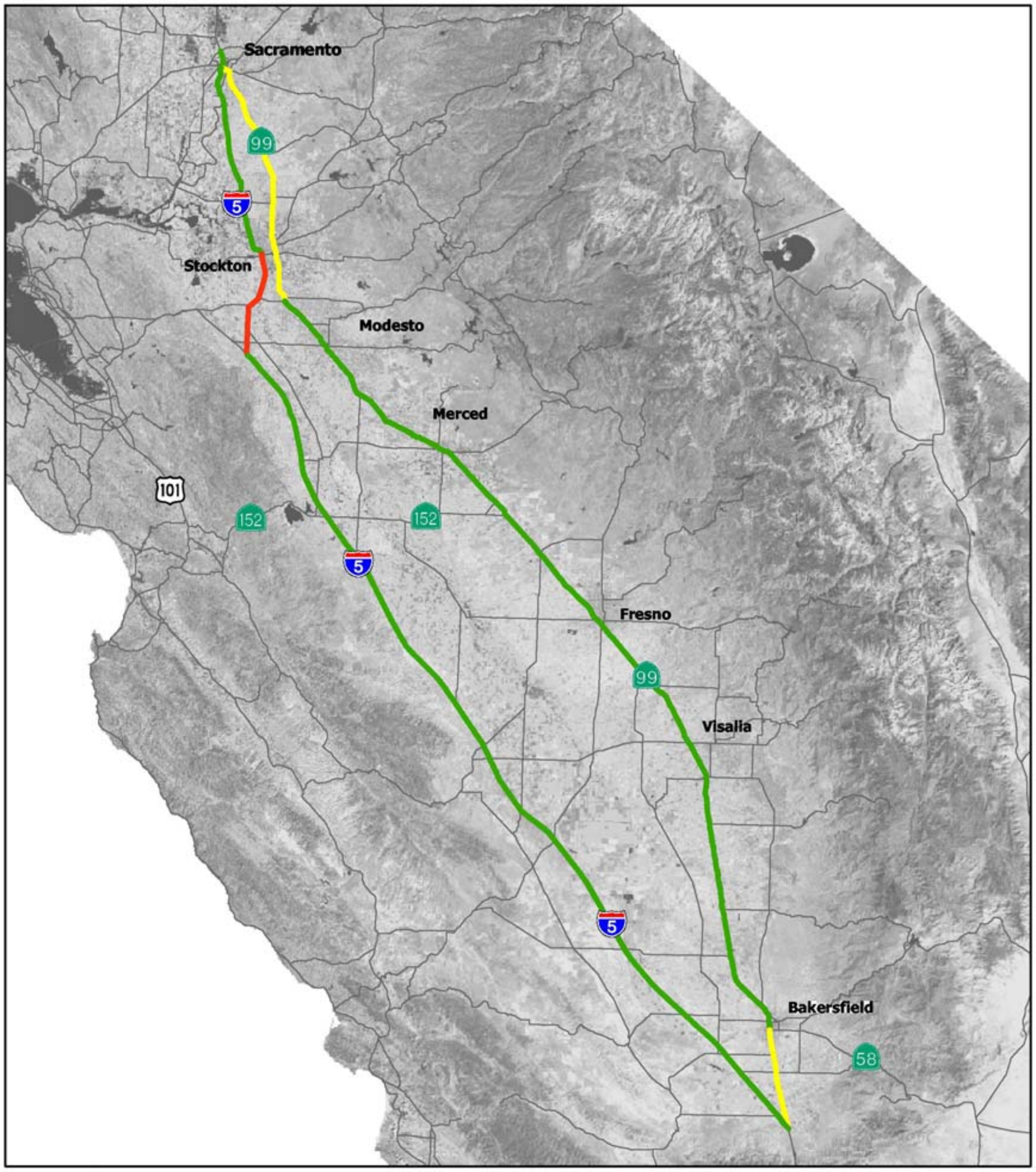
Under the No-Project Alternative (see Figure 12), the IR for the various highway segments ranges from L to H. The area of H impact is the I-5 corridor from the middle of Stockton to I-5. These same trends are also seen for the Modal Alternative. This result is not unexpected considering the close proximity of residential land along this alignment segment. 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. For most of the No-Project and Modal alignment segments, the IR is L. Two segments with an M rating are along SR99 south from Sacramento to Manteca and also south from Bakersfield to I-5.

The HST Alternative (see Figure 13) is indicated to have potential noise impacts, which are rated L everywhere except between Sacramento and Stockton along one of the alignment options, for which it is rated H in that area. In general, this is as would be expected considering the sparseness of residential land use and open space along most of the alignments evaluated. However, there are numerous concentrated locations in the San Joaquin Valley where the various alignment options pass through populated areas. The potential noise impacts to these areas are not reflected in the rating of the segment options, which cover larger areas. However, the Typology analyses do address these locations, since they only look at populated locations.

The two main alignment options (UP and BNSF) do pass through areas with residential population. Overall the HST Alternative has IRs which range from L to M depending primarily on the density of residential population, but averaged over the entire segment length. Whereas, the noise Typology study results are seen to reflect the local conditions encountered along the alignment options. 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 potential impact would be the longest segment with the highest IR and conversely the segment with the least potential 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 following segment options: A8, B2, C12, D1, E2 and either F6 or F12. The HST alignment with the greatest potential for noise impact consists of the following segment options: A1, B1, C2, D6, E1 and F13.



Source: Landsat 1985

April 7, 2003

California High Speed Train Program EIR/EIS

10 5 0 10 20 30 40 Miles

10 5 0 10 20 30 40 Kilometers

Legend

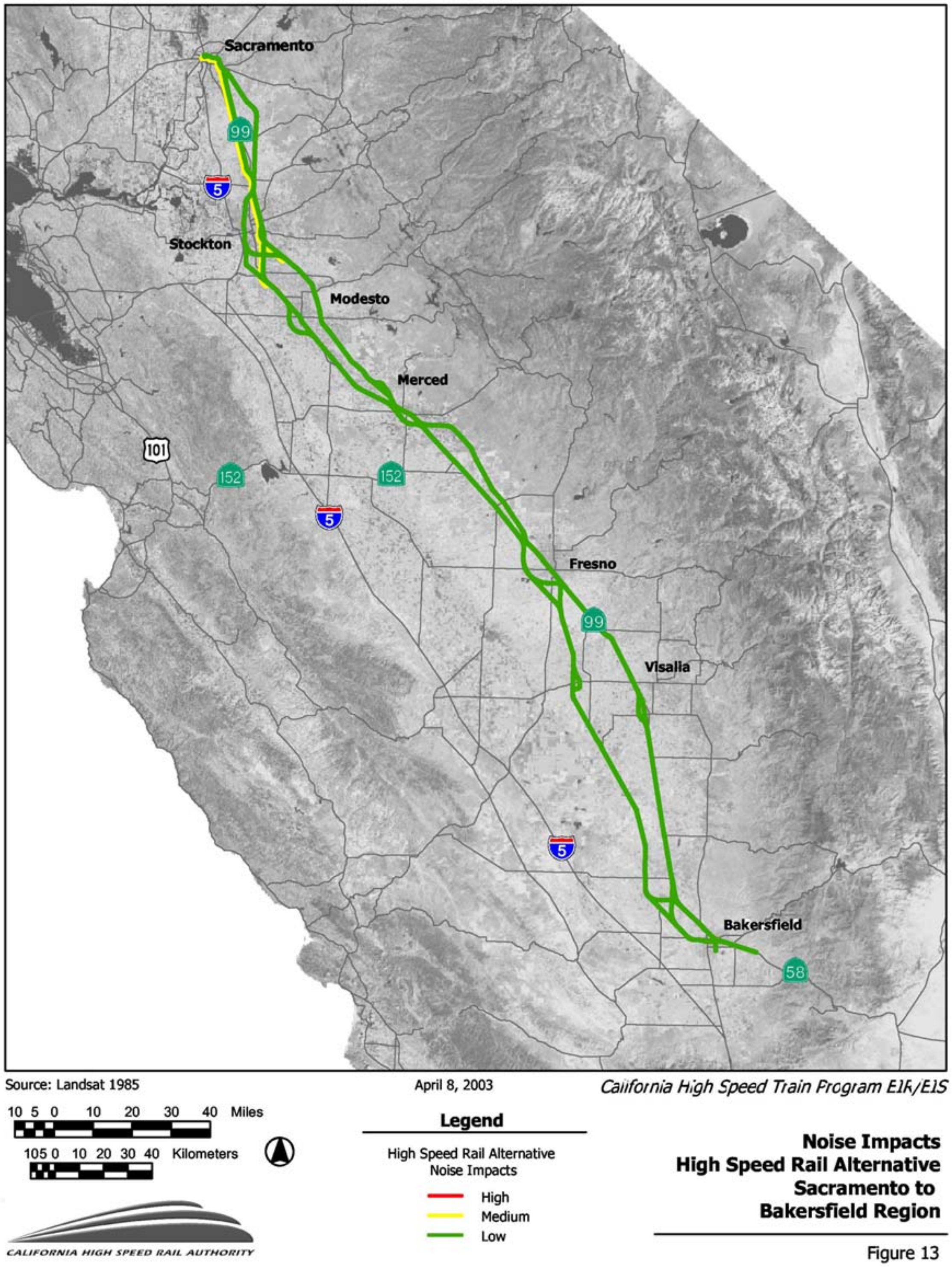
No-Build and Modal Alternative
Highways - Noise Impacts

- High
- Medium
- Low

CALIFORNIA HIGH SPEED RAIL AUTHORITY

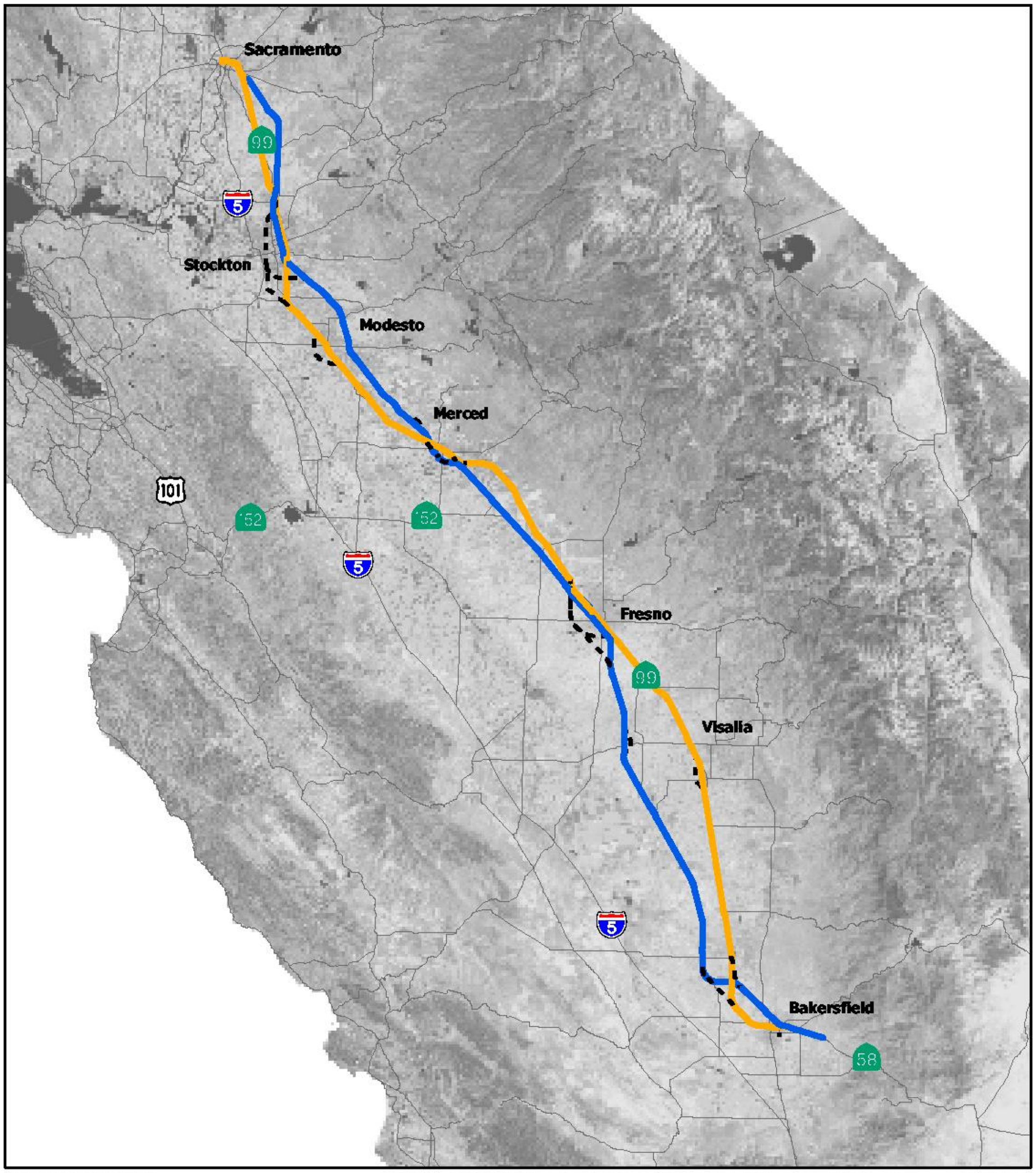
Noise Impacts
No-Build and Modal Alternatives
Sacramento to
Bakersfield Region

Figure 12



Noise Impacts
High Speed Rail Alternative
Sacramento to
Bakersfield Region

Figure 13



Source: Landsat 1985

April 8, 2003

California High Speed Train Program EIR/EIS

10 5 0 10 20 30 40 Miles

10 5 0 10 20 30 40 Kilometers

Legend

High Speed Rail Alternative Potential Noise Impacts

- Least
- Greatest
- Other Routes

Routes with Least and Greatest Potential Noise Impacts High Speed Rail Alternative Sacramento to Bakersfield Region

CALIFORNIA HIGH SPEED RAIL AUTHORITY

Figure 14

Table 4.5.1 Analysis/Comparison Table – Potential Noise Impacts
Sacramento to Bakersfield

	Residential (no. of people)	MU (no. of people)	Parkland (acres)	Institution Hospitals	Institution Schools	Impact Rating (H,M,L)
NO-PROJECT						
Fresno to Tulare/Visalia	423	35	0	0	1	L
Gilroy to SR-152	0	0	0	0	0	L
I-5 to SR-58	1,175	0	0	0	0	M
I-5 to SR-99	1	0	0	0	0	L
I-580/SR-120 to SR-152	520	0	1.9	0	0	L
I-80 to Stockton	285	0	53.2	0	0	L
I-880 to I-5 (Sacramento)	4	0	0	0	0	L
I-880 to I-5 (via I-238)	0	0	0	0	0	L
Merced to SR-152	273	0	0	0	0	L
Modesto to Merced	1,378	87	17.3	0	2	L
SR-120 to Modesto	0	0	0	0	0	L
SR-152 to Fresno	317	0	0	0	3	L
SR-152 to SR-99	81	56	0	0	0	L
SR-99 to SR-14 (Palmdale)	639	0	0	0	0	L
Sacramento to SR-120	5,023	0	43	1	4	M
San Jose to Gilroy	0	0	0	0	0	L
Stockton to I-580/SR-120	5,422	0	27.4	0	1	H
Tulare/Visalia to SR-58	1,775	343	0	0	1	L
US-101 to I-5	0	0	0	0	0	L
MODAL						
Fresno to Tulare/Visalia	531	35	0	0	3	L
Gilroy to SR-152	0	0	0	0	0	L
I-5 to SR-58	1,541	0	0	0	0	M
I-5 to SR-99	1	0	0	0	0	L
I-580/SR-120 to SR-152	633	0	2.5	0	0	L
I-80 to Stockton	418	0	63.7	0	0	L
I-880 to I-5 (Sacramento)	5	0	0	0	0	L
I-880 to I-5 (via I-238)	0	0	0	0	0	L
Merced to SR-152	394	0	0	0	0	L
Modesto to Merced	1,646	87	22.9	0	2	L
SR-120 to Modesto	0	0	0	0	0	L
SR-152 to Fresno	410	0	0	1	3	M
SR-152 to SR-99	111	56	0	0	0	L
SR-99 to SR-14 (Palmdale)	639	0	0	0	0	L
Sacramento to SR-120	6,144	0	55.5	1	5	M
San Jose to Gilroy	0	0	0	0	0	L
Stockton to I-580/SR-120	6,542	0	33.3	0	1	H
Tulare/Visalia to SR-58	2,144	343	0	0	1	L
US-101 to I-5	0	0	0	0	0	L

	Residential (no. of people)	MU (no. of people)	Parkland (acres)	Institution		Impact Rating (H,M,L)
				Hospitals	Schools	
HST CORRIDOR & STATION OPTIONS						
SACRAMENTO TO STOCKTON						
A1	5,709	0	19.3	1	5	L
A2	2,484	0	14.8	1	6	L
A3	4,903	0	10.1	0	4	L
A4	1,678	0	5.6	0	5	L
A5	4,286	0	20.8	1	5	L
A6	1,646	0	13.9	1	6	L
A7	3,480	0	11.6	0	4	L
A8	840	0	4.7	0	5	L
STOCKTON TO MODESTO						
B1	1,319	6	0.0	0	0	L
B1	249	0	0.0	0	1	L
MODESTO TO MERCED						
C1	941	0	53.2	0	1	L
C2	1,005	0	53.2	0	1	L
C3	985	0	53.2	0	1	L
C4	1,052	0	53.2	0	1	L
C5	645	0	90.8	0	0	L
C6	674	0	90.8	0	0	L
C7	688	0	90.8	0	0	L
C8	721	0	90.8	0	0	L
C9	811	0	53.2	0	0	L
C10	814	0	53.2	0	0	L
C11	482	0	90.8	0	0	L
C12	485	0	90.8	0	0	L
C13	500	0	90.8	0	0	L
C14	663	0	90.8	0	0	L
C15	503	0	90.8	0	0	L
C16	706	0	90.8	0	0	L
MERCED TO FRESNO						
D1	478	40	0.0	0	1	L
D2	775	40	0.0	0	2	L
D3	478	40	0.0	0	1	L
D4	756	40	0.0	0	2	L
D5	580	201	0.0	0	0	L
D6	831	201	0.0	0	1	L
D7	580	201	0.0	0	0	L
D8	850	201	0.0	0	1	L

	Residential (no. of people)	MU (no. of people)	Parkland (acres)	Institution Hospitals	Institution Schools	Impact Rating (H,M,L)
Fresno to Tulare						
E1	149	95	0.0	0	0	L
E2	387	0	5.0	0	0	L
Tulare to Bakersfield						
F1	2,565	277	0.0	0	1	L
F2	2,023	277	0.0	0	1	L
F3	2,296	255	0.0	0	1	L
F4	1,754	255	0.0	0	1	L
F5	1,670	0	0.0	0	1	L
F6	1,128	0	0.0	0	1	L
F7	2,565	277	0.0	0	1	L
F8	2,023	277	0.0	0	1	L
F9	2,296	255	0.0	0	1	L
F10	1,754	255	0.0	0	1	L
F11	1,670	0	0.0	0	1	L
F12	1,128	0	0.0	0	1	L
F13	2,418	281	0.0	0	2	L
F14	2,149	259	0.0	0	2	L
F15	3,049	332	0.0	1	4	L
F16	2,507	332	0.0	1	4	L
F17	2,780	310	0.0	1	4	L
F18	2,238	310	0.0	1	4	L
F19	2,627	323	0.0	1	1	L
F20	2,085	323	0.0	1	1	L
F21	2,358	301	0.0	1	1	L
F22	1,816	301	0.0	1	1	L
F23	2,258	55	0.0	1	4	L
F24	1,716	55	0.0	1	4	L

4.6 Focused Noise Study

The Sacramento to Bakersfield HST alternative proposes rail alignment options that would allow express trains to bypass certain intermediate stations. Such bypass tracks are referred to as high speed loops, which allow express trains to avoid traveling through more heavily populated areas. Without a high speed loop, there is a greater potential for impact to people in urban areas due to the higher levels of noise associated with express trains and the greater density of people. The high speed loops tend to be outside populated areas.

It is possible to see that there may be a noise impact benefit from implementing a high speed loop compared to a situation in which all the trains (both stopping and express trains) pass through all the stations. There are also other rail loops, which are used to access certain parts of larger cities. These other rail loops are included in the regular screening analysis results and are not highlighted.

The regular noise screening analysis results for this corridor were used to quantify and compare the differences between the two configurations with and without high speed loops. The high speed loop which skirts Fresno was chosen as an example to highlight the noise benefits which might be obtained by implementing high speed loops. The focused evaluation compares the number of people impacted by the option with no loop, and the number of people impacted by the option which includes the high speed loop around Fresno. Fresno has two potential high speed loops, depending on which of the two rail alignments is selected as the mainline HST route (UP or BNSF).

The screening distance used for the high speed loop is the distance associated with high speed trains (i.e., 207mph). With the high speed loop included as part of the option, the screening distance used for the mainline, is that associated with stopping or accelerating trains (i.e., less than 125mph). Using the GIS database, the numbers of people potentially impacted for the two scenarios were determined.

The UP alignment high speed loop option analysis indicates that if express trains use the mainline track (no high speed loop), the number of people potentially impacted by noise is 704 compared with only 589 people potentially impacted by including this high speed loop. This is a 16% reduction in the number of people impacted. The BNSF high speed loop option analysis indicates 738 people are potentially impacted by noise if all trains use the mainline compared with only 651 people impacted with the high speed loop option. This is a 12% reduction in the number of people potentially impacted. This comparative evaluation shows that the number of people impacted by noise should be less with the high speed loop, although the difference is not large.

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 Representative Case, land use typology, vibration studies are shown in the Typology Analysis Table below. The Representative Cases illustrate the typologies that exist throughout the Sacramento to Bakersfield portion of the HST Alternative. Representative Cases were chosen to show a range of the impact levels that are likely to be encountered in Tier 2 analyses

The results of the typology analyses using the FRA criteria for assessing vibration impacts are indicated in Table 5.4.1. Of the thirteen cases analyzed, six 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 50 feet from the alignment, as in the case of the residences in Stockton on Aurora Street, the projected vibration level is 80 dBV or 8 dBV greater than the criterion. In a similar situation, the residences in Corcoran on Gardener Street, are also impacted, but at a slightly higher level (83 dBV), or 9 dBV greater than the criterion due to a higher speed at this location.

Speed of the train is an important factor in the level of vibration generated. The distance vibration impact can occur extends out to greater distances with increasing speed, as in the case of residences in Galt on Twin Cities Street and the residences in Tripton on Hamlin Street both groups of which are at 260 feet away. The train speed for the receptors in Galt is slightly lower than the speed of the train in Tripton (200mph compared with 207mph). In this instance the projected vibration is indicated to be over the criterion by 1 dBV.

The typology vibration analyses would seem to indicate that where train speeds are less than 200mph the vibration impact extends to about 200 feet from the alignment in the case of residences. . This is consistent with the screening distance of 200 feet used for most of the Sacramento to Bakersfield alignment segments. Where the speed is as high as 207mph, the vibration impact distance extends as far as 275 feet and maybe 300 feet. For schools, the distance beyond which impact ceases appears to be between 150 feet and 200 feet at the higher train speed of 207mph, but probably is limited to a distance of 150 feet for speeds less than 200mph. 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, 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
Sacramento to Bakersfield

ALIGNMENT/ SEGMENT	LAND USE/DESCRIPTION	CITY/ COUNTY	CORRIDOR TYPE	DISTANCE (ft)*	SPEED (mph)	MAX. ALLOWED (dBV)	PROJECT (dBV)	IMPACT? (YES/no)
UPRR \ UP3	Amador Ave & Railroad	Sacramento	Exist. Rail	320	198	72	70	NO
BNSF \ BN4	End of Lacey	Wilton	Exist. Rail	430	207	72	68	NO
UPRR \ UP4	Twin Cities & Midway	Galt	Exist. Rail	260	200	72	73	YES
UPRR \ UP5	Aurora & 5th St.	Stockton	Exist. Rail	50	148	72	80	YES
UPRR LOOP/CON \ UPC10	Garfield & Shaw	Fresno	Exist. Rail	110	207	72	79	YES
BNSF LOOP/CON \ BNC8	Cherry Ave & South	Easton	New	780	207	72	59	NO
BNSF \ BN22	Gardner & Brokaw	Corcoran	Exist. Rail	50	207	72	83	YES
UPRR \ UP21	Along Hamlin	Tripton	Exist. Rail	260	207	72	73	YES
UPRR \ UP21	Jenkins near Hageman	Rosedale	Exist. Rail	780	207	72	59	NO
UPRR \ UP11	Merced Medical Center	Merced	Exist. Rail	375	207	72	69	NO
UPRR \ UP13	Madera Community Hospital	Madera	Exist. Rail	780	207	72	59	NO
BNSF \ BN5	Greenwood School (Historical)	Morada	Exist. Rail	80	207	75	81	YES
BNSF \ BN15	Madera Community College	Madera	Exist. Rail	440	207	75	67	NO

*Measured from centerline of alignment

5.5.1 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. All alignment options are indicated as having IRs of L. This situation is similar to the noise screening, in which the potential impact is averaged over alignment segments that cover more area than the communities though which they pass. The portions of alignment segments, which are in populated areas have higher local impacts. This is better reflected in the vibration Typology analyses.

Table 5.5.1 Analysis/Comparison Table – Potential Vibration Impacts
Sacramento to Bakersfield

	Residential (no. of people)	MU (no. of people)	Institutional		Impact Rating (H,M,L)
			Hospitals	Schools	
No-Project*	N/A	N/A	N/A	N/A	N/A
Modal*	N/A	N/A	N/A	N/A	N/A
HST Corridor & Station Options					
SACRAMENTO TO STOCKTON					
A1	1,833	0	0	1	L
A2	1,046	0	0	1	L
A3	1,624	0	0	1	L
A4	836	0	0	1	L
A5	1,737	0	0	1	L
A6	976	0	0	1	L
A7	1,528	0	0	1	L
A8	767	0	0	1	L
STOCKTON TO MODESTO					
B1	368	2	0	0	L
B1	13	0	0	0	L
MODESTO TO MERCED					
C1	376	0	1	0	L
C2	543	0	1	0	L
C3	289	0	1	0	L
C4	376	0	1	0	L
C5	553	0	0	0	L
C6	635	0	0	0	L
C7	466	0	0	0	L
C8	468	0	0	0	L
C9	304	0	1	0	L
C10	225	0	1	0	L
C11	520	0	0	0	L
C12	440	0	0	0	L

	Residential (no. of people)	MU (no. of people)	Institutional		Impact Rating (H,M,L)
			Hospitals	Schools	
C13	521	0	0	0	L
C14	554	0	0	0	L
C15	441	0	0	0	L
C16	467	0	0	0	L
MERCED TO FRESNO					
D1	193	22	0	0	L
D2	442	22	0	0	L
D3	193	22	0	0	L
D4	918	22	0	0	L
D5	569	59	1	0	L
D6	1,382	59	1	0	L
D7	569	59	1	0	L
D8	907	59	1	0	L
FRESNO TO TULARE					
E1	94	62	0	0	L
E2	375	0	0	0	L
TULARE TO BAKERSFIELD					
F1	556	154	3	0	L
F2	553	154	3	0	L
F3	714	145	0	0	L
F4	711	145	0	0	L
F5	70	0	0	0	L
F6	67	0	0	0	L
F7	556	154	3	0	L
F8	553	154	3	0	L
F9	714	145	0	0	L
F10	711	145	0	0	L
F11	70	0	0	0	L
F12	67	0	0	0	L
F13	622	154	3	1	L
F14	780	145	0	1	L
F15	581	181	4	0	L
F16	578	181	4	0	L
F17	739	172	1	0	L
F18	736	172	1	0	L
F19	586	178	3	0	L
F20	583	178	3	0	L
F21	744	169	0	0	L
F22	741	169	0	0	L
F23	98	27	1	0	L
F24	95	27	1	0	L

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 A1

Table Alignment Options
Sacramento to Bakersfield

Option	Origin Station	Route	Destination Station	Southerly Connection	Other	Nodes	Segments														
							Main Line											Loop			
Sacramento to Stockton																					
A1	Sacramento Downtown Depot	via UPRR	to Stockton Downtown Station	with connection to UPRR south of Stockton	plus high-speed loop around Stockton	1A-2A-3A-4A-5A-5B-7A and 5A-6A-7A STATION LOOP	UP1	UP2	UP3	UP4	BN5	BNC2		storage facility at	BN1	UPC3 (lead)	UP3 (lead)	UP5	UP6		
A2	Sacramento Downtown Depot	via CCT	to Stockton Downtown Station	with connection to UPRR south of Stockton	plus high-speed loop around Stockton	1A-2A-3A-4B-5A-5B-7A and 5A-6A-7A STATION LOOP	UP1	UP2	BNC1	BN4	BN5	BNC2		storage facility at	UPC1	BN3 (lead)	UP3 (lead)	UP5	UP6		
A3	Sacramento Downtown Depot	via UPRR	to Stockton Downtown Station	with connection to BNSF south of Stockton	plus high-speed loop around Stockton	1A-2A-3A-4A-5A-5B-6B and 5A-6A-6B STATION LOOP	UP1	UP2	UP3	UP4	BN5	BN6		storage facility at	BN1	UPC3 (lead)	UP3 (lead)	UP5	UPC4		
A4	Sacramento Downtown Depot	via CCT	to Stockton Downtown Station	with connection to BNSF south of Stockton	plus high-speed loop around Stockton	1A-2A-3A-4B-5A-5B-6B and 5A-6A-6B STATION LOOP	UP1	UP2	BNC1	BN4	BN5	BN6		storage facility at	UPC1	BN3 (lead)	UP3 (lead)	UP5	UPC4		
A5	Power Inn Road Station	via UPRR	to Stockton Downtown Station	with connection to UPRR south of Stockton	plus high-speed loop around Stockton	2B-1B-4A-5A-5B-7A and 5A-6A-7A STATION LOOP	UPC2	UPC3	UP4	BN5	BNC2			storage facility at	UPC1	no leads		UP5	UP6		
A6	Power Inn Road Station	via CCT	to Stockton Downtown Station	with connection to UPRR south of Stockton	plus high-speed loop around Stockton	2B-4B-5A-5B-7A and 5A-6A-7A STATION LOOP	BN2	BN3	BN4	BN5	BNC2			storage facility at	BN1	no leads		UP5	UP6		

Option	Origin Station	Route	Destination Station	Southerly Connection	Other	Nodes	Segments														
							Main Line											Loop			
A7	Power Inn Road Station	via UPRR	to Stockton Downtown Station	with connection to BNSF south of Stockton	plus high-speed loop around Stockton	2B-1B-4A-5A-5B-6B and 5A-6A-6B STATION LOOP	UPC2	UPC3	UP4	BN5	BN6			storage facility at	UPC1	no leads		UP5	UPC4		
A8	Power Inn Road Station	via CCT	to Stockton Downtown Station	with connection to BNSF south of Stockton	plus high-speed loop around Stockton	2B-4B-5A-5B-6B and 5A-6A-6B STATION LOOP	BN2	BN3	BN4	BN5	BN6			storage facility at	BN1	no leads		UP5	UPC4		
Stockton to Modesto																					
B1		via UPRR	to Modesto Downtown Station		plus high-speed loop around Modesto	7A-8A-9A and 8A-9A LOOP	UP7	UP8										UPC5			
B2		via BNSF	to Modesto Briggsmore Station			6B-7B-8B	BN7	BN8													
Modesto to Merced																					
C1		via UPRR	to Merced Downtown Station	with connection to UPRR south of Merced		9A-10A-11B-12B-13A	UP9	UP10	UP11 (2)	UP12											
C2		via UPRR	to Merced Downtown Station	with connection to UPRR south of Merced	plus high-speed loop around Merced	9A-10A-11B-12B-13A and 10A-11A-12A-13A LOOP	UP9	UP10	UP11	UP12								UPC6	UPC7	UPC8	
C3		via UPRR	to Merced Downtown Station	with connection to BNSF south of Merced		9A-10A-11B-12B-13B	UP9	UP10	UP11 (2)	BN13											
C4		via UPRR	to Merced Downtown Station	with connection to BNSF south of Merced	plus high-speed loop around Merced	9A-10A-11B-12B-13B and 10A-11A-12A-13B LOOP	UP9	UP10	UP11	BN13								UPC6	UPC7	BNC6	
C5		via BNSF	to Merced Downtown Station	with connection to UPRR south of Merced		8B-9B-10B-11B-12B-13A	BN9	BN10	BN11	BN12 (2)	UP12										
C6		via BNSF	to Merced Downtown Station	with connection to UPRR south of Merced	plus high-speed loop around Merced	8B-9B-10B-11B-12B-13A and 10B-1C-12A-13A LOOP	BN9	BN10	BN11	BN12	UP12							BNC4	BNC5	UPC8	

Option	Origin Station	Route	Destination Station	Southerly Connection	Other	Nodes	Segments														
							Main Line											Loop			
C7		via BNSF	to Merced Downtown Station	with connection to BNSF south of Merced		8B-9B-10B-11B-12B-13B	BN9	BN10	BN11	BN12 (2)	BN13										
C8		via BNSF	to Merced Downtown Station	with connection to BNSF south of Merced	plus high-speed loop around Merced	8B-9B-10B-11B-12B-13B and 10B-1C-12A-13B LOOP	BN9	BN10	BN11	BN12	BN13							BNC4	BNC5	BNC6	
C9		via UPRR	to Merced Municipal Airport Station	with connection to UPRR south of Merced		9A-10A-11A-12A-13A	UP9	UPC6	UPC7 (2)	UPC8											
C10		via UPRR	to Merced Municipal Airport Station	with connection to BNSF south of Merced		9A-10A-11A-12A-13B	UP9	UPC6	UPC7 (2)	BNC6											
C11		via BNSF	to Merced Municipal Airport Station	with connection to UPRR south of Merced		8B-9B-10B-1C-12A-13A	BN9	BN10	BNC4	BNC5 (2)	UPC8										
C12		via BNSF	to Merced Municipal Airport Station	with connection to BNSF south of Merced		8B-9B-10B-1C-12A-13B	BN9	BN10	BNC4	BNC5 (2)	BNC6										
C13		via BNSF	to Castle Air Force Base Station	with connection to UPRR south of Merced	via west loop	8B-9B-10B-1C-12A-13A and 9B-10B STATION LOOP	BN9	BN10	BNC4	BNC5	UPC8							BNC3			
C14		via BNSF	to Castle Air Force Base Station	with connection to UPRR south of Merced	through downtown Merced	8B-9B-10B-11B-12B-13A and 9B-10B STATION LOOP	BN9	BN10	BN11	BN12	UP12							BNC3			
C15		via BNSF	to Castle Air Force Base Station	with connection to BNSF south of Merced	via west loop	8B-9B-10B-1C-12A-13B and 9B-10B STATION LOOP	BN9	BN10	BNC4	BNC5	BNC6							BNC3			
C16		via BNSF	to Castle Air Force Base Station	with connection to UPRR south of Merced	through downtown Merced	8B-9B-10B-11B-12B-13B and 9B-10B STATION LOOP	BN9	BN10	BN11	BN12	BN13							BNC3			
Merced to Fresno																					
D1		via BNSF	to Fresno Downtown Station	with connection to BNSF south of Fresno		13B-14B-15B-15A-16A-17A-16B	BN14	BN15	BN16	BN17	BN18 (2)	BN19									
D2		via BNSF	to Fresno Downtown Station	with connection to BNSF south of Fresno	plus high-speed loop	13B-14B-15B-15A-16A-17A-16B and 15B-2C-16B LOOP	BN14	BN15	BN16	BN17	BN18	BN19						BNC7	BNC8		

Option	Origin Station	Route	Destination Station	Southerly Connection	Other	Nodes	Segments														
							Main Line											Loop			
D3		via BNSF	to Fresno Downtown Station	with connection to UPRR south of Fresno		13B-14B-15B-15A-16A-17A-18A	BN14	BN15	BN16	BN17	BN18 (2)	UP17									
D4		via BNSF	to Fresno Downtown Station	with connection to UPRR south of Fresno	plus high-speed loop	13B-14B-15B-15A-16A-17A-18A and 15B-2C-18A LOOP	BN14	BN15	BN16	BN17	BN18	UP17						BNC7	UPC10		
D5		via UPRR	to Fresno Downtown Station	with connection to UPRR south of Fresno		13A-14A-15A-16A-17A-18A	UP13	UP14	UP15	UP16 (2)	UP17										
D6		via UPRR	to Fresno Downtown Station	with connection to UPRR south of Fresno	plus high-speed loop	13A-14A-15A-16A-17A-18A and 14A-2C-18A LOOP	UP13	UP14	UP15	UP16	UP17							UPC9	UPC10		
D7		via UPRR	to Fresno Downtown Station	with connection to BNSF south of Fresno		13A-14A-15A-16A-17A-16B	UP13	UP14	UP15	UP16 (2)	BN19										
D8		via UPRR	to Fresno Downtown Station	with connection to BNSF south of Fresno	plus high-speed loop	13A-14A-15A-16A-17A-16B and 14A-2C-16B LOOP	UP13	UP14	UP15	UP16	BN19							UPC9	BNC8		
Fresno to Tulare																					
E1		via UPRR	to Visalia Airport Station			18A-19A-20A	UP18	UP19													
E2		via BNSF	to Hanford Station		plus high-speed loop	16B-17B-18B and 17B-18B LOOP	BN20	BN21										BNC9			
Tulare to Bakersfield																					
F1		via UPRR	to Bakersfield Airport Station	with connection to SR58		20A-21A-22A-23A-24A-25A-26A-27A-28A-3C-29A-30A	UP20	UP21	UP22	UP23	UP24 (2)	UP25	UP26	UP27	UP28	UP29	UP30	Mtc Fac at	UP23		
F2		via UPRR	to Bakersfield Airport Station	with connection to Wheeler Ridge		20A-21A-22A-23A-24A-25A-26A-27A-28A-3C-29A	UP20	UP21	UP22	UP23	UP24 (2)	UP25	UP26	UP27	UP28	UP29		Mtc Fac at	UP23		
F3		via UPRR, around Tulare	to Bakersfield Airport Station	with connection to SR58		20A-21A(LOOP)-22A-23A-24A-25A-26A-27A-28A-3C-29A-30A	UPC11	UP21	UP22	UP23	UP24 (2)	UP25	UP26	UP27	UP28	UP29	UP30	Mtc Fac at	UP23		

Option	Origin Station	Route	Destination Station	Southerly Connection	Other	Nodes	Segments														
							Main Line											Loop			
F4		via UPRR, around Tulare	to Bakersfield Airport Station	with connection to Wheeler Ridge		20A-21A(LOOP)-22A-23A-24A-25A-26A-27A-28A-3C-29A	UPC11	UP21	UP22	UP23	UP24 (2)	UP25	UP26	UP27	UP28	UP29		Mtc Fac at	UP23		
F5		via BNSF	to Bakersfield Airport Station	with connection to SR58		18B-19B-23A-24A-25A-26A-27A-28A-3C-29A-30A	BN22	BNC10	UP23	UP24 (2)	UP25	UP26	UP27	UP28	UP29	UP30		Mtc Fac at	UP23		
F6		via BNSF	to Bakersfield Airport Station	with connection to Wheeler Ridge		18B-19B-23A-24A-25A-26A-27A-28A-3C-29A	BN22	BNC10	UP23	UP24 (2)	UP25	UP26	UP27	UP28	UP29			Mtc Fac at	UP23		
F7		via UPRR	to Golden State Station	with connection to SR58		20A-21A-22A-23A-24A-25A-26A-27A-28A-3C-29A-30A	UP20	UP21	UP22	UP23	UP24	UP25	UP26 (2)	UP27 (2)	UP28	UP29	UP30	Mtc Fac at	UP23		
F8		via UPRR	to Golden State Station	with connection to Wheeler Ridge		20A-21A-22A-23A-24A-25A-26A-27A-28A-3C-29A	UP20	UP21	UP22	UP23	UP24	UP25	UP26 (2)	UP27 (2)	UP28	UP29		Mtc Fac at	UP23		
F9		via UPRR, around Tulare	to Golden State Station	with connection to SR58		20A-21A(LOOP)-22A-23A-24A-25A-26A-27A-28A-3C-29A-30A	UPC11	UP21	UP22	UP23	UP24	UP25	UP26 (2)	UP27 (2)	UP28	UP29	UP30	Mtc Fac at	UP23		
F10		via UPRR, around Tulare	to Golden State Station	with connection to Wheeler Ridge		20A-21A(LOOP)-22A-23A-24A-25A-26A-27A-28A-3C-29A	UPC11	UP21	UP22	UP23	UP24	UP25	UP26 (2)	UP27 (2)	UP28	UP29		Mtc Fac at	UP23		
F11		via BNSF	to Golden State Station	with connection to SR58		18B-19B-23A-24A-25A-26A-27A-28A-3C-29A-30A	BN22	BNC10	UP23	UP24	UP25	UP26 (2)	UP27 (2)	UP28	UP29	UP30		Mtc Fac at	UP23		
F12		via BNSF	to Golden State Station	with connection to Wheeler Ridge		18B-19B-23A-24A-25A-26A-27A-28A-3C-29A	BN22	BNC10	UP23	UP24	UP25	UP26 (2)	UP27 (2)	UP28	UP29			Mtc Fac at	UP23		
F13		via UPRR	to Truxtun (Union Avenue) Station	with connection to Union Avenue		20A-21A-22A-23A-24A-25A-26A-27A-31A	UP20	UP21	UP22	UP23	UP24	UP25	UP26	UPC14				Mtc Fac at	UP23		
F14		via UPRR, around Tulare	to Truxtun (Union Avenue) Station	with connection to Union Avenue		20A-21A(LOOP)-22A-23A-24A-25A-26A-27A-31A	UPC11	UP21	UP22	UP23	UP24	UP25	UP26	UPC14				Mtc Fac at	UP23		
F15		via UPRR	to Truxtun (Amtrak) Station	with connection to SR58		20A-21A-22A-20B-21B-22B-3C-29A-30A	UP20	UP21	UPC12	BN24	BN25	BN26 (2)	BN27	UP30				Mtc Fac at	BN23		

Option	Origin Station	Route	Destination Station	Southerly Connection	Other	Nodes	Segments														
							Main Line											Loop			
F16		via UPRR	to Truxtun (Amtrak) Station	with connection to Wheeler Ridge		20A-21A-22A-20B-21B-22B-3C-29A	UP20	UP21	UPC12	BN24	BN25	BN26 (2)	BN27					Mtc Fac at	BN23		
F17		via UPRR, around Tulare	to Truxtun (Amtrak) Station	with connection to SR58		20A-21A(LOOP)-22A-20B-21B-22B-3C-29A-30A	UPC11	UP21	UPC12	BN24	BN25	BN26 (2)	BN27	UP30				Mtc Fac at	BN23		
F18		via UPRR, around Tulare	to Truxtun (Amtrak) Station	with connection to Wheeler Ridge		20A-21A(LOOP)-22A-20B-21B-22B-3C-29A	UPC11	UP21	UPC12	BN24	BN25	BN26 (2)	BN27					Mtc Fac at	BN23		
F19		via UPRR	to Truxtun (Amtrak) Station	with connection to SR58	with high-speed loop on UPRR	20A-21A-22A-23A-24A-25A-26A-27A-28A-3C-29A-30A and 25A-21B-22B-3C STATION LOOP	UP20	UP21	UP22	UP23	UP24	UP25	UP26	UP27	UP28	UP29	UP30	UPC13	BN25	BN26	Mtc Fac at UP23
F20		via UPRR	to Truxtun (Amtrak) Station	with connection to Wheeler Ridge	with high-speed loop on UPRR	20A-21A-22A-23A-24A-25A-26A-27A-28A-3C-29A and 25A-21B-22B-29A STATION LOOP	UP20	UP21	UP22	UP23	UP24	UP25	UP26	UP27	UP28	UP29		UPC13	BN25	BN26	Mtc Fac at UP23
F21		via UPRR, around Tulare	to Truxtun (Amtrak) Station	with connection to SR58	with high-speed loop on UPRR	20A-21A(LOOP)-22A-23A-24A-25A-26A-27A-28A-3C-29A-30A and 25A-21B-22B-3C STATION LOOP	UPC11	UP21	UP22	UP23	UP24	UP25	UP26	UP27	UP28	UP29	UP30	UPC13	BN25	BN26	Mtc Fac at UP23
F22		via UPRR, around Tulare	to Truxtun (Amtrak) Station	with connection to Wheeler Ridge	with high-speed loop on UPRR	20A-21A(LOOP)-22A-23A-24A-25A-26A-27A-28A-3C-29A and 25A-21B-22B-3C STATION LOOP	UPC11	UP21	UP22	UP23	UP24	UP25	UP26	UP27	UP28	UP29		UPC13	BN25	BN26	Mtc Fac at UP23
F23		via BNSF	to Truxtun (Amtrak) Station	with connection to SR58		18B-19B-20B-21B-22B-3C-29A-30A	BN22	BN23	BN24	BN25	BN26 (2)	BN27	UP30					Mtc Fac at	BN23		
F24		via BNSF	to Truxtun (Amtrak) Station	with connection to Wheeler Ridge		18B-19B-20B-21B-22B-3C-29A	BN22	BN23	BN24	BN25	BN26 (2)	BN27						Mtc Fac at	BN23		

**Analysis/Comparison Table – Potential Noise Impacts
Sacramento to Bakersfield**

	Residential	MU	Parkland	Institution		Impact Rating
	(no. of people)	(no. of people)	(acres)	Schools	Hospitals	(H,M,L)
NO-PROJECT						
Fresno to Tulare/Visalia	423	35	0	1	0	L
Gilroy to SR-152	0	0	0	0	0	L
I-5 to SR-58	1,175	0	0	0	0	M
I-5 to SR-99	1	0	0	0	0	L
I-580/SR-120 to SR-152	520	0	1.9	0	0	L
I-80 to Stockton	285	0	53.2	0	0	L
I-880 to I-5 (Sacramento)	4	0	0	0	0	L
I-880 to I-5 (via I-238)	0	0	0	0	0	L
Merced to SR-152	273	0	0	0	0	L
Modesto to Merced	1,378	87	17.3	2	0	L
SR-120 to Modesto	0	0	0	0	0	L
SR-152 to Fresno	317	0	0	3	0	L
SR-152 to SR-99	81	56	0	0	0	L
SR-99 to SR-14 (Palmdale)	639	0	0	0	0	L
Sacramento to SR-120	5,023	0	43	4	1	M
San Jose to Gilroy	0	0	0	0	0	L
Stockton to I-580/SR-120	5,422	0	27.4	1	0	H
Tulare/Visalia to SR-58	1,775	343	0	1	0	L
US-101 to I-5	0	0	0	0	0	L
MODAL						
Fresno to Tulare/Visalia	531	35	0	3	0	L
Gilroy to SR-152	0	0	0	0	0	L
I-5 to SR-58	1,541	0	0	0	0	M

	Residential (no. of people)	MU (no. of people)	Parkland (acres)	Institution		Impact Rating (H,M,L)
				Schools	Hospitals	
I-5 to SR-99	1	0	0	0	0	L
I-580/SR-120 to SR-152	633	0	2.5	0	0	L
I-80 to Stockton	418	0	63.7	0	0	L
I-880 to I-5 (Sacramento)	5	0	0	0	0	L
I-880 to I-5 (via I-238)	0	0	0	0	0	L
Merced to SR-152	394	0	0	0	0	L
Modesto to Merced	1,646	87	22.9	2	0	M
SR-120 to Modesto	0	0	0	0	0	L
SR-152 to Fresno	410	0	0	3	1	H
SR-152 to SR-99	111	56	0	0	0	L
SR-99 to SR-14 (Palmdale)	639	0	0	0	0	L
Sacramento to SR-120	6,144	0	55.5	5	1	H
San Jose to Gilroy	0	0	0	0	0	L
Stockton to I-580/SR-120	6,542	0	33.3	1	0	H
Tulare/Visalia to SR-58	2,144	343	0	1	0	M
US-101 to I-5	0	0	0	0	0	L
HST CORRIDOR & STATION OPTIONS						
SACRAMENTO TO STOCKTON						
Main Segments						
UP 1	16	0	1.1	0	0	L
UP 2	950	0	0.5	0	0	H
UP 3	469	0	3.4	0	0	L
UP 4	3,071	0	1.1	0	0	M
UP 5	354	0	4.0	2	0	L
UP6	643	0	9.1	0	1	L
BN 1	11	0	0.0	0	0	L
BN 2	147	0	0.7	0	0	M
BN 3	1	0	0.0	0	0	L
BN 4	295	0	0.0	1	0	L
BN 5	22	0	0.0	1	0	L
BN 6	4	0	0.0	0	0	L

	Residential (no. of people)	MU (no. of people)	Parkland (acres)	Institution Schools	Institution Hospitals	Impact Rating (H,M,L)
Loop Segments						
UPC 1	159	0	1.8	0	0	M
UPC 2	0	0	0.0	0	0	L
UPC 3	12	0	6.5	0	0	L
UPC 4	16	0	0.0	1	0	L
BNC 1	21	0	0.0	0	0	L
BNC 2	184	0	0.0	2	0	L
STOCKTON TO MODESTO						
Main Segments						
UP 7	28	6	0.0	0	0	L
UP 8	424	0	0.0	0	0	L
BN 7	748	0	53.2	0	0	L
BN 8	41	0	0.0	0	0	L
Loop Segments	377	0	0.0	0	0	L
UPC 5	867	0	0.0	0	0	L
MODESTO TO MERCED						
Main Segments						
UP 9	748	0	53.2	0	0	L
UP 10	41	0	0.0	0	0	L
UP 11	120	0	0.0	1	0	M
UP 12	33	0	0.0	0	0	L
BN 9	109	0	82.8	0	0	L
BN 10	343	0	8.0	0	0	L
BN 11	77	0	0.0	0	0	L
BN 12	82	0	0.0	0	0	L
BN 13	77	0	0.0	0	0	L
Loop Segments			0.0			
UPC 6	47	0	0.0	0	0	L
UPC 7	16	0	0.0	0	0	L
UPC 8	1	0	0.0	0	0	L
BNC 3	18	0	0.0	0	0	L
BNC 4	9	0	0.0	0	0	L
BNC 5	19	0	0.0	0	0	L
BNC 6	4	0	0.0	0	0	L
MERCED TO FRESNO						
Main Segments						
UP 13	241	161	0.0	0	0	L
UP 14	189	0	0.0	0	0	L
UP 15	114	0	0.0	0	0	L
UP 16	33	40	0.0	0	0	L
UP 17	2	0	0.0	0	0	L
BN 14	5	0	0.0	0	0	L
BN 15	97	0	0.0	1	0	L
BN 16	226	0	0.0	0	0	L
BN 17	114	0	0.0	0	0	L
BN 18	33	40	0.0	0	0	L

	Residential (no. of people)	MU (no. of people)	Parkland (acres)	Institution Schools	Institution Hospitals	Impact Rating (H,M,L)
BN 19	2	0	0.0	0	0	L
Loop Segments	377	0	0.0	0	0	L
UPC 9	91	0	0.0	0	0	L
UPC 10	160	0	0.0	1	0	L
BNC 7	118	0	0.0	0	0	L
BNC 8	179	0	0.0	1	0	L
FRESNO TO TULARE	377	0	0.0	0	0	L
Main Segments	377	0	0.0	0	0	L
UP 18	137	8	0.0	0	0	L
UP 19	11	87	0.0	0	0	L
BN 20	10	0	5.0	0	0	L
BN 21	0	0	0.0	0	0	L
Loop Segments	377	0	0.0	0	0	L
BNC 9	377	0	0.0	0	0	L
TULARE TO BAKERSFIELD						
Main Segments						
UP 20	1,013	54	0.0	0	0	M
UP 21	323	223	0.0	0	0	L
UP 22	1	0	0.0	0	0	L
UP 23	0	0	0.0	0	0	L
UP 24	0	0	0.0	0	0	L
UP 25	315	0	0.0	1	0	H
UP 26	146	0	0.0	0	0	M
UP 27	45	0	0.0	0	0	L
UP 28	111	0	0.0	0	0	L
UP 29	68	0	0.0	0	0	H
UP 30	542	0	0.0	0	0	L
BN 22	442	0	0.0	0	0	L
BN 23	103	0	0.0	0	0	L
BN 24	896	0	0.0	2	0	M
BN 25	17	0	0.0	0	0	L
BN 25L*	6	0	0.0	0	0	L
BN 26	188	55	0.0	2	1	H
BN 26L*	47	46	0.0	0	1	L
BN 27	68	0	0.0	0	0	H
BN 27L*	1	0	0.0	0	0	L
Loop Segments						
UPC 11	744	32	0.0	0	0	L
UPC 12	0	0	0.0	0	0	L
UPC 13	9	0	0.0	0	0	L
UPC 14	620	4	0.0	1	0	M
BNC 10	0	0	0.0	0	0	L

* Low Speed

Detailed Analysis/Comparison Table
Potential CAHSR Noise Impacts
SAKBAK

SEGMENT_ID	miles	# of noise Ander 11 people	People/mile	# of noise Ander 16 people	People/mile	# of Hospitals	Hospitals/mile	# of schools	# of schools/mile	Severit Metric	Rating
BN1	1.24	11	8.7	-	-	-	-	-	-	9	L
BN10	8.26	343	41.6	-	-	-	-	-	-	42	L
BN11	2.77	77	27.9	-	-	-	-	-	-	28	L
BN12	4.51	82	18.2	-	-	-	-	-	-	18	L
BN13	4.23	77	18.1	-	-	-	-	-	-	18	L
BN14	14.30	5	0.4	-	-	-	-	-	-	0	L
BN15	22.98	97	4.2	-	-	-	-	1	0.04	15	L
BN16	5.76	226	39.3	-	-	-	-	-	-	39	L
BN17	5.45	114	20.9	-	-	-	-	-	-	21	L
BN18	3.73	33	8.8	40	11	-	-	-	-	12	L
BN19	10.54	2	0.2	-	-	-	-	-	-	0	L
BN2	1.55	147	94.9	-	-	-	-	-	-	95	M
BN20	13.05	10	0.8	-	-	-	-	-	-	1	L
BN21	7.63	0	0.0	-	-	-	-	-	-	-	L
BN22	53.87	442	8.2	-	-	-	-	-	-	8	L
BN23	13.67	103	7.5	-	-	-	-	-	-	8	L
BN24	8.02	896	111.8	-	-	-	-	2	0.25	174	M
BN25	1.30	17	13.3	-	-	-	-	-	-	13	L
BN25L	1.30	6	4.6	-	-	-	-	-	-	5	L
BN26	3.89	188	48.5	55	14	1	0	2	0.51	207	H
BN26L	3.89	47	12.1	46	12	1	0	-	-	41	L
BN27	0.31	68	220.8	-	-	-	-	-	-	221	H
BN27L	0.31	1	3.2	-	-	-	-	-	-	3	L
BN3	1.55	1	0.6	-	-	-	-	-	-	1	L
BN4	29.12	295	10.1	-	-	-	-	1	0.03	19	L
BN5	9.40	22	2.4	-	-	-	-	1	0.11	29	L
BN6	13.05	4	0.3	-	-	-	-	-	-	0	L
BN7	14.14	228	16.2	-	-	-	-	1	0.07	34	L
BN8	3.11	20	6.6	-	-	-	-	-	-	7	L
BN9	20.79	109	5.2	-	-	-	-	-	-	5	L
BNC1	4.64	21	4.5	-	-	-	-	-	-	4	L
BNC10	12.45	0	0.0	-	-	-	-	-	-	-	L
BNC2	16.60	184	11.1	-	-	-	-	2	0.12	41	L
BNC3	8.79	18	2.0	-	-	-	-	-	-	2	L
BNC4	2.49	9	3.5	-	-	-	-	-	-	4	L
BNC5	5.87	19	3.3	-	-	-	-	-	-	3	L
BNC6	4.06	4	0.9	-	-	-	-	-	-	1	L

BNC7	5.34	118	22.1	-	-	-	-	-	-	22	L
BNC8	20.67	179	8.6	-	-	-	-	1	0.05	21	L
BNC9	9.35	377	40.3	-	-	-	-	-	-	40	L
UP1	1.94	16	8.4	-	-	-	-	-	-	8	L
UP10	3.73	41	10.9	-	-	-	-	-	-	11	L
UP11	4.48	120	26.8	-	-	-	-	1	0.22	83	M
UP12	4.22	33	7.8	-	-	-	-	-	-	8	L
UP13	35.42	241	6.8	161	5	-	-	-	-	8	L
UP14	4.97	189	38.1	-	-	-	-	-	-	38	L
UP15	5.45	114	20.9	-	-	-	-	-	-	21	L
UP16	3.73	33	8.8	40	11	-	-	-	-	12	L
UP17	5.12	2	0.4	-	-	-	-	-	-	0	L
UP18	27.03	137	5.1	8	0	-	-	-	-	5	L
UP19	4.04	11	2.8	87	22	-	-	-	-	9	L
UP2	3.42	950	277.6	-	-	-	-	-	-	278	H
UP20	11.18	1013	90.6	54	5	-	-	-	-	92	M
UP21	36.34	323	8.9	223	6	-	-	-	-	11	L
UP22	10.25	1	0.1	-	-	-	-	-	-	0	L
UP23	4.04	-	0.0	-	-	-	-	-	-	-	L
UP24	3.60	-	0.0	-	-	-	-	-	-	-	L
UP25	1.68	315	187.7	-	-	-	-	1	0.60	336	H
UP26	1.24	146	118.0	-	-	-	-	-	-	118	M
UP27	1.74	45	26.0	-	-	-	-	-	-	26	L
UP28	1.68	111	66.0	-	-	-	-	-	-	66	L
UP29	0.31	68	220.8	-	-	-	-	-	-	221	H
UP3	5.90	469	79.6	-	-	-	-	-	-	80	L
UP30	8.37	542	64.8	-	-	-	-	-	-	65	L
UP4	26.09	3071	117.7	-	-	-	-	-	-	118	M
UP5	15.54	354	22.8	-	-	-	-	2	0.13	55	L
UP6	13.06	643	49.2	-	-	1	0	-	-	57	L
UP7	5.59	28	5.0	6	1	-	-	-	-	5	L
UP8	13.30	424	31.9	-	-	-	-	-	-	32	L
UP9	24.60	748	30.4	-	-	-	-	-	-	30	L
UPC1	1.33	159	120	-	-	-	-	-	-	120	M
UPC10	18.16	160	9	-	-	-	-	1	0.06	23	L
UPC11	11.49	744	65	32	3	-	-	-	-	66	L
UPC12	14.87	-	-	-	-	-	-	-	-	-	L
UPC13	4.10	9	2	-	-	-	-	-	-	2	L
UPC14	5.04	620	123	4	1	-	-	1	0.20	173	M
UPC2	1.24	0	-	-	-	-	-	-	-	-	L
UPC3	2.54	12	5	-	-	-		-	-	5	L
UPC4	12.58	16	1.3	-	-	-	-	1	0.08	21	L
UPC5	15.01	867	57.8	-	-	-	-	-	-	58	L
UPC6	3.58	47	13.2	-	-	-	-	-	-	13	L
UPC7	5.43	16	2.9	-	-	-	-	-	-	3	L
UPC8	3.76	1	0.2	-	-	-	-	-	-	0	L
UPC9	4.05	91	22.5	-	-	-	-	-	-	23	L

Analysis/Comparison Table – Potential Vibration Impacts
Sacramento to Bakersfield

	Residential (no. of people)	MU (no. of people)	Institutional Schools	Institutional Hospitals	Impact Rating (H,M,L)
NO-PROJECT*	N/A	N/A	N/A	N/A	N/A
MODAL*	N/A	N/A	N/A	N/A	N/A
HST CORRIDOR & STATION OPTIONS					
SACRAMENTO TO STOCKTON					
Main Segments					
UP 1	0	0	0	0	L
UP 2	69	0	0	0	L
UP 3	27	0	0	0	L
UP 4	848	0	0	0	L
UP 5	676	0	0	0	M
UP6	203	0	0	0	L
BN 1	0	0	0	0	L
BN 2	0	0	0	0	L
BN 3	0	0	0	0	L
BN 4	88	0	0	0	L
BN 5	2	0	1	0	L
BN 6	0	0	0	0	L
Loop Segments					
UPC1	0	0	0	0	L
UPC2	0	0	0	0	L
UPC3	0	0	0	0	L
UPC 4	1	0	0	0	L
BNC 1	0	0	0	0	L
BNC 2	7	0	0	0	L
STOCKTON TO MODESTO					
Main Segments					
UP 7	35	2	0	0	L
UP 8	232	0	0	0	L
BN 7	137	0	0	1	L
BN 8	110	0	0	0	L
Loop Segments	138	0	0	0	L
UPC 5	100	0	0	0	L

	Residential (no. of people)	MU (no. of people)	Institutional		Impact Rating (H,M,L)
			Schools	Hospitals	
MODESTO TO MERCED					
Main Segments					
UP 9	137	0	0	1	L
UP 10	110	0	0	0	L
UP 11	41	0	0	0	L
UP 12	88	0	0	0	L
BN 9	40	0	0	0	L
BN 10	398	0	0	0	M
BN 11	1	0	0	0	L
BN 12	26	0	0	0	L
BN 13	1	0	0	0	L
Loop Segments					
UPC 6	77	0	0	0	L
UPC 7	9	0	0	0	L
UPC 8	81	0	0	0	L
BNC 3	1	0	0	0	L
BNC 4	0	0	0	0	L
BNC 5	1	0	0	0	L
BNC 6	2	0	0	0	L
MERCED TO FRESNO					
Main Segments					
UP 13	351	37	0	1	L
UP 14	140	0	0	0	L
UP 15	65	0	0	0	L
UP 16	13	22	0	0	L
UP 17	0	0	0	0	L
BN 14	7	0	0	0	L
BN 15	6	0	0	0	L
BN 16	102	0	0	0	L
BN 17	65	0	0	0	L
BN 18	13	22	0	0	L
BN 19	0	0	0	0	L
Loop Segments	138	0	0	0	L
UPC 9	199	0	0	0	M
UPC 10	614	0	0	0	L
BNC 7	111	0	0	0	L
BNC 8	139	0	0	0	L
FREsno to Tulare	138	0	0	0	L
Main Segments	138	0	0	0	L
UP 18	92	5	0	0	L
UP 19	2	57	0	0	L
BN 20	237	0	0	0	L
BN 21	0	0	0	0	L
Loop Segments	138	0	0	0	L
BNC 9	138	0	0	0	L

	Residential (no. of people)	MU (no. of people)	Institutional		Impact Rating (H,M,L)
			Schools	Hospitals	
TULARE TO BAKERSFIELD					
Main Segments					
UP 20	346	22	0	3	M
UP 21	178	132	0	0	L
UP 22	8	0	0	0	L
UP 23	0	0	0	0	L
UP 24	0	0	0	0	L
UP 25	14	0	0	0	L
UP 26	8	0	0	0	L
UP 27	0	0	0	0	L
UP 28	0	0	0	0	L
UP 29	0	0	0	0	L
UP 30	3	0	0	0	L
BN 22	46	0	0	0	L
BN 23	1	0	0	0	L
BN 24	49	0	0	0	L
BN 25	0	0	0	0	L
BN 25L**	0	0	0	0	L
BN 26	0	27	0	1	L
BN 26L**	1	24	0	0	L
BN 27	0	0	0	0	L
BN 27L**	0	0	0	0	L
Loop Segments					
UPC 11	504	13	0	0	M
UPC 12	5	0	0	0	L
UPC 13	29	0	0	0	L
UPC 14	69	0	1	0	M
BNC 10	0	0	0	0	L

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

Detailed Analysis / Comparison Table
Potential CAHSR Vibration Impacts
SAKBAK

SEGMENT_ID	miles	# of Vib ander 11 people	People/mile	# of vib ander 16 people	People/mile	# of Hospitals	Hospitals/mile	# of schools	# of schools/mile	Severit Metric	Rating
BN1	1.24	-	-	-	-	-	-	-	-	-	L
BN10	8.26	398	48	-	-	-	-	-	-	48	M
BN11	2.77	1	0	-	-	-	-	-	-	0	L
BN12	4.51	26	6	-	-	-	-	-	-	6	L
BN13	4.23	1	0	-	-	-	-	-	-	0	L
BN14	14.30	7	0	-	-	-	-	-	-	0	L
BN15	22.98	6	0	-	-	-	-	-	-	0	L
BN16	5.76	102	18	-	-	-	-	-	-	18	L
BN17	5.45	65	12	-	-	-	-	-	-	12	L
BN18	3.73	13	3	22	6	-	-	-	-	5	L
BN19	10.54	0	-	-	-	-	-	-	-	-	L
BN2	1.55	-	-	-	-	-	-	-	-	-	L
BN20	13.05	237	18	-	-	-	-	-	-	18	L
BN21	7.63	-	-	-	-	-	-	-	-	-	L
BN22	53.87	46	1	-	-	-	-	-	-	1	L
BN23	13.67	1	0	-	-	-	-	-	-	0	L
BN24	8.02	49	6	-	-	-	-	-	-	6	L
BN25	1.30	-	-	-	-	-	-	-	-	-	L
BN25L	1.30	-	-	-	-	-	-	-	-	-	L
BN26	3.89	-	-	27	7	1	0	-	-	28	L
BN26L	3.89	1	0	24	6	-	-	-	-	2	L
BN27	0.31	-	-	-	-	-	-	-	-	-	L
BN27L	0.31	-	-	-	-	-	-	-	-	-	L
BN3	1.55	-	-	-	-	-	-	-	-	-	L
BN4	29.12	88	3	-	-	-	-	-	-	3	L
BN5	9.40	2	0	-	-	-	-	1	0.11	27	L
BN6	13.05	-	-	-	-	-	-	-	-	-	L
BN7	14.14	10	1	-	-	-	-	-	-	1	L
BN8	3.11	3	1	-	-	-	-	-	-	1	L
BN9	20.79	40	2	-	-	-	-	-	-	2	L
BNC1	4.64	-	-	-	-	-	-	-	-	-	L
BNC10	12.45	-	-	-	-	-	-	-	-	-	L
BNC2	16.60	7	0	-	-	-	-	-	-	0	L
BNC3	8.79	1	0	-	-	-	-	-	-	0	L
BNC4	2.49	-	-	-	-	-	-	-	-	-	L
BNC5	5.87	1	0	-	-	-	-	-	-	0	L
BNC6	4.06	2	0	-	-	-	-	-	-	0	L

BNC7	5.34	111	21	-	-	-	-	-	-	21	L
BNC8	20.67	139	7	-	-	-	-	-	-	7	L
BNC9	9.35	138	15	-	-	-	-	-	-	15	L
UP1	1.94	0	-	-	-	-	-	-	-	-	L
UP10	3.73	110	29	-	-	-	-	-	-	29	L
UP11	4.48	41	9	-	-	-	-	-	-	9	L
UP12	4.22	88	21	-	-	-	-	-	-	21	L
UP13	35.42	351	10	37	1	1	0	-	-	13	L
UP14	4.97	140	28	-	-	-	-	-	-	28	L
UP15	5.45	65	12	-	-	-	-	-	-	12	L
UP16	3.73	13	3	22	6	-	-	-	-	5	L
UP17	5.12	0	-	-	-	-	-	-	-	-	L
UP18	27.03	92	3	5	0	-	-	-	-	3	L
UP19	4.04	2	0	57	14	-	-	-	-	5	L
UP2	3.42	69	20	-	-	-	-	-	-	20	L
UP20	11.18	346	31	22	2	3	0	-	-	58	M
UP21	36.34	178	5	132	4	-	-	-	-	6	L
UP22	10.25	8	1	-	-	-	-	-	-	1	L
UP23	4.04	-	-	-	-	-	-	-	-	-	L
UP24	3.60	-	-	-	-	-	-	-	-	-	L
UP25	1.68	14	8	-	-	-	-	-	-	8	L
UP26	1.24	8	6	-	-	-	-	-	-	6	L
UP27	1.74	-	-	-	-	-	-	-	-	-	L
UP28	1.68	-	-	-	-	-	-	-	-	-	L
UP29	0.31	-	-	-	-	-	-	-	-	-	L
UP3	5.90	27	5	-	-	-	-	-	-	5	L
UP30	8.37	3	0	-	-	-	-	-	-	0	L
UP4	26.09	848	33	-	-	-	-	-	-	33	L
UP5	15.54	676	44	-	-	-	-	-	-	44	M
UP6	13.06	203	16	-	-	-	-	-	-	16	L
UP7	5.59	35	6	2	0	-	-	-	-	6	L
UP8	13.30	232	17	-	-	-	-	-	-	17	L
UP9	24.60	137	6	-	-	1	0	-	-	10	L
UPC1	1.33	0	-	-	-	-	-	-	-	-	L
UPC10	18.16	614	34	-	-	-	-	-	-	34	L
UPC11	11.49	504	44	13	1	-	-	-	-	44	M
UPC12	14.87	5	0	-	-	-	-	-	-	0	L
UPC13	4.10	29	7	-	-	-	-	-	-	7	L
UPC14	5.04	69	14	-	-	-	-	1	0.20	63	M
UPC2	1.24	0	-	-	-	-	-	-	-	-	L
UPC3	2.54	0	-	-		-	-	-	-	-	L
UPC4	12.58	1	0	-	-	-	-	-	-	0	L
UPC5	15.01	100	7	-	-	-	-	-	-	7	L
UPC6	3.58	77	22	-	-	-	-	-	-	22	L
UPC7	5.43	9	2	-	-	-	-	-	-	2	L
UPC8	3.76	81	22	-	-	-	-	-	-	22	L
UPC9	4.05	199	49	-	-	-	-	-	-	49	M

Detailed Analysis/Comparison Table
Potential Highway No-Project Impacts
SAKBAK

SEGMENT_ID	length (miles)	# No Biuld ander 11 people	# No Biuld ander 16 people	People/mile ander. 11	People/mile ander. 16	# of Hospitals	Hospitals/mile	# of schools	# of schools/mile	Severity Metric	Rating
Fresno to Tulare/Visalia	46.39	423	35	9	1	-	-	1	0	15	L
Gilroy to SR-152	1.45	-	-	-	-	-	-	-	-	-	L
I-5 to SR-58	17.83	1,175	-	66	-	-	-	-	-	66	M
I-5 to SR-99	42.84	1	-	0	-	-	-	-	-	0	L
I-580/SR-120 to SR-152	52.42	520	-	10	-	-	-	-	-	10	L
I-80 to Stockton	50.58	285	-	6	-	-	-	-	-	6	L
I-880 to I-5 (Sacramento)	30.76	4	-	0	-	-	-	-	-	0	L
I-880 to I-5 (via I-238)	34.38	-	-	-	-	-	-	-	-	-	L
Merced to SR-152	21.48	273	-	13	-	-	-	-	-	13	L
Modesto to Merced	39.01	1,378	87	35	2	-	-	2	0	49	L
SR-120 to Modesto	14.51	-	-	-	-	-	-	-	-	-	L
SR-152 to Fresno	33.38	317	-	9	-	-	-	3	0	32	L
SR-152 to SR-99	178.57	81	56	0	0	-	-	-	-	1	L
SR-99 to SR-14 (Palmdale)	45.02	639	-	14	-	-	-	-	-	14	L
Sacramento to SR-120	62.62	5,023	-	80	-	1.00	0	4	0	98	M
San Jose to Gilroy	20.19	-	-	-	-	-	-	-	-	-	L
Stockton to I-580/SR-120	25.80	5,422	-	210	-	-	-	1	0	220	H
Tulare/Visalia to SR-58	68.86	1,775	343	26	5	-	-	1	0	31	L
US-101 to I-5	40.83	-	-	-	-	-	-	-	-	-	L

Detailed Analysis/Comparison Table
Potential Highway Modal Impacts
SAKBAK

SEGMENT_ID	length (miles)	# modal ander 11 people	# modal ander 16 people	People/mile ander. 11	People/mile ander. 16	# of Hospitals	Hospitals/mile	# of schools	# of schools/mile	Severity Metric	Rating
Fresno to Tulare/Visalia	46.39	531	35	11	1	-	-	3	0	28	L
Gilroy to SR-152	1.45	-	-	-	-	-	-	-	-	-	L
I-5 to SR-58	17.83	1,541	-	86	-	-	-	-	-	86	M
I-5 to SR-99	42.84	1	-	0	-	-	-	-	-	0	L
I-580/SR-120 to SR-152	52.42	633	-	12	-	-	-	-	-	12	L
I-80 to Stockton	50.58	418	-	8	-	-	-	-	-	8	L
I-880 to I-5 (Sacramento)	30.76	5	-	0	-	-	-	-	-	0	L
I-880 to I-5 (via I-238)	34.38	-	-	-	-	-	-	-	-	-	L
Merced to SR-152	21.48	394	-	18	-	-	-	-	-	18	L
Modesto to Merced	39.01	1,646	87	42	2	-	-	2	0	56	L
SR-120 to Modesto	14.51	-	-	-	-	-	-	-	-	-	L
SR-152 to Fresno	33.38	410	-	12	-	1.00	0	3	0	38	L
SR-152 to SR-99	178.57	111	56	1	0	-	-	-	-	1	L
SR-99 to SR-14 (Palmdale)	45.02	639	-	14	-	-	-	-	-	14	L
Sacramento to SR-120	62.62	6,144	-	98	-	1.00	0	5	0	120	M
San Jose to Gilroy	20.19	-	-	-	-	-	-	-	-	-	L
Stockton to I-580/SR-120	25.80	6,542	-	254	-	-	-	1	0	263	H
Tulare/Visalia to SR-58	68.86	2,144	343	31	5	-	-	1	0	36	L
US-101 to I-5	40.83	-	-	-	-	-	-	-	-	-	L

California High Speed Rail

Sacramento to Bakersfield - Typology Analysis

Noise Impact Analysis

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

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

Num.	Landuse	Community	Location and/or Description	Corridor Type	Civil Station	Train Speed (mph)	Distance to Alignment (ft)	Existing Ambient (Ldn/Leqday)	FRA Landuse Category	Alignment Geometry
1	Residential	Sacramento	Amador Ave & Railroad	Exist. Rail	UP321+700	198	320	59	2	as
2	Residential	Wilton	End of Lacey	Exist. Rail	BN4 37+000	207	430	50	2	sc
3	Residential	Galt	Twin Cities & Midway	Exist. Rail	UP4 50+000	200	260	65	2	emb
4	Residential	Stockton	Aurora & 5th St.	Exist. Rail	UP592+000	148	50	67	2	ag
5	Residential	Fresno	Garfield & Shaw	New	UPC10 271+000	207	110	65	2	as
6	Residential	Easton	Cherry Ave & South	New	BNC8285+700	207	780	50	2	emb
7	Residential	Corcoran	Gardner & Brokaw	Exist. Rail	BN22 348+100	207	50	54	2	as
8	Residential	Tripton	Along Hamlin	Exist. Rail	UP21372+700	207	260	60	2	ag
9	Residential	Rosedale	Jenkins near Hageman	Exist. Rail	BN24 437+000	207	780	58	2	ag
10	Hospital	Merced	Merced Medical Center	Exist. Rail	UP11 197+000	207	375	56	2	ag
11	Hospital	Madera	Madera Community Hospital	Exist. Rail	UP13 252+000	207	780	56	2	ag
12	School	Morada	Greenwood School (Historical)	New	BN5 74+000	207	80	60	3	ag
13	School	Madera	Madera Community College	Exist. Rail	BN15 245+600	207	440	53	3	emb
14	Park	Livingston	Mc Connel State Park	Exist. Rail	UP9 170+000	207	50	67	3	as
15	Park	Manteca	Mayor's Park	Exist. Rail	UP6107+000	161	50	67	3	ag

Sacramento to Bakersfield - Typology Analysis
Noise Impact Analysis (Continued)

Sacramento to Merced

	TOTAL # TRAINS One/Direction			
	7 to 22		22 to 7	
	NB	SB	NB	SB
Gold LIne	17	17	1	1
Green Line	16	17	2	1
Blue Line	0	0	0	0
total trains both direct.	67		5	
train/hr	4.5		0.6	

Merced to Bakersfield

	TOTAL # TRAINS One/Direction			
	7 to 22		22 to 7	
	NB	SB	NB	SB
Gold LIne	17	16	1	2
Green Line	0	0	0	0
Blue Line	42	44	4	3
total trains both direct.	119		10	
train/hr	7.9		1.1	

Speed Regime	Reference SEL	Speed Coefficient K	Reference Speed	Reference Length	Shielding Correction	SEL @ 50ft	Leqday @ 50ft	Leqnight @ 50ft	Ldn @ 50 ft	Project Ldn/Leq @ Receiver	No Mitigation Impact
3	99.0	47	180	73	2	103.9	77	68	77	65	SI
3	99.0	47	180	73	-3	104.9	73	64	73	59	I
3	99.0	47	180	73	0	104.2	75	66	75	65	I
2	93.0	17	90	634	0	99.8	71	62	71	71	SI
3	99.0	47	180	73	2	104.9	80	72	81	76	SI
3	99.0	47	180	73	0	104.9	78	70	79	61	SI
3	99.0	47	180	73	2	104.9	80	72	81	81	SI
3	99.0	47	180	73	0	104.9	78	70	79	68	SI
3	99.0	47	180	73	0	104.9	78	70	79	61	I
3	99.0	47	180	73	0	104.9	76	67	76	63	SI
3	99.0	47	180	73	0	104.9	78	70	79	61	I
3	99.0	47	180	73	0	104.9	76	67	76	73	SI
3	99.0	47	180	73	0	104.9	78	70	79	64	I
3	99.0	47	180	73	2	104.9	78	69	78	78	SI
2	93.0	17	90	634	0	100.5	71	62	72	71	I

California High Speed Rail

Sacramento to Bakersfield - 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	Train Speed (mph)	Distance to Alignment (ft)	Existing Ambient (Ldn/Leqday)	FRA Landuse Category	Alignment Geometry
1	Residential	Sacramento	Amador Ave & Railroad	Exist. Rail	UP321+700	198	320	59	2	nb
2	Residential	Wilton	End of Lacey	Exist. Rail	BN4 37+000	207	430	50	2	nb
3	Residential	Galt	Twin Cities & Midway	Exist. Rail	UP4 50+000	200	260	65	2	nb
4	Residential	Stockton	Aurora & 5th St.	Exist. Rail	UP592+000	148	50	67	2	nb
5	Residential	Fresno	Garfield & Shaw	New	UPC10 271+000	207	110	65	2	nb
6	Residential	Easton	Cherry Ave & South	New	BNC8285+700	207	780	50	2	nb
7	Residential	Corcoran	Gardner & Brokaw	Exist. Rail	BN22 348+100	207	50	54	2	nb
8	Residential	Tripton	Along Hamlin	Exist. Rail	UP21372+700	207	260	60	2	nb
9	Residential	Rosedale	Jenkins near Hageman	Exist. Rail	BN24 437+000	207	780	58	2	nb
10	Hospital	Merced	Merced Medical Center	Exist. Rail	UP11 197+000	207	375	56	2	nb
11	Hospital	Madera	Madera Community Hospital	Exist. Rail	UP13 252+000	207	780	56	2	nb
12	School	Morada	Greenwood School (Historical)	New	BN5 74+000	207	80	60	3	nb
13	School	Madera	Madera Community College	Exist. Rail	BN15 245+600	207	440	53	3	nb
14	Park	Livingston	Mc Connel State Park	Exist. Rail	UP9 170+000	207	50	67	3	nb
15	Park	Manteca	Mayor's Park	Exist. Rail	UP6107+000	161	50	67	3	nb

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

Sacramento to Bakersfield - Typology Analysis
Noise Impact Analysis Mitigated (Continued)

Sacramento to Merced

	TOTAL # TRAINS One/Direction			
	7 to 22		22 to 7	
	NB	SB	NB	SB
Gold LIne	17	17	1	1
Green Line	16	17	2	1
Blue Line	0	0	0	0
total trains both direct.	67		5	
train/hr	4.5		0.6	

Merced to Bakersfield

	TOTAL # TRAINS One/Direction			
	7 to 22		22 to 7	
	NB	SB	NB	SB
Gold LIne	17	16	1	2
Green Line	0	0	0	0
Blue Line	42	44	4	3
total trains both direct.	119		10	
train/hr	7.9		1.1	

Speed Regime	Reference SEL	Speed Coefficient K	Reference Speed	Reference Length	Shielding Correction	SEL @ 50ft	Leqday @ 50ft	Leqnight @ 50ft	Ldn @ 50 ft	Project Ldn/Leq @ Receiver	Mitigation Impact
3	99.0	47	180	73	-5	103.9	70	61	70	58	I
3	99.0	47	180	73	-5	104.9	71	62	71	57	I
3	99.0	47	180	73	-5	104.2	70	61	70	60	NI
2	93.0	17	90	634	-10	99.8	61	52	61	61	NI
3	99.0	47	180	73	-5	104.9	73	65	74	69	SI
3	99.0	47	180	73	-5	104.9	73	65	74	56	I
3	99.0	47	180	73	-5	104.9	73	65	74	74	SI
3	99.0	47	180	73	-5	104.9	73	65	74	63	SI
3	99.0	47	180	73	-5	104.9	73	65	74	56	NI
3	99.0	47	180	73	-5	104.9	71	62	71	58	I
3	99.0	47	180	73	-5	104.9	73	65	74	56	NI
3	99.0	47	180	73	-5	104.9	71	62	71	68	I
3	99.0	47	180	73	-5	104.9	73	65	74	59	I
3	99.0	47	180	73	-5	104.9	71	62	71	71	I
2	93.0	17	90	634	-10	100.5	61	52	62	61	NI

California High Speed Rail

Sacramento to Bakersfield

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	Sacramento	Amador Ave & Railroad	Exist. Rail	UP321+700	198	320	2	72	70	NO
2	Residential	Wilton	End of Lacey	Exist. Rail	BN4 37+000	207	430	2	72	68	NO
3	Residential	Galt	Twin Cities & Midway	Exist. Rail	UP4 50+000	200	260	2	72	73	YES
4	Residential	Stockton	Aurora & 5th St.	Exist. Rail	UP592+000	148	50	2	72	80	YES
5	Residential	Fresno	Garfield & Shaw	New	UPC10 271+000	207	110	2	72	79	YES
6	Residential	Easton	Cherry Ave & South	New	BNC8285+700	207	780	2	72	59	NO
7	Residential	Corcoran	Gardner & Brokaw	Exist. Rail	BN22 348+100	207	50	2	72	83	YES
8	Residential	Tripton	Along Hamlin	Exist. Rail	UP21372+700	207	260	2	72	73	YES
9	Residential	Rosedale	Jenkins near Hageman	Exist. Rail	BN24 437+000	207	780	2	72	59	NO
10	Hospital	Merced	Merced Medical Center	Exist. Rail	UP11 197+000	207	375	2	72	69	NO
11	Hospital	Madera	Madera Community Hospital	Exist. Rail	UP13 252+000	207	780	2	72	59	NO
12	School	Morada	Greenwood School (Historical)	New	BN5 74+000	207	80	3	75	81	YES
13	School	Madera	Madera Community College	Exist. Rail	BN15 245+600	207	440	3	75	67	NO
14	Park	Livingston	Mc Connel State Park	Exist. Rail	UP9 170+000	207	50	3	75	83	YES
15	Park	Manteca	Mayor's Park	Exist. Rail	UP6107+000	161	50	3	75	81	YES

Sacramento to Bakersfield
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
65	30	40	45	49	64	65	54	48	43	45	42	37	36	36	(4)	(22)	(24)	(21)	(20)
62	29	37	44	47	61	62	49	44	39	41	38	33	32	33	(8)	(25)	(26)	(23)	(20)
68	31	41	47	50	65	68	56	51	46	48	44	39	38	38	(2)	(20)	(22)	(20)	(20)
77	34	44	51	56	73	77	68	66	64	68	66	63	62	63	23	5	1	0	(4)
74	32	43	50	54	71	74	64	60	57	59	55	50	50	50	10	(8)	(11)	(12)	(14)
54	25	33	38	40	52	54	39	34	30	32	30	25	24	24	(16)	(32)	(30)	(24)	(21)
77	34	44	51	56	73	77	68	66	64	68	66	63	62	63	23	5	1	0	(4)
68	31	41	47	50	65	68	56	51	46	48	44	39	38	38	(2)	(20)	(22)	(20)	(20)
54	25	33	38	40	52	54	39	34	30	32	30	25	24	24	(16)	(32)	(30)	(24)	(21)
64	30	38	44	48	62	64	51	45	41	43	40	35	34	35	(6)	(23)	(25)	(22)	(20)
54	25	33	38	40	52	54	39	34	30	32	30	25	24	24	(16)	(32)	(30)	(24)	(21)
76	33	43	50	55	72	76	66	63	60	63	60	56	55	56	16	(2)	(6)	(7)	(10)
62	28	37	44	46	61	62	49	43	39	41	37	33	32	32	(8)	(25)	(26)	(23)	(20)
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)

Sacramento to Bakersfield

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

Sacramento to Bakersfield
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
16	19	20	22	23	22	22	20	18	16	15	13	11	6	(17)	(35)	(45)	(50)	(53)
15	16	19	20	20	19	17	16	14	12	11	9	7	3	(21)	(38)	(47)	(52)	(53)
17	20	22	23	24	25	24	23	21	19	17	15	13	8	(15)	(33)	(43)	(49)	(53)
20	23	26	29	32	34	36	38	39	39	39	39	37	33	10	(8)	(20)	(29)	(37)
18	22	25	27	30	31	32	32	32	30	28	26	25	20	(3)	(21)	(32)	(41)	(47)
11	12	13	13	11	11	7	6	5	3	3	1	(1)	(6)	(29)	(45)	(51)	(53)	(54)
20	23	26	29	32	34	36	38	39	39	39	39	37	33	10	(8)	(20)	(29)	(37)
17	20	22	23	24	25	24	23	21	19	17	15	13	8	(15)	(33)	(43)	(49)	(53)
11	12	13	13	11	11	7	6	5	3	3	1	(1)	(6)	(29)	(45)	(51)	(53)	(54)
16	17	19	21	21	21	19	17	16	14	13	11	9	5	(19)	(36)	(46)	(51)	(53)
11	12	13	13	11	11	7	6	5	3	3	1	(1)	(6)	(29)	(45)	(51)	(53)	(54)
19	22	25	28	31	33	34	35	35	34	33	32	30	26	3	(15)	(27)	(36)	(43)
14	16	19	19	20	19	17	15	14	12	10	9	7	2	(21)	(38)	(47)	(52)	(53)
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: Sacramento to Bakersfield - 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	738.5	62.6	25.8	826.9
Modal	720.7	80.5	25.8	826.9
HST - Least	316.0	0.0	0.0	316.0
HST - Greatest	385.8	0.0	0.0	385.8

Exec Summary Charts

Region: Sacramento to Bakersfield - 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	319.0	0.0	0.0	319.0
HST - Greatest	361.0	0.0	0.0	361.0

California High Speed Rail

Sacramento to Bakersfield - Typology Analysis

Detailed Noise Analysis

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

Cross-Section Geometry

According with Figure 5-3

ge=general

sha=shallow cut

ele=reciever elevated

slope=source in slopet cut

trench

Num.	Landuse	Community	Location and/or Description	Corridor Type	Civil Station	Train Speed (mph)	Distance to Alignment (ft)	Existing Ambient (Ldn/Leqday)	FRA Landuse Category	Height Receiver **(Hr,ft)**	**GEOMETRY** Cross-Section Geometry
1	Residential	Fresno	Garfield & Shaw	New	UPC10 271+000	190	110	65	2	5	ge
							110			5	ge
							110			5	ge
							110			5	ge
							110			5	ge
2	Residential	Corcoran	Garden & Brokaw	Exist. Rail	BN22 348+100	202	50	54	2	5	ge
							50			5	ge
							50			5	ge
							50			5	ge
							50			5	ge
3	Residential	Tripton	Along Hamlin	Exist. Rail	UP21 372+700	207	260	60	2	5	ge
							260			5	ge
							260			5	ge
							260			5	ge
							260			5	ge

Sacramento to Bakersfield - Typology Analysis
Noise Impact Analysis (Continued)

Sacramento to Merced	TOTAL # TRAINS One/Direction				Merced to Bakersfield
	7 to 22		22 to 7		
	NB	SB	NB	SB	
Gold LIne	17	17	1	1	Gold LIne
Green Line	16	17	2	1	Green Line
Blue Line	0	0	0	0	Blue Line
total trains both direct.	67		5		total trains both direct.
train/hr	4.5		0.6		train/hr

Shallow cut, Sloped cut or trench WIDE (ft) **A**	Shallow cut, Sloped cut or trench DEPTH **Hc** (ft)	Initial Barrier Height **Hb** (ft)	Terrain Heigh Adjustment (ft)	Source	sel REF	Len ref (ft)	Speed ref (mph)	SEL (n) @ 50 ft	ge	sha	ele
0	0	0	38	Propulsion	86	73	20	87	28	0	0
0	0	0	38	Wheel-rail	91	634	90	101	22	0	0
0	0	0	38	Train-noise	89	73	180	91	27	0	0
0	0	0	38	Wheel-region	89	634	180	94	24	0	0
0	0	0	38	Pantograph	86	0	180	87	29	0	0
0	0	0	20	Propulsion	86	73	20	87	19	0	0
0	0	0	20	Wheel-rail	91	634	90	101	13	0	0
0	0	0	20	Train-noise	89	73	180	93	18	0	0
0	0	0	20	Wheel-region	89	634	180	95	15	0	0
0	0	0	20	Pantograph	86	0	180	89	20	0	0
0	0	0	0	Propulsion	86	73	20	87	9	0	0
0	0	0	0	Wheel-rail	91	634	90	101	3	0	0
0	0	0	0	Train-noise	89	73	180	93	8	0	0
0	0	0	0	Wheel-region	89	634	180	96	5	0	0
0	0	0	0	Pantograph	86	0	180	90	10	0	0

Sacramento to Bakersfield - Typology Analysis
Noise Impact Analysis (Continued)

TOTAL # TRAINS One/Direction			
7 to 22		22 to 7	
NB	SB	NB	SB
17	16	1	2
0	0	0	0
42	44	4	3
119		10	
7.9		1.1	

					NO MITIGATION							MITIGATION		
slope	trench	H_eff	Ground Factor G_{nb}	SEL(n) @ D	Cumulative SEL	Excess Attenuation	Ldn/Leq day	Ldn/Leq night	Ldn/ Leq Passby	Project Ldn @ Reciever	Mitigation Impact	Barrier Height **(Hb)**	Distance Source-Barrier (ft)	P (ft)
0.0	0	27.5	0.3	81.6	97.6	0.0	71	62	72	**72**	**SI**	**16**	30	0.80
0.0	0	22.0	0.4	95.7								16	30	4.22
0.0	0	26.5	0.0	87.5								16	30	1.23
0.0	0	24.0	0.0	90.1								16	30	2.71
0.0	0	29.0	0.0	84.0								16	30	0.32
0.0	0	18.5	0.4	85.5	102.6	0.0	76	67	77	**77**	**SI**	**16**	30	2.60
0.0	0	13.0	0.5	100.8								16	30	6.21
0.0	0	17.5	0.0	92.5								16	30	3.17
0.0	0	15.0	0.0	95.2								16	30	4.78
0.0	0	20.0	0.0	89.0								16	30	1.85
0.0	0	8.5	0.6	73.6	93.3	0.0	67	58	67	**68**	**SI**	**16**	30	0.43
0.0	0	3.0	0.7	89.0								16	30	3.77
0.0	0	7.5	0.0	86.0								16	30	0.81
0.0	0	5.0	0.0	88.6								16	30	2.22
0.0	0	10.0	0.0	82.5								16	30	0.09

Sacramento to Bakersfield - Typology Analysis
Noise Impact Analysis (Continued)

Att. Barrier	ge	sha	ele	slope	trench	H_eff	Ground Factor G_b	**IL Barrier**	SEL(n) @ Reciever	Cumulative SEL	Excess Attenuation	Ldn/Leq day	Ldn/Leq night	Ldn/ Leq Passby	Project Ldn @ Reciever	Mitigation Impact
12.0	44	0	0	0	0	43.5	0.0	**11.1**	70.5	85.1	0.0	58	50	59	**66**	**I**
22.2	38	0	0	0	0	38.0	0.1	**21.3**	74.5							
8.0	43	0	0	0	0	42.5	0.0	**8.0**	79.5							
11.3	40	0	0	0	0	40.0	0.0	**11.3**	78.9							
3.4	45	0	0	0	0	45.0	0.0	**3.4**	80.6							
17.1	35	0	0	0	0	34.5	0.1	**17.1**	68.4	86.0	0.0	59	51	60	**61**	**I**
23.9	29	0	0	0	0	29.0	0.2	**23.9**	76.9							
12.0	34	0	0	0	0	33.5	0.0	**12.0**	80.6							
13.7	31	0	0	0	0	31.0	0.0	**13.7**	81.4							
9.7	36	0	0	0	0	36.0	0.0	**9.7**	79.3							
9.4	25	0	0	0	0	24.5	0.3	**7.4**	66.3	84.9	0.0	58	50	59	**62**	**I**
21.7	19	0	0	0	0	19.0	0.4	**20.0**	69.0							
6.3	24	0	0	0	0	23.5	0.0	**6.3**	79.6							
10.4	21	0	0	0	0	21.0	0.0	**10.4**	78.2							
1.1	26	0	0	0	0	26.0	0.0	**1.1**	81.3							