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Section 3.10
# Noise and Vibration

## 3.10.1 Introduction

This section describes the existing noise and vibration environment in the Proposed Project area and examines potential short- and long-term changes that may result from the Proposed Project, focusing on existing and projected levels of noise and groundborne vibration. This section incorporates information and analysis presented in the 1992 EIR and addresses changes in noise conditions, proposed operations, and noise standards that have occurred subsequent to the noise and vibration analysis that was prepared for the 1992 document.

The setting information, methodology, and impact analysis presented here are summarized from analysis prepared by Jones & Stokes, the noise and vibration report prepared by Harris, Miller, Miller & Hanson (Appendix O), as well as from review of relevant documents

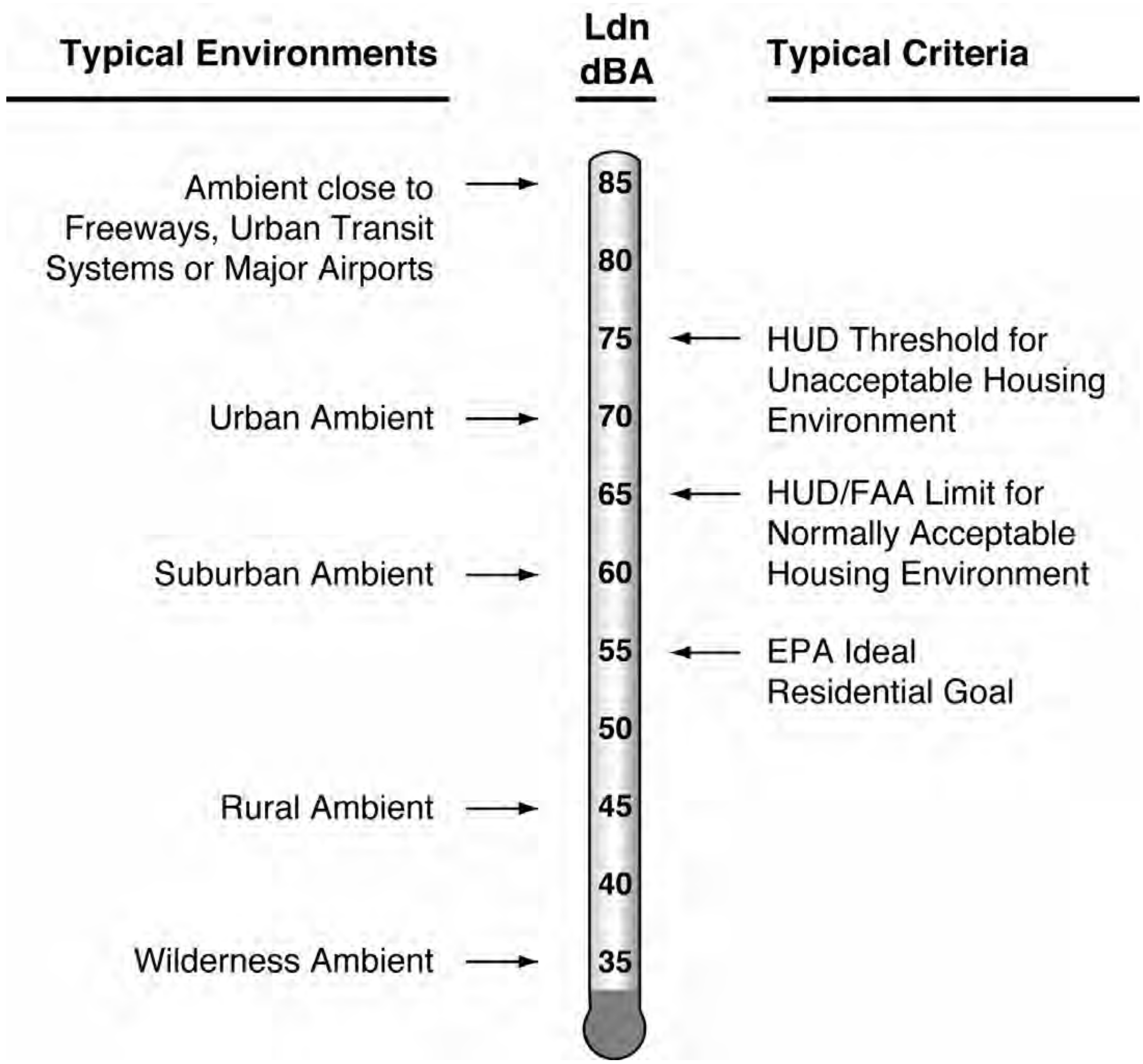
## Terminology Used in this Section

### Noise Terminology

*Sound* is mechanical energy transmitted by pressure waves in a compressible medium such as air. *Noise* can be defined as unwanted sound. Sound is characterized by various parameters that include the rate of oscillation of sound waves (*frequency*), the speed of propagation, and the pressure level or energy content (*amplitude*). Sound pressure level (amplitude) is the most common descriptor used to characterize the loudness of ambient sound. The decibel (dB) scale is used to quantify sound intensity. Because sound pressure varies over an extremely large range, the dB scale is logarithmic, which keeps sound intensity numbers convenient and manageable. Because the human ear is not equally sensitive to all frequencies, noise measurements are also commonly weighted more heavily for frequencies of maximum human sensitivity in a process called *A-weighting*. These adjusted measurements are expressed in units called A-weighted decibels, or dBA.

Several different types of descriptors are used to characterize the time-varying nature of sound. These descriptors include the equivalent sound level ($L_{eq}$), the minimum and maximum sound levels ($L_{min}$ and $L_{max}$), the percentile-exceeded sound levels ($L_{xx}$), the day-night level ($L_{dn}$), and the community noise equivalent level (CNEL). Brief definitions of these and other terms used in this section follow.

- **Sound –** A vibratory disturbance created by a vibrating object, which, when transmitted by pressure waves through a medium such as air, is capable of being detected by a receiving mechanism, such as the human ear or a microphone.
- **Noise –** Sound that is loud, unpleasant, unexpected, or otherwise undesirable.
- **Decibel (dB) –** A unitless measure of sound on a logarithmic scale that indicates the squared ratio of sound pressure amplitude to a reference sound pressure amplitude (20 micropascals). The range of normally encountered sound can be expressed by values between 0 and 120 decibels. In general, human sound perception is such that a change in sound level of 3 dB is just noticeable; a change of 5 dB is clearly noticeable; and a change of 10 dB is perceived as doubling or halving the sound level.
- **A-Weighted Decibel (dBA) –** An overall frequency-weighted sound level measurement in decibels that approximates the frequency response of the human ear. The human ear can detect a wide range of frequencies. However, because the sensitivity of human hearing varies with frequency, the A-weighting system is commonly used when measuring environmental noise to provide a single number descriptor that correlates with human subjective response.
- **Maximum Sound Level ($L_{max}$) –** The maximum sound level measured during the measurement period.
- **Minimum Sound Level ($L_{min}$) –** The minimum sound level measured during the measurement period.
- **Equivalent Sound Level ($L_{eq}$) –** $L_{eq}$ can be thought of as the steady-state sound level that represents the same sound energy contained in the actual varying sound levels over a specified time period (typically 1 hour or 24 hours). Because environmental noise fluctuates from moment to moment, it is common practice to condense all of this information into a single number, called the "equivalent" sound level ($L_{eq}$). Often the $L_{eq}$ values over a 24-hour period are used to calculate cumulative noise exposure in terms of the Day-Night Sound Level ($L_{dn}$).
- **Day-Night Level ($L_{dn}$) –** The energy average of the A-weighted sound levels occurring during a 24-hour period, with 10 dB added to sound levels occurring during the period from 10:00 p.m. to 7:00 a.m. Many surveys have shown that $L_{dn}$ is well correlated with human annoyance; therefore this descriptor is widely used for environmental noise impact assessment. Figure 3.10-1 provides examples of typical noise environments and criteria in terms of $L_{dn}$. While the extremes of $L_{dn}$ are shown to range from 35 dBA in a wilderness environment to 85 dBA in noisy urban environments, $L_{dn}$ is generally found to range between 55 dBA and 75 dBA in most communities. As shown in Figure 3.10-1, span ranges between an "ideal" residential environment and the threshold for an unacceptable residential environment according to the U.S. Department of Housing and Urban Development and the U.S. EPA.
- **Percentile-Exceeded Sound Level ($L_{xx}$) –** The sound level exceeded during a specified percentage ($_{xx}$) of a given time period. For example, $L_{10}$ is the sound level exceeded 10% of the time.

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Source: Harris, Miller, Miller & Hanson 2002.

**Figure 3.10-1**
**Ambient Noise Enviroments and Criteria**

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- **Community Noise Equivalent Level (CNEL) –** The energy average of the A-weighted sound levels occurring during a 24-hour period, with approximately 4.8 dB added to the A-weighted sound levels during the period from 7:00 p.m. to 10:00 p.m. and 10 dB added to the A-weighted sound levels during the period from 10:00 p.m. to 7:00 a.m.

$L_{dn}$ and CNEL values rarely differ by more than 1 dB. As a matter of practice, $L_{dn}$ and CNEL values are considered equivalent and are treated as such in this assessment.

Appendix O provides a more detailed discussion of noise terminology.

### Vibration Terminology

*Groundborne vibration* is the oscillatory motion of the ground about some equilibrium position, and can be described in terms of displacement, velocity, or acceleration. Because sensitivity to vibration typically corresponds to the amplitude of vibration velocity within the low-frequency range of most concern for environmental vibration (roughly 5 to 100 Hz), velocity is the preferred measure for evaluating groundborne vibration from transit projects.

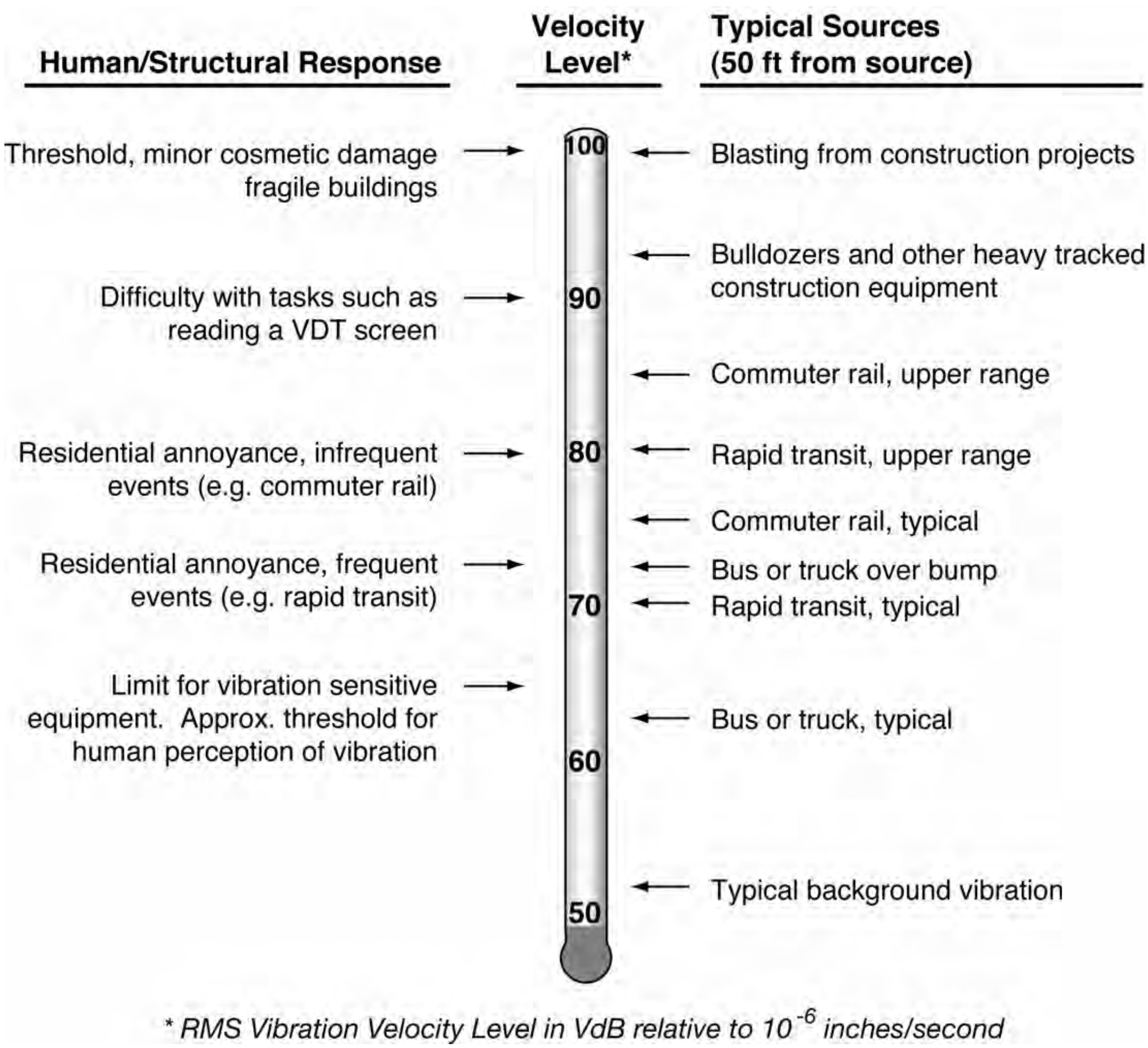
The most common measure used to quantify vibration amplitude is the peak particle velocity (PPV), defined as the maximum instantaneous peak of the vibratory motion. PPV is typically used in monitoring blasting and other types of construction-generated vibration, since it is related to the stresses experienced by building components. Although PPV is appropriate for evaluating building damage, it is less suitable for evaluating human response. Human response is better related to the average vibration amplitude. Thus, groundborne vibration from transit trains is usually characterized in terms of the "smoothed" root mean square (rms) vibration velocity level in decibels (VdB), with a reference quantity of 1 micro-inch per second. VdB is used in place of dB to avoid confusing vibration decibels with sound decibels.

Figure 3.10-2 illustrates typical groundborne vibration levels for common sources as well as criteria for human and structural response to groundborne vibration. As shown, the range of interest is from approximately 50 to 100 VdB, from imperceptible background vibration to the threshold of damage. Although the approximate threshold of human perception to vibration is 65 VdB, annoyance is usually not significant unless the vibration exceeds 70 VdB.

# 3.10.2 Environmental Setting

## Methodology for Assessment of Existing Conditions

The noise and vibration study area comprises developed land uses adjacent to the Proposed Project alignment. The following sections describe the methods used to characterize existing noise and vibration conditions in the noise and vibration study area, and provide background information on airborne noise and groundborne vibration issues related to the Proposed Project.

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Source: Harris, Miller, Miller & Hanson 2002.

**Figure 3.10-2**
**Vibration Sources and Responses**

# Existing Conditions

## Assessment of Existing Noise Conditions

For the Proposed Project alignment, noise-sensitive land uses were first identified based on preliminary alignment drawings, aerial photographs, and visual surveys. Areas adjacent to the alignment include single- and multi-family residences, together with some non-residential (commercial and industrial) and institutional land uses (e.g. schools, churches, hospitals). Adjacent uses are currently exposed to noise from vehicle traffic (on Driscoll Road, Washington Boulevard, Old Grimmer Boulevard, and other local streets) and from freight trains on the UP rail lines. Railroad activity on the existing UP tracks varies between 17 and 20 train operations daily, with operations occurring intermittently throughout the day and night. Estimates of the average number of cars per train vary between 60 and 70, with 2 to 4 locomotives per train. The average speed of the rail cars along the tracks is 20 to 50 mph (Furtney, pers. comm.).

Existing ambient noise levels in the above areas were characterized through direct measurements at selected sites along the Proposed Project alignment during the period from May 13 through May 16, 2002. Estimating existing noise exposure is an important step in the noise impact assessment because the thresholds used to assess the significance of cumulative noise impacts are based on existing levels of noise exposure. The measurements taken in May 2002 included both long-term (typically 24-hour) and short-term (1-hour) monitoring of the A-weighted sound level at representative noise-sensitive locations.

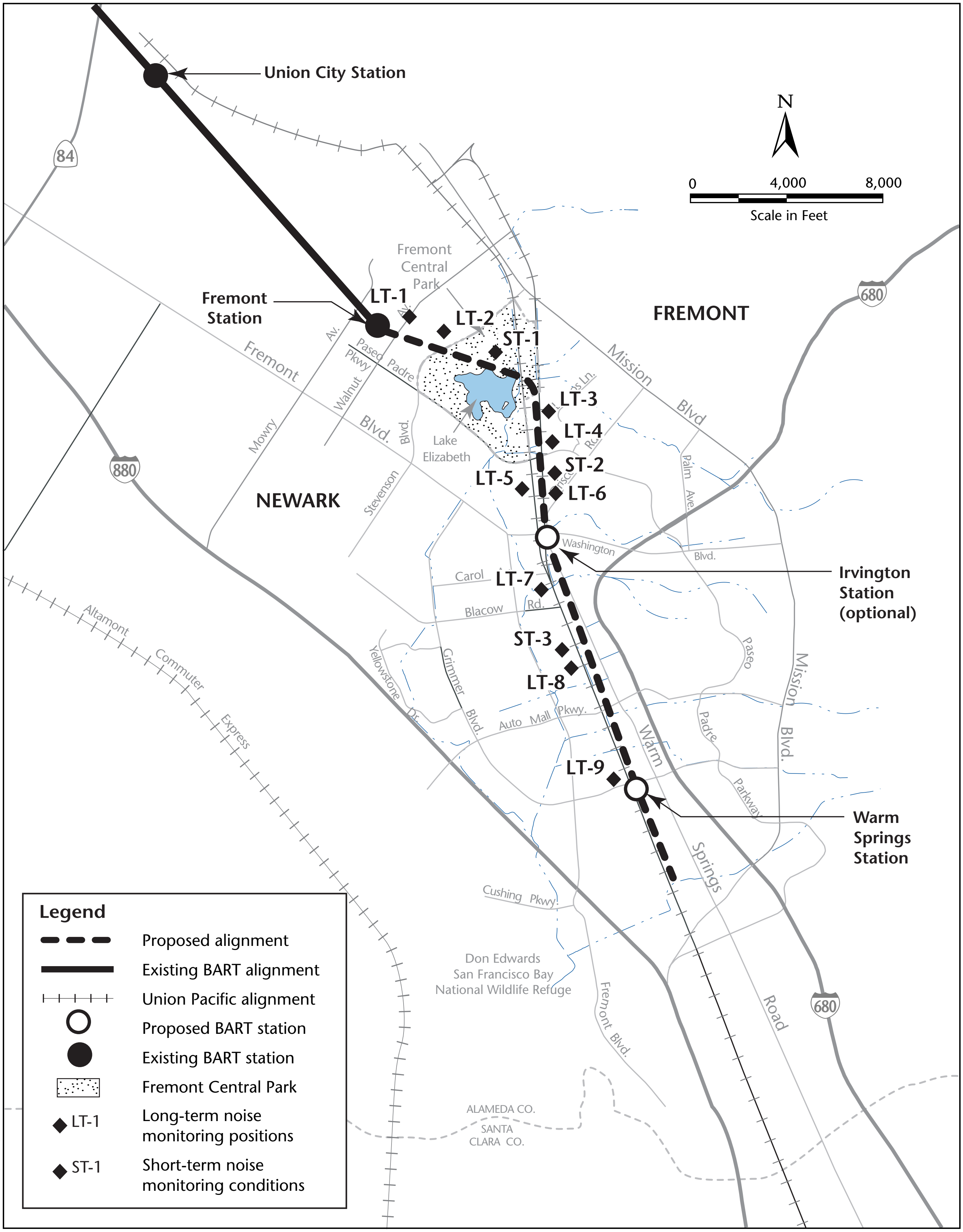
All the measurement sites were located in noise-sensitive areas and were selected to represent a range of existing noise conditions along the alignment. These are the same sites that were analyzed in the 1992 EIR. At each site, the measurement microphone was positioned to characterize the exposure of the site to the dominant noise sources in the area. For example, microphones were located at the approximate setback lines of the receptors from adjacent roads or rail lines and were positioned to avoid acoustic shielding by landscaping, fences, or other obstructions.

Figure 3.10-3 shows the general location of the nine long-term (LT) monitoring sites (LT-1 through LT-9) and three short-term (ST) monitoring sites (ST-1 through ST-3). A description of each noise measurement site follows. Predominant sources of noise and land uses near each measurement position are also discussed.

### *North of Walnut Avenue to Fremont Central Park–Lake Elizabeth*

Washington Hospital is located west of BART's existing Fremont Station. The hospital facility was not identified in the 1992 EIR. Residential land uses are located to the north and south of the Proposed Project alignment; new multi-family residential units that have been erected since the certification of the 1992 EIR include the Presidio, Benton, and Red Hawk Ranch complexes.

**Site LT-1** was located east of the Proposed Project alignment at the Presidio Apartments. The microphone was located in the parking lot at the edge of the Proposed Project alignment. Traffic on Walnut and local residential activities were the largest contributors to the noise environment.

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Source: Base map: Jones & Stokes 2002; noise monitoring by Harris, Miller, Miller & Hanson 2002.

**Figure 3.10-3**
**Noise Monitoring Sites**

**Site LT-2** was located east of the Proposed Project alignment at the Red Hawk Ranch Apartments. The microphone was located in the parking lot at the edge of the Proposed Project alignment. Distant traffic and neighborhood activities contributed to the noise environment at this measurement site.

### *Fremont Central Park–Lake Elizabeth to Paseo Padre Parkway*

Noise-sensitive receptors in this area include users of Fremont Central Park and single-family residences at the corner of Paseo Padre Parkway and the UP tracks. These residences were identified in the 1992 EIR.

**Site LT-3** was located east of the Proposed Project alignment, at 1549 Valdez Way. The microphone was located in the back yard of the single-family residence. Dominant sources of noise at this site included freight trains, distant auto traffic and neighborhood activities.

**Site LT-4** was located east of the Proposed Project alignment at 40807 Vaca Road. The microphone was located in the backyard of the single-family residence. An 8-foot-high wooden fence separates the back yard from the former WP tracks. Traffic on Paseo Padre Parkway was the dominant source of noise at this site. Local activities also contributed to the noise environment.

**Site ST-1** was located east of the Proposed Project alignment at Fremont Central Park, near the walking path off Stevenson Boulevard. Distant traffic and construction contributed to the noise environment at this site.

### *Paseo Padre Parkway to Washington Boulevard*

Noise-sensitive receptors in this area include single-family residences on both west and east sides of the Proposed Project alignment, south of Paseo Padre Parkway. These residences were identified in the 1992 EIR.

**Site LT-5** was located west of the Proposed Project alignment at 3240 Neal Road. The microphone was placed in the backyard of a multi-family residence separated from the adjacent freight tracks by a 6-foot-high fence. Freight trains, traffic, and local activities contributed to the noise environment at this site.

**Site LT-6** was located east of the Proposed Project alignment at 3073 Driscoll Road. The microphone was located in the yard of the single-family residence. Freight trains, as well as vehicle traffic on Driscoll Road and Washington Boulevard, contributed to the noise environment at this site.

**Site ST-2** was located at the two churches on Driscoll Road. The noise measurement was taken from the site of the loudest peak-hour at LT-6, which was located next to the churches at a single-family residence. Contributors to noise at this site included traffic on Driscoll Road.

### *Washington Boulevard to Auto Mall Parkway*

Noise-sensitive receptors in this area include single-family residences along the entire western stretch of the Proposed Project alignment and single-family residences east of the alignment along Bruce Drive and Osgood Road. These residences were identified in the 1992 EIR.

**Site LT-7** was located west of the Proposed Project alignment at 3621 Kay Court. The microphone was located in the backyard of the single-family residence at the end of the cul-de-sac. Freight train traffic dominated the noise environment at this site.

**Site LT-8** was located west of the Proposed Project alignment at 43244 Newport Drive. The microphone was located behind the single-family residence, at the façade of the house. Freight train traffic dominated the noise environment at this site.

**Site ST-3** was located west of the Proposed Project alignment at E.M. Grimmer Elementary School. The microphone was located in the playing fields near the freight tracks. Airplane overflights and local activities contributed to the noise environment at this site.

### *Auto Mall Parkway to South of East Warren Avenue*

East of the Proposed Project alignment, land uses are commercial/industrial. West of the alignment, land uses are primarily commercial/industrial, except for a few scattered residences north of Grimmer Boulevard. These land uses were identified in the 1992 EIR. The Church of Mission Peak is located approximately 2,500 feet from the Proposed Project alignment on Brown Road, and Warm Springs Baptist Church is located approximately 1,600 feet from the Proposed Project alignment on East Warren Street. These churches were not identified in the 1992 EIR.

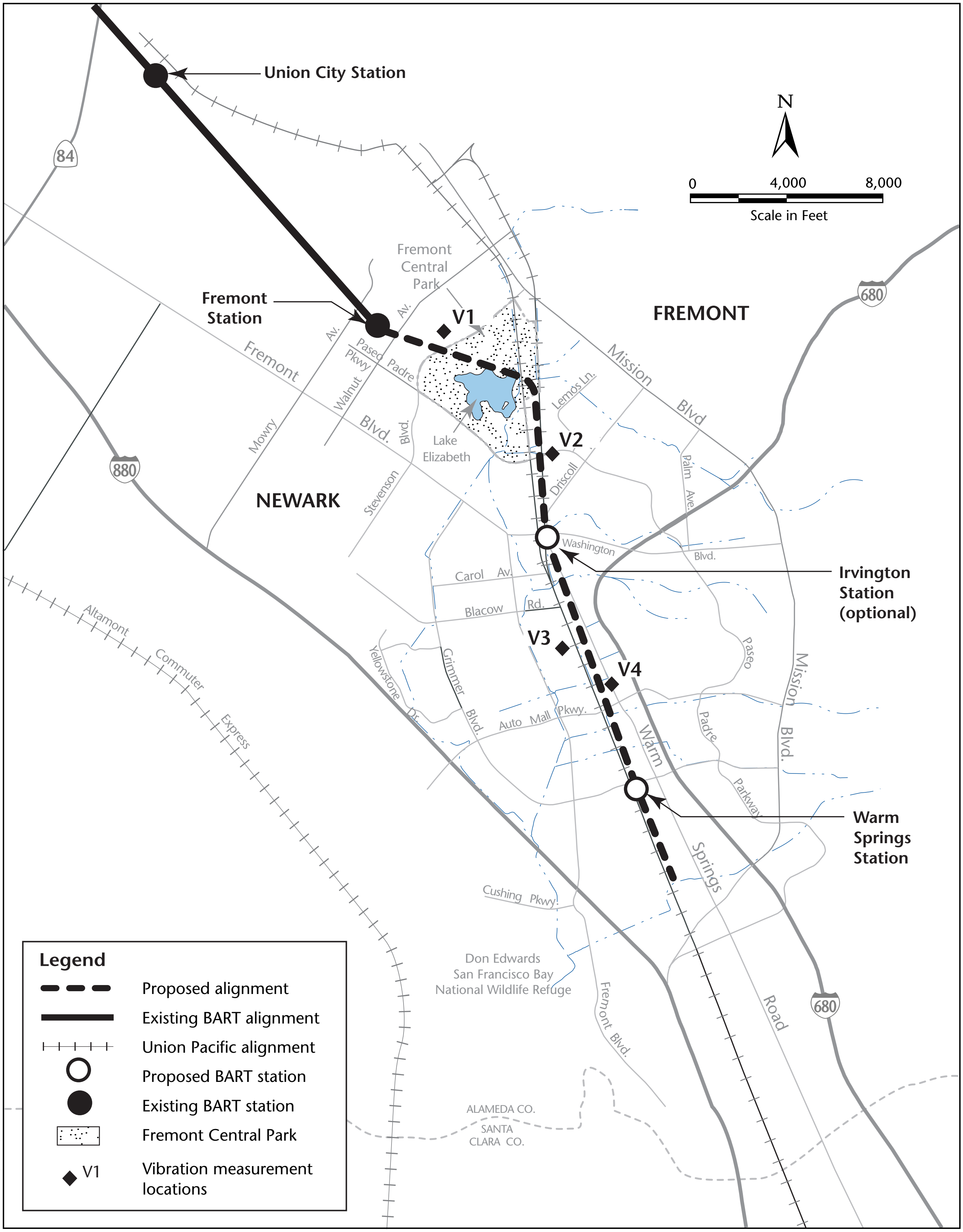
**Site LT-9** was located west of the Proposed Project alignment at 44788 Old Warm Springs Road. The microphone was placed in the side yard of a single-family residence. Auto traffic on Grimmer Boulevard and Old Warm Springs Road dominated the noise environment at this site.

## Assessment of Existing Groundborne Vibration Conditions

Four vibration testing sites (V-1 though V-4) were selected to represent a range of soil conditions in areas along the corridor that include a significant number of vibration-sensitive receptors (Figure 3.10-4). From May 14 through May 15, 2002, a groundborne vibration propagation test was conducted at each of these sites by impacting the ground and measuring the input force and corresponding ground vibration response at various distances from the input site. The resulting force-response transfer function can be combined with the known input force characteristics of the BART vehicle to predict future vibration levels at locations along the Proposed Project corridor. A description of each vibration testing site follows. Land uses near each measurement position are also discussed.

**Site V-1** was located along the Proposed Project alignment near the Red Hawk Ranch Apartments, at the southern end of the undeveloped area extending from Walnut Avenue and Tule Pond south to Stevenson Boulevard. This site is representative of the vibration-sensitive receptors in the northern section of the corridor.

**Site V-2** was located east of the Proposed Project alignment adjacent to Paseo Padre Parkway. This site is representative of vibration-sensitive sites on both sides of Paseo Padre Parkway.




Source: Base map: Jones & Stokes 2002; monitoring by Harris, Miller, Miller & Hanson 2002.

**Figure 3.10-4**
**Vibration Measurement Locations**

**Site V-3** was located west of the Proposed Project alignment at E.M. Grimmer Elementary School. This site is representative of vibration-sensitive receptors west of the Proposed Project corridor and south of Washington Boulevard.

**Site V-4** was located east of the Proposed Project alignment in an industrial area on Osgood Court. The measurements were performed across the Proposed Project alignment from a residential area north of Auto Mall Parkway. This site is representative of vibration-sensitive receptors at the southern end of the Proposed Project alignment.

## Existing Conditions

### Noise

Table 3.10-1 describes the land uses surrounding each of the noise monitoring sites measured in 1992 and the principal existing noise sources affecting each site. Table 3.10-2 summarizes the results of noise monitoring at additional sites conducted in 2002.

### Vibration

The only considerable sources of existing groundborne vibration along the Proposed Project alignment are the UP freight trains operating along the existing tracks in the corridor. Figure 3.10-5 shows existing vibration levels generated by the freight trains as a function of distance from the track. The vibration measurements of the freight trains represent the current vibration levels experienced by residents near the active UP line, and are not related to the BART vehicles.

In addition to measuring the vibration levels from the existing freight trains, the vibration propagation characteristics of the substrate was also measured at representative locations. This information is used later in the process of predicting ground vibration from BART train operations.

# 3.10.3 Regulatory Setting

## Federal Guidelines

The Federal Transit Administration (FTA) has adopted noise and vibration standards for mass transit projects, including rail rapid transit systems (Federal Transit Administration 1995). Compliance with these standards is not required because there are no federal monies involved in the project, and there is no federal approval of the project. Operational noise and vibration impacts associated with the Proposed Project are assessed using the significance criteria developed by BART. These criteria are discussed below. Cumulative noise impacts are assessed using the FTA noise and vibration criteria.

The FTA noise impact criteria are founded on well-documented research on community reaction to noise and are based on a sliding-scale description of change in noise exposure. Although higher transit noise levels are allowed in neighborhoods with high levels of existing noise, smaller increases in cumulative noise exposure are allowed with increasing levels in areas with higher existing noise.

**Table 3.10-1.** Description of 1992 Ambient Noise and Vibration Measurement Sites

| Site Number | Closest Receptor | Surrounding Land Use | Major Existing Noise and Vibration Sources | Approximate Distance from Source (Feet) |
|---|---|---|---|---|
| 1 | Fremont Villas | Residential/park | Stevenson Boulevard (n, v[a]) | 300 |
| | | | Former SP (n) | 3000 |
| 2 | Softball field in Central Park | Park | Stevenson Boulevard (n, v) | 800 |
| | | | Former SP (n) | 1400 |
| | | | UP (n) | 2200 |
| 3 | 1621 Valdez Way | Residential | Former SP (n, v) | 675[b] |
| | | | UP (n, v) | 80[b] |
| 4 | 40779 Vaca Drive | Residential | Former SP (n) | 620[b] |
| | | | UP (n, v) | 90[b] |
| | | | Paseo Padre Parkway (n) | 570[b] |
| 5 | 3224, 3232 Neal Terrace | Multi-family residential | Former SP (n, v) | 50 |
| | | | UP (n, v) | 400 |
| | | | Washington Boulevard (n, v) | 1400 |
| 6 | Apartments south of Washington Boulevard, west of alignment | Residential/commercial | Former SP (n, v) | 60 |
| | | | UP (n, v) | 350 |
| | | | Washington Boulevard (n) | 250 |
| 7 | Homes at end of Blacow Road | Residential | Former SP (n, v) | 50 |
| | | | UP (n, v) | 100 |

| Site Number | Closest Receptor | Surrounding Land Use | Major Existing Noise and Vibration Sources | Approximate Distance from Source (Feet) |
|---|---|---|---|---|
| 8 | Grimmer Elementary School | Residential | Former SP (n, v) | 50 |
| | | | UP (n, v) | 100 |
| | | | I-680 (n, v) | 1400 |
| 9 | 42950 Osgood Road | Commercial | Former SP (n) | 730 |
| | | | UP (n) | 670 |
| | | | I-680 (n) | 420[c] |
| | | | Osgood Road (n, v) | 13 |
| 10 | Hackamore Lane and Warm Springs Boulevard | Residential | Warm Springs Boulevard (n, v) | 17 |
| 11 | 47671 Westinghouse Drive | Industrial | Former SP (n, v) | 200 |
| | | | UP (n, v) | 100 |
| | | | I-880 (n) | 1800 |
| 12 | 101 Camphor Avenue | Residential | Warm Springs Boulevard (n, v) | 25 |

Notes:

[a] n = noise, v = vibration
[b] Partially shielded from noise source

Source: Wilson, Ihrig & Associates 1991; Harris, Miller, Miller and Hanson 2002

**Table 3.10-2.** Summary of May 2002 Existing Ambient Noise Measurement Results

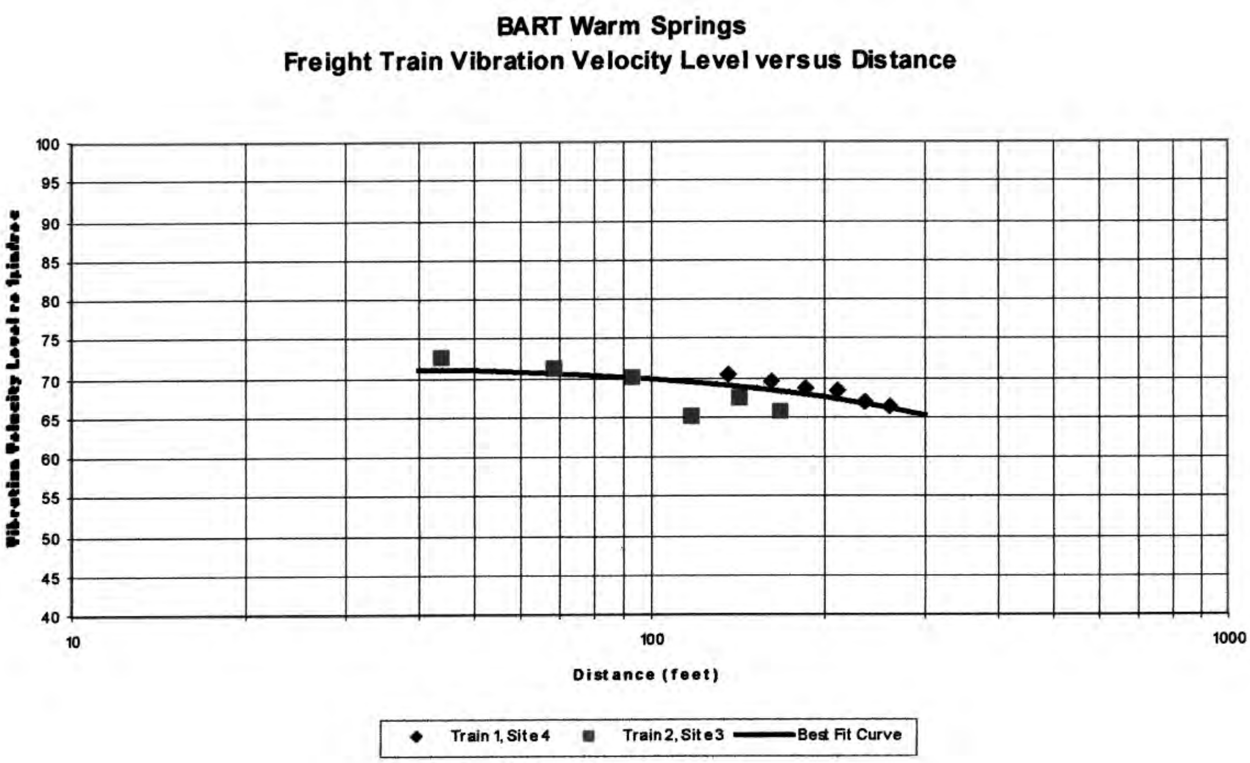
| Site Number[a] | Description of Measurement Site | Start of Measurement | | Measurement Duration (Hours) | Noise Exposure (dBA)[b] | |
|---|---|---|---|---|---|---|
| | | Date | Time | | $L_{dn}$ | $L_{eq}$ |
| LT-1 | Multi-family residential; Presidio apartment complex | 5/15/02 | 10:00 | 24 | 57 | – |
| LT-2 | Multi-family residential; Red Hawk Ranch Apartments | 5/15/02 | 10:00 | 24 | 53 | – |
| LT-3 | Single-family residence at 1549 Valdez Way | 5/13/02 | 17:00 | 24 | 53 | – |
| LT-4 | Single-family residence at 40807 Vaca Road | 5/13/02 | 17:00 | 24 | 53 | – |
| LT-5 | Multi-family residential; 3240 Neal Road | 5/13/02 | 18:00 | 24 | 60 | – |
| LT-6 | Single-family residence at 3073 Driscoll Road, Apt A | 5/13/02 | 18:00 | 24 | 54 | – |
| LT-7 | Single-family residence at 3621 Kay Court | 5/14/02 | 18:00 | 24 | 66 | – |
| LT-8 | Single-family residence at 43244 Newport Drive | 5/14/02 | 18:00 | 24 | 65 | – |
| LT-9 | Single-family residence at 44788 Old Warm Springs Road | 5/15/02 | 19:00 | 24 | 61 | – |
| ST-1 | Fremont Central Park, near walking path | 5/16/02 | 7:35 | 1 | – | 49 |
| ST-2 | St. Anne's Episcopal Church/Church of Christ | 5/13/02 | 17:00 | 1 | – | 54 |
| ST-3 | E. M. Grimmer Elementary School | 5/16/02 | 16:56 | 1 | – | 53 |

Notes:

[a] Locations of noise measurement sites are shown on Figure 3.10-3.

[b] BART cumulative impact criteria for residential uses is express in terms of $L_{dn}$, while the criteria for institutional uses is expressed in terms of hourly $L_{eq}$. Accordingly, ambient noise for these uses is expressed in terms of the corresponding metric.

Source: Harris, Miller, Miller and Hanson, 2002

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Source: Harris, Miller, Miller & Hanson 2002.

**Figure 3.10-5**
**Maximum Existing Union Pacific Freight Train Vibration**

The FTA Noise Impact Criteria group noise-sensitive land uses into the following three categories.

- **Category 1 –** Buildings or parks where quiet is an essential element of their purpose.
- **Category 2 –** Residences and buildings where people normally sleep. This category includes residences, hospitals, and hotels, where nighttime sensitivity is assumed to be of utmost importance.
- **Category 3 –** Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, churches, and active parks.

$L_{dn}$ is used to characterize noise exposure for residential areas (Category 2). For other noise-sensitive land uses, such as outdoor amphitheaters and school buildings (Categories 1 and 3), the maximum 1-hour $L_{eq}$ during the facility's operating period is used.

The FTA criteria include two levels of impacts, summarized below.

- **Severe –** Severe noise impacts are considered "significant," as this term is used in the National Environmental Policy Act (NEPA) and implementing regulations. Noise mitigation will normally be specified for severe impact areas unless no practical method of mitigating the noise exists.
- **Impact –** In this range of noise impact, sometimes referred to as *moderate impact*, other project-specific factors must be considered to determine the magnitude of the impact and assess the need for mitigation. These other factors can include the predicted increase over existing noise levels, the types and number of noise-sensitive land uses affected, existing outdoor-indoor sound insulation, and the cost-effectiveness of mitigating noise to more acceptable levels.

# 3.10.4 Impact Assessment and Mitigation Measures

This section presents the analysis of potential noise and vibration impacts that could result from implementation of the Proposed Project. Where significant noise impacts are identified, mitigation measures to reduce impacts to a less-than-significant level are identified, where feasible.

## Methodology for Impact Analysis

CEQA requires that significance of noise and vibration impacts be determined for proposed projects. The process of assessing the significance of noise and vibration impacts associated with the Proposed Project involved establishing thresholds at which significant impacts are considered to occur at noise-sensitive land uses. These land uses include residences and institutional uses (e.g. schools, churches). Noise and vibration levels associated with project-related activities were then predicted and compared to the significance thresholds. Where a noise or vibration level was predicted to exceed a threshold, the predicted impact was considered significant. Mitigation was then evaluated for each significant impact. A discussion of specific methods used to assess noise and vibration impacts follows.

## Noise Impact Assessment Methodology

BART train noise impacts associated with implementation of the Proposed Project were evaluated using methods defined by FTA (Federal Transit Administration 1995). Additional information considered included noise measurements conducted by Wilson, Ihrig & Associates, Inc. (WIA) and published in 1998 (Wilson, Ihrig & Associates, Inc. 1998), the speed profile designed by BART's General Engineering Consultant and the conceptual engineering drawings of the alignment (see Figures 2-4a through Figure 2-4f). Key assumptions and analytical methods used in this assessment are summarized below.

- Based on the WIA memorandum, the predictions assume that a single 75-foot-long vehicle operating at 80 mph on ballast and tie track with continuous welded rail (CWR) generates a maximum noise level of 84 dBA at a distance of 50 feet from the track centerline. The projections of $L_{max}$ values at receptors along the corridor are calculated using standard models for transit vehicles.
- The span of service (hours of operation) for the Proposed Project will be between 4:00 a.m. and midnight. The operating plan for BART service specifies peak headways of 12 minutes and an off-peak headway of 20 minutes, for both the Richmond service and the 24th Street service. BART vehicles will operate with 10 cars throughout the day.
- Peak operations will occur between 4:00 a.m. and 7:00 p.m. and off-peak operations will occur between 7:00 p.m. and 12:00 a.m. for the Warm Springs/Richmond Service. The operations would be identical for the Warm Springs/24th Street Service, except that peak operations will commence at 5:00 a.m.
- Vehicle operating speeds are based on the speed profile. Speed limits range from 37 mph to 70 mph along the corridor.
- An additional 6 dB is added to the noise projections for receptors near crossovers.[1]

Noise impacts resulting from construction activities were modeled using methodology developed by the FTA (Federal Transit Administration 1995). Under this methodology, FTA identifies noise source levels at a fixed distance of 50 feet for various types of construction activity. The noise levels from these sources are then calculated at receiver locations based on a noise attenuation model.

## Vibration Impact Assessment Methodology

Vibration impacts caused by BART trains associated with implementation of the Proposed Project were evaluated using methods defined by FTA (Federal Transit Administration 1995) and vibration measurement data. Key assumptions and analysis methods used in this assessment are summarized below.

[1] The term *crossover* refers to special trackwork that allow transit vehicles to switch between tracks. Crossovers contain gaps in the track to allow the wheels to move from one track to the other, and these gaps generate additional noise and vibration as the vehicle moves through the crossover.

- Vibration source levels were based on measurements previously conducted on vehicles operating on the existing BART system by WIA (1998).
- Vibration propagation tests were conducted at four sites along the corridor near sensitive receptors. Figure 3.10-5 shows the locations of the propagation tests along the proposed corridor. These tests measured the response of the ground to an input force. The results of these tests were combined with the vibration source level measurements to provide projections of future vibration levels from vehicles operating on the Proposed Project. A more detailed discussion of the vibration impact analysis procedure is contained in Appendix O.
- Vehicle operating speeds are based on the BART speed profile. The speed limits range from 37 mph to 70 mph along the corridor.
- An additional 10 dB is added to the vibration projections for receptors near crossovers.

The assessment assumes that the BART vehicle wheels and track are maintained in good condition with regular wheel truing and rail grinding.

# Criteria for Determining Significance of Impacts

## Criteria for Operational Noise Impacts

BART has adopted criteria for noise and vibration in its 1992 *Extensions Program System Design Criteria*. The criteria specify maximum passby noise and vibration levels for BART trains and maximum noise levels from ancillary facilities, which are related directly to the community area categories defined by BART. The BART train noise criteria are based on the maximum noise level ($L_{max}$) generated by a train passby. The criteria depend on the type of receptor (single-family, multi-family, commercial) and the area land use category. Table 3.10-3 presents the BART design criteria for operational noise. Table 3.10-4 presents the BART criteria for ancillary facilities. In addition to the criteria, BART has also adopted the FTA noise criteria for cumulative noise impacts. These criteria are discussed in the section on cumulative impacts.

The BART noise criteria were used to assess the significance of potential noise impacts related to the Proposed Project. This procedure differs from the procedure used in the 1992 EIR, which used the former Urban Mass Transit Administration (UMTA, now FTA) and the American Public Transportation Association (APTA) guidelines for evaluating noise impacts from the Proposed Project.

Specifically, an operational noise impact from trains or ancillary facilities was considered significant if either of the following are predicted to occur.

- A BART train maximum passby noise level exceeds values listed in Table 3.10-3.
- Noise from ancillary facilities exceeds values listed in Table 3.10-4.

Where implementation of all feasible exterior noise mitigation does not reduce noise to a level that is below the thresholds defined above, implementation of interior noise-mitigation measures that reduce

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interior noise to less than 45 dB- $L_{dn}$ is considered to mitigate significant noise impacts to a less-than-significant level.

**Table 3.10-3.** BART Design Criteria for Operational Noise from BART Trains

| BART Area Category* | Maximum Passby Noise Level (dBA) Single-Family Dwellings | Multi-Family Dwellings | Commercial Buildings |
|---|---|---|---|
| I Low Density Residential: urban residential, open space park, suburban residential or quiet recreation area. No nearby highways or boulevards | 70 | 75 | 80 |
| II Average Residential: urban residential, quiet apartments and hotels, open space, suburban residential, or occupied outdoor areas near busy streets | 75 | 75 | 80 |
| III High Density Residential: urban residential, average semi-residential/commercial areas, parks, museum, and non-commercial public building areas | 75 | 80 | 85 |
| IV Commercial: areas with office buildings, retail stores, etc., primarily daytime occupancy. Central Business Districts | 80 | 80 | 85 |
| V Industrial/Highway: areas or Freeway and Highway Corridors. | 80 | 85 | 85 |
| *Special Receptors* | | | |
| "Quiet" Outdoor Recreation Areas | | 70 | |
| Concert Halls, Radio and TV Studios | | 70 | |
| Churches, Theaters, Schools, Hospitals | | 75 | |

Note:
* Residential land uses are described in additional detail in Section 3.4 (*Land Use and Planning*).

Source: San Francisco Bay Area Rapid Transit District 1992

**Table 3.10-4.** BART Design Criteria for Operational Noise from Ancillary Facilities

| BART Area Category* | Maximum Noise Level (dBA) | |
|---|---|---|
| | Transient | Continuous |
| I Low Density Residential: urban residential, open space park, suburban residential or quiet recreation area. No nearby highways or boulevards | 50 | 40 |
| II Average Residential: urban residential, quiet apartments and hotels, open space, suburban residential, or occupied outdoor areas near busy streets | 55 | 45 |
| III High Density Residential: urban residential, average semi-residential/commercial areas, parks, museum, and non-commercial public building areas | 60 | 50 |
| IV Commercial: areas with office buildings, retail stores, etc., primarily daytime occupancy. Central Business Districts | 65 | 55 |
| V Industrial/Highway: areas or Freeway and Highway Corridors. | 70 | 65 |

Notes:
Criteria are reduced by 5 dBA for noises with pure tones.
* Residential land uses are described in additional detail in Section 3.4 (*Land Use and Planning*).

Source: San Francisco Bay Area Rapid Transit District 1992

## Criteria for Construction-Related Noise Impacts

BART has adopted criteria for construction noise in its 1992 *Extensions Program System Design Criteria*. Construction noise criteria are based on the BART specifications. These criteria, summarized in Table 3.10-5, are based on land use and type of noise, either intermittent (day or night) or continuous. A construction noise impact was considered significant if predicted construction noise levels are predicted to exceed values listed in Table 3.10-5.

**Table 3.10-5.** BART Specifications for Construction Noise

| Land Use of Receptor | Maximum Daytime Intermittent Noise Level (dBA) | Maximum Nighttime Intermittent Noise Level (dBA) | Maximum Continuous Noise Level (dBA) |
|---|---|---|---|
| Single Family Residential | 75 | 60 | 60 |
| Commercial Areas (including hotels) | 80 | 70 | 70 |
| Industrial Areas (without Hotels) | 85 | 85 | 70 |

Note:
Maximum noise levels (Lmax) for intermittent activities apply to non-repetitive, short-term noises not lasting more than a few hours. Maximum continuous noise levels (Lmax) apply to either repetitive or long-term noise lasting more than a few hours. Outdoor recreational areas in the project corridor are designated with the criteria for “Commercial Areas (including hotels).”

Source: San Francisco Bay Area Rapid Transit District

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## Criteria for Operational Vibration Impacts

BART has adopted criteria for groundborne vibration generated by BART trains in its 1992 *Extensions Program System Design Criteria*. These criteria are presented in Table 3.10-6. A vibration impact from train operations was considered significant if vibration levels were predicted to exceed values listed in Table 3.10-6.

**Table 3.10-6.** BART Design Criteria for Operational Groundborne Vibration

| | Ground-Borne Vibration Maximum Passby Velocity Levels (VdB, µin/sec) | | |
|---|---|---|---|
| BART Area Category | Single Family Dwellings | Multi Family Dwellings | Commercial Buildings |
| I Low Density Residential | 70 | 70 | 70 |
| II Average Residential | 70 | 70 | 75 |
| III High Density Residential | 70 | 75 | 75 |
| IV Commercial | 70 | 75 | 75 |
| V Industrial/Highway | 75 | 75 | 75 |
| | Maximum Passby Levels ( VdB, µin/sec) | | |
| Concert Halls and TV Studios | 65 | | |
| Churches and Theaters | 70-75 | | |
| Hospital Sleeping Rooms | 70-75 | | |
| Courtrooms, Schools, Libraries | 75 | | |
| Offices | 75-80 | | |
| Commercial and Industrial Buildings | 75-85 | | |
| Vibration-Sensitive Industry or Research | 60-70 | | |

Source: San Francisco Bay Area Rapid Transit District 1992, *Extensions Program System Design Criteria*

## Criteria for Construction-Related Vibration Impacts

BART has adopted criteria for groundborne vibration generated by construction activity in its 1992 *Extensions Program System Design Criteria*. A vibration impact from construction was considered significant if vibration levels were predicted to exceed 80 VdB (more than 1 hour per day), 90 VdB (less than 1 hour per day), or 100 VdB (less than 10 minutes per day), or the peak particle velocity damage threshold of 0.20 inches per second for fragile buildings or structures.

# Impacts and Mitigation Measures

## Impacts Related to Warm Springs Extension

### *Operational Impacts*

**Impact N1 – Exposure of noise-sensitive land uses to noise from BART trains in the Proposed Project corridor.** Where BART will run above ground, detailed projections were made of the project-induced maximum noise levels at noise-sensitive land uses along the Proposed Project alignment. The noise projections were compared with the BART design criteria to determine locations where operations are predicted to result in significant project-induced noise impacts. Tables 3.10-7 and 3.10-8 present the results of the project-induced noise impact analysis. Table 3.10-7 includes results for residential receptors from north to south along the alignment. Table 3.10-8 lists all institutional receptors (churches, schools, etc.) from north to south along the alignment. For the project-induced noise impact analysis, all residential receptors are assumed to be in the Category II Average Residential or Category III High Density Residential land use category of the BART design criteria.

As shown in Table 3.10-7, significant project-induced noise impacts are predicted at a total of 110 residences. A brief discussion of each impacted area follows.

- Walnut Avenue to Stevenson Boulevard (east side). No significant project-induced noise impacts are predicted to occur at residences in this location because the residences are located at distances of approximately 145 feet from the tracks, and the portal walls provide shielding.
- Walnut Avenue to Stevenson Boulevard (west side). Significant project-induced noise impacts are predicted to occur at three buildings in the Fremont Villas condominiums, each with four units for a total of 12 residences. The noise impact will result from a combination of the speed of the BART vehicles and the proximity of the buildings (less than 50 feet for some buildings) to the tracks.
- Valdez Way/Vaca Road (east side). No significant project-induced noise impacts are predicted to occur at residences in this location. The residences are located at distances of over 300 feet from the tracks.
- Paseo Padre Parkway to Washington Boulevard (west side). No significant project-induced noise impacts are predicted to occur at residences in this location. The residences are located at distances of more than 400 feet from the tracks.
- Paseo Padre Parkway to Washington Boulevard (east side). Significant project-induced noise impacts are predicted to occur at 31 single-family residences in this area. Along Valero Drive, 22 residences are located within 170 feet of the tracks. The crossover between points 2309 and 2315 is projected to contribute to the noise impact at these residences in addition to the proximity of the residences to the tracks and the speed of the BART vehicles. Significant noise impacts are also predicted to occur at nine additional residences located just to the south of this area along Driscoll Road. The noise impacts at this location result primarily from the small distance between the tracks and the residences (20 feet for the closest residence).

**Table 3.10-7.** Residential Noise Impacts of Proposed Project

| Location | Civil Stn | Side of Track | Dist to Near Track (ft) | Speed (mph) | Maximum Passby Noise Level (dBA) | BART Design Criterion (dBA) 1 | # of Residences Impacted |
|---|---|---|---|---|---|---|---|
| Walnut Ave to Stevenson Blvd | 2227 to 2242 | NB | 145 | 50/70 | 71 | 75 | 0 |
| Walnut Ave to Stevenson Blvd | 2230 to 2238 | SB | 45 | 50/70 | 81 | 75 | 12 |
| Valdez Way/Vaca Road | 2290 to 2304 | NB | 300 | 70 | 70 | 75 | 0 |
| Paseo Padre Parkway to Washington Blvd | 2308 to 2334 | SB | 390 | 70 | 73 | 75 | 0 |
| Paseo Padre Parkway to Washington Blvd | 2308 to 2334 | NB | 20 | 70 | 89 | 75 | 31 |
| Washington Blvd to Blacow Road | 2339 to 2370 | NB | 340 | 70 | 69 | 75 | 0 |
| Washington Blvd to Blacow Road | 2339 to 2368 | SB | 95 | 70 | 79 | 75 | 12 |
| Blacow Road to Auto Mall Parkway | 2370 to 2415 | SB | 130 | 70 | 76 | 75 | 55 |
| Auto Mall Parkway to South Grimmer Road | 2415 to 2451 | SB | 230 | 70 | 72 | 75 | 0 |
| Total: | | | | | | | **110** |

Note:

1. BART design criterion of 75 dBA is based on the Average Density and High Density Residential Categories for Single and Multi-Family Dwellings. (See Table 3.10-3.)

Source: Harris, Miller, Miller and Hanson 2002

**Table 3.10-8.** Institutional Noise Impacts of Proposed Project

| Location | Civil Stn | Side of Track | Dist to Near Track (ft) | Speed (mph) | Maximum Passby Noise Level (dBA) | BART Design Criterion (dBA) * | Impact? |
|---|---|---|---|---|---|---|---|
| St. Anne's Episcopal Church | 2329 | NB | 390 | 70 | 68 | 75 | No |
| Church of Christ | 2330 | NB | 290 | 70 | 70 | 75 | No |
| E.M. Grimmer Elementary School | 2391 | SB | 300 | 60 | 68 | 75 | No |
| E.M. Grimmer Elementary School Playground | 2391 | SB | 95 | 60 | 77 | 75 | Yes |

Note:

* BART design criterion of 75 dBA is based on the maximum passby noise level for churches, theaters, schools, and hospitals. (See Table 3.10-3.)

Source: Harris, Miller, Miller and Hanson 2002

- Washington Boulevard to Blacow Road (east side). No significant project-induced noise impacts are predicted to occur at residences in this location. The residences are located at distances of more than 300 feet from the tracks.

- Washington Boulevard to Blacow Road (west side). Significant project-induced noise impacts are predicted to occur at twelve single-family residences. The noise impacts result from a combination of the speed of the BART vehicles (70 mph) and the proximity of the residences to the tracks (within 100 feet).

- Blacow Road to Auto Mall Parkway (west side). Significant project-induced noise impacts are predicted to occur at a total of 55 single-family residences. The noise impacts result from a combination of the speed of the BART vehicles (70 mph) and the proximity of the residences to the tracks (within 100 feet).

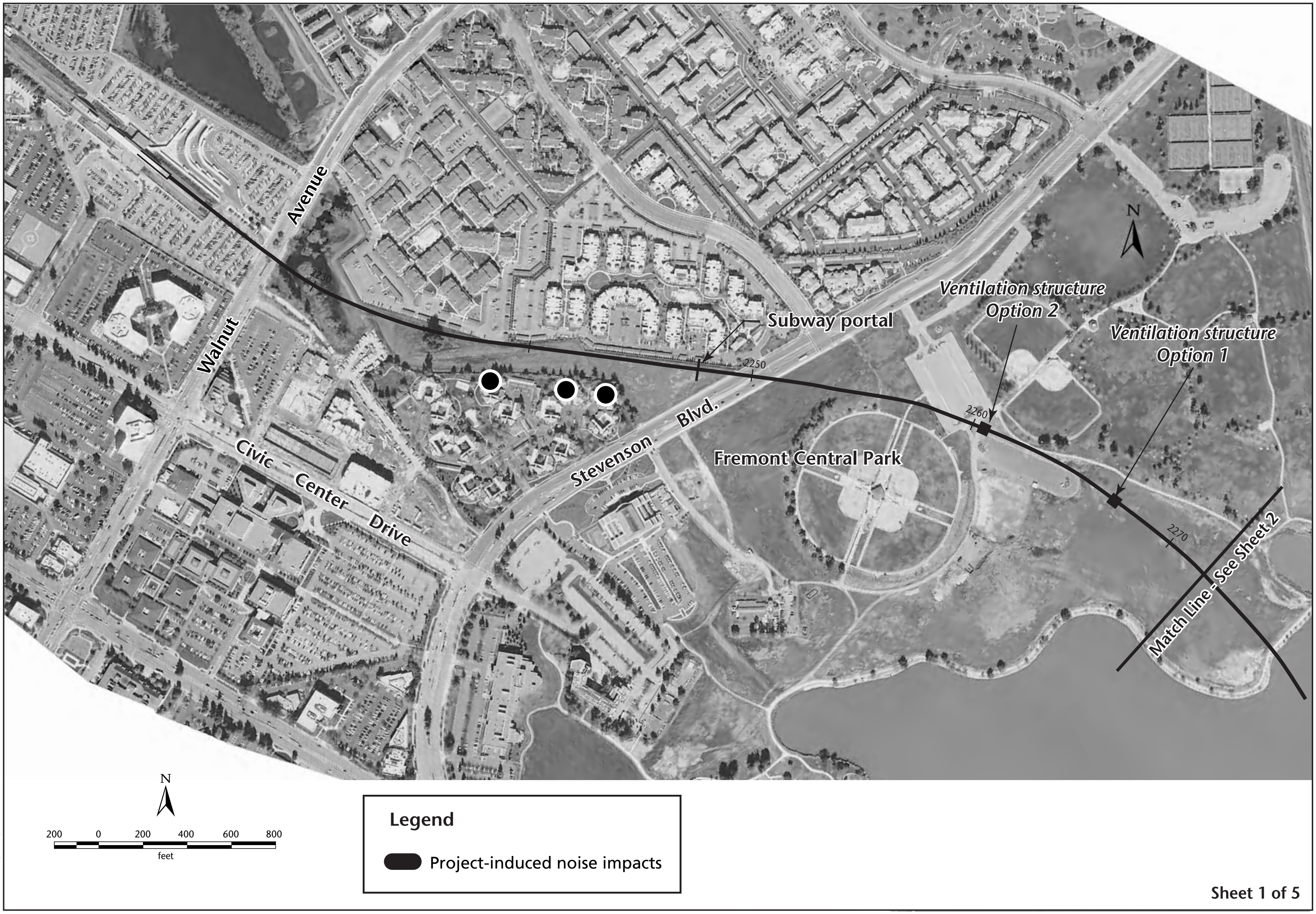
- Auto Mall Parkway to South Grimmer Road (west side). No significant project-induced noise impacts are predicted to occur at residences in this location. The residences are located at distances of more than 200 feet from the tracks.

As indicated in Table 3.10-8, a significant project-induced noise impact is predicted to occur at the E. M. Grimmer Elementary School playground. The noise impact results from the proximity of the nearest active areas of the playground to the tracks and the speed (70 mph) of the BART vehicles.

Figures 3.10-6a through 3.10-6e show the locations of the predicted significant project-induced noise impacts discussed above. Implementation of the following mitigation measure would reduce this impact to a less-than-significant level. *(Less than significant with mitigation incorporated.)*

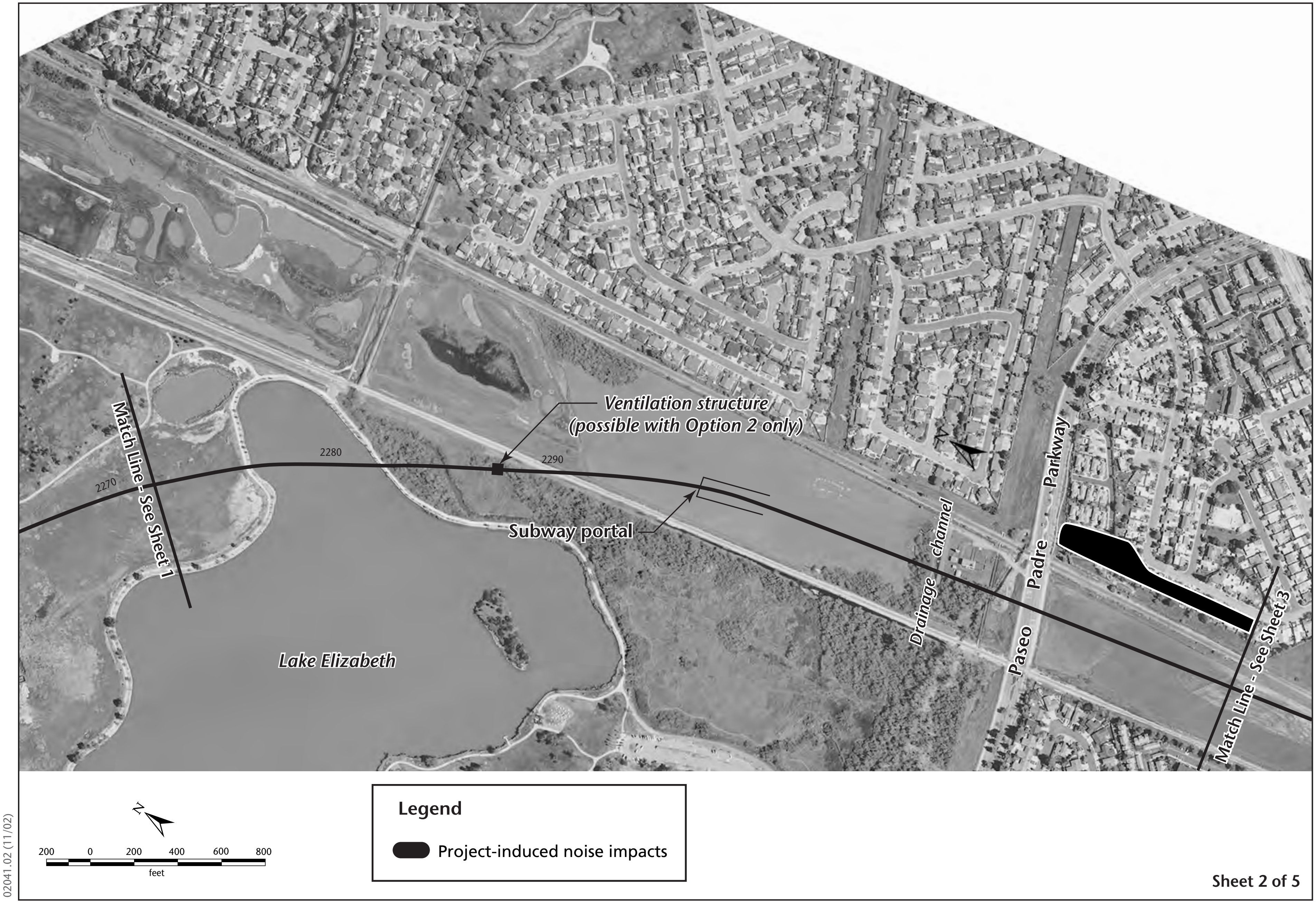
**Mitigation Measure N1 – Implement noise-reducing measures at noise-sensitive land uses in the Proposed Project corridor.** BART will design and implement noise-reducing measures such that noise from train operations does not exceed the operational noise limits listed in Table 3.10-3. The measures may include but are not limited to the following.

- **Noise Barriers** – Construction of barriers is a common approach to reducing noise impacts from surface transportation sources. The primary requirements for an effective noise barrier are that (1) the barrier must be high enough and long enough to break the line-of-sight between the sound source and the receiver; (2) the barrier must be of an impervious material with a minimum surface density of 4 lb/sq. ft.; and (3) the barrier must not have any gaps or holes between the panels or at the bottom. Because numerous materials meet these requirements, the selection of materials for noise barriers is usually dictated by aesthetics, durability, cost, and maintenance considerations. Depending on the proximity of the barrier to the tracks and on the track elevation, transit system noise barriers typically range in height from between 4 and 8 feet.



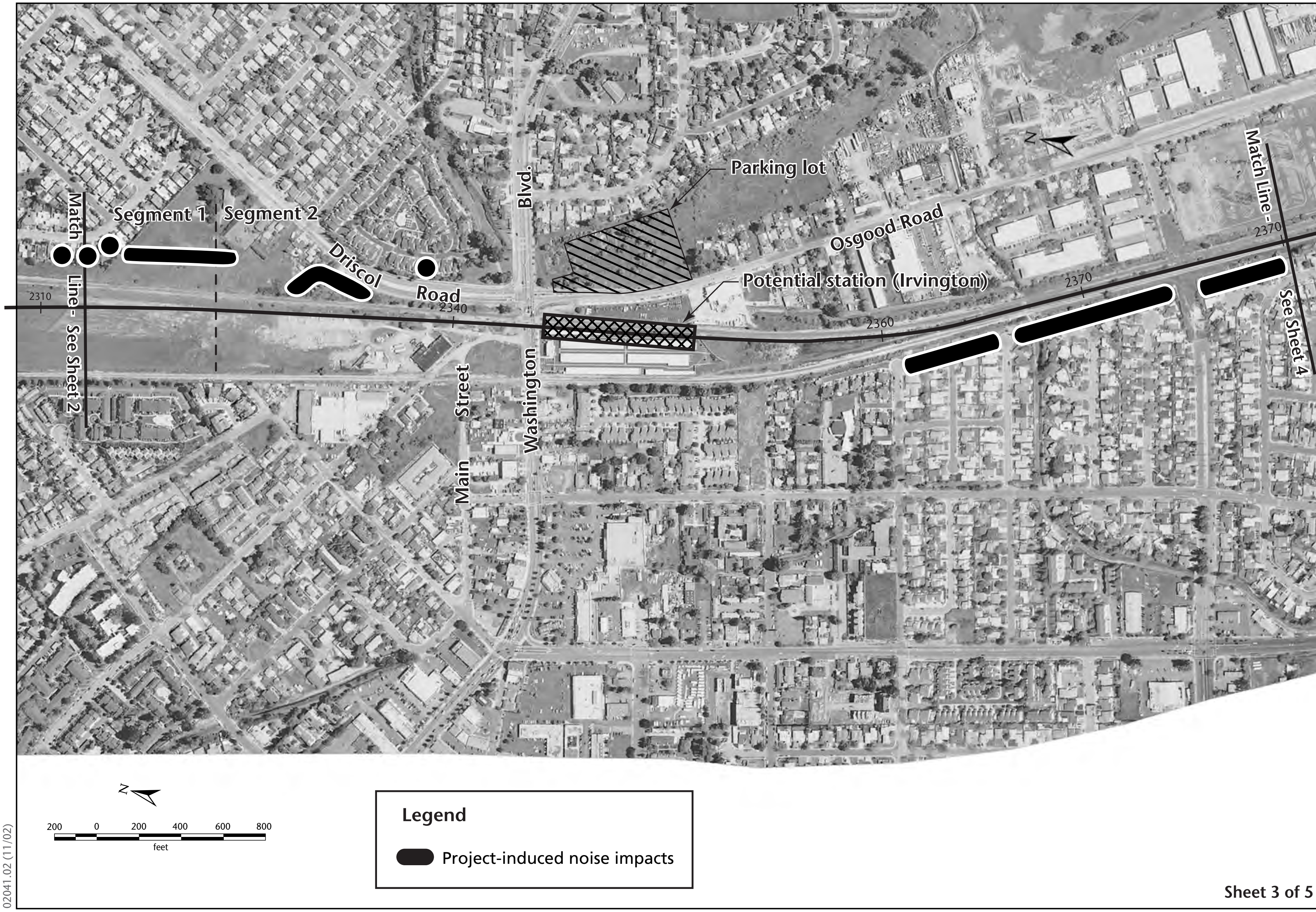

Source: Harris, Miller, Miller & Hanson 2002.

**Figure 3.10-6a**
**Project-Induced Noise Impacts**




Source: Harris, Miller, Miller & Hanson 2002.

**Figure 3.10-6b**
**Project-Induced Noise Impacts**




Source: Harris, Miller, Miller & Hanson 2002.

**Figure 3.10-6c**
**Project-Induced Noise Impacts**


02041.02 (2/03)

Source: Harris, Miller, Miller & Hanson 2002.

**Figure 3.10-6d**
**Project-Induced Noise Impacts**


02041.02 (2/03)

Source: Harris, Miller, Miller & Hanson 2002.

**Figure 3.10-6e**
**Project-Induced Noise Impacts**
**Proposed Bus Alternative**

- **Building Sound Insulation** – Sound insulation of residences and institutional buildings to improve the outdoor-to-indoor noise reduction has been widely applied around airports and has seen limited application for transit projects. Although this approach has no effect on noise in exterior areas, it may be the best choice for sites where noise barriers are not feasible or desirable, and for buildings where indoor sensitivity is of greatest concern. Substantial improvements in building sound insulation (on the order of 5 to 10 dBA) can often be achieved by adding an extra layer of glazing to the windows, by sealing any holes in exterior surfaces that act as sound leaks, and by providing forced ventilation and air-conditioning so that windows do not need to be opened.
- **Special Trackwork at Crossovers** – Because the impacts of wheels over rail gaps at track crossover locations increase noise by about 6 dBA, crossovers are a major source of noise impact when they are located in sensitive areas. If crossovers cannot be relocated away from residential areas, another approach is to use spring-rail or moveable point crossovers in place of standard crossovers. These special types of crossovers eliminate the gap in the track caused by crossovers in the main traffic direction, thereby eliminating the additional noise associated with crossovers.

Based on the results of the noise assessment, potential mitigation measures have been identified. The primary mitigation measure would be the construction of sound barrier walls to shield areas where significant impacts are predicted. Table 3.10-9 indicates the approximate noise barrier locations, lengths, and side of track as well as the number of significant impacts that would be reduced. Barriers are assumed to provide at least 8dB of noise reduction. Other measures may include relocating the crossover near Station 2311 and the installation of building sound insulation

A combination of noise barriers, building sound insulation, and relocation of the crossover near Station 2311 would reduce all significant noise impacts along the Proposed Project alignment to a less-than-significant level.

Specific implementation of the noise mitigation measures described above, including details regarding noise barrier heights and lengths, locations for sound insulation, and locations of crossover, will be addressed in detail during preliminary engineering and final design, when further detail about track and receiver elevation, track location, and other pertinent information will be available. This information will be utilized to adapt the mitigation measures presented above on a site-specific basis and will allow design at an appropriate level of detail. However, based on reasonable worst-case assumptions, deploying these mitigation measures individually or in combination as necessary will suffice to reduce noise impacts to a less-than-significant level.

**Table 3.10-9.** Potential Locations for Noise Barriers

| Location | Civil Stn | Side of Track | Length (Feet) | Number of Residences Exposed to Significant Impacts Without Mitigation | Number of Residences Exposed to Significant Impacts With Mitigation [1] |
|---|---|---|---|---|---|
| Walnut Ave to Stevenson Blvd | 2228 – 2240 | SB | 1200 | 12 | 0 |
| Paseo Padre Parkway to Washington Blvd | 2308 – 2337 | NB | 2900 | 31 | 2 |
| Washington Blvd to Blacow Road | 2353 – 2370 | SB | 1700 | 12 | 0 |
| Blacow Road to Auto Mall Parkway | 2370 – 2415 | SB | 4500 | 55 | 0 |
| **Total:** | | | **10,300** | **110** | **2** |

Note:
[1] The mitigation assessment assumes a minimum of 8 dB of noise reduction for a noise barrier. Detailed barrier design and mitigation projections will be made during the design phase of the project.

Source: Harris, Miller, Miller and Hanson 2002

**Impact N2 – Exposure of vibration-sensitive land uses to groundborne vibration from BART trains.** Predicted groundborne vibration levels (VdB re 1 micro-in./sec.) resulting from BART train operations are summarized in Tables 3.10-10 and 3.10-10. Vibration-sensitive land uses (listed from north to south) along the alignment are included in Table 3.10-10 for residential land uses and in Table 3.10-11 for institutional land uses. Each table lists the locations from north to south, the civil station, the side of the track, the distance to the near track, and the projected speed at each location. The predicted project maximum vibration level and the BART impact criterion level are also indicated together with the number of residences predicted to be exposed to significant vibration impacts.

Table 3.10-10 indicates that 124 residences are predicted to be exposed to significant vibration impacts. A brief discussion of each impacted area follows.

- Walnut Avenue to Stevenson Boulevard (east side). Significant project-induced vibration impacts are predicted to occur at two buildings in the Red Hawk Ranch Apartments complex with a total of 54 units. The vibration impacts result from a combination of the speed of the BART vehicles and the proximity of the buildings (less than 100 feet for some buildings) to the tracks.
- Walnut Avenue to Stevenson Boulevard (west side). Significant project-induced vibration impacts are predicted to occur at three buildings in the Fremont Villas condominiums with four units each (for a total of 12 residences). The vibration impacts result from a combination of the speed of the BART vehicles and the proximity of the buildings (less than 50 feet for some buildings) to the tracks.

**Table 3.10-10.** Residential Vibration Impacts of Proposed Project

| Location | Civil Station | Side of Track | Dist to Near Track (ft) | Speed (mph) | Max Project Vibration Level[1, 2] | BART CEQA Significance Criterion[1] | Number of Residences Exposed to Significant Impacts |
|---|---|---|---|---|---|---|---|
| Walnut Ave to Stevenson Blvd | 2227 to 2242 | NB | 95 | 50/70 | 74 | 70 | 54 |
| Walnut Ave to Stevenson Blvd | 2230 to 2238 | SB | 45 | 50/70 | 81 | 70 | 12 |
| Valdez Way/Vaca Road | 2290 to 2304 | NB | 300 | 70 | 62 | 70 | 0 |
| Paseo Padre Parkway to Washington Blvd | 2308 to 2334 | SB | 390 | 70 | 60 | 70 | 0 |
| Paseo Padre Parkway to Washington Blvd | 2308 to 2334 | NB | 20 | 70 | 87 | 70 | 8 |
| Washington Blvd to Blacow Road | 2339 to 2370 | NB | 340 | 70 | 55 | 70 | 0 |
| Washington Blvd to Blacow Road | 2339 to 2368 | SB | 95 | 70 | 73 | 70 | 10 |
| Blacow Road to Auto Mall Parkway | 2370 to 2415 | SB | 115 | 70 | 71 | 70 | 40 |
| Auto Mall Parkway to South Grimmer Road | 2415 to 2451 | SB | 230 | 70 | 55 | 70 | 0 |
| **Total:** | | | | | | | **124** |

Notes:
[1]Vibration levels are measured in VdB referenced to 1 micro-inch/second.
[2]The vibration levels in this column represent the highest vibration levels at a receptor in this location.

Source: Harris, Miller, Miller and Hanson 2002

**Table 3.10-11.** Institutional Vibration Impacts of Proposed Project

| Location | Civil Stn | Side of Track | Dist to Near Track (ft) | Speed (mph) | Max Project Vibration Level[1] | BART CEQA Significance Criterion[2] | Significant Impact? |
|---|---|---|---|---|---|---|---|
| St. Anne's Episcopal Church | 2324 | NB | 390 | 70 | 63 | 75 | No |
| Church of Christ | 2325 | NB | 290 | 70 | 66 | 75 | No |
| E.M. Grimmer Elementary School | 2386 | SB | 300 | 70 | 61 | 75 | No |

Note:
[1] Vibration levels are measured in VdB referenced to 1 micro-inch/sec.
[2] BART criterion for schools and churches (see Table 3.10-6).

Source: Harris, Miller, Miller and Hanson 2002

- Valdez Way/Vaca Road (east side). No significant project-induced vibration impacts are predicted to occur at residences in this location. The residences are located at distances of more than 300 feet from the tracks.
- Paseo Padre Parkway to Washington Boulevard (west side). No significant project-induced vibration impacts are predicted to occur at residences in this location. The residences are located at distances of more than 400 feet from the tracks.
- Paseo Padre Parkway to Washington Boulevard (east side). Significant project-induced vibration impacts are predicted to occur at eight single-family residences in this area. Three residences along Valero Drive are located within 170 feet of the tracks. In addition to the proximity of the residences to the tracks and the speed of the BART vehicles, the crossover between points 2309 and 2315 is expected to contribute to the vibration impact at these residences. Significant project-induced vibration impacts are predicted to occur at five additional residences located just to the south of this area along Driscoll Road. The vibration impacts result primarily from the small distance between the tracks and the residences (20 feet for the closest residence).
- Washington Boulevard to Blacow Road (east side). No significant project-induced vibration impacts are predicted to occur at residences in this location. The residences are located at distances of more than 300 feet from the tracks.
- Washington Boulevard to Blacow Road (west side). Ten single-family residences are projected to sustain vibration impact. The vibration impacts result from a combination of the speed of the BART vehicles (70 mph) and the proximity of the residences to the tracks (within 100 feet).
- Blacow Road to Auto Mall Parkway (west side). Forty single-family residences are projected to sustain vibration impact. The vibration impacts result from a combination of the speed of the BART vehicles (70 mph) and the proximity of the residences to the tracks (within 100 feet).
- Auto Mall Parkway to South Grimmer Boulevard (west side). No significant project-induced vibration impacts are predicted to occur at residences in this location. The residences are located at distances of more than 200 feet from the tracks.

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As shown in Table 3.10-11, no potential institutional vibration impacts were identified along the Proposed Project alignment.

Figures 3.10-7a through 3.10-7e show the locations of potential impacts created by groundborne vibration discussed above. Exposure of residences to vibration from BART train operations is considered a significant impact. Implementation of the following mitigation measure is expected to reduce this impact to a less-than-significant level. However there may be some situations where implementation of all feasible mitigation would not reduce the impact to less than significant. The situations where this could occur cannot be determined until the detailed vibration mitigation design is developed. Because there may be some situations where significant vibration impacts cannot be mitigated to less than significant, this impact is considered significant and unavoidable. *(Significant and unavoidable.)*

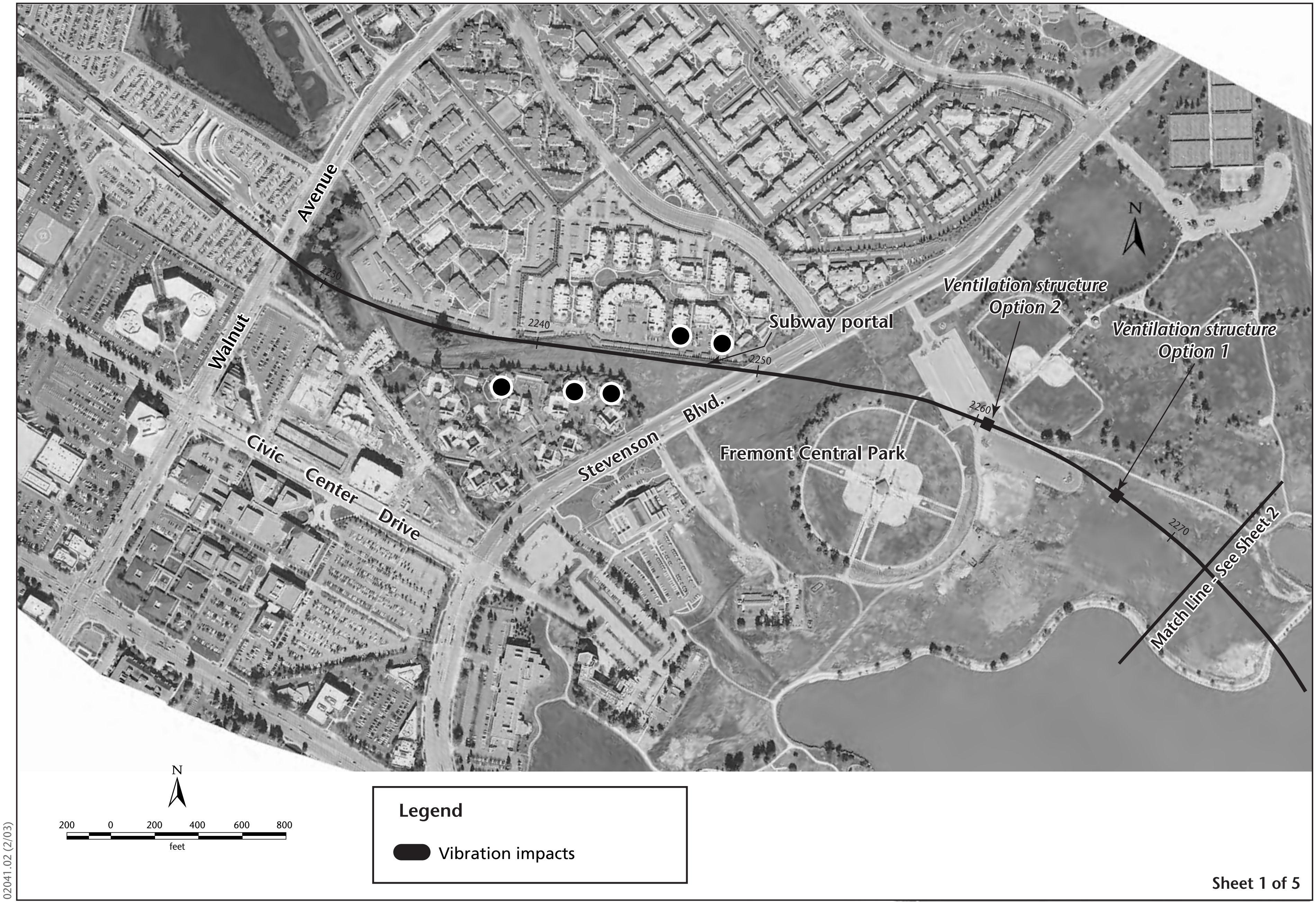
**Mitigation Measure N2 – Implement vibration-reducing measures at vibration-sensitive land uses in the Proposed Project corridor.** BART will design and implement vibration-reducing measures such that groundborne vibration from train operations does not exceed the operational vibration limits listed in Table 3.10-6. The measures may include but are not limited to the following.

- **Ballast Mats** – Rail trackways consist of ballast and ties. Ballast is the aggregate rock material that lies between the crosspieces of wood or concrete that support the rails. A ballast mat consists of a pad made of rubber or rubber-like material placed on an asphalt or concrete base with the normal ballast, ties, and rail above. The reduction in ground-borne vibration provided by a ballast mat depends strongly on the frequency content of the vibration and on the design and support of the mat. Ballast mats will only work in locations where there is ballast and tie track.

- **Resilient Fasteners and/or Resiliently Supported Ties** – A number of resilient fastening systems for reducing vibration are available. However, many resilient fasteners are suitable for direct fixation only and would not work for ballast and tie track. Resilient fasteners reduce the amount of vibration energy that is transferred into the track substructure and are effective in reducing ground-borne vibration in frequencies above 30 Hz.

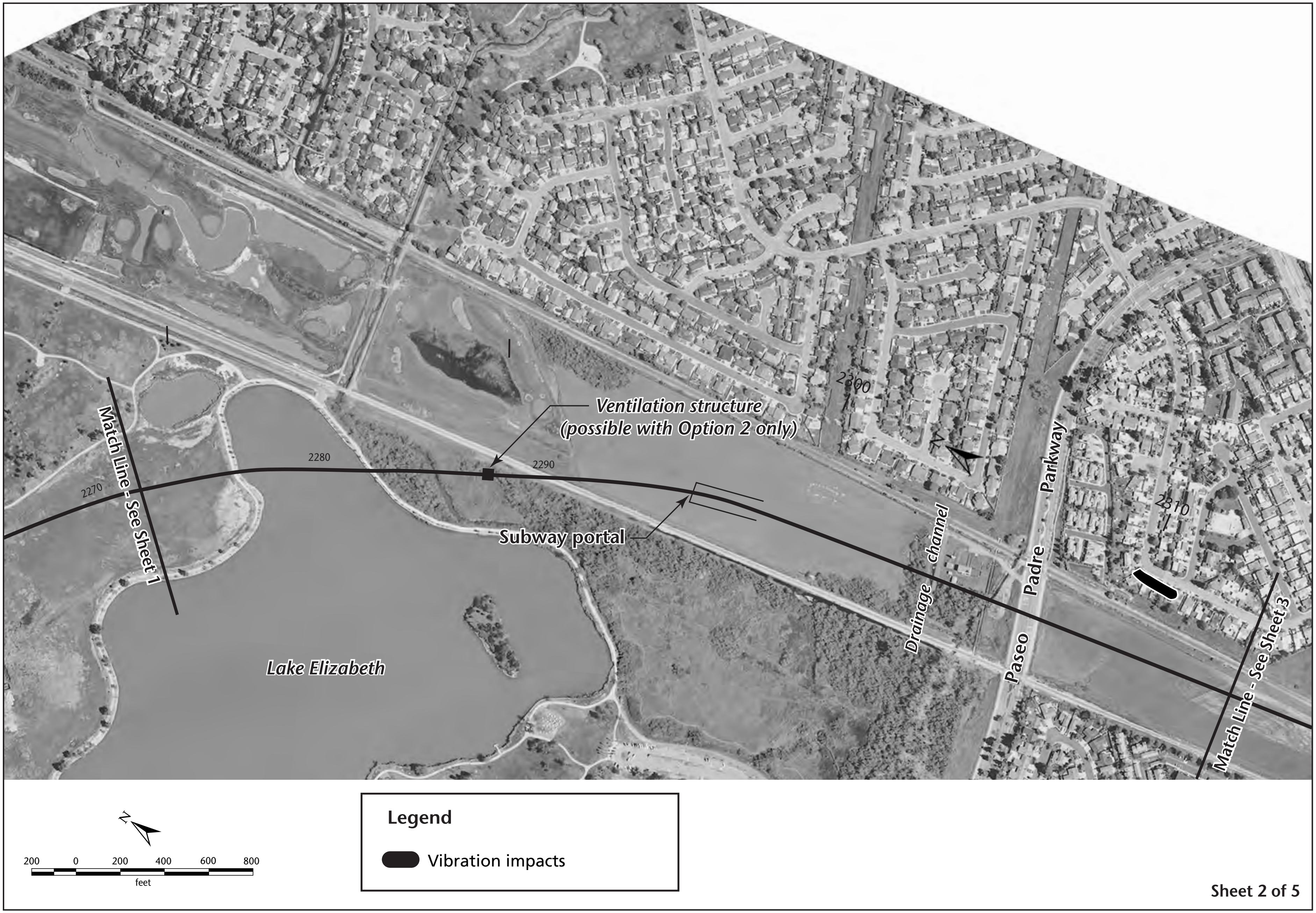
- **Special Trackwork at Crossovers** – Because the impacts of wheels over rail gaps at track crossover locations increases vibration by about 10 dBA, crossovers are a major source of vibration impact when they are located in sensitive areas. If crossovers cannot be relocated away from residential areas, another approach is to use spring-rail or moveable point crossovers instead of standard crossovers. These special types of crossovers eliminate the gap in the track caused by crossovers in the main traffic direction, thereby eliminating the additional vibration associated with crossovers.

Table 3.10-12 indicates the areas along the Proposed Project alignment where mitigation would be needed to reduce vibration levels. At a minimum, the installation of ballast mats would be required. However, more extensive measures or



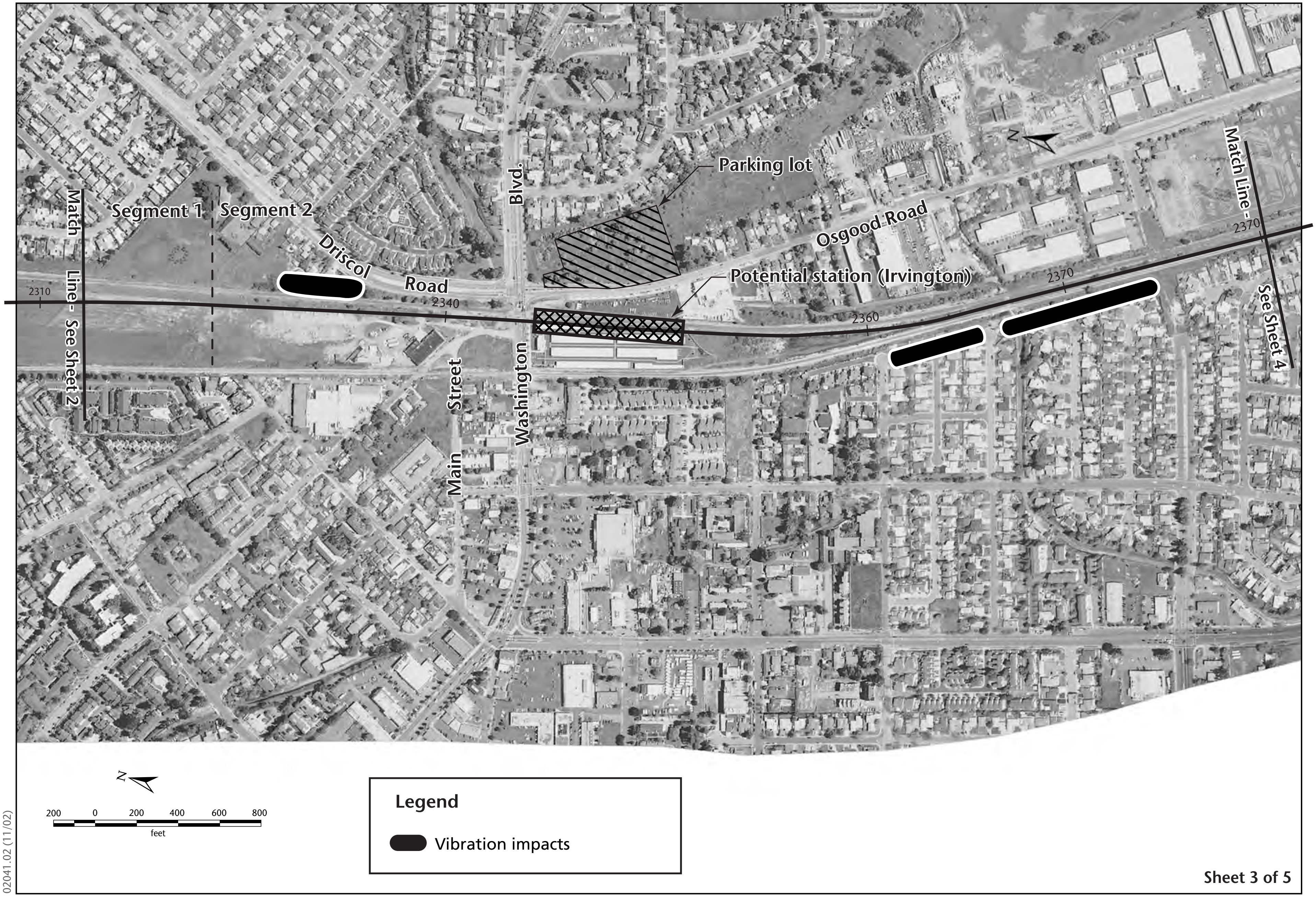

Source: Harris, Miller, Miller & Hanson 2002.

**Figure 3.10-7a**
**Project-Induced Vibration Impacts**




Source: Harris, Miller, Miller & Hanson 2002.

**Figure 3.10-7b**
**Project-Induced Vibration Impacts**




Source: Harris, Miller, Miller & Hanson 2002.

**Figure 3.10-7c**
**Project-Induced Vibration Impacts**


Source: Harris, Miller, Miller & Hanson 2002.

**Figure 3.10-7d**
**Project-Induced Vibration Impacts**


Source: Harris, Miller, Miller & Hanson 2002.

**Figure 3.10-7e**
**Project-Induced Vibration Impacts**

a combination of measures may be required to reduce significant impacts to a less-than-significant level at some locations.

**Table 3.10-12.** Potential Locations for Vibration Mitigation

| Location | Civil Station | Length (Feet) | Impacts |
|---|---|---|---|
| Walnut Ave to Stevenson Blvd | 2230 to-– 2245 | 1500 | 66 |
| Paseo Padre Parkway to Washington Blvd | 2325 to 2332 | 700 | 5 |
| Washington Blvd to Auto Mall Parkway | 2354 to 2384 and 2388 to 2408 | 5000 | 50 |
| **Total:** | | 7200 | **121** |

Source: Harris, Miller, Miller and Hanson 2002

In addition, moving the crossover near Station 2312 will mitigate the three remaining vibration impacts not mentioned in the table above.

Specific implementation of the vibration mitigation measures described above, including details regarding the specific locations and types of mitigation, would be addressed in detail during preliminary engineering and final design. During preliminary engineering and final design, further detail about track and receiver elevation, track location, and other pertinent information will be available. This information would be used to adopt the mitigation measures presented above on a site-specific basis and to allow design at an appropriate level of detail. Implementation of these mitigation measures is expected to reduce significant impacts to a less-than-significant level. However there may be some situations where implementation of all feasible mitigation would not reduce the impact to less than significant. The situations where this could occur cannot be determined until the detailed vibration mitigation design is developed.

**Impact N3 – Exposure of noise-sensitive land uses to noise from ancillary equipment.** Fixed facilities such as electrical substations and vent shafts can be a source of noise. Using prediction methodology recommended by FTA (Federal Transit Administration 1995) and BART design criteria for ancillary equipment, Table 3.10-13 has been developed to show distances at which significant noise impacts from ancillary equipment could occur at Category II Average Residential receivers. Although detailed information on the location of substations and vent shafts is not available at this time, the results in Table 3.10-13 indicate that there is potential for significant noise impacts from this equipment to occur. There is potential for noise from ancillary equipment to result in significant noise impacts. Implementation of the following mitigation measure would reduce this impact to a less-than-significant level. *(Less than significant with mitigation incorporated.)*

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**Table 3.10-13.** Summary of BART Ancillary Equipment Noise Impact Assessment

| | Projected Impact Distance (ft) | | | |
|---|---|---|---|---|
| | Transient Noise | | Continuous Noise | |
| Equipment Type | Broadband | Tonal | Broadband | Tonal |
| Substation | 125 | 225 | 400 | 700 |
| Vent Shaft | 160 | 280 | 500 | 900 |

Source: San Francisco Bay Area Rapid Transit District 1992

**Mitigation Measure N3 – Design and construct electrical substations, vent shafts, and other ancillary facilities to reduce noise.** Electrical substations, vent shafts, and other ancillary facilities to reduce noise will be designed so that noise generated by these facilities does not exceed limits specified in Table 3.10-4. Measures to be employed may include but are not limited to the following.

- Orient noise-generating components away from noise-sensitive land uses or locating buildings between noise-generating components and noise-sensitive land uses.
- Use acoustically rated vents to reduce noise.
- Construct local barriers or enclosures around noise-generating components.

### *Construction-Related Impacts*

Construction noise and vibration varies greatly depending on the construction process, type and condition of equipment used, and layout of the construction site. Many of these factors are traditionally left to the contractor's discretion, which makes it difficult to accurately estimate levels of construction noise and vibration. Overall, construction noise levels are governed primarily by the noisiest pieces of equipment. For most construction equipment, the engine, which is usually diesel, is the dominant noise source. This is particularly true of engines without sufficient muffling. For special activities such as impact pile driving and pavement breaking, noise generated by the actual process dominates. Impact pile driving and pavement breaking also create the most ground vibration.

**Impact N4 –Exposure of noise-sensitive land uses to construction noise.** Assuming that construction noise is reduced by 6 decibels for each doubling of distance from the center of the construction site, screening distances for significant construction noise impacts can be estimated. For a typical piece of construction equipment, such as a bulldozer, the impact screening distances for single-family residential (the strictest set of criteria) would be 160 feet for intermittent daytime activities, and up to 900 feet for intermittent nighttime or continuous activities. This indicates that there is potential for construction of the Proposed Project to result in significant construction noise impacts. Implementation of the following mitigation measures would reduce this impact to a less-than-significant level. *(Less than significant with mitigation incorporated.)*

**Mitigation Measure N4(a) – Employ noise-reducing construction practices.** The construction contractor will employ noise-reducing construction practices such that construction noise does not exceed the limits specified in Table 3.10-5 at occupied land uses. Measures to be employed may include but are not limited to the following.

- Avoid nighttime construction in residential areas.
- Use equipment with enclosed engines and/or high performance mufflers.
- Locate stationary equipment as far as possible from noise-sensitive uses.
- Construct noise barriers, such as temporary walls or piles of excavated material between noise activities and noise sensitive uses.
- Re-route construction-related traffic along roads that will result in the least amount of disturbance to residences.
- Where pile driving is planned within 1,200 feet of residences, or within 650 feet of hotels or in-use outdoor recreation areas, use cast-in-drilled-hole (CIDH) piles, pre-drilled piles, soil-mix wall technology, shielded pile drivers, vibratory pile drivers. (Shielded pile drivers or vibratory pile drivers can be used only where geotechnical conditions allow.)

**Mitigation Measure N4(b) – Disseminate essential information to residences and implement a complaint response/tracking program.** BART will notify residences within 500 feet of a construction area of the construction schedule in writing, prior to construction. BART and the construction contractor will designate a noise-disturbance coordinator who will be responsible for responding to complaints regarding construction noise. The coordinator will determine the cause of the complaint and will ensure that reasonable measures are implemented to correct the problem. A contact telephone number for the noise disturbance coordinator will be conspicuously posted on construction site fences and will be included in the written notification of the construction schedule sent to nearby residents.

**Impact N5 – Exposure of vibration-sensitive land uses to construction vibration.** Table 3.10-14 lists distances at which vibration from various types of construction equipment could exceed the vibration significance thresholds. This indicates that there is potential for construction of the Proposed Project to result in significant construction vibration impacts at residences. Implementation of the following mitigation measure would reduce this impact to a less-than-significant level. *(Less than significant with mitigation incorporated.)*

**Table 3.10-14.** Summary of BART Construction Vibration Impact Assessment

| | Projected Impact Distance (ft) | | |
|---|---|---|---|
| Equipment Type | 80 VdB | 90 VdB | 100 VdB |
| H Piles | 150 | 75 | 40 |
| Sheet Piles | 100 | 40 | 15 |
| Vibratory Roller | 260 | 100 | 40 |
| Dynamic Compaction | 95 | 55 | 30 |

Source: San Francisco Bay Area Rapid Transit District

**Mitigation Measure N5 – Employ vibration-reducing construction practices.** The construction contractor will employ vibration-reducing construction practices such that construction vibration does not exceed 80 VdB (more than 1 hour per day), 90 VdB (less than 1 hour per day), or 100 VdB (less than 10 minutes per day), or the peak particle velocity damage threshold of 0.20 inches per second for fragile buildings or structures. The Horner House at 3101 Driscoll Road is the only historic structure in close proximity to the project area that is potentially in the fragile category. Measures to be employed may include but are not limited to the following.

- Locate vibration-generating equipment as far as possible from vibration-sensitive land uses.
- Avoid simultaneous operation of multiple pieces of vibration-generating equipment.
- Avoid nighttime construction in residential areas.
- Avoid construction processes that generate high vibration levels (for example vibration from pile driving can be reduced or eliminated by using pre-drilled holes or using pushed piles).
- Avoid the use of vibratory rollers near vibration-sensitive uses.

## Impacts Related to Optional Irvington Station

### *Operational Impacts*

The operational noise and vibration impacts and mitigation measures of the Proposed Project with the Optional Irvington Station would be the same as those for the Proposed Project without the station.

### *Construction-Related Impacts*

The construction-related noise and vibration impacts and mitigation measures of the Proposed Project with the optional Irvington Station would be the same as those for the Proposed Project without the station.

## Contribution to Cumulative Impacts

### *Criteria for Cumulative Impacts*

The cumulative noise impact analysis for the Proposed Project was based on the criteria defined in the FTA's guidance manual, *Transit Noise and Vibration Impact Assessment* (Federal Transit Administration 1995). These criteria are used by BART to assess cumulative noise impacts. The Proposed Project's contribution to cumulative noise impacts is determined by combining the anticipated future cumulative background noise level, expressed in $L_{dn}$, with the projected $L_{dn}$ produced by operation of BART trains. Determination of the future cumulative background noise level is based on the existing background noise level and the effect on noise of the list of approved and pending development projects in Fremont as of the date of preparation of this SEIR (Table 3.1-1 and Section 3.1.6 in Section 3.1). Surface-street traffic generally governs the background noise level in the project area. A comparison of existing traffic volumes to predicted 2025 traffic volumes that takes into account approved and pending development projects indicates that the background noise level in the project area will typically not change by more than 1 dB. Accordingly, the future cumulative background noise level is considered to be the same as the existing background noise level. This is typical for this type of developed urban setting. The cumulative impact assessment for noise considers the potential for the Proposed Project, in combination with the projects described in Section 3.1, to have impacts to the physical environment.

The cumulative noise impact criteria allowed by FTA and BART are summarized in Table 3.10-15. The Proposed Project would result in a significant impact if operational noise contributes to a cumulative increase in noise level that would be considered a severe impact under the FTA criteria.

### *Contribution of Warm Springs Extension to Cumulative Impacts*

#### Operational Contribution

**Impact N-Cume1 – Operational contribution to significant cumulative noise impacts.** Detailed projections were made of the future noise exposure along the Proposed Project alignment. The future noise levels were compared to measured existing noise levels presented in Section 3.10.2 to determine locations where significant cumulative impacts are expected to result from operation of the Proposed Project. Table 3.10-16 includes results for the residential receptors from north to south along the alignment with both daytime and nighttime sensitivity to noise (e.g., residences and hotels). Table 3.10-17 lists all institutional receptors from north to south along the alignment, consisting of sites that are not sensitive to noise at night (e.g., schools and churches). Both tables include the locations along the alignment, the civil station, side of track, distance to the near track and the vehicle speed. The distance from the near track and the projected noise level represent the worst case within the group of residences. All the receptors along the alignment fall into FTA categories 2 (residences and buildings where people sleep) or 3 (institutional uses with primarily daytime and evening use such as schools, libraries, and churches) for the cumulative noise impact analysis.

**Table 3.10-15.** Cumulative Noise Level Increase Allowed by FTA Criteria

| Existing Noise Exposure ($L_{eq}$ or $L_{dn}$, expressed in dBA) | Impact Threshold for Increase in Cumulative Noise Exposure (dBA) | | | |
|---|---|---|---|---|
| | Category 1 or 2 Sites | | Category 3 Sites | |
| | Impact | Severe Impact | Impact | Severe Impact |
| 45 | 8 | 14 | 12 | 19 |
| 46 | 7 | 13 | 12 | 18 |
| 47 | 7 | 12 | 11 | 17 |
| 48 | 6 | 12 | 10 | 16 |
| 49 | 6 | 11 | 10 | 16 |
| 50 | 5 | 10 | 9 | 15 |
| 51 | 5 | 10 | 8 | 14 |
| 52 | 4 | 9 | 8 | 14 |
| 53 | 4 | 8 | 7 | 13 |
| 54 | 3 | 8 | 7 | 12 |
| 55 | 3 | 7 | 6 | 12 |
| 56 | 3 | 7 | 6 | 11 |
| 57 | 3 | 6 | 6 | 10 |
| 58 | 2 | 6 | 5 | 10 |
| 59 | 2 | 5 | 5 | 9 |
| 60 | 2 | 5 | 5 | 9 |
| 61 | 1.9 | 5 | 4 | 9 |
| 62 | 1.7 | 4 | 4 | 8 |
| 63 | 1.6 | 4 | 4 | 8 |
| 64 | 1.5 | 4 | 4 | 8 |
| 65 | 1.4 | 4 | 3 | 7 |
| 66 | 1.3 | 4 | 3 | 7 |
| 67 | 1.2 | 3 | 3 | 7 |
| 68 | 1.1 | 3 | 3 | 6 |
| 69 | 1.1 | 3 | 3 | 6 |
| 70 | 1.0 | 3 | 3 | 6 |
| 71 | 1.0 | 3 | 3 | 6 |
| 72 | 0.8 | 3 | 2 | 6 |
| 73 | 0.6 | 2 | 1.8 | 5 |
| 74 | 0.5 | 2 | 1.5 | 5 |
| 75 | 0.4 | 2 | 1.2 | 5 |

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Note:
$L_{dn}$ is used for land uses where nighttime sensitivity is a factor; maximum 1-hour $L_{eq}$ is used for land use involving only daytime activities.

Sources: Federal Transit Administration 1995; Harris, Miller, Miller and Hanson 2002

Table 3.10-16 includes the existing and future noise levels in terms of $L_{dn}$, the projected increase in cumulative noise, the amount of increase allowed by the BART design criteria, and the number of impacts. Table 3.10-17 contains the same information for institutional uses, but the noise levels are presented in terms of the Peak-Hour $L_{eq}$, instead of the $L_{dn}$.

As shown in Table 3.10-16, significant cumulative noise impacts are anticipated for a total of 146 residences. A brief discussion of each impacted area follows.

- Walnut Avenue to Stevenson Boulevard (east side). Significant cumulative noise impacts are predicted to occur at three buildings in the Red Hawk Ranch Apartments complex with 84 total units. These noise impacts result from a combination of the speed of the BART vehicles and the proximity of the buildings (less than 100 feet for some buildings) to the tracks.
- Walnut Avenue to Stevenson Boulevard (west side). Significant cumulative noise impacts are predicted to occur at three buildings in the Fremont Villas condominiums with four units each (for a total of 12 residences). These noise impacts result from a combination of the speed of the BART vehicles and the proximity of the buildings (less than 50 feet for some buildings) to the tracks.
- Valdez Way/Vaca Road (east side). No significant cumulative noise impacts are predicted to occur at residences in this location. The residences are located at distances of more than 300 feet from the tracks.
- Paseo Padre Parkway to Washington Boulevard (west side). No significant cumulative noise impacts are predicted to occur at residences in this location. The residences are located at distances of more than 400 feet from the tracks.
- Paseo Padre Parkway to Washington Boulevard (east side). Significant cumulative noise impacts are predicted to occur at a total of 44 single-family residences in this area. Of these, 24 are located along Valero Drive (including the Senior Housing Project) within 170 feet of the tracks. In addition to the proximity of the residences to the tracks and the speed of the BART vehicles, the crossover between Stations 2309 and 2315 is projected to contribute to the noise impact at these residences. Significant cumulative noise impacts are predicted to occur at 20 additional residences located just to the south of this area along Driscoll Road. The noise impacts at this location will result primarily from the short distance between the tracks and the residences (20 feet for the closest residence).
- Washington Boulevard to Blacow Road (east side). No significant cumulative noise impacts are predicted to occur at residences in this location. The residences are located at distances of over 300 feet from the tracks.

**Table 3.10-16.** Cumulative Residential Noise Impacts of Proposed Project

| Location | Civil Stn | Side of Track | Dist to Near Track (ft) | Speed (mph) | Noise Level (Ldn, dBA) | | Cumulative Noise Exposure (Ldn, dBA) 1 | | # of Significant Impacts |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Existing | Future[a] | Increase | Significance Criterion | |
| Walnut Ave to Stevenson Blvd | 2227 to 2242 | NB | 145 | 50/70 | 57 | 63 | 8.4 | 6.6 | 84 |
| Walnut Ave to Stevenson Blvd | 2230 to 2238 | SB | 45 | 70/70 | 53 | 70 | 16.3 | 8.2 | 12 |
| Valdez Way/Vaca Road | 2290 to 2304 | NB | 300 | 70 | 53 | 60 | 7.4 | 8.8 | 0 |
| Paseo Padre Parkway to Washington Blvd | 2308 to 2334 | SB | 390 | 70 | 60 | 65 | 4.6 | 5.0 | 0 |
| Paseo Padre Parkway to Washington Blvd | 2308 to 2334 | NB | 20 | 70 | 54 | 77 | 22.7 | 7.6 | 44 |
| Washington Blvd to Blacow Road | 2339 to 2370 | NB | 340 | 70 | 54 | 60 | 5.8 | 7.6 | 0 |
| Washington Blvd to Blacow Road | 2339 to 2368 | SB | 95 | 70 | 66 | 70 | 3.8 | 3.4 | 6 |
| Blacow Road to Auto Mall Parkway | 2370 to 2415 | SB | 130 | 70 | 65 | 68 | 3.1 | 3.9 | 0 |
| Auto Mall Parkway to South Grimmer Road | 2415 to 2451 | SB | 230 | 70 | 61 | 63 | 2.0 | 4.7 | 0 |
| **Total:** | | | | | | | | | **146** |

Note:
[a] Future cumulative ambient noise conditions are assumed to be the same as existing ambient noise conditions.

Source: Harris, Miller, Miller and Hanson 2002

**Table 3.10-17.** Cumulative Institutional Noise Impacts of Proposed Project

| Location | Civil Stn | Side of Track | Dist to Near Track (ft) | Speed (mph) | Noise Level (Peak Hour Leq, dBA) | | Cumulative Noise Exposure (Peak Hour Leq, dBA) * | | Significant Impact? |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Existing | Future | Increase | Significance Criterion | |
| St. Anne's Episcopal Church | 2329 | NB | 390 | 70 | 54 | 57 | 3.3 | 12.7 | No |
| Church of Christ | 2330 | NB | 290 | 70 | 54 | 58 | 4.5 | 12.7 | No |
| E.M. Grimmer Elementary School | 2391 | SB | 300 | 60 | 53 | 57 | 4.3 | 13.3 | No |
| E.M. Grimmer Elementary School Playground | 2391 | SB | 95 | 60 | 53 | 63 | 10.8 | 13.3 | No |

Note:
* Increases in noise level and the impact criterion are reported to 0.1 decibels so that rounding errors in the results do not lead to confusion.

Source: Harris, Miller, Miller and Hanson 2002

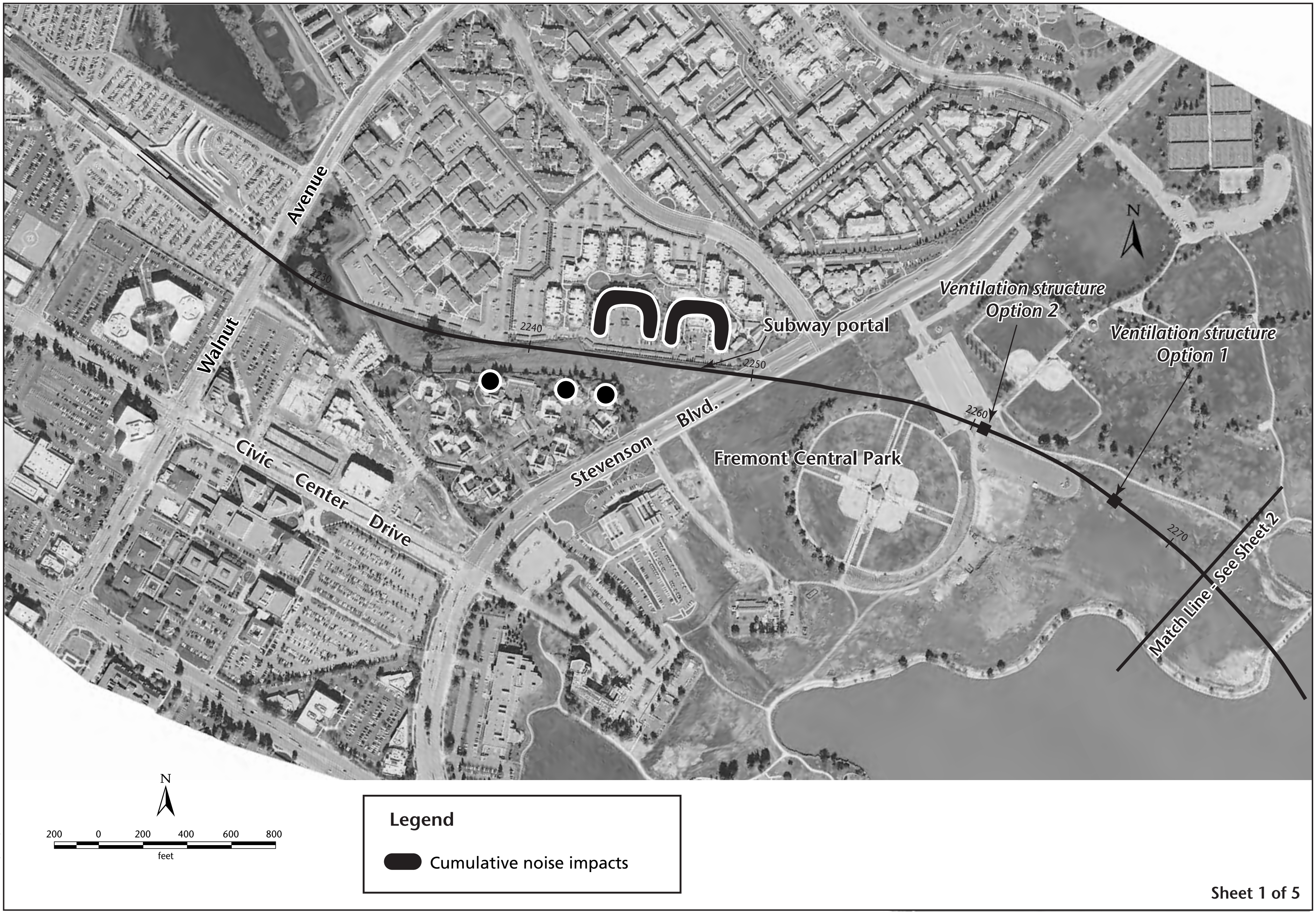
- Washington Boulevard to Blacow Road (west side). Six significant cumulative noise impacts are predicted to occur at residences in this location. The noise impacts at this location will result primarily from the speed of the BART vehicles (70 mph).
- Blacow Road to Auto Mall Parkway (west side). No significant cumulative noise impacts are predicted to occur at residences in this location. The existing noise levels are high (65 dBA Ldn) because of freight trains, and the addition of the BART operations contributes only slightly to cumulative noise increases.
- Auto Mall Parkway to South Grimmer Boulevard (west side). No significant cumulative noise impacts are predicted to occur at residences in this location. The residences are located at distances of more than 200 feet from the tracks.

An assessment of cumulative noise impacts for institutional receptors was also conducted (see Table 3.10-17). This assessment was also based on a comparison of the predicted maximum noise level with the BART criteria for these types of buildings.

The measured peak hour $L_{eq}$ at the school tends to be low. The measurement was taken during a period proscribed by FTA for institutional land uses. For a significant impact to occur, the peak hour $L_{eq}$ must be around 42 to 45 dBA, which is not likely for a suburban daytime $L_{eq}$. As indicated in Table 3.10-17, the results predict no significant cumulative noise impact at any institutional locations.

The total number of both cumulative and project-induced significant noise impacts (both residential and institutional) along the Proposed Project alignment is 256. Figures 3.10-8a through 3.10-8e show the locations of the significant cumulative noise impacts discussed above. Of these, 49 are both cumulative and Project-induced, and are primarily located between Walnut Avenue and Stevenson Boulevard and between Paseo Padre Parkway and Washington Boulevard. Table 3.10-18 identifies the location of noise barriers needed to address the cumulative noise impacts along the Proposed Project alignment. This table indicates that noise mitigation with barriers is not feasible for two residences. Mitigation with building acoustical insulation would be required to reduce this impact to a less-than-significant level. Mitigation Measure N1, as modified below, would reduce the Proposed Project's contribution to this impact to a less-than-significant level. *(Less than significant with mitigation incorporated.)*

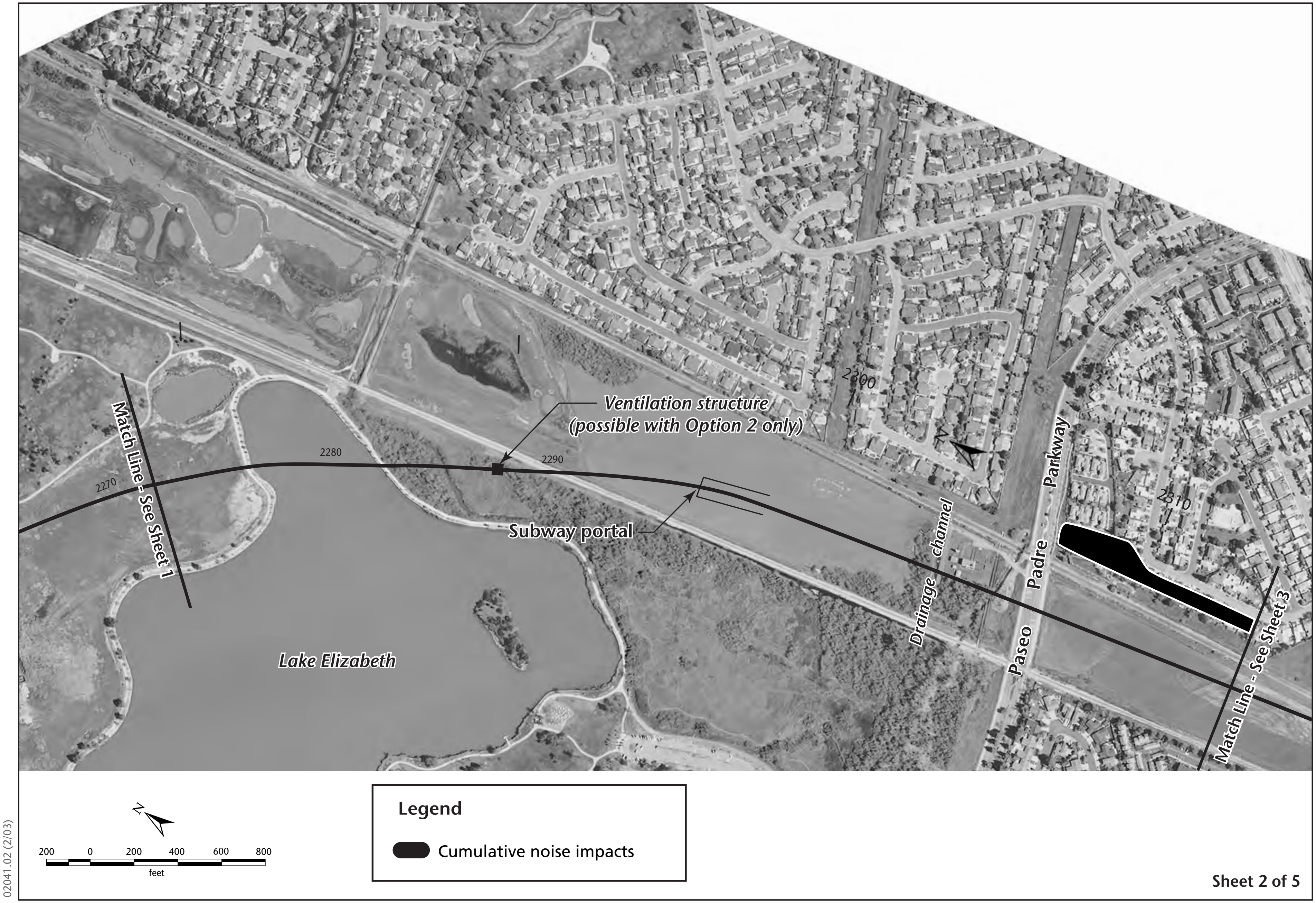
> **Mitigation Measure N1 – Implement noise-reducing measures at noise-sensitive land uses in the Proposed Project corridor.** This mitigation measure is described above. For two residences located at 3153 and 3185 Driscoll Road, east of the Proposed Project alignment between Paseo Padre Parkway and Washington Boulevard, building acoustical insulation may be required.




02041.02 (2/03)

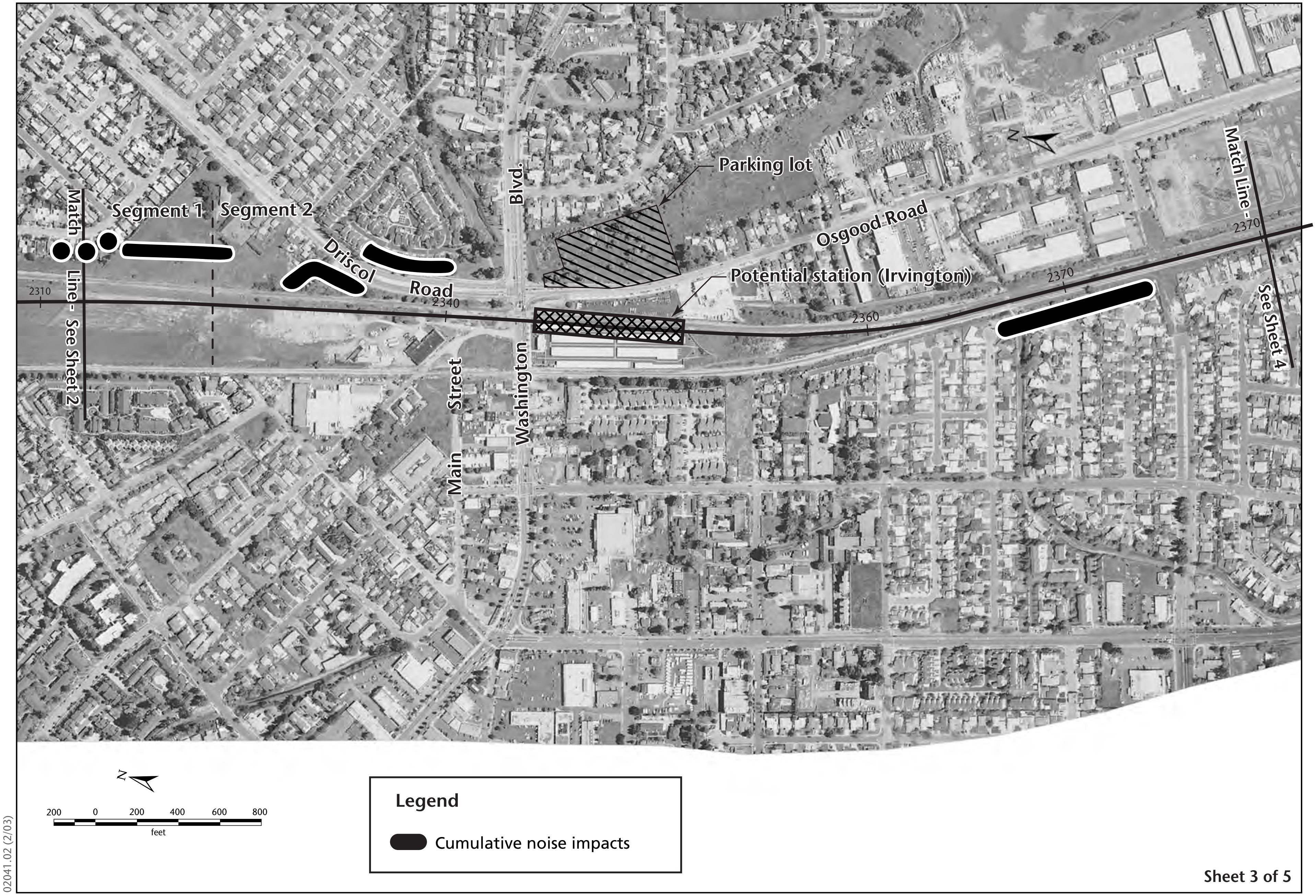
Source: Harris, Miller, Miller & Hanson 2002.

**Figure 3.10-8a**
**Cumulative Noise Impacts**




Source: Harris, Miller, Miller & Hanson 2002.

**Figure 3.10-8b**
**Cumulative Noise Impacts**




Source: Harris, Miller, Miller & Hanson 2002.

**Figure 3.10-8c**
**Cumulative Noise Impacts**


02041.02 (2/03)

Source: Harris, Miller, Miller & Hanson 2002.

**Figure 3.10-8d**
**Cumulative Noise Impacts**


02041.02 (2/03)

Source: Harris, Miller, Miller & Hanson 2002.

**Figure 3.10-8e**
**Cumulative Noise Impacts**

**Table 3.10-18.** Potential Locations for Noise Barriers due to Cumulative Impacts

| Location | Civil Stn | Side of Track | Length (Feet) | Number of Residences Exposed to Significant Impacts Without Mitigation | Number of Residences Exposed to Significant Impacts With Mitigation* |
|---|---|---|---|---|---|
| Walnut Ave to Stevenson Blvd | 2232 – 2242 | NB | 1000 | 84 | 0 |
| Walnut Ave to Stevenson Blvd | 2228 – 2240 | SB | 1200 | 12 | 0 |
| Paseo Padre Parkway to Washington Blvd | 2308 – 2337 | NB | 2900 | 44 | 2 |
| Washington Blvd to Blacow Road | 2355 – 2369 | SB | 1400 | 6 | 0 |
| **Total:** | | | **6500** | **146** | **2** |

Note:
* The mitigation assessment assumes a minimum of 8 dB of noise reduction for a noise barrier. Detailed barrier design and mitigation projections should be made during the design phase of the project.

Source: Harris, Miller, Miller and Hanson 2002

**Impact N-Cume2 – Contribution to significant cumulative vibration impacts to vibration-sensitive receptors.** Most of the approved and pending development projects listed in Table 3.1-1 and Section 3.1.6 in Section 3.1 (*Introduction to Environmental Analysis*) would not contribute to groundborne vibration impacts in the project area. However, operation of the SVRTC project would contribute to groundborne vibration impacts in the southern end of the project area because it would generate groundborne vibration at a level similar to the Proposed Project. Where the Proposed Project and SVRTC would abut, just south of the Warm Springs Station, it is possible that the Proposed Project, in combination with SVRTC, would contribute to cumulative groundborne vibration. In addition, the UP freight rail switching yard serving NUMMI, which is immediately adjacent on the west side of the site where the two projects would meet, would contribute to potential cumulative groundborne vibration impacts. Since land uses in this area are industrial and commercial, there are no vibration-sensitive receptors located in the immediate vicinity. Therefore, implementation of the Proposed Project would not contribute to significant cumulative groundborne vibration impacts to vibration-sensitive receptors. No mitigation for cumulative groundborne vibration impacts is required. *(Less than significant.)*

**Mitigation – None required.**

## Construction-Related Contribution

**Impact N-Cume3 – Cumulative contribution to significant cumulative construction-related noise and vibration impacts.** Noise and vibration from construction of the Proposed Project will be highly localized and will be mitigated through the implementation of Mitigation Measures N4(a)

(Employ noise-reducing construction practices), N4(b) (Disseminate essential information to residences and implement a complaint response/tracking program), and N5 (Employ vibration-reducing construction practices). It is not anticipated that construction of other projects listed in Table 3.1 will occur at the same time and in the same location as construction of the Proposed Project. For these reasons, no cumulative construction noise or vibration impacts are anticipated. (*No impact.*)

**Mitigation - None required.**

### *Contribution of Optional Irvington Station to Cumulative Impacts*

#### Operational Contribution

Because BART operations with the optional Irvington Station would be the same as the Proposed Project without the Irvington Station, the cumulative operational noise and vibration impacts of the Proposed Project with the optional Irvington Station are predicted to be the same as those for the Proposed Project without the station.

#### Construction-Related Contribution

For the same reasons presented above for the Proposed Project without the optional Irvington Station, no cumulative construction noise or vibration impacts are anticipated for the Propose Project with the optional Irvington Station.

# 3.10.5 References Cited in this Section

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