4.11 Noise and Vibration

Noise is generally defined as unwanted sound. The degree to which noise can affect the human environment ranges from levels that interfere with speech and sleep (annoyance and nuisance) to levels that cause adverse health effects (hearing loss and psychological effects).

Vibration is an oscillatory motion through a solid medium in which the motion's amplitude can be described in terms of displacement, velocity, or acceleration. Vibration can be a serious concern, causing buildings to shake and rumbling sounds to be heard.

This section evaluates the potential for construction and operation of the project alternatives to result in substantial increases in noise and/or vibration. Information in this section was drawn from a project-specific noise analysis. This analysis is included as Appendix H and is on file with the San Francisco County Transportation Authority (SFCTA).

Human response to noise is subjective and can vary greatly from person to person. Factors that influence individual response include the intensity, frequency, the pattern of noise, and the amount of background noise

High levels of vibration may cause physical personal injury or damage to buildings. However, ground-borne vibration levels rarely affect human health

4.11.1 | Regulatory Setting

This section summarizes applicable federal, state, and local regulations regarding noise and vibration.

4.11.1.1 | FEDERAL

4.11.1.1.1 UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (EPA)

The federal Noise Control Act of 1972 (Act) addressed the issue of noise as a threat to human health and welfare, particularly in urban areas. In response to the Act, EPA published *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* (1974). According to these recommendations, under ideal conditions, the yearly average L_{eq} (defined at right) should not exceed 55 dBA outdoors and 45 dBA indoors in noise-sensitive areas, i.e., residential areas (refer to this page's sidebar for definitions of terms). EPA identified an increase of 5 dBA as an adequate margin of safety relative to a baseline noise exposure level of 55 dBA L_{dn} before a noticeable increase in adverse community reaction would be expected. EPA does not promote these recommendations as universal standards or regulatory goals with mandatory applicability to all communities, but instead as advisory exposure levels below which there would be no reason to suspect that there would be risk from any of the identified health or welfare effects of noise.

4.11.1.1.2 FEDERAL TRANSIT ADMINISTRATION (FTA)

FTA has developed guidance to evaluate noise effects from operation of surface transportation modes (i.e., passenger cars, trucks, buses, and rail) in the *FTA Transit Noise Impact and Vibration Assessment* (FTA Assessment; 2006). Mass transit projects receiving FTA funding are required to use these guidelines to predict and assess potential noise and vibration effects. FTA extended EPA's incremental impact criteria to higher baseline ambient levels. As ambient levels increase, smaller and

DEFINITIONS

EQUIVALENT CONTINUOUS NOISE LEVEL (L_{eq}): The average noise level on an energy basis for any specific time period. The L_{eq} for one hour is the energy average noise level during the hour

DAY-NIGHT AVERAGE SOUND PRESSURE LEVEL (L_{dn}): A 24-hour L_{eq} with an adjustment to reflect the greater sensitivity of most people to nighttime noise. The adjustment is a 10-dBA penalty for all sound that occurs during the nighttime hours of 10:00 p.m. to 7:00 a.m.

DECIBEL (dB): The standard unit of measurement for sound

dBA: The "A-weighted scale," abbreviated dBA, reflects the normal hearing sensitivity range of the human ear. On this scale, the range of human hearing extends from approximately 3 to 140 dBA

smaller increments of noise above the baseline are recommended to limit community annoyance. This is because in areas with high ambient noise, it takes a smaller increase in noise to attain the same percentage increase in highly annoyed people as a larger increase in noise in areas with low ambient noise.

FTA has identified three categories of noise-sensitive land uses.

- **Category 1** are tracts of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet, and such land uses as outdoor amphitheaters and concert pavilions, as well as National Historic Landmarks with significant outdoor use. Also included are recording studios and concert halls.
- **Category 2** are residences and buildings where people normally sleep. This category includes homes, hospitals and hotels where a nighttime sensitivity to noise is assumed to be of utmost importance.
- **Category 3** are institutional land uses with primarily daytime and evening use. This category includes schools, libraries, theaters, and churches where it is important to avoid interference with such activities as speech, meditation and concentration on reading material. Places for meditation or study associated with cemeteries, monuments, museums, campgrounds and recreational facilities can also be considered to be in this category. Certain historical sites and parks are also included.

4.11.1.2 | STATE

4.11.1.2.1 GOVERNOR'S OFFICE OF PLANNING AND RESEARCH

The Governor's Office of Planning and Research *General Plan Guidelines* (Guidelines; 2003) promote the use of L_{dn} for evaluating the compatibility of various land uses with respect to their noise exposure. The Guidelines provide ranges of community noise exposure for specific types of land use that are "normally acceptable," "conditionally acceptable," "normally unacceptable," and "clearly unacceptable." The Guidelines provide each local community some flexibility in setting local noise standards that allow for the variability in community preferences and existing ambient noise levels.

- "Normally acceptable" for a given land use category implies that the interior noise levels would be acceptable to the occupant without the need for any special structural acoustic treatment.
- "Conditionally acceptable" indicates that new development of a given type should be undertaken only after a detailed analysis of the noise reduction requirements has been made and needed noise insulation features included in the design; conventional construction but with closed windows and fresh air supply systems or air conditioning will normally suffice.
- "Normally unacceptable" indicates that new development of a given type should generally be discouraged unless a detailed analysis of the noise reduction requirements is made and any identified noise insulation features are included in the design.
- "Clearly unacceptable" indicates that new development of a given type should generally not be undertaken.

4.11.1.2.2 CALIFORNIA NOISE INSULATION STANDARDS

The California Building Code and Title 24 of the California Code of Regulations establish uniform noise insulation standards for residential projects. For limiting noise from exterior sources, these regulations establish an interior standard of 45 dBA L_{dn} in any habitable room and, where such units are proposed in areas subject to exterior noise levels greater than 60 dBA L_{dn}, a demonstration of how dwelling units have been designed to meet this interior standard is also required. If the interior noise level depends on windows being closed, the design for the structure must also include a heating, ventilation, and air conditioning system that will provide for adequate fresh air ventilation as specified by the California Building Code.

4.11.1.3 | LOCAL

4.11.1.3.1 SAN FRANCISCO NOISE CONTROL ORDINANCE[1]

Pertinent noise requirements of San Francisco include:

- **Residential Property Noise Limits**. No person shall produce or allow to be produced a noise level more than 5 dBA above the ambient noise level.
- **Public Property Noise Limits**. No person shall produce or allow to be produced a noise level more than 10 dBA above the local ambient at a distance of 25 feet or more.
- **Fixed Residential Interior Noise Limits**. In order to prevent sleep disturbance, protect public health and prevent the environment from progressive deterioration due to increasing use and influence of mechanical equipment, no fixed noise source may cause the noise level measured inside any dwelling unit to exceed 45 dBA between the hours of 10:00 p.m. to 7:00 a.m. or 55 dBA between the hours of 7:00 a.m. to 10:00 p.m. with windows open.

Regarding noise related to construction activities, Section 2907 of the San Francisco Police Code states that it shall be unlawful for any person to operate any powered construction equipment if the operation of such equipment emits noise level above 80 dBA when measured at a distance of 100 feet from such equipment. However, this provision is not applicable to impact tools and equipment with exhaust mufflers that are approved by the Director of Public Works or the Director of Building Inspection. Section 2908, Construction Work at Night states that it shall be unlawful for any person to erect, construct, demolish, excavate, alter or repair any building or structure between the hours of 8:00 p.m. and 7:00 a.m. if the noise level created would result in the ambient noise level to increase by 5 dBA. Exemption to these time limits may be granted by permit from the Director of Public Works or the Director of Building Inspection.

San Francisco Public Works Code and Department of Public Works Orders

Article 2.4 of the Public Works Code governs excavation within public right-of-way (ROW) areas under the jurisdiction of San Francisco Public Works (SFPW). The article requires any person excavating in the public ROW to obtain an excavation permit and comply with Orders and Regulations of SFPW.

[1] City and County of San Francisco Police Code Article 29, Section 2909.

Order No. 176,707 (Regulations for Excavating and Restoring Streets in San Francisco) establishes rules and regulations for excavating and restoring streets that are under SFPW jurisdiction. This order requires contractors to conduct their operations in a manner that causes the least possible noise consistent with normal construction efficiency. Any operation or the use of any equipment that makes excessive or unusual noise is not allowed. Compressors must have effective mufflers and be mounted and insulated to the maximum extent feasible to minimize noise.

San Francisco Municipal Transportation Agency (SFMTA) Blue Book

The "Blue Book" is as guide for doing work in San Francisco streets that is applicable to City agencies (SFPW, SFMTA, San Francisco Public Utilities Commission [SFPUC], Port of San Francisco, etc.), utility crews, private contractors, and others performing work on City streets. The Blue Book's main purpose is to establish rules so that work can be done safely and in a way that will cause the least possible interference with pedestrians, bicycle, transit and other vehicular traffic. In addition to the regulations in this manual, a contractor is responsible for complying with all City, state, and federal codes, rules, and regulations. The Blue Book requires a Night Noise Permit for any construction work done between the hours of 8:00 p.m. and 7:00 a.m. in the roadway or sidewalk area.

San Francisco General Plan – Environmental Protection Element

Within the Environmental Protection Element of the San Francisco General Plan, there are several policies aimed at reducing transportation-related noise, to minimize the impacts of noise, and to promote land uses that are compatible with various transportation noise levels.

4.11.2 | Affected Environment

4.11.2.1 | FUNDAMENTALS OF SOUND

This analysis discusses sound levels in terms of Equivalent Noise Level (L_{eq}) and Day Night Noise Level (L_{dn})

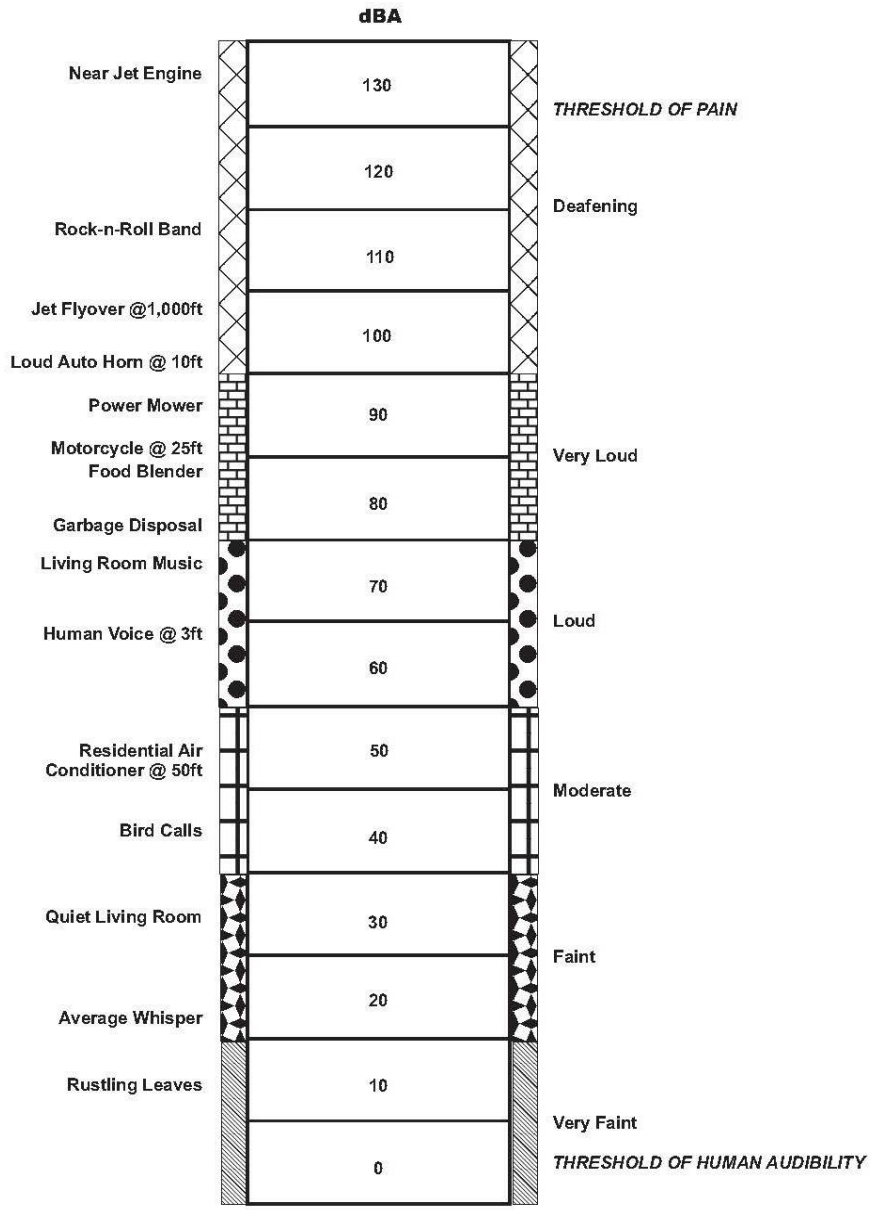
Sound is technically described in terms of the loudness (amplitude) and frequency (pitch) of the sound. The standard unit of measurement for sound is the decibel (dB). The human ear is not equally sensitive to sound at all frequencies. The "A-weighted scale," abbreviated dBA, reflects the normal hearing sensitivity range of the human ear. On this scale, the range of human hearing extends from approximately 3 to 140 dBA. Figure 4.11-1 provides examples of A-weighted noise levels from common sounds.

This analysis discusses sound levels in terms of Equivalent Noise Level (L_{eq}) and Day Night Noise Level (L_{dn}).

L_{eq} is the average noise level on an energy basis for any specific time period. The L_{eq} for one hour is the energy average noise level during the hour. The average noise level is based on the energy content (acoustic energy) of the sound. L_{eq} can be thought of as the level of a continuous noise which has the same energy content as the fluctuating noise level. The equivalent noise level is expressed in units of dBA.

L_{dn} is a 24-hour L_{eq} with an adjustment to reflect the greater sensitivity of most people to nighttime noise. The adjustment is a 10-dBA penalty for all sound that occurs during the nighttime hours of 10:00 p.m. to 7:00 a.m. The effect of the penalty is that in the calculation of L_{dn}, any event that occurs during the nighttime hours is equivalent to ten of the same event during the daytime hours.

Figure 4.11-1 A-Weighted Decibel Scale



SOURCE: Cowan, James P., *Handbook of Environmental Acoustics*

4.11.2.1.1 | AUDIBLE NOISE CHANGES

Studies have shown that the smallest perceptible change in sound level for a person with normal hearing sensitivity is approximately 3 dBA. A change of at least 5 dBA would be noticeable and would likely evoke a community reaction. A 10-dBA increase is subjectively heard as a doubling in loudness and would cause a community response.

Noise levels decrease as the distance from the noise source to the receiver increases. Noise generated by a stationary noise source, or "point source," will decrease by approximately 6 dBA over hard surfaces (e.g., reflective surfaces such as parking lots or smooth bodies of water) and 7.5 dBA over soft surfaces (e.g., absorptive surfaces such as soft dirt, grass, or scattered bushes and trees) for each doubling of the distance. For example, if a noise source produces a noise level of 89 dBA at a reference distance of 50 feet, then the noise level would be 83 dBA at a distance of 100 feet from the noise source, 77 dBA at a distance of 200 feet, and so on. Noise generated by a mobile source will decrease by approximately 3 dBA over hard surfaces and 4.5 dBA over soft surfaces for each doubling of the distance.

Sound measurements were taken to determine existing ambient daytime off-peak noise levels in the vicinity of the Geary corridor. Noise measurements were conducted at 11 sites for duration of 20 minutes each

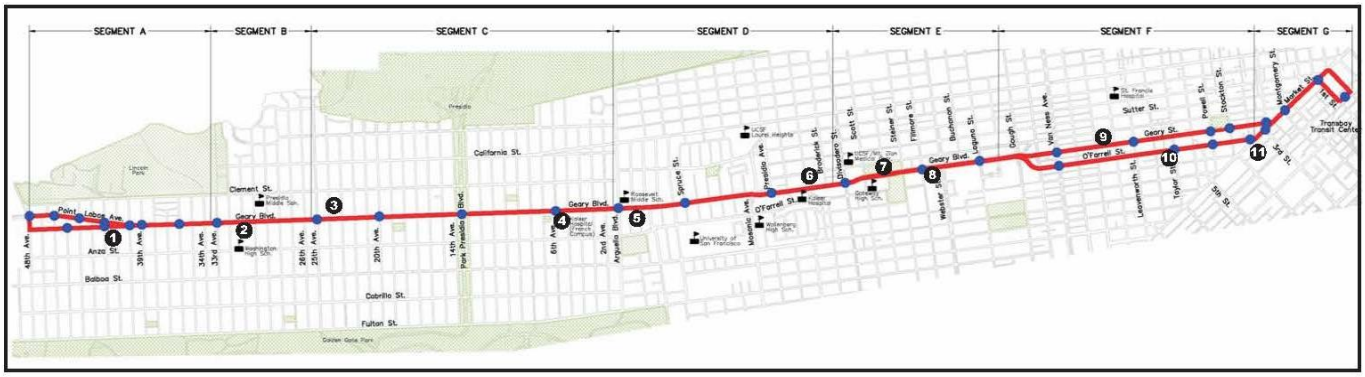
Generally, noise is most audible when traveling by direct line-of-sight. Barriers, such as walls, berms, or buildings between the source and the receiver can greatly reduce noise levels from the source since sound can only reach the receiver by bending over the top of the barrier (diffraction). Such barriers can reduce sound levels by up to 20 dBA. However, if a barrier is not high or long enough to break the line-of-sight from the source to the receiver, its effectiveness is greatly reduced.

4.11.2.1.2 | EXISTING NOISE ENVIRONMENT

The noise environment in the Geary corridor is comprised mostly of pass-by noise from automobiles, buses, and trucks, occasional motor vehicle horn noise, and clatter from street-level pedestrian and commercial activities. Noise monitoring locations were chosen to best represent existing noise sources and volumes throughout the Geary corridor. The presence of substantial institutional receptors, large blocks of receptors, and areas with different traffic volumes or other noise differentiators were key factors used in selecting monitoring locations so as to ensure an accurate representation of existing conditions. Figure 4.11-2 shows noise monitoring locations.[2]

[2] The ambient noise environment was monitored in 2011. The Geary corridor was, and remains, a fully built urban area. It is not anticipated that existing 2014 conditions have changed substantially such that they would significantly alter monitored noise levels. Therefore, the monitored noise accurately represents typically urban noise levels along the Geary corridor.

Figure 4.11-2 Noise Monitoring Locations



LEGEND:

- Existing 38-L Route
- Existing 38-L Stops
- Parks, Open Space
- Schools, Hospitals
- Noise Monitoring Locations

1. Single- and Multi-Family Residences
2. George Washington High School
3. St. Monica's Rectory and School
4. Kaiser Permanente Hospital (French Campus)
5. Institute on Aging
6. Hamilton Memorial Church
7. Hamilton Recreation Center
8. Sleep Quest Inc.
9. Alhambra Apartments
10. Super 8 Motel
11. Four Seasons Hotel

APPROX. SCALE

N

0 1,000 2,000 FEET

SOURCE: Jacobs Engineering Group, 2011 and TAHA, 2013.

Table 4.11-1 shows measured existing ambient sound levels at the selected locations, and each location's associated FTA's land use categories for transit noise impacts (see 4.11.1.1.2 above). Existing noise levels are typical for an urbanized area along an arterial roadway, ranging between 64.3 and 73.6 dBA L_{eq}.[3]

Table 4.11-1 Existing Noise Levels

MONITOR NUMBER	NOISE MONITORING LOCATION	FTA LAND USE CATEGORY	SOUND LEVEL (DBA, LEQ) OCTOBER 25, 2011	SOUND LEVEL (DBA, LEQ) OCTOBER 26, 2011
1	Single- and Multi-Family Residences	2	64.3	66.5
2	George Washington High School	3	68.8	66.4
3	St. Monica's Rectory and School	3	69.2	68.0
4	Kaiser Permanente Medical Center	2	73.1	72.3
5	Institute on Aging	2	73.6	72.5
6	Hamilton Memorial Church	3	71.1	71.8
7	Hamilton Recreation Center	3	71.4	71.0
8	Sleep Quest Inc.	2	67.5	69.2
9	Alhambra Apartments	2	68.8	68.2
10	Super 8 Hotel	2	70.8	68.1
11	Four Seasons Hotel and Residence	2	n/a	71.1

"n/a" = Noise level was not available at this location.

Source: Terry A. Hayes Associates Inc., 2014

4.11.2.1.3 | SENSITIVE RECEPTORS

For the Geary corridor, receptors that require further noise analysis are those within 200 feet of the source and with unobstructed views of the source, and those within 100 feet of the source and with intervening buildings between the receptor and source

Residences, schools, hospitals, guest lodging, libraries and some passive recreation areas would each be considered noise- and vibration-sensitive and may warrant unique measures for protection from intruding noise. As shown in Table 4.11-1, only category 2 and 3 land uses are present in the Geary corridor study area.

FTA has established noise screening criteria to identify sensitive receptors that may be affected by transit projects. FTA guidance prescribes sensitive receptor screening distances for noise impacts that are dependent on transit mode type, rail type, and other factors. A 200-foot screening distance applies to buses that travel in dedicated transit lanes where no intervening buildings are present, whereas a 500 foot screening distance is recommended for buses that travel in mixed-flow travel lanes without any intervening structures. Given that the only portion of the Geary corridor where buses would travel in mixed-flow travel lanes would be between 34th and 48th Avenues, the noise analysis uses the screening criteria for buses traveling in dedicated bus-only lanes because this portion of the corridor is lined with many intervening structures that would attenuate noise effects. Sensitive receptors within 200 feet of the noise source and with unobstructed views of the noise source, as well as those within 100 feet of the source but with intervening buildings between the

[3] The California Department of Transportation Technical Noise Supplement (November 2009) states that the 24-hour L_{dn} is typically within 2 dBA of the peak hour L_{eq}. This statement is supported by the 2011 Van Ness BRT noise analysis where the average L_{dn} was within 2.7 dBA of the peak hour L_{eq}. Therefore, when necessary, the monitored L_{eq} was adjusted and increased by 2.7 dBA to obtain the existing L_{dn} for the peak period.

receptor and source were used.[4] These types of land uses and structures are present throughout the Geary corridor.

Table 4.11-7 below lists sensitive receptors along the Geary corridor that are within the noise screening criteria. Since there are numerous single- and multi-family residences located adjacent to the north and south Geary corridor, these residences have been grouped together as clusters.

4.11.2.2 | VIBRATION

There are several different methods that are used to quantify vibration. The peak particle velocity (PPV) is defined as the maximum instantaneous peak of the vibration signal. The PPV is most frequently used to describe vibration effects to buildings and is usually measured in inches per second. The root mean square (RMS) amplitude is most frequently used to describe the effect of vibration on the human body. The RMS amplitude is defined as the average of the squared amplitude of the signal. Decibel notation (Vdb) is commonly used to measure RMS. The decibel notation acts to compress the range of numbers required to describe vibration.

DEFINITION

ROOT MEAN SQUARE AMPLITUDE (RMS): RMS is most frequently used to describe the effect of vibration on the human body. The RMS amplitude is defined as the average of the squared amplitude of the signal. Decibel notation (Vdb) is commonly used to measure RMS

4.11.2.2.1 EFFECTS OF VIBRATION

In contrast to noise, ground-borne vibration is not a phenomenon that most people experience every day. The background vibration velocity level in residential areas is usually 50 RMS or lower, well below the threshold of perception for humans which is around 65 RMS. Most perceptible indoor vibration is caused by sources within buildings, such as operation of mechanical equipment, movement of people or slamming of doors. Typical outdoor sources of perceptible ground-borne vibration are construction equipment, steel-wheeled trains and traffic on rough roads. If the roadway is smooth, the vibration from traffic is rarely perceptible.

There are no stationary sources of vibration located within the Geary corridor. Heavy-duty trucks can generate ground-borne vibrations that vary depending on vehicle type and weight, and pavement conditions. However, vibration levels from adjacent roadways are not typically perceptible at the project site.

4.11.2.2.2 VIBRATION SENSITIVE RECEPTORS

FTA has identified three categories of vibration-sensitive land uses.

- **Category 1** receptors are highly sensitive to vibration and typical land uses include vibration-sensitive research and manufacturing, hospitals with vibration-sensitive equipment and university research operations.
- **Category 2** receptors include all residential land uses and buildings where people sleep, such as hotels and hospitals.
- **Category 3** receptors include schools, churches, other institutions and quiet offices that do not have not have vibration-sensitive equipment, but still have the potential for activity interference.

[4] Sensitive receptors do exist beyond the 200 foot screening distance used in some portion of the Geary corridor. But, given that there are no adverse effects within the 200 foot screening distance, the nature of noise is such that noise would attenuate at further distances, so sensitive receptors in the larger geography would not be adversely affected.

4.11.3 | Methodology

The alternatives were evaluated for potential noise and vibration effects in terms of several considerations, including land use, noise changes, bus lane type, construction equipment, etc. The alternatives have the potential to result in construction period and/or operational period effects as noted below.

Construction-Related Effects

- Use of heavy equipment in construction and demolition

Operational-Related Effects

- Changes in noise from bus activity

Potential noise and vibration related effects associated with the items listed above were evaluated in terms of project-related change in transit vehicle frequencies and the introduction of transit vehicles to new bus-only lanes based on projected baseline conditions at the project's opening year of 2020.

Projected bus speed and the distance of bus-only lanes from sensitive receptors are important criteria in determining noise changes associated with the project alternatives.

Table 4.11-2 summarizes FTA noise impact criteria. These criteria are based on a comparison of the existing outdoor noise levels and the future outdoor noise levels from implementation of a given project (here, the build alternatives). Some land use activities are more sensitive to noise than others, such as parks, churches and residences, as compared to industrial and commercial uses. The Assessment has identified three categories of sensitive land uses.

Table 4.11-2 Land Use Categories And Metrics For Transit Noise Impact Criteria

LAND USE CATEGORY	NOISE METRIC (DBA)	DESCRIPTION OF LAND USE CATEGORY
1	Outdoor $L_{eq}(h)/a/$	Tracts of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet, and such land uses as outdoor amphitheaters and concert pavilions, as well as National Historic Landmarks with significant outdoor use. Also included are recording studios and concert halls.
2	Outdoor L_{dn}	Residences and buildings where people normally sleep. This category includes homes, hospitals and hotels where a nighttime sensitivity to noise is assumed to be of utmost importance.
3	Outdoor $L_{eq}(h)/a/$	Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, theaters, and churches where it is important to avoid interference with such activities as speech, meditation and concentration on reading material. Places for meditation or study associated with cemeteries, monuments, museums, campgrounds, and recreational facilities can also be considered to be in this category. Certain historical sites and parks are also included.

L/a/ Leq for the noisiest hour of transit-related activity during hours of noise sensitivity.

Source: Federal Transit Administration, *Transit Noise and Vibration Impact Assessment*, May 2006

The noise impact criteria for human annoyance are based on a comparison of the ambient and future outdoor noise levels. The criteria include activity interference caused by the transit project alone and annoyance due to the change in the noise environment caused by implementation of the build alternatives. The following two impact levels are included in the FTA criteria, as shown in Table 4.11-3:

- **Moderate Impact**. The change in the existing noise level is noticeable to most people, but may not be sufficient to cause strong, adverse reactions from the community. In this range, other project-specific factors must be considered to determine the magnitude of the impact and the need for mitigation. These other factors may include the predicted increase over existing noise levels, the type and number of noise-sensitive land uses affected, existing outdoor- indoor sound insulation, and the cost effectiveness of mitigating noise to more acceptable levels.
- **Severe Impact**. A substantial percentage of people would be highly annoyed by the additional or new noise and noise mitigation will be specified unless there is no practical method of mitigating the noise.

Table 4.11-3 Noise Levels Defining Impact for Transit Project

EXISTING NOISE EXPOSURE L_{eq}(H) OR Ldn (dBA) /a/	PROJECT NOISE IMPACT EXPOSURE, L_{eq}(H) OR L_{dn} (dBA) /a/					
	CATEGORY 1 OR 2 SITES			CATEGORY 3 SITES		
	NO IMPACT	MODERATE IMPACT	SEVERE IMPACT	NO IMPACT	MODERATE IMPACT	SEVERE IMPACT
61	<59	59-64	>64	<64	64-69	69
62	<59	59-64	>64	<64	64-69	69
63	<60	60-65	>65	<65	65-70	70
64	<61	61-65	>65	<66	66-70	70
65	<61	61-66	>66	<66	66-71	71
66	<62	62-67	>67	<67	67-72	72
67	<63	63-67	>67	<68	68-72	72
68	<63	63-68	>68	<68	68-73	73
69	<64	64-69	>69	<69	69-74	74
70	<65	65-69	>69	<70	70-74	74
71	<66	66-70	>70	<71	71-75	75
72	<66	66-71	>71	<71	71-76	76
73	<66	66-71	>71	<71	71-76	76
74	<66	66-72	>72	<71	71-77	77
75	<66	66-73	>73	<71	71-78	78
76	<66	66-74	>74	<71	71-79	79
77	<66	66-74	>74	<71	71-79	79
>77	<66	66-75	>75	<71	71-80	80

/a/ Ldn is used for land use where nighttime sensitivity is a factor; Leq during the hour of maximum transit noise exposure is used for land use involving only daytime activities.

Source: Federal Transit Administration, Transit Noise and Vibration Impact Assessment, May 2006

On street segments with two-way traffic, noise levels were modeled from the curbline of the rightmost lane to the nearest sensitive receptors. For one way traffic street segments, noise levels were modeled from the curbline of the rightmost lane and from the left edge of the rightmost curb lane depending on the location of the closet sensitive receptor. Bus noise on all segments was assessed based on existing noise levels in the area and posted speed limits. A maximum noise level analysis was

completed for the area near Fillmore Street that accounted for this portion of Geary Boulevard being raised to street level in Alternatives 3 and 3-Consolidated. This scenario generates the maximum noise level as all vehicle activity would be closer to adjacent land uses than currently with the existing underpass area.

4.11.4 | Environmental Consequences

An assessment was conducted to calculate project noise and vibration levels for the project alternatives, during both operational and construction phases. This section is organized as follows to address all pertinent regulatory requirements.

- Section 4.11.4.1: Hybrid Alternative/LPA Modifications –Analysis of Potential Additive Effects since Publication of the Draft EIS/EIR
- Section 4.11.4.2: No Build Alternative - Construction Period Noise and Vibration
- Section 4.11.4.3: Build Alternatives - Construction Period Noise
- Section 4.11.4.4: Build Alternatives - Construction Period Vibration
- Section 4.11.4.5: No Build Alternative - Operational Period Noise and Vibration
- Section 4.11.4.6: Build Alternatives - Operational Period Noise
- Section 4.11.4.7: Build Alternatives - Operational Period Vibration

This section describes potential impacts and benefits for noise and vibration. The analysis compares each build alternative relative to the No Build Alternative.

As set forth in Section 4.11.4.1, the modifications to the Hybrid Alternative/LPA since publication of the Draft EIS/EIR do not change the conclusions regarding noise and vibration impacts in the Draft EIS/EIR.

4.11.4.1 | HYBRID ALTERNATIVE/LPA MODIFICATIONS: ANALYSIS OF POTENTIAL ADDITIVE EFFECTS SINCE PUBLICATION OF THE DRAFT EIS/EIR

As discussed in Section 2.2.7.6, the Hybrid Alternative/LPA now includes the following six minor modifications added since the publication of the Draft EIS/EIR:

1) Retention of the Webster Street pedestrian bridge;
2) Removal of proposed BRT stops between Spruce and Cook streets (existing stops would remain and provide local and express services);
3) Addition of more pedestrian crossing and safety improvements;
4) Addition of BRT stops at Laguna Street;
5) Retention of existing local and express stops at Collins Street; and
6) Relocation of the westbound center- to side-running bus lane transition to the block between 27th and 28th avenues.

This section presents analysis of whether these six modifications could result in any new or more severe noise and vibration impacts during construction or operation. As documented below, the Hybrid Alternative/LPA as modified would not result in any new or more severe noise and vibration impacts relative to what was disclosed in the Draft EIS/EIR.

Retention of the Webster Street Pedestrian Bridge

Construction: Retaining the Webster Street bridge would reduce demolition in this area, and thus substantially reduce anticipated construction-period noise and vibration in the immediate vicinity. This modification would not result in any new or more severe noise and vibration impacts during construction.

Operation: This modification would not substantially affect bus operations relative to what was described in the Draft EIS/EIR (see Section 3.3); buses would not operate any closer to nearby sensitive receptors than previously envisioned. Therefore, this modification would not result in any new or more severe noise and vibration impacts during operation.

Removal of Proposed BRT Stops between Spruce and Cook Streets

Construction: Since no new BRT stops would be constructed in this area, construction period noise would be substantially reduced relative to what was assumed in the Draft EIS/EIR. Therefore, this modification would not result in any new or more severe noise and vibration impacts during construction.

Operation: This modification would not substantially affect bus operations relative to what was described in the Draft EIS/EIR (see Section 3.3); the only change would be that BRT buses would pass by this block rather than make stops. This would result in BRT buses passing by at higher speeds, which may increase operational noise levels at this location. However, already being situated on a busy transportation corridor, BRT buses passing by would represent a marginal change in the existing noise environment. Therefore, this modification would not result in any new or more severe noise and vibration impacts during operation.

Addition of More Pedestrian Crossing and Safety Improvements

Construction: Construction of additional pedestrian improvements would increase short-term noise levels in the areas where such improvements would be implemented. However, the relatively short duration of such activities (4-6 days) and their location within the public right-of-way limits the potential for these additional improvements to increase the severity of any previously identified construction-period noise effects. Therefore, this modification would not result in any new or more severe noise and vibration impacts during construction.

Operation: This modification would not affect bus operations, lane configurations, or turning movements relative to what was described in the Draft EIS/EIR (see Section 3.3). Therefore, this modification would not result in any new or more severe noise and vibration impacts during operation.

Addition of BRT Stops at Laguna Street

Construction: Construction of the in-street boarding platforms at Laguna Street would increase short-term noise levels in this area, but the relatively short duration of such activities (2-3 weeks) and their location within the public right-of-way limits the potential for these additional improvements to increase the severity of any previously identified construction-period noise effects. Therefore, this modification would not result in any new or more severe noise and vibration impacts during construction.

Operation: This modification would have more buses making stops at Laguna Street; the Draft EIS/EIR anticipated noise levels associated with side-running bus lanes with only local buses making stops. Since the modification would result in the bus-only lanes being further from the face of curb and BRT buses would typically make stops (as demand warrants), this modification would likely reduce operational noise levels in this area from what was described in the Draft EIS/EIR and would not foreseeably result in any new or more severe noise and vibration impacts during operation.

Retention of Existing Local and Express Stops at Collins Street

Construction: Since existing stops would be maintained at this location, construction noise and vibration would be reduced. This modification would not result in any new or more severe noise and vibration impacts during construction.

Operation: This modification would not substantially affect bus operations relative to what was described in the Draft EIS/EIR (see Section 3.3). Instead of all buses passing by Collins Street, local and express buses would make stops. This modification would therefore somewhat reduce operational noise levels from the operational pattern described in the Draft EIS/EIR.

Relocation of the Westbound Center- to Side-Running Bus Lane Transition

Construction: Relocation of the westbound bus lane transition at 27th Avenue would not alter the level of construction activities but would simply shift about half of it one block to the west. This modification would alter roadway striping and the location of the transit signal queue jump, but would not require additional median removal or other intensive construction activities beyond what was described in the Draft EIS/EIR and, thus, would not create new or more severe noise and vibration effects. Therefore, this modification would not result in any new or more severe noise and vibration impacts during construction.

Operation: This modification would not substantially affect bus operations relative to what was described in the Draft EIS/EIR (see Section 3.3). Therefore, this modification would not result in any new or more severe noise and vibration impacts during operation.

4.11.4.2 | NO BUILD ALTERNATIVE – CONSTRUCTION PERIOD NOISE AND VIBRATION

Under the No Build Alternative, transit and transportation facilities and services would remain unaltered except for changes that are currently planned or programmed to be implemented in the Geary corridor by 2020 (see Section 2.2.2). Construction period noise and vibration would likely occur for the various transportation and infrastructure improvement projects included in the No Build Alternative. Construction of these projects would be subject to the same City regulations (the Noise Ordinance, DPW Article 2.4, and DPW Order 176,607) as the build alternatives. As such, construction of the No Build improvements would not be expected to result in adverse construction-related noise or vibration effects.

4.11.4.3 | BUILD ALTERNATIVES - CONSTRUCTION PERIOD NOISE

With adherence to the San Francisco Noise Ordinance, temporary construction period noise associated with all of the build alternatives would not result in adverse effects

The FTA Assessment does not include standardized criteria for assessing construction noise effects but instead states that local noise ordinances may be used. Accordingly, construction activity would be subject to pertinent aspects of the San Francisco Noise Ordinance, DPW Article 2.4, and DPW Order 176,707:

- Any construction between the hours of 8 p.m. and 7 a.m. shall not produce noise levels in excess of 5 dBA above the ambient noise level at the property line, unless a special permit is approved by SFPW.
- Limit noise from any individual piece of construction equipment, except impact tools, to 80 dBA at 100 feet.

Construction of the any of the project alternatives would result in temporary increases in ambient noise levels on an intermittent basis. The increases in noise would occur during construction, the duration of which would depend on the alternative selected and any phasing (see Section 4.15 regarding construction duration and phasing information). Noise levels would fluctuate depending on the construction phase, equipment type and duration of use, distance between the noise source and receptor, and presence or absence of noise attenuation barriers. Perceived noise would also fluctuate depending on time of day. Some nighttime work is anticipated as a means of helping keep the Geary corridor operational during daytime hours.

Construction activities typically require the use of various types of heavy equipment. Table 4.11-4 lists typical noise levels from various types of construction equipment.

Table 4.11-4 Typical Noise Levels From Construction Equipment

	NOISE LEVEL (DBA)	
NOISE SOURCE	50 FEET	100 FEET
Air Compressor	81	75
Back Hoe	80	74
Compactor	82	76
Concrete Mixer	85	79
Concrete Pump	82	76
Crane Mobile	83	77
Concrete Vibrator	76	70
Drill Rig Truck	79	76
Dump Truck	88	82
Generator	81	75
Jack Hammer	88	82
Loader	85	79
Paver	77	71
Pneumatic Tool	85	79
Roller	74	68
Saw	76	70

Source: Federal Transit Administration, 2006

4.11.4.3.1 | ALTERNATIVE 2 - CONSTRUCTION EFFECTS

As shown on Table 4.11-4 above, the expected noise levels from construction equipment would exceed 80 dBA at 100 feet from dump trucks and jack hammering. With adherence to the San Francisco Noise Ordinance, which includes limiting the noise levels from individual pieces of construction equipment to 80 dBA at a distance of 100 feet, equipping impact tools with both intake and exhaust mufflers, and obtaining a noise permit for night work from SFPW, these temporary construction noise effects would not be adverse.

While the build alternatives would be required to adhere to the Noise Ordinance and construction equipment noise would not be anticipated to exceed 80 dBA at 100 feet, some construction-related activities nonetheless have potential to result in disturbance and annoyance effects on nearby sensitive receptors. To this end, minimization measures are incorporated herein to provide for noise monitoring throughout construction as well as the implementation of additional sound-attenuating measures (including but not limited to sound walls, management of truck routes, etc.) that are necessary to minimize adverse effects.

Build Alternative 2 includes demolition and removal of the pedestrian bridges at Webster and Steiner Streets, including all above- and below-ground bridge components. The bridge at Webster Street is located as close as 15 feet to residential uses; the bridge at Steiner Street is located approximately 60 feet from residences.

Bridge demolition and removal would expose sensitive receptors to temporary noise increases during active demolition. The primary source of noise associated with bridge removal would be from jack hammers and similar impact equipment. Jack hammers generate a noise level of approximately 88 dBA at 50 feet, or 82 dBA at 100 feet. Section 2907(b) of the San Francisco Police Code states that it shall be unlawful for any person to operate any powered construction equipment if the operation of such equipment emits noise level above 80 dBA when measured at a distance of 100 feet from such equipment. However, this provision is not applicable to impact tools and equipment fitted with intake and exhaust mufflers recommended by the manufacturers and approved by the Director of Public Works or the Director of Building Inspection as best accomplishing maximum noise attenuation. In addition, pavement breakers and jackhammers are required to be equipped with acoustically attenuating shields or shrouds recommended by the manufacturers and approved by the Director of Public Works or the Director of Building Inspection as best accomplishing maximum noise attenuation. With adherence to the San Francisco Noise Control Ordinance the temporary construction noise generated would not result in any adverse effects.

All build alternatives may result in noise levels in excess of 80 dBA at 100 feet due to removal of pedestrian bridges at Webster and Steiner Streets. However, with adherence to the aforementioned provisions of the San Francisco Noise Ordinance, these temporary construction noise effects would not be adverse.

4.11.4.3.2 ALTERNATIVES 3 AND 3-CONSOLIDATED - CONSTRUCTION EFFECTS

The same general construction methods described for Alternative 2 would be used to build the physical elements of Alternatives 3 and 3-Consolidated, although Alternatives 3 and 3-Consolidated would entail more intensive construction of bus-only lanes and medians in the center of Geary Boulevard west of Gough Street. This activity would be further from sensitive receptors compared to Alternative 2, which would construct bus-only lanes closer to the edge of the street.

These alternatives would also include the conversion of the Fillmore Street underpass to a conventional, at-grade intersection (which in turn involves the filling and/or removal of the existing pump station, demolition of the existing grade separation structure, and rebuilding of the roadway). As previously discussed, the expected noise levels from construction equipment could exceed 80 dBA at 100 feet. With adherence to the San Francisco Noise Ordinance, equipping impact tools with both intake and exhaust mufflers, and obtaining a noise permit for night work from SFPW, temporary construction noise effects would not be adverse.

4.11.4.3.3 HYBRID ALTERNATIVE/LPA – CONSTRUCTION EFFECTS

The Hybrid Alternative/LPA consists of different components from Alternatives 2, 3, and 3-Consolidated, thus the focus of construction activity would not be concentrated in one particular section of the street right-of-way. Therefore, the Hybrid Alternative/LPA would be represented by the range of construction activity covered between the three build alternatives. However, given that the Hybrid Alternative/LPA would not remove the Webster Street pedestrian bridge, nor would it construct a new BRT station at Spruce-Cook or remove existing stops at Collins Street, construction-period noise impacts would be reduced relative to the other build alternatives.

With adherence to the San Francisco Noise Ordinance, equipping impact tools with both intake and exhaust mufflers, and obtaining a noise permit for night work from SFPW, temporary construction noise effects would not be adverse.

4.11.4.4 | BUILD ALTERNATIVES - CONSTRUCTION PERIOD VIBRATION

The vibration from most rubber-tired construction vehicles moving slowly through the construction area would not be expected to result in adverse vibration effects. Impact equipment, such as vibratory rollers, hoe rams, small bulldozers loaded trucks, and jackhammers would be used during construction for utility relocation, asphalt removal and repaving and the construction of project elements. Construction of the build alternatives would not require construction activities, such as pile driving or underground tunneling that produce high levels of vibration.

DEFINITION

CATEGORY I: Reinforced concrete buildings with steel or timber (no plaster)

CATEGORY II: Engineered concrete and masonry buildings (no plaster)

CATEGORY III: Non-engineered timber and masonry buildings

CATEGORY IV: Buildings extremely susceptible to vibration damage

FTA has developed impact criteria for four types of buildings. Commercial type multiple-storied structures are generally represented by Categories I and II. Typical wood-framed residences fall under Category III, while any structurally fragile buildings (i.e., more likely to be historical in nature) fall under Category IV. The impact criteria are presented in Table 4.11-5. The vibration levels generated by construction equipment are shown in Table 4.11-6. FTA then calculated the distances at which vibration effects would likely occur according based on the criteria presented in Table 4.11-3. Table 4.11-6 also shows the results of those

calculations as classified per building category. The distances shown are the maximum distances at which short-term construction vibration impacts may occur.

Table 4.11-5 Construction Vibration Damage Criteria

BUILDING CATEGORY	PPV (IN/SEC)	APPROXIMATE VIBRATION VELOCITY LEVEL (L_V)
I. Reinforced-concrete, steel or timber (no plaster)	0.5	102
II. Engineered concrete and masonry (no plaster)	0.3	98
III. Non-engineered timber and masonry buildings	0.2	94
IV. Buildings extremely susceptible to vibration damage	0.12	90

Source: Federal Transit Administration, Transit Noise and Vibration Impact Assessment, May 2006

Table 4.11-6 Vibration Velocities for Construction Equipment

EQUIPMENT	PPV AT 25 FEET (INCHES/SECOND)	IMPACT DISTANCE FOR BUILDING CATEGORY, (FT)			
		I	II	III	IV
Vibratory Roller	0.210	14	19	25	36
Hoe Ram	0.089	7	11	14	20
Large Bulldozer	0.089	7	11	14	20
Jackhammer	0.035	4	5	7	11
Loaded Trucks	0.076	7	10	13	18
Small Bulldozer	0.003	1	1	2	2

Source: Federal Transit Administration, Transit Noise and Vibration Impact Assessment, May 2006

4.11.4.4.1 ALTERNATIVE 2 - CONSTRUCTION EFFECTS

Vibration effects from equipment used during installation of right-of-way improvements as well as associated utility relocation/demolition activities could potentially cause physical damage or alteration to historic properties, affect existing underground infrastructure, or cause annoyance among nearby sensitive receptors.

Historic properties are typically considered more sensitive to vibration owing to their construction methods, ornamentation, age, fragility, or other factors. Table 4.11-6 above shows the distances at which vibration impacts would be projected to occur by vibration level and historic building type.

As shown in Table 4.11-6, the most sensitive buildings are potentially susceptible to vibration-related effects at peak-particle velocities (PPV) of 0.12 inches per second. Vibratory rollers, commonly used in road building, have a PPV of 0.21 inches per second. Per Table 4.11-6, vibratory rollers could have adverse effects on "class III" historic properties when used at a distance of 25 feet; "class IV" properties, generally the most susceptible to vibration, could be adversely affected by vibratory roller use at a distance of 36 feet. In comparison, other typical vibration-causing equipment, like a jackhammer, would have somewhat lower potential to affect historic properties. As shown in Table 4.11-6, jackhammers would have adverse effects if used within 11 feet of a class IV property or 7 feet of a class III property.

Since Alternative 2 construction would be focused on side-running lanes, which would be less than 36 feet from most buildings fronting on the Geary corridor, there is a potential to affect nearby historic properties. Fifty-three historic properties have been identified along the Geary corridor; however, adherence to minimization measures incorporated herein would avoid or lessen any such effects such that no adverse effect would be expected to occur. Minimization includes employing site-specific, low-vibration construction methods near sensitive resources.

In addition, construction vibration could potentially affect existing SFPUC infrastructure within the project's area of influence, including subsurface brick sewers that are concentrated in the northern and eastern parts of the City.[5] However, prior to construction within the public ROW, SFMTA is required to obtain permits from SFPW in accordance with Article 2.4 of the Public Works Code. As part of the plan check process, SFPUC, the agency responsible for maintaining the City's sewer system, reviews the plans. If SFPUC determines that the proposed construction work may damage the older brick sewers, SFPW may impose specific conditions as part of the permit process to eliminate the potential for damage. Adherence to such conditions imposed pursuant to Article 2.4 would avoid or minimize any such potential adverse effects to brick sewers.

Potential annoyance related to vibration would be addressed through a minimization measure incorporated herein. Specifically, the project construction plan would include a program for accepting and addressing noise and construction-related complaints. Contact information for the Project Manager, Resident Engineer, and Contractor would be posted on site, with direction to call if there are any concerns. Complaints would be logged and tracked to ensure they are addressed.

4.11.4.4.2 ALTERNATIVES 3 AND 3-CONSOLIDATED - CONSTRUCTION EFFECTS

The same general construction methods described for Alternative 2 would be used to build the physical elements of Alternatives 3 and 3-Consolidated, although Alternatives 3 and 3-Consolidated would entail more intensive construction of bus-only lanes and medians in the center of Geary Boulevard west of Gough Street. These alternatives would also include the conversion of the Fillmore Street underpass to a conventional, at-grade intersection (which in turn involves the filling and/or removal of the existing pump station, demolition of the existing grade separation structure, and rebuilding of the roadway). A vibratory roller has the greatest potential to generate a vibration impact during the Fillmore Street conversion process. As shown in Table 4.11-6, a vibratory roller generates a vibration level of 0.210 inches per second. The vibratory roller would operate at least 30 feet from structures along Geary Boulevard, and would not exceed the vibration damage criteria shown in Table 4.11-5 for Category I, II, and III buildings. The vibratory roller would exceed the damage criterion when operated within 36 feet of Category IV structurally fragile buildings (i.e., more likely to be historical in nature). However, no Category IV buildings have been identified near the Fillmore Street conversion construction area. Such activities would be further from sensitive receptors than in Alternative 2. Accordingly, construction vibration effects for

[5] City and County of San Francisco. (2010). 2030 Sewer System Master Plan Task 500 Technical Memorandum NO. 506 Collection System Rehabilitation Program.

Alternatives 3 and 3-Consolidated would be generally similar to those described for Alternative 2, including for historic properties.

4.11.4.4.3 HYBRID ALTERNATIVE/LPA - CONSTRUCTION EFFECTS

Because the Hybrid Alternative/LPA is composed of a mix of elements drawn from Alternatives 2, 3, and 3-Consolidated, the focus of construction activity would not be concentrated in one particular section of the street ROW. Therefore, the Hybrid Alternative/LPA would be represented by the range of construction activity covered between the three build alternatives. Similar to Alternatives 2, 3, and 3-Consolidated, construction activity for the Hybrid Alternative/LPA would likely result in vibration effects for vibration-intensive construction activity located as close as 36 feet to certain historic structures. Section 4.11.5 below identifies avoidance, minimization, and mitigation measures to address such effects.

Similar to Alternatives 2, 3, and 3-Consolidated, SFPW may impose specific conditions as part of the permit process to eliminate the potential for damage to subsurface brick sewers during plan checks for construction activity. No adverse construction vibration effects to subsurface brick sewers would occur.

4.11.4.5 | NO BUILD ALTERNATIVE - OPERATIONAL NOISE AND VIBRATION EFFECTS

Under the No Build Alternative, transit and transportation facilities and services would remain unaltered except for changes that are currently planned or programmed to be implemented in the Geary corridor by 2020. These projects have previously or will soon undergo individual environmental review in which operational noise effects would be analyzed. Given the relatively small scale of the infrastructure improvements, it is unlikely that any adverse operational noise or vibration effects would result.

4.11.4.6 | BUILD ALTERNATIVES: OPERATIONAL PERIOD NOISE

Under Alternative 2, bus headways would be 5.5 minutes during peak hours and 7.5 minutes during midday hours and 7.5 to 20 minutes during evening and nighttime hours. Operational noise levels were calculated using the operation schedule, speed, and distance to the proposed operating lane (bus-only or mixed-flow, depending on location). Table 4.11-7 summarizes all relevant project information used in assessing future noise effects with the FTA transit noise model. The Table identifies the sensitive receptors along the Geary corridor (described further at 4.11.2.1.3 above). Project-related noise levels at these receptor sites would not exceed FTA significance criteria. The maximum expected noise increase is 1 dBA, which is not perceptible to the human ear. Thus, Alternative 2 operational noise would not result in any adverse effect, as shown in Table 4.11-3.

Noise levels modeled for Alternative 2, described above, represent "worst case" conditions, as the levels are measured at the closest points to sensitive receptors. Moreover, bus headways for Alternative 3 would be the same as identified for in Alternative 2. Noise levels identified in Table 4.11-7 would thus also be the maximum range for Alternative 3. Noise levels associated with Alternative 3 would not exceed the FTA significance criteria. Thus, Alternative 3 operational noise would not result in any adverse effect.

Headways for Alternative 3-Consolidated would be shorter than those for Alternatives 2 and 3. In other words, buses would run more frequently. However, noise levels in Table 4.11-7 would also apply as the maximum range. This is because Alternative 2 would have buses running closest to sensitive receptors. Therefore, similar to Alternative 3, Alternative 3-Consolidated operational noise would not result in any adverse effect.

Because the Hybrid Alternative/LPA consists of various components adapted from Alternatives 2, 3, and 3-Consolidated, the distance from bus operating lane to sensitive receptors would be represented by the range of operational noise covered between the other three build alternatives. Therefore, the expected noise levels shown in Table 4.11-7 would also apply for the Hybrid Alternative/LPA. Project-related noise levels would not exceed the FTA significance criteria. Thus, Hybrid Alternative/LPA operational noise would not result in any adverse effect.

4.11.4.7 | BUILD ALTERNATIVES - OPERATIONAL PERIOD VIBRATION

Vibration impact criteria relate to the potential to result in human annoyance; the criteria are based on the frequency of vibration-causing events. For example, residences that experience frequent events (defined as more than 70 vibration events of the same source per day), may be exposed to vibration levels of up to 72 VdB without experiencing an adverse effect.

Bus operations do not generally contribute to adverse vibration effects. Rubber tires and suspension systems provide vibration isolation, which limit the dispersion of ground-borne vibration. When buses cause effects such as rattling of windows, the source is almost always airborne noise. Most problems with bus-related vibration can be directly related to a discontinuity in the road surface, such as a bump, expansion joint, or pothole.[6] Such discontinuities would be unlikely, as the road would be rehabilitated/resurfaced (see Section 2.3.3). As such, the potential for bus-related vibration would be decreased compared to existing roadway conditions.

None of the build alternatives would involve other significant stationary sources of ground-borne vibration, such as heavy equipment operations. Operational ground-borne vibration in the Geary corridor would be generated by vehicular travel on the local roadways. However, similar to existing conditions, project-related traffic vibration levels would not be perceptible by sensitive receptors. Thus, operational vibration would not result in an adverse effect for any of the build alternatives.

[6] Federal Transit Administration. (2006). Transit Noise and Vibration Impact Assessment. FTA-VA-90-1003-06.

Table 4.11-7 Operational Noise Effects

RECEPTOR	FTA NOISE-SENSITIVE LAND USE CATEGORY	NOISE LEVELS (LDN OR LEQ)					INCREASE (DBA)	ADVERSE EFFECT /BA/
			EXISTING + PROJECT /C/					
		EXISTING	PROJECT NOISE /A/	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 3-CONSOLIDATED		
Residential Cluster 1 (48th Ave to 34th Ave)	2	68	62	69	69	69	1	No
Residential Cluster 2 (34th Ave to 27th Ave)	2	71	61	71	71	71	0	No
Residential Cluster 3 (27th Ave to Arguello Blvd)	2	72	60	72	72	72	0	No
Residential Cluster 4 (Arguello Blvd to Broderick)	2	74	64	74	74	74	0	No
Residential Cluster 5 (Broderick to Scott St)	2	74	61	74	74	74	0	No
Residential Cluster 6 (Scott St to Laguna St)	2	71	63	72	72	72	1	No
Residential Cluster 7 (Laguna St to Gough St)	2	71	61	71	71	71	0	No
Residential Cluster 8 (Gough St to Van Ness Ave)	2	72	64	72	73	73	1	No
Residential Cluster 9 (Van Ness Ave to Taylor St)	2	72	60	72	72	72	0	No
Sutro Heights Park	3	65	41	65	65	65	0	No
Seventh Day Adventist Church	3	65	56	66	66	66	1	No
Ka Ming Head Start	3	68	51	68	68	68	0	No
Ta Kioh Buddhist Temple	3	68	51	68	68	68	0	No
Holy Virgin Cathedral	3	68	51	68	68	68	0	No
St. Monica's Church and School	3	69	51	69	69	69	0	No
Eastern Catholic Center	3	69	51	69	69	69	0	No
First Burmese Baptist Church	3	69	45	69	69	69	0	No
Golden Gate Christian Church	3	69	45	69	69	69	0	No
Kaiser Permanente French Campus	2	73	51	73	73	73	0	No
Holt Labor Library	3	73	53	73	73	73	0	No
Institute of Aging	3	73	51	73	73	73	0	No
Roosevelt Middle School	3	73	46	73	73	73	0	No
Star of the Sea School	3	73	46	73	73	73	0	No
Park Presidio United Methodist	3	73	51	73	73	73	0	No
Geary Parkway Motel	2	76	60	76	76	76	0	No
Sinai Memorial Chapel	3	71	53	71	71	71	0	No
UCSF /Children's Hospital Medical Offices	3	73	53	73	73	73	0	No

RECEPTOR	FTA NOISE-SENSITIVE LAND USE CATEGORY	NOISE LEVELS (LDN OR LEQ)					INCREASE (DBA)	ADVERSE EFFECT /BA/
			EXISTING + PROJECT /C/					
		EXISTING	PROJECT NOISE /A/	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 3-CONSOLIDATED		
Kaiser Permanente Medical Center	2	71	55	71	71	71	0	No
Hamilton Memorial Church	3	71	55	71	71	71	0	No
Presidio Street Surgery Center	2	71	47	71	71	71	0	No
UCSF Medical Center at Mt. Zion	2	71	47	71	71	71	0	No
Western Addition Library	3	71	52	71	71	71	0	No
Sleep Quest	2	68	55	68	68	68	0	No
NorCal Presbyterian Senior Housing	2	71	61	71	71	71	0	No
Jones Methodist Church	3	71	49	71	71	71	0	No
Gateway High School	3	71	52	71	71	71	0	No
Cathedral of St. Mary	3	68	45	68	68	68	0	No
Hotel Kabuki	2	71	63	72	72	72	1	No
Monarch Hotel	2	71	57	69	69	69	0	No
Charlie's Hotel	2	71	61	71	71	71	0	No
Opal Hotel	2	71	57	71	71	71	0	No
Archdiocese of San Francisco	3	68	55	68	68	68	0	No
Hamilton Square Baptist Church	3	68	57	68	68	68	0	No
St. Marks	3	68	50	68	68	68	0	No
First Unitarian	3	68	48	68	68	68	0	No
Cathedral of St. Mary	3	68	40	68	68	68	0	No
Union Square Park	3	69	56	69	69	69	0	No
Graystone Hotel	2	72	62	72	72	72	0	No
Stratford Hotel	2	72	58	72	72	72	0	No
Villa Florence Hotel	2	72	56	72	72	72	0	No
Handlery Union Square	2	71	58	71	71	71	0	No
Fusion Hotel	2	72	48	72	72	72	0	No
Hotel Nikko	2	71	63	72	72	72	1	No
Hilton Towers	2	71	60	71	71	71	0	No
Clift Hotel	2	71	57	71	71	71	0	No

RECEPTOR	FTA NOISE-SENSITIVE LAND USE CATEGORY	NOISE LEVELS (LDN OR LEQ)					INCREASE (DBA)	ADVERSE EFFECT /BA/
			EXISTING + PROJECT /C/					
		EXISTING	PROJECT NOISE /A/	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 3-CONSOLIDATED		
Hotel Monaco	2	71	57	71	71	71	0	No
Hotel G	2	71	63	72	72	72	1	No
Westin St. Francis Hotel	2	71	61	71	71	71	0	No
Hotel Diva	2	71	63	72	72	72	1	No
Warwick Regis Hotel	2	71	63	72	72	72	1	No
King George Hotel	2	71	50	71	71	71	0	No
Hotel Adagio	2	71	64	72	72	72	1	No
Hotel California	2	71	64	72	72	72	1	No
Abby Hotel	2	71	64	72	72	72	1	No
Adante Hotel	2	71	63	72	72	72	1	No
Hotel Union	2	71	58	71	71	71	0	No
Motel 6	2	71	57	71	71	71	0	No
California Hotel	2	71	63	72	72	72	1	No
Alexis Park Hotel	2	71	48	71	71	71	0	No
Civic Center Inn	2	71	48	71	71	71	0	No
Hartland Hotel	2	71	58	71	71	71	0	No
Hotel President	2	71	58	71	71	71	0	No
Ambika Hotel	2	71	58	71	71	71	0	No
Edgeworth Hotel	2	71	58	71	71	71	0	No
Luz Hotel	2	71	58	71	71	71	0	No
Admiral Hotel	2	71	57	71	71	71	0	No
Sweden House	2	71	62	72	72	72	1	No
America’s Best Value Inn	2	71	62	72	72	72	1	No
Layne Hotel	2	71	49	71	71	71	0	No
Halcyon Hotel	2	71	50	71	71	71	0	No
Beresford Arms	2	71	48	71	71	71	0	No
Nazareth Hotel	2	71	58	71	71	71	0	No
Coast Hotel	2	71	57	71	71	71	0	No

RECEPTOR	FTA NOISE-SENSITIVE LAND USE CATEGORY	NOISE LEVELS (LDN OR LEQ)					INCREASE (DBA)	ADVERSE EFFECT /BA/
			EXISTING + PROJECT /C/					
		EXISTING	PROJECT NOISE /A/	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 3-CONSOLIDATED		
Columbia Hotel	2	71	63	72	72	72	1	No
Super 8 Motel	2	71	63	72	72	72	1	No
Gateway Inn	2	71	57	71	71	71	0	No
Serrano Hotel	2	71	58	71	71	71	0	No
Union Square Hostel	2	71	52	71	71	71	0	No
Touchstone Hotel	2	71	63	72	72	72	1	No
Union Square Plaza	2	71	63	72	72	72	1	No
Adelaide Hostel	2	71	49	71	71	71	0	No
Hotel Mark Twain	2	71	47	71	71	71	0	No
San Francisco Hostel	2	71	57	71	71	71	0	No
Hotel Union Square	2	72	44	72	72	72	0	No
St. Moritz Hotel	2	72	57	72	72	72	0	No
Four Seasons Hotel	2	72	60	72	72	72	0	No
Palace Hotel	2	72	60	72	72	72	0	No
Herbert Hotel	2	72	63	73	73	73	1	No
Acer Hotel	2	71	57	71	71	71	0	No
Aldrich Hotel	2	71	47	71	71	71	0	No
Fifth Church of Christ Scientist	3	69	55	69	69	69	0	No
Fashion Institute of Design Merchandising	3	68	54	68	68	68	0	No
UC Berkeley Extension	3	69	52	69	69	69	0	No
University of Phoenix	3	69	52	69	69	69	0	No

/A/ Project Level Noise models Alternative 2 as the worst case scenario since the side-running lane has the closest distance to sensitive receptors. Bus noise levels were assumed as posted speed limits.

/B/ Effect is measured against the Noise Criteria for land use type. () indicates that an adverse effect would only occur for that Build Alternative.

/C/ Hybrid Alternative/LPA noise levels are represented by noise levels for Alternatives 2, 3, and 3-Consolidated, depending on location. Please see section 4.11. 3.2.5 for more information.

Note - Noise levels modeled for Alternative 2, described above, represent the worst case conditions as the levels are measured at the closest points to sensitive receptors. Moreover, headways for Alternative 3 and 3-Consolidated are evaluated as identified for in Alternative 2.

Source: Terry A. Hayes Associates Inc., 2014

4.11.4.8 | COMPARATIVE EFFECTS OF ALTERNATIVES

As demonstrated in the preceding subsections, the No Build Alternative would have the lowest level of construction period noise and vibration, followed by Alternative 2, the Hybrid Alternative/LPA and then Alternatives 3 and 3-Consolidated. Operational period noise would be largely similar among the build alternatives, although Alternative 2 and the Hybrid Alternative/LPA would each feature areas of side-running bus only lanes that would bring bus activity closer to sensitive receptors on either side of the Geary corridor. None of the build alternatives, however, would result in any operational period adverse effects.

4.11.5 Avoidance, Minimization and/or Mitigation Measures

4.11.5.1 | CONSTRUCTION MEASURES

MIN-NOISE-C1. A Vibration Reduction and Minimization Plan shall be developed to avoid construction vibration damage using all reasonable and feasible means available. The Plan shall provide a procedure for establishing thresholds and limiting vibration values for structures with a potential to be adversely affected. The following steps shall be taken in development of the location-specific vibration reduction plan:

- Potential vibration-sensitive structures shall be identified using the distance impact thresholds in the final engineering drawings;
- Vibration-sensitive structures shall be individually assessed to identify the structure's ability to withstand the loads and displacements due to construction vibrations;
- Construction related vibration in proximity to identified vibration-sensitive historic structures shall not be allowed to exceed the recommended levels set forth in pertinent FTA guidance;
- Peak particle velocities shall be monitored and recorded near sensitive receptors identified where the highest vibration producing activities occur;
- Rubber tired instead of tracked vehicles shall be used near vibration sensitive areas;
- Pavement breaking shall be prohibited during nighttime hours; and
- Residents within 300 feet of areas where construction activities and pavement breaking will take place shall be notified at least two weeks in advance of the proposed activity through the media and mail. A program shall be implemented to receive and respond to public complaints regarding vibration during construction.

MIN-NOISE-C2. Project construction shall implement best practices in equipment noise control, including the following:

- Use newer equipment with improved noise muffling and ensure that all equipment items have the manufacturers' recommended noise abatement measures, such as mufflers, engine covers, and engine vibration isolators intact and operational. Newer equipment will generally be quieter in operation than older equipment. All construction equipment should be inspected at periodic intervals to ensure proper maintenance and presence of noise control devices (e.g., mufflers and shrouding).

- Perform all construction in a manner that minimizes noise. Utilize construction methods or equipment that will provide the lowest level of noise effects.

- Idling times shall be minimized either by shutting equipment off when not in use or reducing the maximum idling time to 5 minutes.

- Impact tools and equipment, such as jack hammers, shall have intake exhaust mufflers and acoustically attenuating shields or shrouds recommended by the manufacturers and approved by the Director of Public Works or the Director of Building Inspection.

MIN-NOISE-C3: Project construction will conduct truck loading, unloading, and hauling operations so that noise and vibration are kept to a minimum by carefully selecting routes to avoid passing through residential neighborhoods to the greatest possible extent.

MIN-NOISE-C4: Perform independent noise monitoring in sensitive areas, as needed, to demonstrate compliance with applicable noise limits. Require contractors to modify and/or reschedule their construction activities if monitoring determines that maximum limits are exceeded at residential land uses per the City Noise Ordinance.

MIN-NOISE-C5: Temporary sound walls, curtains, or other noise canceling technologies may be used in locations where sensitive receptors could experience construction-related noise exceedances.

4.11.5.2 | OPERATIONAL MEASURES

The No Build Alternative and build alternatives are not expected to have adverse effects related to noise and vibration. As no adverse effects are expected, no avoidance, minimization, or mitigation measures for operations would be required.

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