CALIFORNIA HIGH-SPEED TRAIN

Program Environmental Impact Report/Environmental Impact Statement

Los Angeles - Orange County – San Diego

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

Los Angeles – Orange County - San Diego Noise & Vibration Technical Evaluation

Prepared by:

Wilson, Ihrig & Associates, Inc.

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CALIFORNIA HIGH-SPEED RAIL AUTHORITY
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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 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 Los Angeles-Orange County-San Diego Corridor is one of five such reports being prepared for each of the regions on the topic, and it is one of fifteen technical reports for this region. This report will be summarized in the Program EIR/EIS and it will be part of the administrative record supporting the environmental review of alternatives.

1.1 ALTERNATIVES

1.1.1. No-Project Alternative

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

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

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

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

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

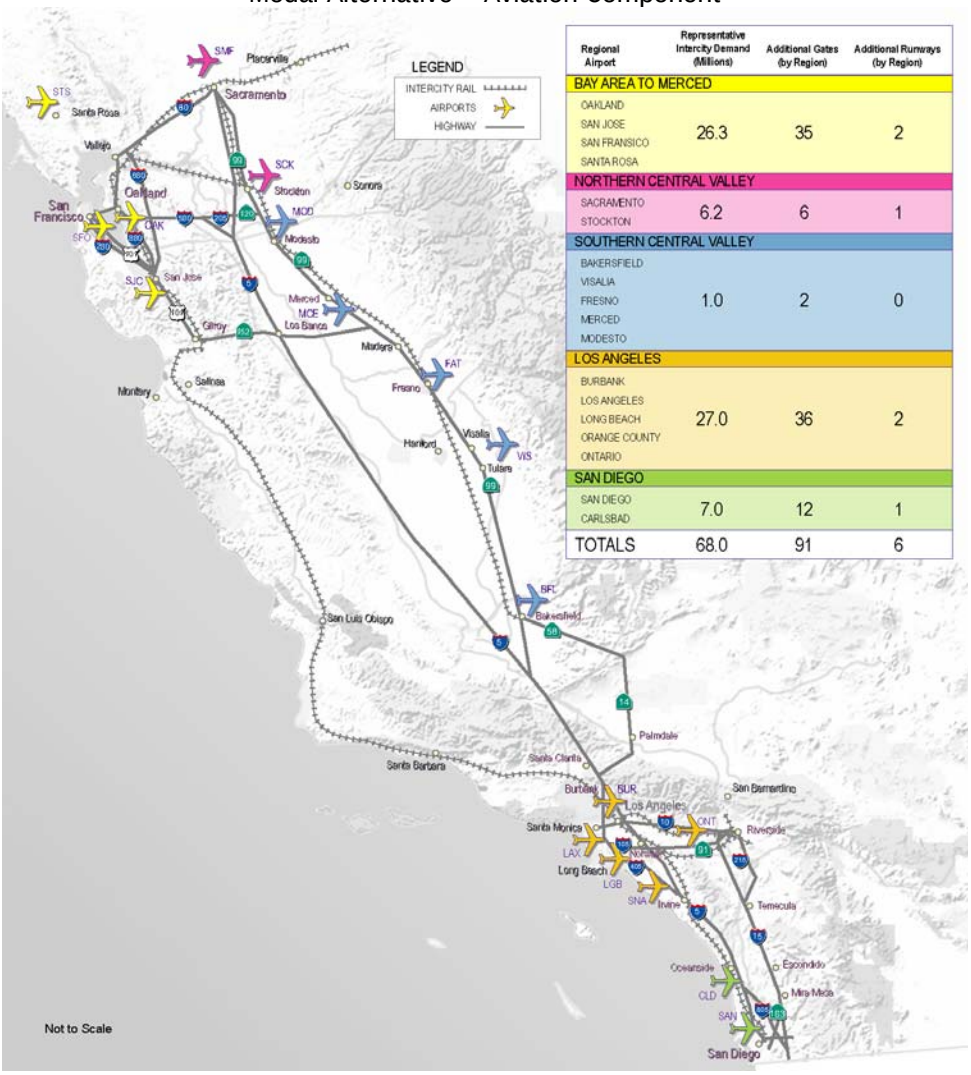
1.1.2 Modal Alternative

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

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

Figure 2
Modal Alternative – Highway Component

Figure 3
Modal Alternative – Aviation Component



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

1.1.3 High-Speed Train Alternative

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

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

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

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

2.0 BASELINE/AFFECTED ENVIRONMENT

2.1 STUDY AREA

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

2.2 GENERAL DESCRIPTION OF REGIONAL NOISE & VIBRATION ENVIRONMENTS

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

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

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

2.3 SENSITIVE NOISE & VIBRATION LAND USE LOCATIONS

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

2.4 REPRESENTATIVE NOISE & VIBRATION TYPOLOGIES IN REGION

Representative land use typologies for the region were selected from residential, institutional, and park uses within the study screening areas for the HST Alternative. For the Los Angeles-Orange County-San Diego region, the land use typologies selected for individual study are as follows:

Table 2.4.1 Representative Typologies for Region

Los Angeles-Orange County-San Diego

Alignment/Segment	Location/Description	City/County	Land Use Type	Distance (ft)*
LAX to US	57th Street between San Pedro Pl. and Towne Avenue	Los Angeles	Residential	340
US to ANA	Along old River School Rd at Dinwiddie	Downey	Residential	50
US to ANA	8th St. near Western Avenue	Buena Park	Residential	210
FUL to IRV	Along Bridgeport Road	Tustin	Residential	145
SJC to SDLC_1	Along Palisade Dr. near bluff	Dana Point	Residential	200
OCSD to ENC	El Arbol Drive	Carlsbad	Residential	300
ENC to SB	San Elijo Ave near Birmingham Drive	Encinitas	Residential	65
SB to I5_1	End of 4th Street	Del mar	Residential	360
SR52 to SFD	Morena Blvd	San Diego	Residential	150
SJC to SDLC3	Samaritan Medical Center	San Clemente	Hospital	420
LAX to US	Hyde Park Elementary	Inglewood	School	375
FUL to IRV	McMillan School	Santa Ana	School	780
SB to I5_2	Del Mar Heights Elementary School	Del Mar	School	50
FUL to IRV	Hoeptner Park	Irvine	Park	50
SJC1	Mission San Juan Capistrano	San juan Capistrano	Historical	470

*Distance from the alignment centerline

The geographic locations for the representative cases indicated in Table 2.4.1 are shown in Figure 5. The northern portion of the Los Angeles-Orange County-San Diego region corridor is densely developed until the alignment reaches the coast. In Los Angeles County and Orange County, there is extensive residential land use along the existing rail alignments. There is also scattered commercial and light industry land use within this northern portion of the corridor.

In the southern portion of Orange County, the area is not as densely populated as it is farther north, but there are many suburban residential developments. Along the existing coastal, rail alignment, the land use is primarily residential outside of the city centers in which there is mixed residential and commercial. Between towns there are open spaces and occasional beach parks next to the alignment and scattered residential areas.

In San Diego County, the land use continues to be medium density residential along the coast until the alignment approaches the city of San Diego. The northern area of San Diego is primarily suburban, with medium density residential developments. As the alignment approaches the Santa Fe Depot, the land use becomes mixed residential and commercial. The residential land in this area tends to be farther from the alignment than elsewhere.

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 and conventional rail alternatives of the project have also been selected, using GIS land use data within the screening distances.

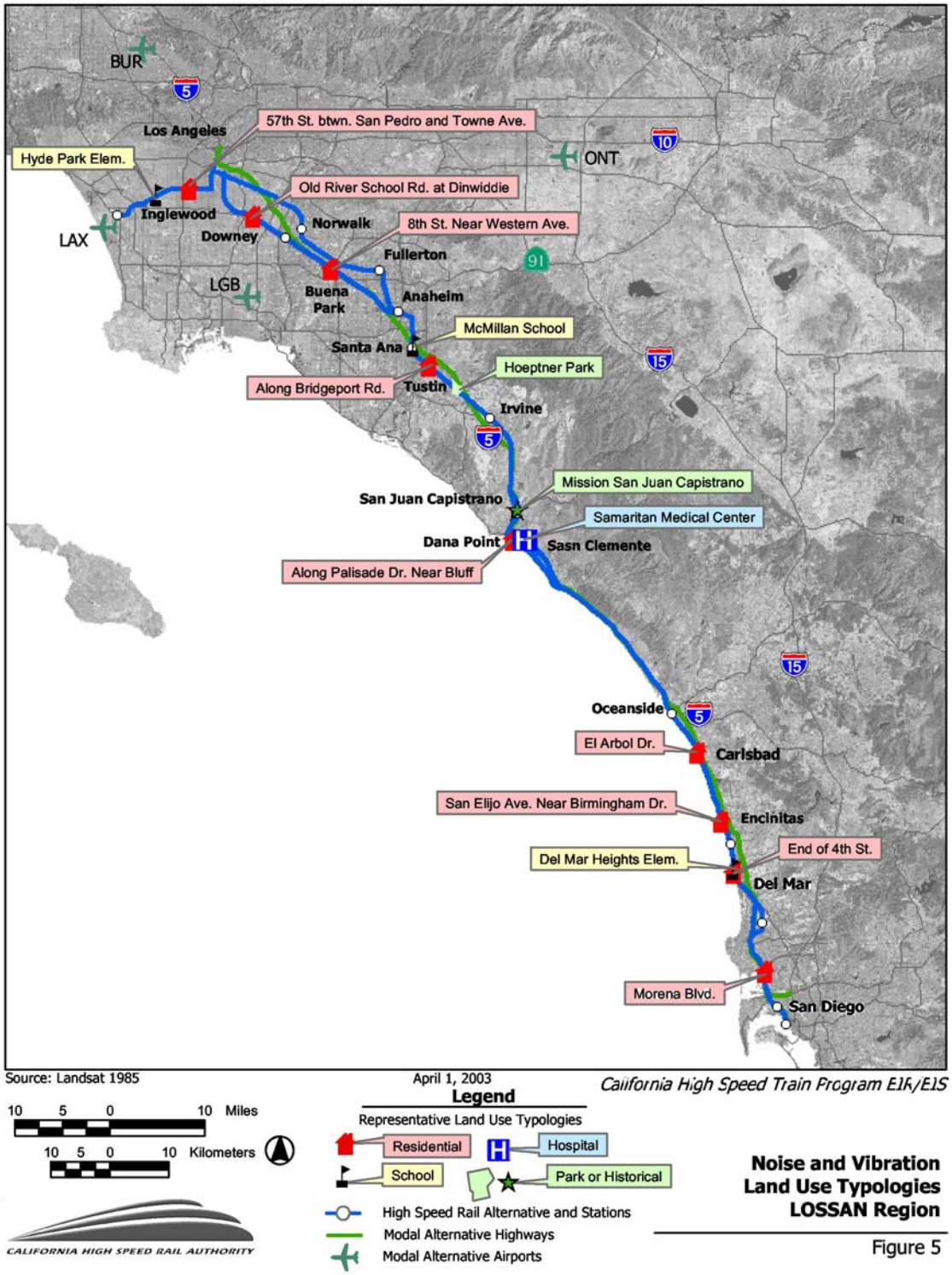
Ambient noise in the Los Angeles-Orange County-San Diego region has been estimated using data in the Noise Element from the General Plan for cities and counties in the region and general methods provided by FRA and FTA for estimating noise. The ambient noise in the northern portion of the region is dominated by motor vehicle traffic in densely populated areas and along freeways. Along the connection to the LAX, the freight railroad contributes to the ambient and in particular near freeways motor vehicle traffic contributes. Closer to the airport, aircraft noise becomes dominant.

Along the conventional rail alignment south from Union Station, existing passenger service (comprised of Amtrak and Metrolink) and freight rail contribute to the local noise. Throughout this portion of the region, roadway traffic also contributes to the ambient. Along the HST alignment, freight rail and motor vehicle traffic comprise the sources of ambient noise. Along the coast, local roadway traffic and passenger rail service contribute to the ambient noise conditions. South of Oceanside, the Coaster passenger rail service operates and adds to the existing ambient conditions.

In the urban areas and suburban areas of the Los Angeles and northern Orange Counties, the ambient noise ranges from L_{dn} 63 to 68 depending on the proximity to noise sources such as rail, roadway and airport. In the more suburban areas of the region, the ambient noise ranges from 58 to 63. Along the coast, the ambient noise environment ranges from L_{dn} 54 to 64 depending on proximity to local noise sources.

For residential land, which is very close to more than one noise source, the ambient can be as high as L_{dn} 71. Ambient environments for institutional land use and parks are also affected by their proximity to sources of noise. In the northern portion of the region, the ambient ranges from L_{eq} 49 to 52 dBA, but can be higher depending on local noise sources. The Mission San Juan Capistrano has an existing L_{eq} of 58 dBA on the side facing the rail alignment. On the side facing the freeway, the ambient noise is higher than this.

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.



Source: Landsat 1985

April 1, 2003

California High Speed Train Program EIR/EIS

10 5 0 10 Miles

10 5 0 10 Kilometers

CALIFORNIA HIGH SPEED RAIL AUTHORITY

Legend

Representative Land Use Typologies

Residential
Hospital
School
Park or Historical

High Speed Rail Alternative and Stations
Modal Alternative Highways
Modal Alternative Airports

Noise and Vibration Land Use Typologies LOSSAN 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).

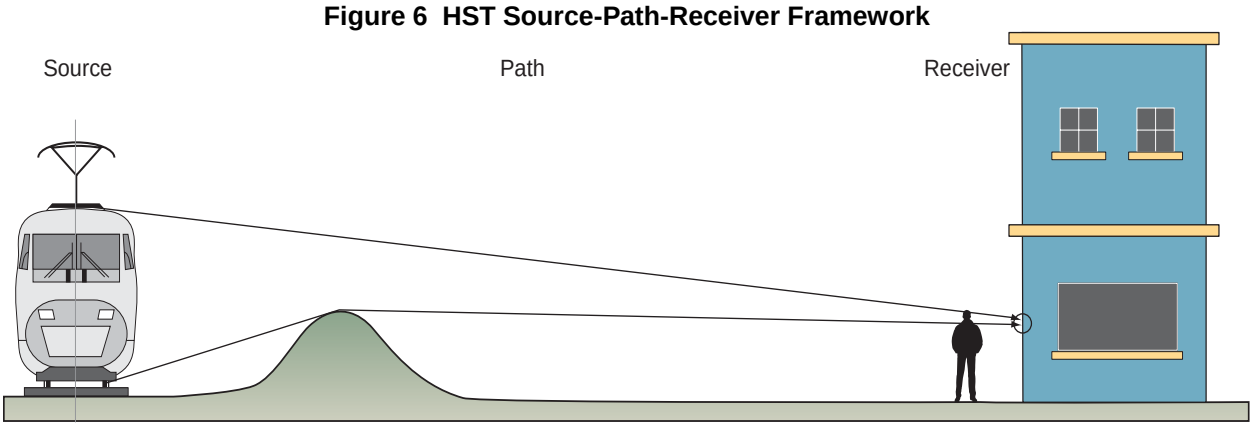
Vibration of the ground caused by the pass-by of the HST is similar to that caused by conventional steel wheel/steel rail trains. The same speed-dependent vibration generation mechanisms are present in each type of train. Holding down the vibration levels associated with the HST are the new track construction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

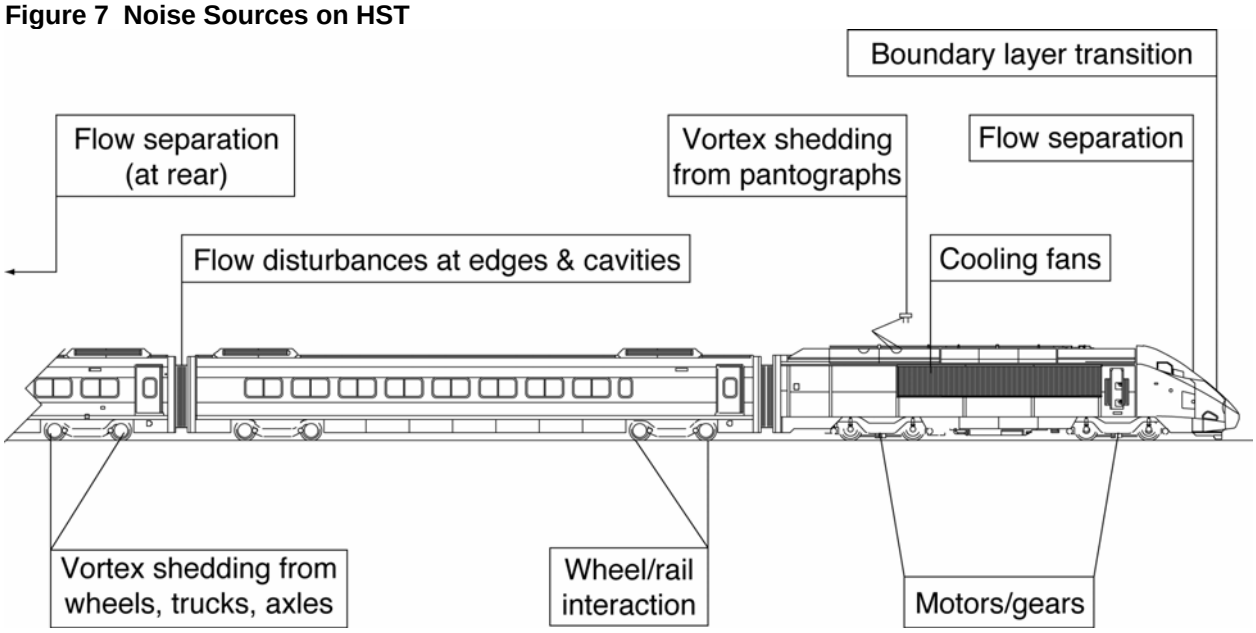
Noise Sources at Medium Speeds. In the speed range from 60 mph to about 150 mph, mechanical noise resulting from wheel/rail interactions and structural vibrations dominate the noise emission from trains. Conventional trains seldom exceed 125 mph, so this speed range which represents a medium range for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

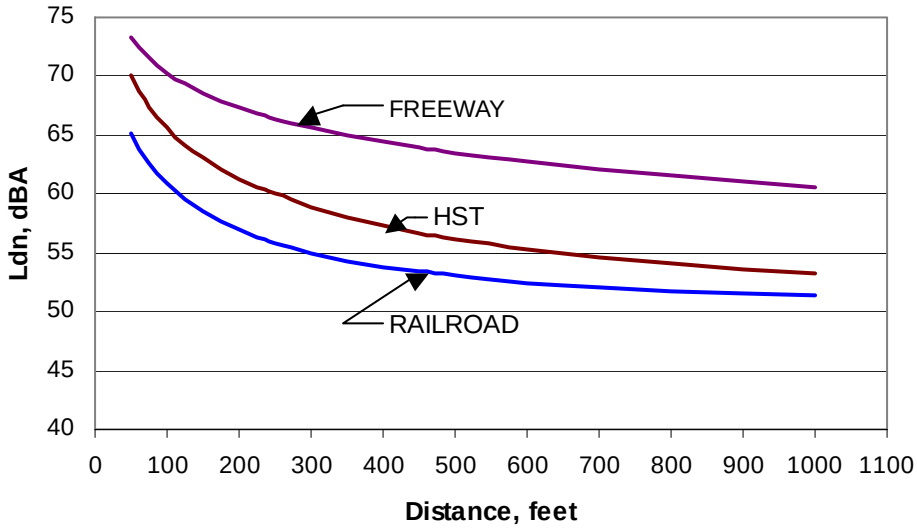
[3] Freight trains with 2 locomotives, 40 cars, 60 mph, 10 daytime, 3 nighttime.

[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		Chain saw			Horns
100		Power Lawn mower		Diesel Truck (not muffled)	HST, 200 mph
90		Shop tools	Shout	Diesel Truck (muffled)	HST, 150 mph Locomotives, 50 mph
80		Blender	Loud voice	Automobile, 70 mph	Passenger Train, 50 mph
70		Dishwasher	Normal voice	Automobile, 40 mph	Freight Cars, 50 mph
60		Air conditioner	Normal voice (back to listener)	Automobile, 20 mph	
50		Refrigerator			
40					
30					
20					
10					
0	Threshold of hearing				

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



3.1.5 Vibration from HST

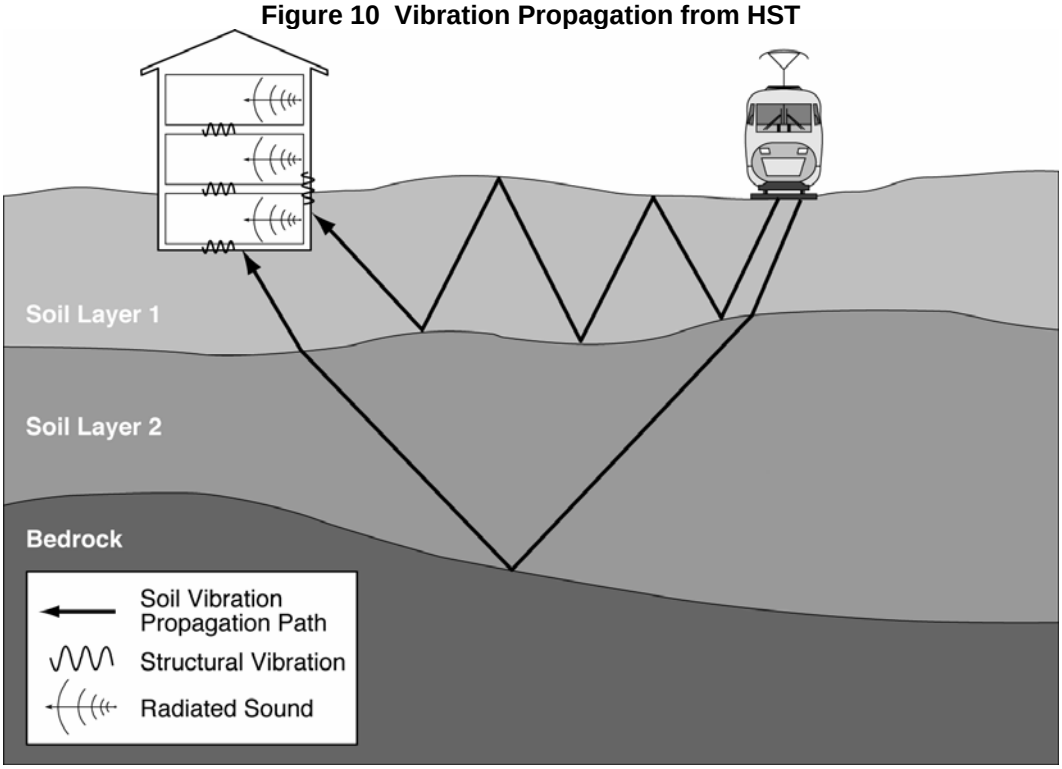
Ground-borne vibration from trains refers to the fluctuating motion experienced by people on the ground and in buildings near railroad tracks. In general, people are not exposed to vibration levels from outside sources that they can feel in their everyday lives. They slam their doors and a wall may shake,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

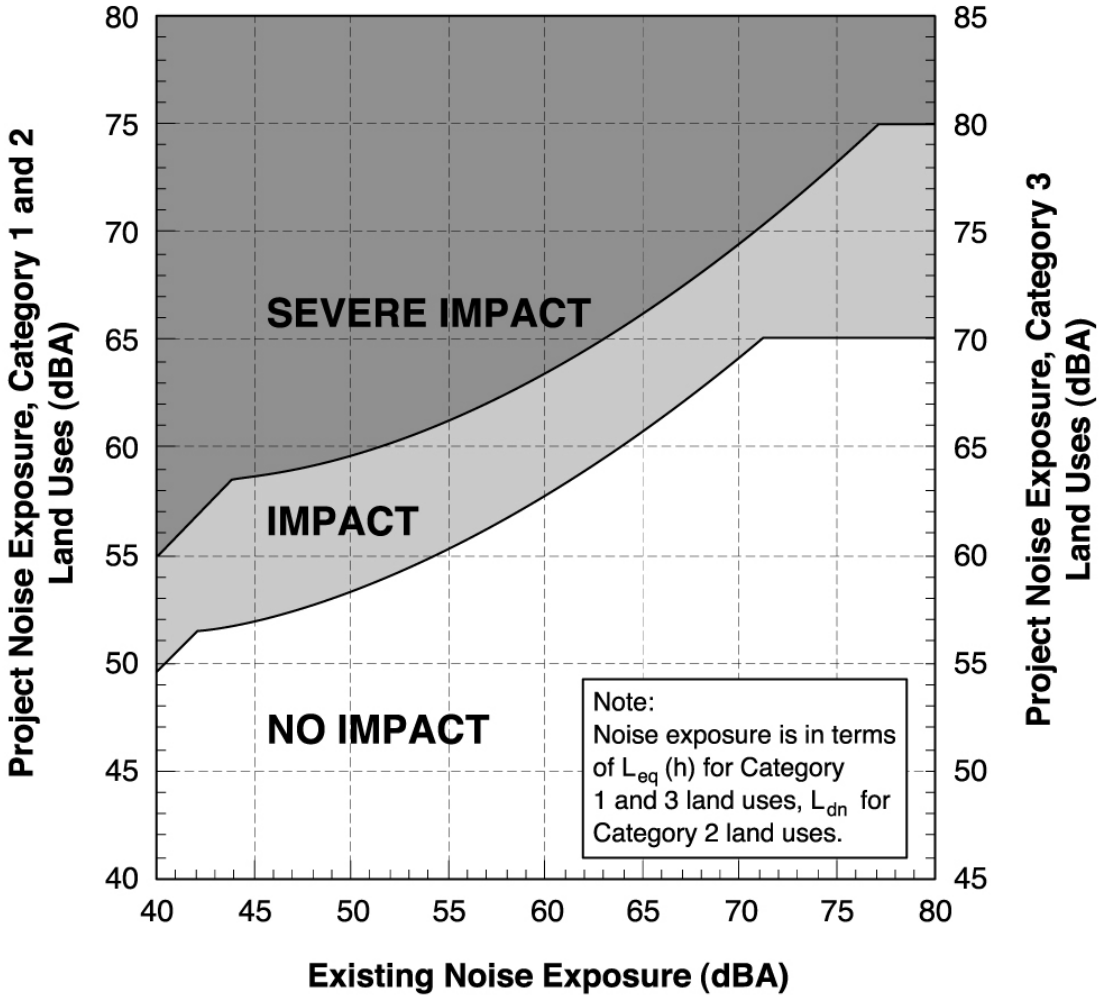
The metric used for noise impact assessment is the day-night sound level (Ldn) in dBA for residential land uses, Land Use Category 1, including buildings where people sleep (hospitals, hotels, motels). The hourly equivalent sound level (Leq) in dBA is applied during hours of active use in parks (Land 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 potential noise impact to be possible, and it identifies locations where the HST has little possibility of noise impact. The method is used for making a general comparison of potential impacts for different corridors. It is also a key element in the identification of locations for subsequent analysis in Tier 2 where the greater refinement in the detailed analysis is used to focus in on the actual impacts. Correspondingly, screening identifies locations where no additional noise studies need be conducted.

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

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

Table 3.3.1 Noise Screening Distances for HST Alternative

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

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

Vibration Screening for HST Alternative. FRA also provides a screening method for HST vibration levels. The method is similar to that for noise, except it assumes typical ground propagation conditions. Vibration propagation is site-specific depending on the soil conditions. Although it is not possible to account for this in a Tier 1 analysis, this has been addressed in the typology analyses. The FRA screening distances are shown below:

Table 3.3.2 Vibration Screening Distances for HST Alternative

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

† Measured from centerline of track

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

Table 3.3.3 Noise Screening Distances for Highways

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

† Measured from centerline of highway

3.4 SUBSEQUENT ANALYSIS IN TIER 2

Locations identified as potentially impacted by noise and vibration in the screening procedure will be revisited with a more detailed assessment in Tier 2 analysis. FRA provides procedures for a general

assessment to refine the noise impact areas, followed by a detailed analysis to develop mitigation for impacted areas.

3.5 PARAMETERS FOR COMPARING ALTERNATIVES

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

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

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

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

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

Implications of the Rating Scheme for noise as defined in this manner are that a moderate impact of only Low (L) with IM less than 80 corresponds to a residential impact of 4 people per house and 20 houses per mile (520 feet between houses for development on both sides of the alignment), and no institutional 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, 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 impacts can be used to compare with the overall results of the No-Project Alternative highway impacts and HST impacts. Complete aviation data for the Modal Alternative is not available for this study, but where data were available an assessment of impact was made. The aviation component will increase the number people impacted and the degree of impact for the Modal Alternative. From the data available, it would appear that the number of people impacted by the aviation component is small in comparison with the highway component. However,

where available the airport impacts were combined with the highway component for comparison between the Modal Alternative and the HST Alternative.

4.3 HIGH-SPEED TRAIN ALTERNATIVE

HST noise typologies were analyzed using the General Assessment method provided by the FRA. Representative Cases were chosen to show, in more detail than is possible with the screening analysis, a range of impact levels that are likely to be encountered in the Tier 2 impact evaluation. Potential impacts for the entire HST Alternative were obtained from the screening analysis. The results of the screening analysis can be used to compare impacts between regional alignment options and between the highway impacts of the Modal Alternative and No-Project Alternative. Residential, park, and institutional noise impact summaries are based upon the GIS land use and location data made available for the screening study and the corresponding screening distances used for each alignment segment.

4.4 NOISE TYPOLOGIES FOR HST

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

The proposed rail improvements for this region include an upgrade to the existing, conventional rail corridor between Union Station in Los Angeles and the Santa Fe Depot in San Diego. Also being proposed for this region is a dedicated HST alignment between Union Station and Anaheim. These two different types of corridors were analyzed for noise associated with changes to the existing conditions along their proposed alignments.

For the conventional rail corridor portion of the project, two scenarios were analyzed for noise. The first analysis assessed the noise impacts due only to passenger train service, including alignment upgrades, which allow higher speeds to be obtained, and the additional trains that would operate along this rail corridor. There are currently three agencies that provide passenger service along the existing corridor. The Amtrak *Surfliner* operates between Los Angeles and San Diego. The *Metrolink* operates between Los Angeles and Oceanside. The *Coaster* compliments the *Metrolink* and connects Oceanside and San Diego. A fourth agency (North Coast Transit District) is projected to provide passenger service between San Diego and Del Mar in the future.

The second analysis for the conventional rail corridor assessed the combined noise impact due to corridor upgrades and new passenger service for these four agencies, and the existing BNSF and additional future freight traffic projected. The combined noise effects on the environment as a result of passenger rail service and freight are a cumulative impact. Analyzing the two cases allows the contribution from both to be assessed.

The proposed HST corridor alternative is a dedicated rail alignment, and the noise impact analysis included all of the passenger trains planned for this service. As part of the proposed HST service there is also a link between Union Station and LAX.

The noise impacts associated with passenger rail service are discussed first. They include impacts associated with the conventional rail corridor and the HST corridors. Reviewing Table 4.4.1, the first three land use typology cases are related to the HST corridors. It can be seen that, in the corridor option between Union Station and LAX, the HST noise impact to the residences on 57th Street in Los Angeles is NI without mitigation. This segment is in a trench, which would provide adequate noise shielding. For

the Hyde Park Elementary School in Inglewood, the impact level indicated in Table 4.4.2, is NI without mitigation, due primarily to the comparatively low speed and distance the alignment would be from this receptor.

In the HST corridor option between Union Station and Anaheim, the noise impact level for the residences in Downey on Dinwiddie Road is I before mitigation. The effect of implementing standard mitigation (an 8 to 10 feet high sound wall) is based on the data provided in the FRA manual. Standard noise mitigation reduces this impact, but not to a level of NI. The other residences analyzed along this HST alignment on 8th Street in Buena Park are indicated as being impacted at a level of SI before mitigation. A standard noise wall reduces this impact to a level of I.

The remainder of land use typology cases indicated in Tables 4.4.1 and 4.4.2 are along the conventional rail corridor south of Anaheim. The residences in Tustin on Bridgeport Road are seen to have a noise impact level of SI before mitigation. Standard noise mitigation reduces this to a level I. The noise impact to the MacMillan School in Santa Ana is NI before mitigation, as indicated in Table 4.4.2. The noise impact to Hoeptner Park in Irvine is a level SI before mitigation, but can be reduced to a level I with standard mitigation.

Along the conventional rail corridor between Irvine and San Clemente, the residences in Dana Point on Palisade Drive are shown as being impacted at a level of I before mitigation, which can be reduced to an impact of NI with standard noise mitigation. The noise impact level for the Mission San Juan Capistrano is indicated to be NI before mitigation. The Samaritan Medical Center in San Clemente is not impacted by noise because it is adjacent to the tunnel alignment option.

South of San Clemente, the existing rail corridor follows the coast. The residences in Carlsbad (on El Arbol) are indicated as having an impact level of I before mitigation, and a standard noise wall reduces the level of impact, but not to NI. The residences in Encinitas on San Elijo Avenue are impacted at a level SI, which can be reduced to a level I with standard mitigation. For the rest of the corridor, the noise impacts to the residences in Del Mar on 4th Street, and the residences in San Diego on Morena Boulevard are at a level of I and SI respectively with standard mitigation. These impacts can be reduced to a level of NI and I respectively. The noise impact to the Del Mar Heights Elementary School is SI without mitigation and I with a standard noise wall.

The second analysis assessed the noise impact from combined freight and passenger service along the conventional rail corridor between Los Angeles and San Diego. Projections for increased BNSF freight traffic on this corridor are for seven additional trains for a total of twelve. Adding freight traffic increases noise in particular because more than half of the additional freight trains are projected to travel at night between 10PM and 7AM. The noise impacts for this condition are indicated in Table 4.4.3 (residences and hospitals) and Table 4.4.4 (schools and parks). There are some changes indicated compared with the first analysis which considers only the impact from the corridor upgrades and new passenger trains service. Some of the impact levels increase, but most do not change.

Comparing the Project noise levels in Table 4.4.3 with the Project plus BNSF noise levels in Table 4.4.1, it can be seen that the L_{dn} levels are from 2 to 4 dBA higher with the freight included. The impact level before mitigation, for the residences in Dana Point on Palisade Drive, change from an I to an SI with inclusion of the additional freight trains. Standard noise mitigation reduce this to a level I, but not NI. The impact level for the residences on Abrol Drive in Carlsbad also increases to an SI. Examining Table 4.4.4, it can be seen that the L_{eq} increases by 1 dBA for most of the receptors when the additional freight trains are included. Standard noise mitigation reduces all of the impacts for residences, hospitals, schools and parks to either a level I or NI.

Table 4.4.1 Potential Residential and Hospital Noise Impacts
Los Angeles-Orange County-San Diego – HSR and Conventional Rail – Passenger Trains

ALIGNMENT SEGMENT	DESCRIPTION	CITY/ COUNTY	CORRIDOR TYPE	DISTANCE (ft)*	SPEED (mph)	EXISTING Ldn	PROJECT Ldn	IMPACT TYPE**	IMPACT TYPE AFTER MITIG.
LAX to US	57th Street between San Pedro Pl and Towne Avenue	Los Angeles	Existing Rail	340	154	58	52	NI	NI
US to ANA	Along Dinwiddie near Old River School Road	Downey	Existing Rail	50	130	68	63	I	I
US to ANA	8th St. near Western Avenue	Buena Park	Highway/ Existing Rail	210	180	60	69	SI	I
FUL to IRV	Along Bridgeport Road	Tustin	Existing Rail	145	107	63	65	SI	I
SJC to SDLC_1	Along Palisade Drive	Dana Point	Existing Rail	200	125	62	62	I	NI
OCSD to ENC	El Arbol Drive	Carlsbad	Existing Rail	300	125	59	62	I	I
ENC to SB	San Elijo Ave near Birmingham Dr	Encinitas	Existing Rail	65	125	69	72	SI	I
SB to I5_1	End of 4th Street	Del Mar	Existing Rail	360	125	61	61	I	NI
SR52 to SFD	Morena Blvd	San Diego	Existing Rail	150	125	65	67	SI	I
SJC to SDLC3	Samaritan Medical Center	San Diego	Highway	420	125	57	-	N/A	N/A

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

Table 4.4.2 Potential School and Park Noise Impacts
Los Angeles-Orange County-San Diego – HSR and Conventional Rail – Passenger Trains

ALIGNMENT SEGMENT	DESCRIPTION	CITY/ COUNTY	CORRIDOR TYPE	DISTANCE (ft)*	SPEED (mph)	EXISTING Leq	PROJECT Leq	IMPACT TYPE**	IMPACT TYPE AFTER MITIG.
LAX to US	Hyde Park Elementary	Inglewood	Existing Rail	375	140	63	49	NI	NI
FUL to IRV	McMillan School	Santa Ana	Existing Rail	780	109	56	52	NI	NI
SB to I5_2	Del Mar Heights Elementary School	Del Mar	Highway	50	125	64	72	SI	I
FUL to IRV	Hoeptner Park	Irvine	Existing Rail	50	155	65	72	SI	I
SJC1	Mission San Juan Capistrano	San Juan Capistrano	Existing Rail	470	125	59	54	NI	NI

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

The second, rail noise analysis examined the combined effects on the noise environment due to the new passenger service and the projected additional BNSF freight traffic. The HST rail alignment will be a dedicated passenger line and therefore the inclusion of freight noise only applies to the conventional rail line. Table 4.4.3 indicates the noise impacts for the combined passenger and freight train movements. It should be noted that most of the additional freight train movements would occur at night, which produces a more dramatic increase in noise than if they occurred during the day.

Table 4.4.3 Potential Residential and Hospital Noise Impacts
Los Angeles-Orange County-San Diego - Conventional Rail with BNSF Freight

ALIGNMENT SEGMENT	DESCRIPTION	CITY/ COUNTY	CORRIDOR TYPE	DISTANCE (ft)*	SPEED (mph)†	EXISTING Ldn	PROJECT Ldn Plus BNSF	IMPACT TYPE**	IMPACT TYPE AFTER MITIG.
FUL to IRV	Along Bridgeport Road	Tustin	Exist. Rail	145	107	63	68	SI	I
SJC to SDLC_1	Along Palisade Drive	Dana Point	Exist. Rail	200	125	62	66	SI	I
OCSD to ENC	El Arbol Drive	Carlsbad	Exist. Rail	300	125	59	64	SI	I
ENC to SB	San Elijo Ave near Birmingham Drive	Encinitas	Exist. Rail	65	125	69	74	SI	I
SB to I5_1	End of 4th Street	Del Mar	Exist. Rail	360	125	61	63	I	I
SR52 to SFD	Morena Blvd	San Diego	Exist. Rail	150	125	65	69	SI	I
SJC to SDLC3	Samaritan Medical Center	San Clemente	Hwy.	420	125	57	-	N/A	N/A

*Measured from centerline of alignment
** NI = No Impact, I = Impact, SI = Severe Impact
† Passenger trains

Table 4.4.4 Potential School and Park Noise Impacts
Los Angeles-Orange County-San Diego - Conventional Rail with BNSF Freight

ALIGNMENT SEGMENT	DESCRIPTION	CITY/ COUNTY	CORRIDOR TYPE	DISTANCE (ft)*	SPEED† (mph)	EXISTING Leq	PROJECT Leq Plus BNSF	IMPACT TYPE**	IMPACT TYPE AFTER MITIG.
SB to I5_2	Del Mar Heights Elementary School	Del Mar	Highway	50	125	64	72	SI	I
FUL to IRV	McMillan School	Santa Ana	Existing Rail	780	109	56	53	NI	NI
FUL to IRV	Hoeptner Park	Irvine	Existing Rail	50	155	65	73	SI	I
SJC1	Mission San Juan Capistrano	San Juan Capistrano	Existing Rail	470	125	59	55	NI	NI

*Measured from centerline of alignment
**NI = No Impact, I = Impact, SI = Severe Impact
† Passenger trains

Addition of the freight traffic is seen to increase the level of impact as might be expected. In all, but two of the residential and hospital cases analyzed, the impact went up one level. Whereas there are no impacts at the SI level indicated with just the passenger train changes, there would be two (the residences in Dana Point and Encinitas) with both the additional passenger and freight trains. All of the impacts can be seen to be reduced by standard noise mitigation, if not to a level NI, then at least a level I. Table 4.4.4 indicates the noise impacts to parks and schools with both passenger and freight trains. All of the cases analyzed are seen to be at a level NI. Consequently, this class of receptors is not impacted by addition of the freight trains, which is as expected since the majority of the additional freight movements are assumed to be at night between 10PM and 7AM. It is possible to conclude that the new passenger along the conventional rail alignment does not produce noise impacts, but the combination of passenger and freight does. Consequently, mitigation is not indicated for the passenger service improvements, but is indicated for the cumulative impact of passenger and freight.

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 areas are found along the corridor between Los Angeles and Irvine.

Table 4.5.1 presents the detailed results of the screening analyses for the three project alternatives. In addition to residential land use impact, 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 in the I-5 corridor from downtown Los Angeles to Irvine and also in San Juan Capistrano, Encinitas and San Diego. These same trends are also seen for the Modal Alternative. This result is not unexpected considering the close proximity of residential land along these alignment segments. The coastal area south of Dana Point up to Encinitas is not as highly impacted. What is different between the No-Project and Modal Alternatives is that the number of people impacted increases with the Modal Alternative and consequently the IM, although not enough to change the IR.

The HST Alternative (see Figure 13) is indicated to have potential impacts, which are H along the LAX connection alignment for HST and the HST alignment to Anaheim. The conventional rail corridor, between Los Angeles and Anaheim, has a lower IR. South of Anaheim the IR is H until San Juan Capistrano. Of the two rail options within San Juan Capistrano, one has an IR of M and the other an L. The IR for the three rail options through San Clemente covers the range of L, M, and H.

South of San Clemente the IR is an L due to the presence of Camp Pendleton. At Oceanside the rail alignment encounters higher population densities and the IR is H between there and through Encinitas. Expect for the westernmost rail option involving I-5/805, the remainder of the alignment has an IR of L to San Diego.

Overall the HST Alternative has IRs which range from L to H depending primarily on the proximity and density of residential population, but also on the speed of the train. The noise Typology study results are seen to reflect the same general trend as the screening analysis results, when the freight trains are combined with the new passenger service. 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 impacts are less and not as substantial.

Figure 14 indicates the two combinations of HST segments which produce the least and the greatest impacts based on the results of the screening analysis. The primary factor used to select the segments for each combination was the number of people potentially impacted. In most cases the HST segment with the greatest impact would be the longest segment with the highest IR and conversely the segment with the least impact would be the shortest segment with the lowest IR. In most cases this is true, but because the IR represents a range of values of the IM, cases arise where, because of the density of population, a shorter segment can have a greater potential impact than a longer segment.

The HST alignment with the least potential noise impacts consists of conventional rail alternative to San Diego with the following options:

San Juan Capistrano - Tunnel along I-5 between SR73 and Avenida Aeropuerto

Dana Point to San Clemente - Short tunnel; double tracking

Del Mar - Tunnel under Camino Del Mar

I-5/805 Split to SR52 - Miramar Hill Tunnel.

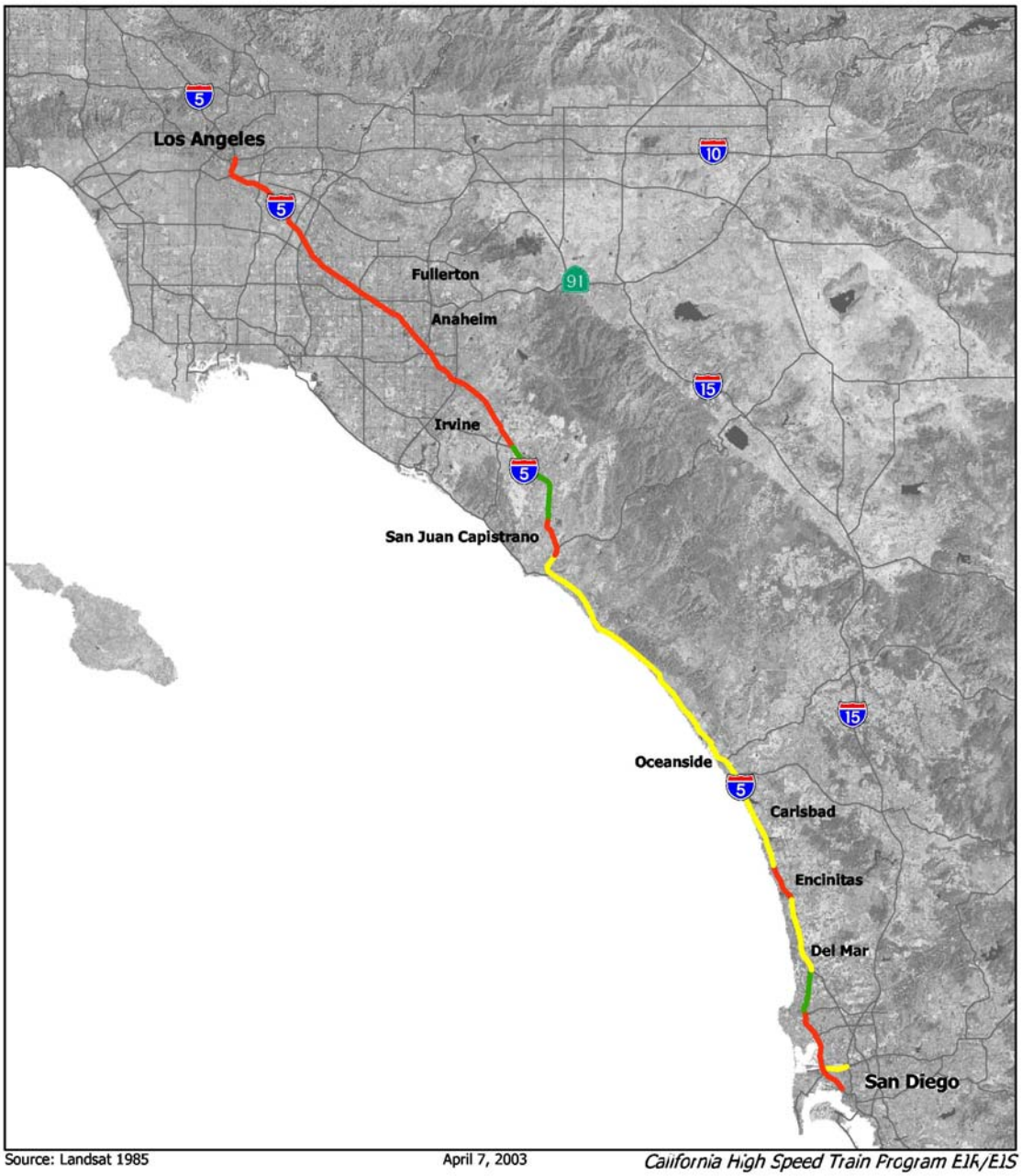
The rail alignment with the greatest potential for noise impact consists of the HST option to Anaheim plus the conventional rail alternative to San Diego with the following options:

San Juan Capistrano – At-grade open trench along the eastern side of Trabuco Creek

Dana Point to San Clemente - Long trench

Del Mar - Covered trench

I-5/805 Split to SR52 - I5 tunnel.



Source: Landsat 1985

April 7, 2003

California High Speed Train Program EIR/EIS

10 5 0 10 Miles

10 5 0 10 Kilometers

CALIFORNIA HIGH SPEED RAIL AUTHORITY

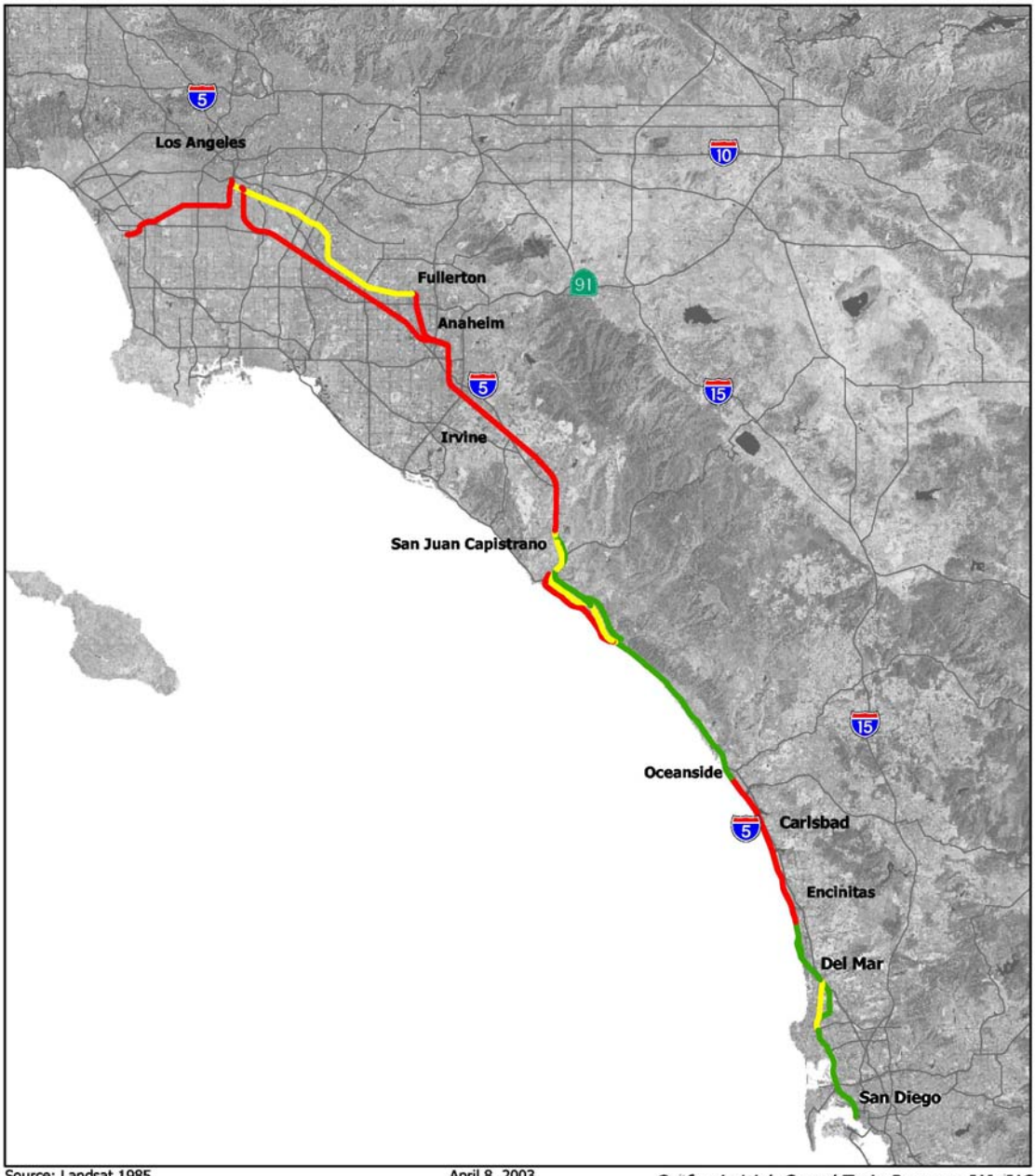
Legend

No-Build and Modal Alternatives
Highways - Noise Impacts

- High
- Medium
- Low

Noise Impacts
No-Build and Modal Alternatives
LOSSAN Region

Figure 12



10 5 0 10 Miles

10 5 0 10 Kilometers

CALIFORNIA HIGH SPEED RAIL AUTHORITY

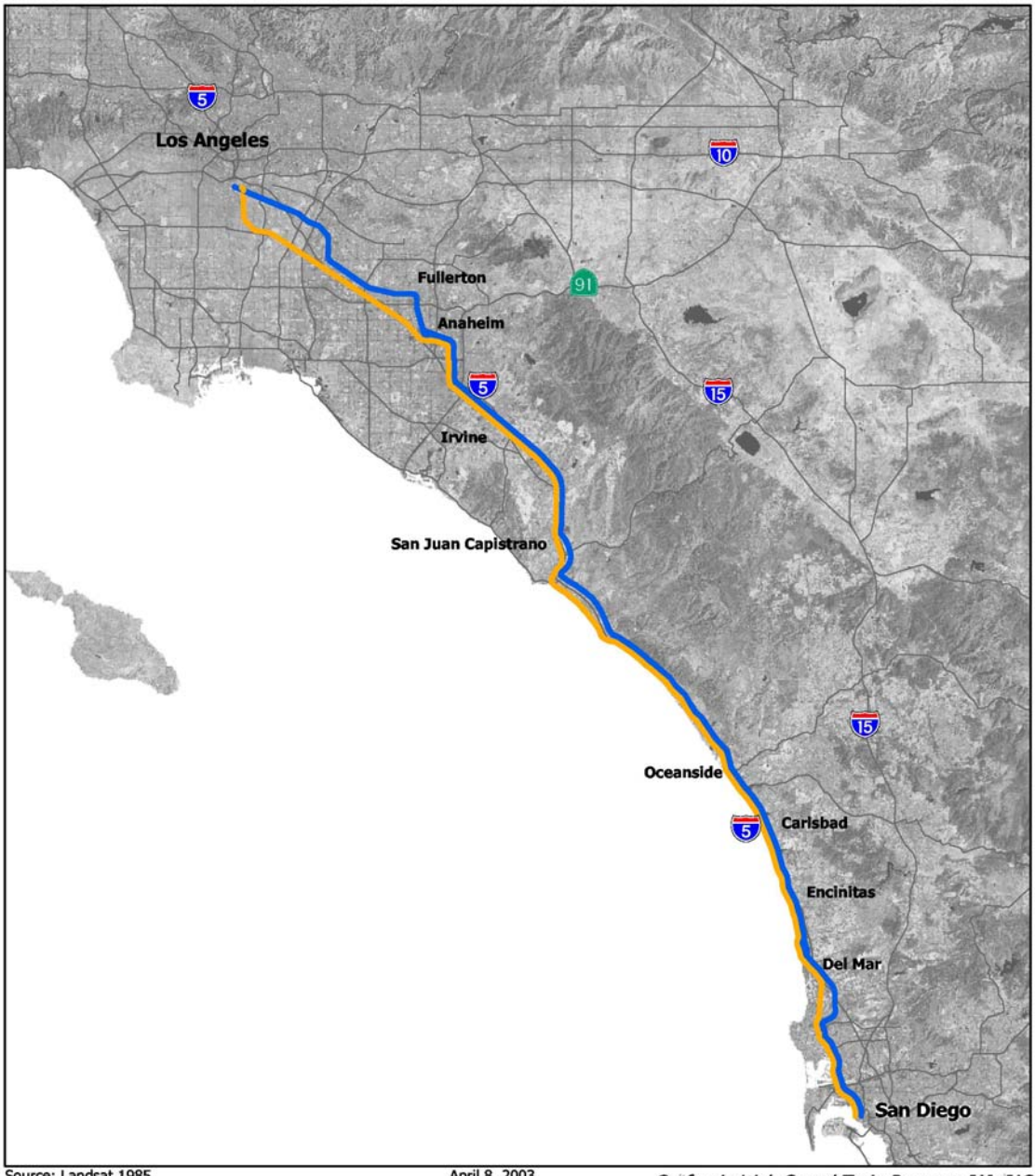
Legend

High Speed Rail Alternative
Noise Impacts

- High
- Medium
- Low

Noise Impacts
High Speed Rail Alternative
LOSSAN Region

Figure 13



10 5 0 10 Miles

10 5 0 10 Kilometers

CALIFORNIA HIGH SPEED RAIL AUTHORITY

Legend

High Speed Rail Alternative
Potential Noise Impacts

- Least
- Greatest
- Other Routes

Routes with Least and Greatest Potential Noise Impacts High Speed Rail Alternative LOSSAN Region

Figure 14

Table 4.5.1 Analysis/Comparison Table – Potential Noise Impacts
Los Angeles-Orange County-San Diego

	Residential (no. of people)	MU (no. of people)	Parkland (acres)	Institution		Impact Rating (H,M,L)
				Schools	Hospitals	
NO-PROJECT						
Hwy 52 To Santa Fe Depot	1914	0	86	0	0	H
Encinitas to Solana Beach	2025	0	7.8	0	0	H
I-5 Fullerton Station To Irvine Station	7428	41	32.9	0	3	H
I-5/805 Split To Hwy 52	0	0	0	1	0	L
I-5 Irvine Station To San Juan Capistrano City Limits	0	0	0	0	0	L
Union Station to LAX (HST only)	2392	0	17	1	1	H
Oceanside to Encinitas	1007	0	3.5	0	1	M
Solana Beach to I-5/805 Split	573	0	16.8	0	0	M
San Onofre/Camp Pendleton to Oceanside	1530	0	118.6	0	0	M
San Juan Capistrano City Limits to San Juan Capistrano	1622	0	0	0	0	H
San Juan Capistrano to San Onofre/Camp Pendleton	587	0	3.7	1	1	M
I-5 Union Station To Fullerton Station	6192	0	21.6	0	0	H
MODAL						
Hwy 52 To Santa Fe Depot	2393	0	106.7	0	0	H
Encinitas to Solana Beach	2474	0	9.2	0	0	H
I-5 Fullerton Station To Irvine Station	9467	52	36.7	3	0	H
I-5/805 Split To Hwy 52	0	0	0	0	1	L
I-5 Irvine Station To San Juan Capistrano City Limits	0	0	0	0	0	L
Union Station to LAX (HST only)	3120	0	21.4	2	1	H
Oceanside to Encinitas	1213	0	4.4	1	0	M
Solana Beach to I-5/805 Split	685	0	21.3	0	0	M

	Residential (no. of people)	MU (no. of people)	Parkland (acres)	Institution		Impact Rating (H,M,L)
				Schools	Hospitals	
San Onofre/Camp Pendleton to Oceanside	1825	0	135.4	1	0	M
San Juan Capistrano City Limits to San Juan Capistrano	1872	0	0	0	0	H
San Juan Capistrano to San Onofre/Camp Pendleton	687	0	4.3	1	1	L
I-5 Union Station To Fullerton Station	7892	0	26.9	1	0	H
HST CORRIDOR & STATION OPTIONS						
LAX To Union Station	4855	0	0	1	1	H
Union Station To Anaheim Station via UPRR	6626	0	0	1	0	H
Union Station To Irvine Station via LOSSAN	61	0	0	0	0	H
CONVENTIONAL RAIL (LOSSAN) & STATION OPTIONS						
Union Station To Fullerton Station (4th main track)	2759	2	0	0	0	M
Fullerton Station To Irvine Station						
Alignments						
AT-GRADE between Walnut Ave (Orange) and E. 17th St. (Santa Ana)	4885	139	0	0	0	H
TRENCH between Walnut Ave (Orange) and E. 17th St. (Santa Ana)	4885	139	0	0	0	H
Irvine Station To San Juan Capistrano City Limits (no improvements in this segment for Conventional Rail)	2195	0	0	1	0	H
San Juan Capistrano (City Limits to Avenida Aeropuerto)						
Alignments						

	Residential (no. of people)	MU (no. of people)	Parkland (acres)	Institution		Impact Rating (H,M,L)
				Schools	Hospitals	
Covered TRENCH/Cut-Fill between Trabuco Creek and Avenida Aeropuerto (trench goes under San Juan Creek); Double tracking	466	0	0	0	0	M
TUNNEL along I-5 between Hwy 73 and Avenida Aeropuerto (tunnel under Trabuco Creek and San Juan Creek); Double tracking	372	0	0	0	0	L
At-Grade/Open Trench along east side of Trabuco Creek	542	0	34.5	0	0	L
Dana Point / San Clemente (Avenida Aeropuerto To San Onofre Power Plant)						
Alignments						
Dana Point Curve Realignment; San Clemente - SHORT TRENCH; Double Tracking (crosses San Mateo and San Onofre Creeks)	3295	0	0	0	0	H
Dana Point Curve Realignment; San Clemente - LONG TRENCH; Double Tracking (crosses San Mateo and San Onofre Creeks)	3295	0	0	0	0	H
Dana Point Curve Realignment; San Clemente - SHORT TUNNEL; Double Tracking (crosses San Mateo and San Onofre Creeks)	1270	0	0	0	0	M
San Clemente - LONG ONE-SEGMENT TUNNEL; Double Tracking (crosses San Mateo and San Onofre Creeks)	93	0	0	0	0	L
San Clemente - LONG TWO-SEGMENT TUNNEL; Double Tracking (crosses San Mateo and San Onofre Creeks)	93	0	0	0	0	L

	Residential (no. of people)	MU (no. of people)	Parkland (acres)	Institution		Impact Rating (H,M,L)
				Schools	Hospitals	
Camp Pendleton (San Onofre Power Plant to Oceanside City Limits)- (Double tracking; crosses Santa Margarita River)	9	0	0	0	0	L
Oceanside/Carlsbad (Oceanside City Limits to Encinitas City Limits)						
Alignments						
Carlsbad - AT-GRADE; double tracking; crosses San Luis Rey, Buena Vista , Aqua Hedionda, and Batiquitos Lagoons	3209	0	0	0	0	H
Carlsbad -TRENCH; double-tracking; crosses San Luis Rey, Buena Vista, Aqua Hedionda, and Batiquitos Lagoons	3209	0	0	0	0	H
Encinitas/Solana Beach (Encinitas City Limits to Solana Beach Station)						
Alignments						
Encinitas - AT-GRADE; Double Tracking; crosses San Elijo Lagoon	1548	0	0	1	0	H
Encinitas - SHORT TRENCH; Double Tracking; crosses San Elijo Lagoon	1548	0	0	1	0	H
Encinitas - LONG TRENCH; Double Tracking; crosses San Elijo Lagoon	1548	0	0	1	0	H
Del Mar(Solana Beach Station to I-5/805 Split)						
Alignments						
COVERED TRENCH on bluffs; crosses San Dieguito and Los Penasquitos Lagoons	453	0	0	O	0	L
TUNNEL under Camino Del Mar; crosses San Dieguito and Los Penasquitos Lagoons	406	0	0	O	0	L
TUNNEL along I-5; crosses San Dieguito and Los Penasquitos Lagoons	408	0	26.3	0	0	L

	Residential (no. of people)	MU (no. of people)	Parkland (acres)	Institution		Impact Rating (H,M,L)
				Schools	Hospitals	
I-5/805 Split To Hwy 52						
Alignments						
Miramar Hill Tunnel	1	0	0	O	0	L
I-5 Tunnel	450	0	0	0	0	M
Hwy 52 To Santa Fe Depot (Curve realignment; Double Tracking; San Diego River Bridge; Trench between Sassafras St and Cedar St)	480	0	0	O	0	L

4.6 FOCUSED NOISE STUDY

The LOSSAN rail alternative would result in improvements to existing rail service along the conventional rail corridor between Los Angeles and San Diego. One of the improvements would be to increase the number of grade separations for the existing rail alignment used by Amtrak's *Surfliner*, the *Metrolink* and the *Coaster*. Currently there are numerous grade crossings along this rail alignment. The rail passenger trains are required by the California PUC, as are freight trains, to sound their warning horn as a safety measure, unless there is a separated grade crossing. As most community members know, the warning horns are loud. After much community prompting, the passenger train agencies now uses the lowest horn level allowable by law. The horn sound used by the passenger trains is still loud in comparison to other community sounds as it needs to be in order to be heard and be an adequate warning device.

The implementation of grade separations along this conventional rail corridor would substantially reduce the need for warning horns. The potential grade separations would primarily occur under what is referred to as the LOSSAN "High" alternative (generally the higher-cost incremental LOSSAN improvements). This would have a positive impact on the noise environment in the communities along this corridor. To assess this effect, an analysis was performed in which a representative case was analyzed with and without the use of horns to estimate the potential benefit of grade separating the existing alignment at selected locations along the corridor.

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

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

The results, of this focused analysis of the horn noise issue, using Tamarack Street as an example are that a significant benefit would occur. The benefit to be gained from eliminating the need for sounding warning horns, where grade crossings are replaced with grade separations, as in the case of Tamarack Street, are that 114 people are currently impacted by the horn sounding, whereas only 26 people would be impacted with a grade separation. This is a 77% reduction in the number of people impacted. Each new grade separation would produce different results, which would depend on the local population density and proximity of residences and other sensitive land use to the current grade crossings, but this example illustrates the magnitude of change to be expected.

5.0 VIBRATION IMPACTS

5.1 NO-PROJECT ALTERNATIVE

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

5.2 MODAL ALTERNATIVE

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

5.3 HIGH-SPEED TRAIN ALTERNATIVE

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

5.4 VIBRATION TYPOLOGIES

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

Table 5.4.1 Typology Analysis Table – Potential Vibration Impacts

Los Angeles-Orange County-San Diego

ALIGNMENT SEGMENT	LAND USE/DESCRIPTION	CITY/ COUNTY	CORRIDOR TYPE	DISTANCE (ft)	SPEED (mph)	MAX. ALLOWED (dBV)	PROJECT (dBV)	IMPACT? (YES/no)
LAX to US	57th Street between San Pedro Pl .and Towne Avenue	Los Angeles	Existing Rail	340	154	72	68	no
US to ANA	Along old River School Road at Dinwiddie	Downey	Existing Rail	50	130	72	79	YES
US to ANA	8th St. near Western Avenue	Buena Park	Highway/ Existing Rail	210	180	72	73	YES
FUL to IRV	Along Bridgeport Road	Tustin	Existing Rail	145	107	72	72	no
SJC to SDLC_1	Along Palisade Drive near bluff	Dana Point	Existing Rail	200	125	72	71	no
OCSD to ENC	El Arbol Drive	Carlsbad	Existing Rail	300	125	72	67	no
ENC to SB	San Elijo Ave near Birmingham Dr	Encinitas	Existing Rail	65	125	72	77	YES
SB to I5_1	End of 4th Street	Del Mar	Existing Rail	100	125	72	76	YES
SR52 to SFD	Morena Blvd	San Diego	Existing Rail	150	125	72	73	YES
SJC to SDLC3	Samaritan Medical Center	San Clemente	Highway	420	125	72	63	no
LAX to US	Hyde Park Elementary	Inglewood	Existing Rail	375	140	75	66	no
SB to I5_2	Del Mar Heights Elementary School	Del Mar	Highway	50	125	75	78	YES
FUL to IRV	McMillan School	Santa Ana	Existing Rail	780	109	75	54	no
SJC1	Mission San Juan Capistrano	San Juan Capistrano	Existing Rail	470	125	65	62	no

5.5 VIBRATION SCREENING ANALYSIS

Table 5.5.1 Analysis/Comparison Table – Potential Vibration Impacts
Los Angeles-Orange County-San Diego

	Residential (no. of people)	MU (no. of people)	Institutional		Impact Rating (H,M,L)
			Schools	Hospitals	
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					
LAX To Union Station	1747	0	0	0	H
Union Station To Anaheim Station via UPRR	2422	0	0	0	M
Union Station To Irvine Station via LOSSAN	14	0	0	0	H
CONVENTIONAL RAIL (LOSSAN) & STATION OPTIONS					
Union Station To Fullerton Station (4th main track)	1111	0	0	0	M
Fullerton Station To Irvine Station	2248	66	0	0	H
Alignments					
AT-GRADE between Walnut Ave (Orange) and E. 17th St. (Santa Ana)	2248	66	0	0	H
TRENCH between Walnut Ave (Orange) and E. 17th St. (Santa Ana)	2248	66	0	0	H
Irvine Station To San Juan Capistrano City Limits (no improvements in this segment for Conventional Rail)	788	0	0	0	M
San Juan Capistrano (City Limits to Avenida Aeropuerto)					
Alignments					
Covered TRENCH/Cut-Fill between Trabuco Creek and Avenida Aeropuerto (trench goes under San Juan Creek); Double tracking	301	0	0	0	M
TUNNEL along I-5 between Hwy 73 and Avenida Aeropuerto (tunnel under Trabuco Creek and San Juan Creek); Double tracking	155	0	0	0	L
At-Grade/Open Trench along east side of Trabuco Creek	94	0	0	0	L
Dana Point/San Clemente (Avenida Aeropuerto To San Onofre Power Plant)					
Alignments					
Dana Point Curve Realignment; San Clemente - SHORT TRENCH; Double Tracking (crosses San Mateo and San Onofre Creeks)	1296	0	0	0	H
Dana Point Curve Realignment; San Clemente - LONG TRENCH; Double Tracking (crosses San Mateo and San Onofre Creeks)	1296	0	0	0	H
Dana Point Curve Realignment; San Clemente -	809	0	0	0	M

	Residential (no. of people)	MU (no. of people)	Institutional		Impact Rating (H,M,L)
			Schools	Hospitals	
SHORT TUNNEL; Double Tracking (crosses San Mateo and San Onofre Creeks)					
San Clemente - LONG ONE-SEGMENT TUNNEL; Double Tracking (crosses San Mateo and San Onofre Creeks)	438	0	0	0	M
San Clemente - LONG TWO-SEGMENT TUNNEL; Double Tracking (crosses San Mateo and San Onofre Creeks)	438	0	0	0	M
Camp Pendleton (San Onofre Power Plant to Oceanside City Limits)- (Double tracking; crosses Santa Margarita River)	1	0	0	0	L
Oceanside/Carlsbad (Oceanside City Limits to Encinitas City Limits)					
Alignments					
Carlsbad - AT-GRADE; double tracking; crosses San Luis Rey, Buena Vista , Aqua Hedionda, and Batiquitos Lagoons	1657	0	0	0	H
Carlsbad -TRENCH; double-tracking; crosses San Luis Rey, Buena Vista, Aqua Hedionda, and Batiquitos Lagoons	1657	0	0	0	H
Encinitas/Solana Beach (Encinitas City Limits to Solana Beach Station)					
Alignments					
Encinitas - AT-GRADE; Double Tracking; crosses San Elijo Lagoon	788	0	0	0	H
Encinitas - SHORT TRENCH; Double Tracking; crosses San Elijo Lagoon	788	0	0	0	H
Encinitas - LONG TRENCH; Double Tracking; crosses San Elijo Lagoon	788	0	0	0	H
Del Mar(Solana Beach Station to I-5/805 Split)					
Alignments					
COVERED TRENCH on bluffs; crosses San Dieguito and Los Penasquitos Lagoons	295	0	0	O	L
TUNNEL under Camino Del Mar; crosses San Dieguito and Los Penasquitos Lagoons	362	0	2	O	H
TUNNEL along I-5; crosses San Dieguito and Los Penasquitos Lagoons	111	0	0	0	L
I-5/805 Split To Hwy 52					
Alignments					
Miramar Hill Tunnel	771	0	0	O	H
I-5 Tunnel	291	0	0	O	M
Hwy 52 To Santa Fe Depot (Curve realignment; Double Tracking; San Diego River Bridge; Trench between Sassafras St and Cedar St)	144	0	0	O	L

6.0 REFERENCES

PUBLICATIONS

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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 Segments Nomenclature

Alignment Description	Nomenclature
MODAL & NO-PROJECT	
Union Station to LAX (HST only)	LAX to US
I-5 Union Station To Fullerton Station	US to FUL
I-5 Fullerton Station To Irvine Station	FUL to IRV
I-5 Irvine Station To San Juan Capistrano City Limits	IRV to SJC
San Juan Capistrano City Limits to San Juan Capistrano	SJC
San Juan Capistrano to San Onofre/Camp Pendleton	SJC to SDCL
San Onofre/Camp Pendleton to Oceanside	SJC to OCSD
Oceanside to Encinitas	OCSD to ENC
Encinitas to Solana Beach	ENC to SB
Solana Beach to I-5/805 Split	SB to I-5
I-5/805 Split To Hwy 52	I-5 to 52
Hwy 52 To Santa Fe Depot	52 to SFD
HST CORRIDORS & STATION OPTIONS	
LAX To Union Station	LAX to US
Union Station To Anaheim Station via UPRR	US to ANA
Union Station To Irvine Station via LOSSAN	US to IRV
CONVENTIONAL RAIL (LOSSAN)	
Union Station To Fullerton Station (4th main track)	US to FUL
Fullerton Station To Irvine Station	
Alignments	
AT-GRADE between Walnut Ave (Orange) and E. 17th St. (Santa Ana)	FUL to IRV
TRENCH between Walnut Ave (Orange) and E. 17th St. (Santa Ana)	FUL to IRV
Irvine Station To San Juan Capistrano City Limits (no improvements in this segment for Conventional Rail)	IRV to SJC
San Juan Capistrano (City Limits to Avenida Aeropuerto)	
Alignments	
Covered TRENCH/Cut-Fill between Trabuco Creek and Avenida Aeropuerto (trench goes under San Juan Creek); Double tracking	SJC_1
TUNNEL along I-5 between Hwy 73 and Avenida Aeropuerto (tunnel under Trabuco Creek and San Juan Creek); Double tracking	SJC_2
At-Grade/Open Trench along east side of Trabuco Creek	SJC_3
Dana Point/San Clemente (Avenida Aeropuerto To San Onofre Power Plant)	
Alignments	
Dana Point Curve Realignment; San Clemente - SHORT TRENCH; Double Tracking (crosses San Mateo and San Onofre Creeks)	SJC to SDCL_1
Dana Point Curve Realignment; San Clemente - LONG TRENCH; Double Tracking (crosses San Mateo and San Onofre Creeks)	SJC to SDCL_1
Dana Point Curve Realignment; San Clemente - SHORT TUNNEL; Double Tracking (crosses San Mateo and San Onofre Creeks)	SJC to SDCL_2
San Clemente - LONG ONE-SEGMENT TUNNEL; Double Tracking (crosses San Mateo and San Onofre Creeks)	SJC to SDCL_3
San Clemente - LONG TWO-SEGMENT TUNNEL; Double Tracking (crosses	SJC to SDCL_3

Alignment Description	Nomenclature
San Mateo and San Onofre Creeks)	
Camp Pendleton **(San Onofre Power Plant to Oceanside City Limits)-** **(**Double tracking; crosses Santa Margarita River**)**	SDCL to OCSD
Oceanside/Carlsbad **(Oceanside City Limits to Encinitas City Limits**)	
Alignments	
Carlsbad - AT-GRADE; double tracking; crosses San Luis Rey, Buena Vista, Aqua Hedionda, and Batiquitos Lagoons	OCSD to ENC
Carlsbad -TRENCH; double-tracking; crosses San Luis Rey, Buena Vista, Aqua Hedionda, and Batiquitos Lagoons	OCSD to ENC
Encinitas/Solana Beach (Encinitas City Limits to Solana Beach Station)	
Alignments	
Encinitas - AT-GRADE; Double Tracking; crosses San Elijo Lagoon	ENC to SD
Encinitas - SHORT TRENCH; Double Tracking; crosses San Elijo Lagoon	ENC to SD
Encinitas - LONG TRENCH; Double Tracking; crosses San Elijo Lagoon	ENC to SD
Del Mar(Solana Beach Station to I-5/805 Split)	
Alignments	
COVERED TRENCH on bluffs; crosses San Dieguito and Los Penasquitos Lagoons	SB to I5_1
TUNNEL under Camino Del Mar; crosses San Dieguito and Los Penasquitos Lagoons	SB to I5_2
TUNNEL along I-5; crosses San Dieguito and Los Penasquitos Lagoons	SB to I5_3
I-5/805 Split To Hwy 52	
Alignments	
Miramar Hill Tunnel	I5 to 52_1
I-5 Tunnel	I5 to 52_2
Hwy 52 To Santa Fe Depot (Curve realignment; Double Tracking; San Diego River Bridge; Trench between Sassafras St and Cedar St)	SR52 to SFD

APPENDIX A2

Detailed Analysis/Comparison Table
Potential CAHSR Noise Impacts
Los Angeles-Orange County-San Diego Region

		number of people		people/(linear miles)							
SEGMENT_ID	length (miles)	11	16	11	16	# of Hospitals	Hospitals/ mile	# of schools	# of schools/mile	Severity Metric	Rating
ENC to SB	7.35	1,548	-	211	-	-	-	1	0	245	H
FUL to IRV	21.14	4,885	139	231	7	-	-	-	-	233	H
I5to52_1	5.00	1	-	0	-	-	-	-	-	0	L
I5to52_2	5.84	450	-	77	-	-	-	-	-	77	L
IRV to SJC	9.43	2,195	-	233	-	-	-	1	0	259	H
LAX to US	15.21	4,855	-	319	-	1.00	0	1	0	342	H
OCSD to ENC	10.44	3,209	-	307	-	-	-	-	-	307	H
SB to I-5_1	7.41	453	-	61	-	-	-	-	-	61	L
SB to I-5_2	7.23	406	-	56	-	-	-	-	-	56	L
SDLC to OCSD	16.53	9	-	1	-	-	-	-	-	1	L
SJC to SDLC3	10.83	93	-	9	-	-	-	-	-	9	L
SJC1	4.93	466	-	95	-	-	-	-	-	95	M
SJC2	5.18	372	-	72	-	-	-	-	-	72	L
SJCtoSDLC1	11.46	3,295	-	288	-	-	-	-	-	288	H
SJCtoSDLC2	11.60	1,270	-	109	-	-	-	-	-	109	M
SR52toSFD	10.75	480	-	45	-	-	-	-	-	45	L
US to ANA	24.35	6,626	-	272	-	-	-	1	0	282	H
US to FUL	21.74	2,759	2	127	0	-	-	-	-	127	M
US to IRV	0.05	61	-	1,220	-	-	-	-	-	1,220	H
SB to I5_3	5.90	408	-	69	-	-	-	-	-	69	L
SJC3	9.59	542	-	57	-	-	-	-	-	57	L

Detailed Analysis/Comparison Table
Potential CAHSR Vibration Impacts
Los Angeles-Orange County-San Diego Region

SEGMENT_ID	length (miles)	number of people 11	number of people 16	people/(linear miles) 11	people/(linear miles) 16	# of Hospitals	Hospitals/mile	# of schools	# of schools/mile	Severity Metric	Rating
ENC to SB	7.35	788	-	107	-	-	-	-	-	107	H
FUL to IRV	21.14	2,248	66	106	3	-	-	-	-	107	H
I5to52_1	5.00	771	-	154	-	-	-	-	-	154	H
I5to52_2	5.84	291	-	50	-	-	-	-	-	50	M
IRV to SJC	9.43	788	-	84	-	-	-	-	-	84	M
LAX to US	15.21	1,747	-	115	-	-	-	-	-	115	H
OCSD to ENC	10.44	1,657	-	159	-	-	-	-	-	159	H
SB to I-5_1	7.41	295	-	40	-	-	-	-	-	40	L
SB to I5_2	7.23	362	-	50	-	-	-	2	0	119	H
SDLC to OCSD	16.53	1	-	0	-	-	-	-	-	0	L
SJC to SDLC3	10.83	438	-	40	-	-	-	-	-	40	M
SJC1	4.93	301	-	61	-	-	-	-	-	61	M
SJC2	5.18	155	-	30	-	-	-	-	-	30	L
SJCtoSDLC1	11.46	1,296	-	113	-	-	-	-	-	113	H
SJCtoSDLC2	11.60	809	-	70	-	-	-	-	-	70	M
SR52toSFD	10.75	144	-	13	-	-	-	-	-	13	L
US to ANA	24.35	2,422	-	99	-	-	-	-	-	99	M
US to FUL	21.74	1,111	-	51	-	-	-	-	-	51	M
US to IRV	0.05	14	-	280	-	-	-	-	-	280	H
SB to I5_3	5.90	111	-	19	-	-	-	-	-	19	L
SJC3	9.59	94	-	10	-	-	-	-	-	10	L

Detailed Analysis/Comparison Table
Potential Highway No-Project Impacts
Los Angeles-Orange County-San Diego Region

SEGMENT_ID	length (miles)	number of people No-Project 11	number of people No-Project 16	people/(linear miles) No-Project 11	people/(linear miles) No-Project 16	# of Hospitals	Hospitals/mile	# of schools	# of schools/mile	Severity Metric	Rating
52 to SFD	8.95	1,914	-	214	-	-	-	-	-	214	H
ENC to SB	6.92	2,025	-	293	-	-	-	-	-	293	H
FUL to IRV	19.03	7,428	41	390	2	-	-	3	0	430	H
I-5 to 52	4.71	-	-	-	-	1.00	0	-	-	21	L
IRV to SJC	9.39	-	-	-	-	-	-	-	-	-	L
LAX to US	4.23	2,392	-	565	-	1.00	0	1	0	648	H
OCSD to ENC	10.19	1,007	-	99	-	-	-	1	0	123	M
SB to I-5	6.45	573	-	89	-	-	-	-	-	89	M
SDLC to OCSD	16.00	1,530	-	96	-	-	-	-	-	96	M
SJC	4.76	1,622	-	341	-	-	-	-	-	341	H
SJC to SDCL	10.39	587	-	56	-	1.00	0	1	0	90	M
US to FUL	17.46	6,192	-	355	-	-	-	-	-	355	H

Detailed Analysis/Comparison Table
Potential Highway Modal Impacts
Los Angeles-Orange County-San Diego Region

SEGMENT_ID	length (miles)	number of people modal 11	number of people modal 16	people/(linear miles) modal 11	people/(linear miles) modal 16	# of Hospitals	Hospitals/mile	# of schools	# of schools/mile	Severity Metric	Rating
52 to SFD	8.95	2,393	-	267	-	-	-	-	-	267	H
ENC to SB	6.92	2,474	-	358	-	-	-	-	-	358	H
FUL to IRV	19.03	9,467	52	497	3	-	-	3	0	538	H
I-5 to 52	4.71	-	-	-	-	1.00	0	-	-	21	L
IRV to SJC	9.39	-	-	-	-	-	-	-	-	-	L
LAX to US	4.23	3,120	-	738	-	1.00	0	2	0	879	H
OCSD to ENC	10.19	1,213	-	119	-	-	-	1	0	144	M
SB to I-5	6.45	685	-	106	-	-	-	-	-	106	M
SDLC to OCSD	16.00	1,825	-	114	-	-	-	1	0	130	M
SJC	4.76	1,872	-	393	-	-	-	-	-	393	H
SJC to SDCL	10.39	687	-	66	-	1.00	0	-	-	76	L
US to FUL	17.46	7,892	-	452	-	-	-	1	0	466	H

California High Speed Rail

Los Angeles to San Diego - Typology Analysis

Noise Impact Analysis HSR - No mitigated

	HST	CONVENTIONAL
Coaches Length (ft)	82	85
Num Coaches	15	5
Power unit Length (ft)	82	75
# powers units	1	1
Total length PU	82	75
Train Length (ft)	1312	500

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	Speed Regime
1	Residential	Los Angeles	57th Street between San Pedro Pl .and Towne Ave.	Exist. Rail	21+500LAX to US	154	340	58	2	sc	2
2	Residential	Downey	Along old River Sch. Rd at Dinwiddie	Exist. Rail	11+500US to ANA	130	50	68	2	sc	2
3	Residential	Buena Park	8th St. near Western Ave.	Hwy./E. Rail	27+200US to ANA	180	210	60	2	as	3
11	School	Inglewood	Hyde Park Elementary	Exist. Rail	27+200LAX to US	140	375	63	3	sc	2

Los Angeles to San Diego - Typology Analysis
Noise Impact Analysis - No mitigated (Continued)
HST

TOTAL # TRAINS One/Direction				
7 to 22		22 to 7		
NB	SB	NB	SB	
11	14	5	0	Gold LIne
0	0	0	0	Green Line
37	35	5	3	Blue Line
97		13		total trains both direct.
6.5		1.4		train/hr

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
93.0	17	90	634	-10	100.1	63	56	64	**52**	**NI**
93.0	17	90	634	-10	98.9	61	55	63	**63**	**I**
99.0	47	180	73	2	102.0	77	70	78	**69**	**SI**
93.0	17	90	634	-10	99.4	62	55	64	49	NI

California High Speed Rail

Los Angeles to San Diego - Typology Analysis
Noise Impact Analysis HSR - Mitigated

	HST	CONVENTIONAL
Coaches Length (ft)	82	85
Num Coaches	15	5
Power unit Length (ft)	82	75
# powers units	1	1
Total length PU	82	75
Train Length (ft)	1312	500

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
1	Residential	Los Angeles	57th Street between San Pedro Pl .and Towne Ave.	Exist. Rail	21+500LAX to US	154	340	58	2
2	Residential	Downey	Along old River Sch. Rd at Dinwiddie	Exist. Rail	11+500US to ANA	130	50	68	2
3	Residential	Buena Park	8th St. near Western Ave.	Hwy./E. Rail	27+200US to ANA	180	210	60	2
11	School	Inglewood	Hyde Park Elementary	Exist. Rail	27+200LAX to US	140	375	63	3

Los Angeles to San Diego - Typology Analysis

Noise Impact Analysis HSR - Mitigated (Continued)

HST Corridor

	TOTAL # TRAINS One/Direction			
	7 to 22		22 to 7	
	NB	SB	NB	SB
Gold LIne	11	14	5	0
Green Line	0	0	0	0
Blue Line	37	35	5	3
total trains both direct.	97		13	
train/hr	6.5		1.4	

Alignment Geometry	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
nb	2											N/A
nb	2	93.0	17	90	634	-10	98.9	61	55	63	63	I
nb	3	99.0	47	180	73	-5	102.0	70	63	71	62	I
nb	2											N/A

Los Angeles to San Diego - Typology Analysis
Noise Impact Analysis Conventional Rail- No mitigated

Loco SEL_ref 92
Car SEL_ref 82

	Community	Location and/or Description	Corridor Type	Civil Station	Existing Ambient (Ldn/Leqday)	FRA Landuse Category	Speed	Distance	# trains both Direct Day	# trains both Direct Night	# Loco	# Cars	Adjustment	Hourly Leq @ 50 ft Day Loco	Hourly Leq @ 50 ft Day Car	Hourly Leq @ 50 ft Night Loco	Hourly Leq @ 50 ft Night Car	Leq @ 50 ft Day	Leq @ 50 ft Night	Ldn @ 50 ft	Ldn @ Receiver	IMPACT
4	Tustin	Along Bridgeport Rd.	Exist. Rail	63+500 FUL to IRV US to IRV	63	2	107	145	77	13	1	5	0	66.8	67.1	61.3	61.6	70	64	72	65	SI
																		61	66	72	65	I
																				Total	68	SI
5	Dana Point	Along Palisade Dr. near bluff	Exist. Rail	100+500 SJC to SDLC1	62	2	125	200	40	9	1	5	0	64.6	65.6	60.4	61.3	68	64	71	62	I
																		61	66	72	63	I
																				Total	66	SI
6	Carlsbad	El Arbol Dr.	Exist. Rail	149+500OCSD to ENC	59	2	125	300	94	14	1	5	0	68.3	69.3	62.3	63.3	72	66	74	62	I
																		61	66	72	60	I
																				Total	64	SI
7	Encinitas	San Elijo Av. near Birmingham Dr.	Exist. Rail	162+000ENC to SB	69	2	125	65	94	14	1	5	0	68.3	69.3	62.3	63.3	72	66	74	72	SI
																		61	66	72	70	SI
																				Total	74	SI
8	Del Mar	End of 4th St.	Exist. Rail	168+000SB to I5_1	61	2	125	360	94	14	1	5	0	68.3	69.3	62.3	63.3	72	66	74	61	I
																		61	66	72	59	I
																				Total	63	I

9	San Diego	Morena Blvd.	Exist. Rail	190+400SR52 to SFD	65	2	125	150	94	14	1	5	0	68.3	69.3	62.3	63.3	72	66	74	67	**SI**
																		61	66	72	65	**I**
																				Total	69	**SI**
12	Del Mar	Del Mar Heights Elementary School	Hwy.	170+000SB to I5_2	64	3	125	50	94	14	1	5	0	68.3	69.3	62.3	63.3	72	66	74	72	**SI**
																		61	66	72	61	**NI**
																				Total	72	**SI**
13	Santa Ana	McMillan School	Exist. Rail	58+500FUL to IRV US to IRV	56	3	109	780	77	13	1	5	0	66.9	67.3	61.4	61.8	70	65	72	52	**NI**
																		61	66	72	43	**NI**
																				Total	53	**NI**
14	Irvine	Hoeptner Park	Exist. Rail	69+000FUL to IRV US to IRV	65	3	155	50	77	13	1	5	0	68.4	70.3	62.9	64.8	72	67	75	72	**SI**
																		61	66	72	61	**NI**
																				Total	73	**SI**
15	San Juan Capistrano	Mission San Juan Capistrano	Exist. Rail	94+500SJC1	59	3	125	470	45	9	1	5	0	65.2	66.1	60.4	61.3	69	64	71	54	**NI**
																		61	66	72	46	**NI**
																				Total	55	**NI**

ADITITONAL FREIGHT TRAIN NOISE

		SEL ref	# of	Speed	# day		# night	daytime Leq @ 50	nighttime Leq @ 50	**Ldn @ 50**
	Loco	91.5	2.5	50	4		8	54	59	
	Car	83.9	50	50	4		8	60	65	
								61	**66**	**72**

Los Angeles to San Diego - Typology Analysis
Noise Impact Analysis Conventional Rail- Mitigated

Loco SEL_ref 92
Car SEL_ref 82

	Schedule to Use	Community	Location and/or Description	Corridor Type	Civil Station	Ambient (Ldn/Leqday)	FRA Landuse Category	Speed	Distance	# trains both Direct Day	# trains both Direct Night	# Loco	# Cars	Adjustment	Hourly Leq @ 50 ft Day Loco	Hourly Leq @ 50 ft Day Car	Hourly Leq @ 50 ft Night Loco	Hourly Leq @ 50 ft Night Car	Leq @ 50 ft Day	Leq @ 50 ft Night	Ldn @ 50 ft	Ldn @ Receiver	IMPACT
4	Santa Ana	Tustin	Along Bridgeport Rd.	Exist. Rail	63+500 FUL to IRV US to IRV	63	2	107	145	77	13	1	5	-5	61.8	62.1	56.3	56.6	65	59	67	60	I
																			56	61	67	60	NI
																					Total	**63**	I
5	SC	Dana Point	Along Palisade Dr. near bluff	Exist. Rail	100+500 SJC to SDLC1	62	2	125	200	40	9	1	5	-5	59.6	60.6	55.4	56.3	63	59	66	57	NI
																			56	61	67	58	NI
																					Total	**61**	I
6	Oceanside	Carlsbad	El Arbol Dr.	Exist. Rail	149+500OCSD to ENC	59	2	125	300	94	14	1	5	-5	63.3	64.3	57.3	58.3	67	61	69	57	I
																			56	61	67	55	NI
																					Total	**59**	I
7	Oceanside	Encinitas	San Elijo Av. near Birmingham Dr.	Exist. Rail	162+000ENC to SB	69	2	125	65	94	14	1	5	-5	63.3	64.3	57.3	58.3	67	61	69	67	I
																			56	61	67	65	I
																					Total	**69**	SI
8	Oceanside	Del Mar	End of 4th St.	Exist. Rail	168+000SB to I5_1	61	2	125	360	94	14	1	5	-5	63.3	64.3	57.3	58.3	67	61	69	56	NI
																			56	61	67	54	NI
																					Total	**58**	I
9	Solana Beach	San Diego	Morena Blvd.	Exist. Rail	190+400SR52 to SFD	65	2	125	150	94	14	1	5	-5	63.3	64.3	57.3	58.3	67	61	69	62	I
																			56	61	67	60	NI
																					Total	**64**	I

12	Oceanside	Del Mar	Del Mar Heights Elementary School	Hwy.	170+000SB to I5_2	64	3	125	50	94	14	1	5	-5	63.3	64.3	57.3	58.3	67	61	69	67	**I**
																			56	61	67	56	**NI**
																					Total	**67**	**I**
13	Santa Ana	Santa Ana	McMillan School	Exist. Rail	58+500FUL to IRV US to IRV	56	3	109	780	77	13	1	5										**N/A**
																							N/A
																							N/A
14	Santa Ana	Irvine	Hoeptner Park	Exist. Rail	69+000FUL to IRV US to IRV	65	3	155	50	77	13	1	5	-5	63.4	65.3	57.9	59.8	67	62	70	67	**I**
																			56	61	67	56	**NI**
																					Total	**68**	**I**
15	SJC	San Juan Capistrano	Mission San Juan Capistrano	Exist. Rail	94+500SJC1	59	3	125	470	45	9	1	5	N/A	N/A								**N/A**
																							N/A
																					Total		**N/A**

ADITITONAL FREIGHT TRAIN NOISE

			SEL ref	# of	Speed	# day	noise barrier	# night	daytime Leq @ 50	nighttime Leq @ 50	Ldn @ 50
		Loco	91.5	2.5	50	4	-5	8	49	54	
		Car	83.9	50	50	4	-5	8	55	60	
									56	61	67

Los Angeles to San Diego - Typology Analysis

CONVENTIONAL RAIL - DETAILED ANALYSIS

Los Angeles to San Diego - Typology Analysis
CONVENTIONAL RAIL - DETAILED ANALYSIS (Continued)

WITHOUT MITIGATION											WITH MITIGATION										
Ldn @ 50ft Cars	Ldn @ 50 ft	Cross-Section Geometry	Height Receiver **(Hr,ft)**	H source	Heff	Ground Factor	Ldn @ Receiver Loco	Ldn @ Receiver Cars	Ldn @ Receiver	IMPACT	Barrier Height **(Hb)**	Distance Source-Barrier (ft)	P (ft)	Att. Barrier	H_eff	Ground Factor **G_b**	**IL Barrier**	Ldn @ Receiver Loco	Ldn @ Receiver Cars	**Ldn @ Receiver**	IMPACT
71	74	at grade	5	8	6.50	0.63	66.9	68.9	71	**SI**	8.0	30.0	0.2	6.5	14.5	0.49	**6.3**	60.6	61.6	**64**	**I**
71	72	at grade	5	8	6.50	0.63	62.0	68.4	69	**SI**	8.0	30.0	0.2	6.5	14.5	0.49	**6.3**	55.6	61.0	**62**	**NI**
									73	**SI**										**66**	**I**

California High Speed Rail

Los Angeles to San Diego

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	Los Angeles	57th Street between San Pedro Pl .and Towne Ave.	Exist. Rail	21+500LAX to US	154	340	2	72	**68**	**NO**
2	Residential	Downey	Along old River Sch. Rd at Dinwiddie	Exist. Rail	11+500US to ANA	130	50	2	72	**79**	**YES**
3	Residential	Buena Park	8th St. near Western Ave.	Hwy./E. Rail	27+200US to ANA	180	210	2	72	**73**	**YES**
4	Residential	Tustin	Along Bridgeport Rd.	Exist. Rail	63+500 FUL to IRV US to IRV	107	145	2	72	**72**	**NO**
5	Residential	Dana Point	Along Palisade Dr. near bluff	Exist. Rail	100+500 SJC to SDLC1	125	60	2	72	**78**	**YES**
6	Residential	Carlsbad	El Arbol Dr.	Exist. Rail	149+500OCSD to ENC	125	300	2	72	**67**	**NO**
7	Residential	Encinitas	San Elijo Av. near Birmingham Dr.	Exist. Rail	162+000ENC to SB	125	65	2	72	**77**	**YES**
8	Residential	Del Mar	End of 4th St.	Exist. Rail	168+000SB to I5_1	125	100	2	72	**76**	**YES**
9	Residential	San Diego	Morena Blvd.	Exist. Rail	190+400SR52 to SFD	125	150	2	72	**73**	**YES**
10	Hospital	San Clemente	Samaritan Medical Center	Hwy.	105+000SJC to SDLC3	125	420	2	72	**63**	**NO**
11	School	Inglewood	Hyde Park Elementary	Exist. Rail	27+200LAX to US	140	375	3	75	**66**	**NO**
12	School	Del Mar	Del Mar Heights Elementary School	Hwy.	170+000SB to I5_2	125	50	3	75	**78**	**YES**
13	School	Santa Ana	McMillan School	Exist. Rail	58+500FUL to IRV US to IRV	109	780	3	75	**54**	**NO**
14	Park	Irvine	Hoeptner Park	Exist. Rail	69+000FUL to IRV US to IRV	155	50	3	75	**80**	**YES**
15	Historical	San Juan Capistrano	Mission San Juan Capistrano	Exist. Rail	94+500SJC1	125	470	1	65	**62**	**NO**

Los Angeles to San Diego
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	39	45	49	63	65	53	47	42	45	41	36	35	36	(5)	(22)	(24)	(22)	(20)
77	34	44	51	56	73	77	68	66	64	68	66	63	62	63	23	5	1	0	(4)
69	31	42	48	52	67	69	58	54	48	51	47	41	41	40	(0)	(18)	(20)	(19)	(19)
72	32	42	49	54	70	72	62	57	54	56	52	46	45	46	5	(12)	(16)	(16)	(17)
77	34	44	51	56	72	77	67	65	63	67	64	61	60	61	20	3	(1)	(2)	(6)
66	31	40	46	49	64	66	54	49	43	46	42	38	36	37	(4)	(21)	(23)	(21)	(20)
77	34	44	51	56	72	77	67	64	62	66	63	60	59	60	19	1	(2)	(3)	(7)
75	32	43	50	55	71	75	65	61	58	60	56	52	51	52	11	(6)	(10)	(11)	(13)
72	32	42	49	54	69	72	61	57	53	56	51	45	45	45	5	(13)	(16)	(16)	(17)
62	29	38	44	47	61	62	50	44	39	42	38	34	33	33	(8)	(25)	(26)	(23)	(20)
64	30	38	44	48	62	64	51	45	41	43	40	35	34	35	(6)	(23)	(25)	(22)	(20)
77	34	44	51	56	73	77	68	66	64	68	66	63	62	63	23	5	1	0	(4)
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)
61	28	37	43	46	60	61	48	43	37	40	37	32	31	32	(9)	(26)	(27)	(23)	(21)

Los Angeles to San Diego
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

Los Angeles to San Diego
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	18	20	22	22	22	21	19	17	16	14	12	10	6	(18)	(35)	(45)	(51)	(53)
20	23	26	29	32	34	36	38	39	39	39	39	37	33	10	(8)	(20)	(29)	(37)
17	21	23	25	26	26	26	26	23	22	20	17	16	10	(13)	(31)	(41)	(48)	(52)
18	21	24	27	29	29	30	29	29	27	25	22	20	16	(8)	(25)	(37)	(45)	(50)
20	23	26	29	31	34	35	37	38	38	37	37	35	31	7	(10)	(22)	(31)	(39)
17	19	21	22	23	23	22	21	18	17	15	14	11	7	(17)	(34)	(44)	(50)	(53)
20	23	26	29	31	34	35	36	37	37	36	36	34	30	6	(12)	(23)	(32)	(40)
18	22	25	28	30	32	33	33	33	31	29	28	26	22	(2)	(19)	(31)	(40)	(46)
18	21	24	27	28	29	29	29	28	27	24	21	20	15	(8)	(26)	(37)	(45)	(50)
15	17	19	20	20	19	18	16	14	13	11	10	8	3	(21)	(38)	(47)	(52)	(53)
16	17	19	21	21	21	19	17	16	14	13	11	9	5	(19)	(36)	(46)	(51)	(53)
20	23	26	29	32	34	36	38	39	39	39	39	37	33	10	(8)	(20)	(29)	(37)
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)
14	16	18	19	19	18	16	15	12	11	10	8	6	2	(22)	(39)	(48)	(52)	(54)

Exec Summary Charts

Region: LA-OC-SD - 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	14.1	43.03	61.4	118.5
Modal	14.1	43.03	61.4	118.5
Rail Alt - Least	55.5	21.7	48.4	125.6
Rail Alt - Greatest	50.1	21.7	84.2	156.1
LAX HST Conect.	0.0	0.0	15.2	15.2

Exec Summary Charts

Region: LA-OC-SD - 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
Rail Alt - Least	42.8	47.8	38.9	129.5
Rail Alt - Greatest	27.3	60.5	62.6	150.4
LAX HST Conect.	0.0	0.0	15.2	15.2

User Input	
Noise Situation (Pick from List)	1
Horn Lmax (dBA) @ 100 feet	96
Horn Location on Locomotive(Pick from List)	2
Non Train Noise Environment (pick from list)	3
Shielding (Pick from List)	6
Length of Impact Area (pick from list)	1
Existing Train Speed (mph)	50
Future Train Speed (mph)	50
Number of Existing Trains in one Direction	21.5
Number of Future Trains in one Direction	21.5
Existing Number of Day Trains (7 am to 10 p.m.)	19
Future Number of Day Trains (7 am to 10 p.m.)	19
Existing Number of Night Trains (10 p.m. to 7 am)	2.5
Future Number of Night Trains (10 p.m. to 7 am)	2.5
Existing Average Number of Cars	5
Future Average Number of Cars	5
Existing Average Number of Locomotives	1
Future Average Number of Locomotives	1

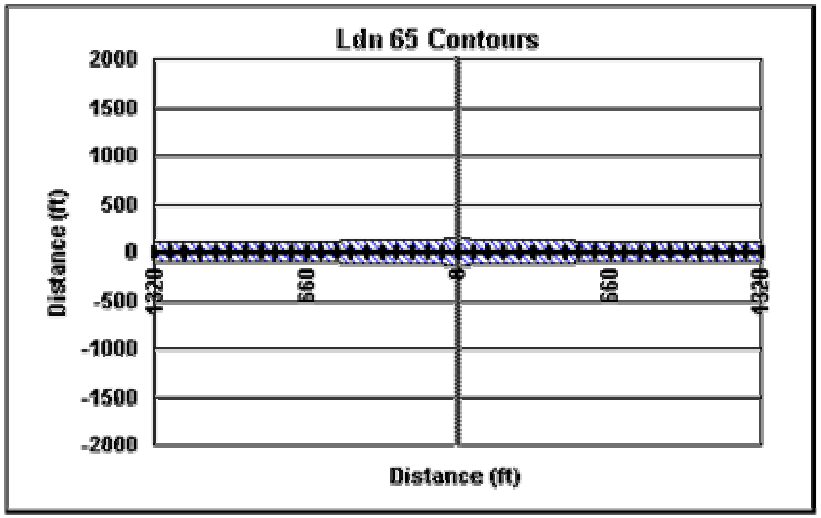
Noise Situation	
Horns Existing and Future	1
Horns in Future Only	2
No Horns Existing and Future	3

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

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

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

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

Ldn 65 Contours Numeric Output (in feet)	
Existing 65 Ldn Contour at X-ing	135
Future 65 Ldn Contour at X-ing	135
Existing 65 Ldn Contour at 1/2 zone length	105
Future 65 Ldn Contour at 1/2 zone length	105
Zone Length	1320
1/2 Zone Length	660

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