Table 4-15 2030 Mobile Source Regional Transportation Pollutant Burdens (kg/day)

Alternative	Emission Burden (kg/day)					Percent Change from No Build				
	VOC	CO	NO_x	PM_{10}	$PM_{2.5}$	VOC	CO	NO_x	PM_{10}	$PM_{2.5}$
No Build	6,874	147,899	4,856	376	175	n/a	n/a	n/a	n/a	n/a
Project	6,561	142,098	4,661	360	167	-4.6%	-3.9%	-4.0%	-4.3%	-4.6%

n/a = not applicable

However, these emissions will be offset in whole or part by the reductions generated by reduced VMT, as indicated in Table 4-15. Furthermore, power plant emissions may be more easily controlled than emissions from individual automobiles.

The Project is expected to have a small positive effect on MSAT emissions in the study corridor, compared to the No Build Alternative because of the reduction of VMT. MSAT levels could be higher in some locations in the study corridor than others, but current tools and science are not adequate to quantify these levels. However, EPA's vehicle and fuel regulations coupled with fleet turnover will result in lower region-wide MSAT levels from current levels.

The Project is predicted to demonstrate a 4-percent reduction in VMT and no change in overall network speed compared to the No Build Alternative. This will result in predicted pollution reductions ranging from 3.9 to 4.6 percent compared to the No Build Alternative.

Greenhouse Gases

The Project will decrease greenhouse gas emissions from transportation sources on O'ahu. Approximately 70 kg of carbon dioxide is emitted per million British thermal units (BTU) consumed when fuel oil, diesel, or gasoline is combusted (USDOE 2009). As detailed in Section 4.11, total daily transportation energy consumption on O'ahu would be 94,890 million BTUs for the No Build Alternative and will be 92,450 million BTUs for the Project. Assuming all electricity is generated from combustion of oil, the daily 2,440-million-BTU energy savings will result in a daily reduction in greenhouse gas emissions of approximately 171 metric tons of carbon dioxide.

Local Effects

The study corridor is currently in attainment for CO, and monitored CO values are less than 20 percent of the applicable NAAQS. Therefore, no violations of the applicable NAAQS are likely to occur with the Project. As a result, a microscale CO analysis was not conducted.

Mitigation

Because no substantial air quality impacts are anticipated to result from operation of the Project, mitigation will not be required.

4.10 Noise and Vibration

This section describes the Project's effects on environmental noise and vibration levels in the study corridor. For more information and references, see the *Honolulu High-Capacity Transit Corridor Project Noise and Vibration Technical Report* (RTD 2008f) and the *Honolulu High-Capacity Transit Corridor Project Addendum 01 to the Noise and Vibration Technical Report* (RTD 2010b).

4.10.1 Background and Methodology

Background

Environmental noise is composed of many frequencies, each occurring simultaneously at its own sound pressure level. The range of magnitude, from the faintest to the loudest sound the ear can hear, is so large that sound pressure is expressed on a logarithmic scale in units called decibels (dB). The commonly used frequency weighting for environmental noise is A-weighting (dBA), which simulates how an average person hears sound.

A common noise descriptor for environmental noise is the equivalent sound level (Leq). Leq is a measure of total noise—a summation of all sounds during a period of time. Leq measured over a one-hour period is the hourly Leq [Leq(h)]. The day/night noise level (Ldn) is a descriptor of the daily noise environment, which incorporates a penalty for high noise levels at night. Lmax is the maximum noise level during an event. Ldn is used by the EPA and FTA to evaluate noise levels in residential areas.

Typical sound levels experienced in urban environments are shown in Figure 4-51.

Noise Terminology

dBA is an A-weighted decibel, a measure that considers how people hear sound

Lmax is the maximum noise level during an event

Leq measures the average sound energy over time

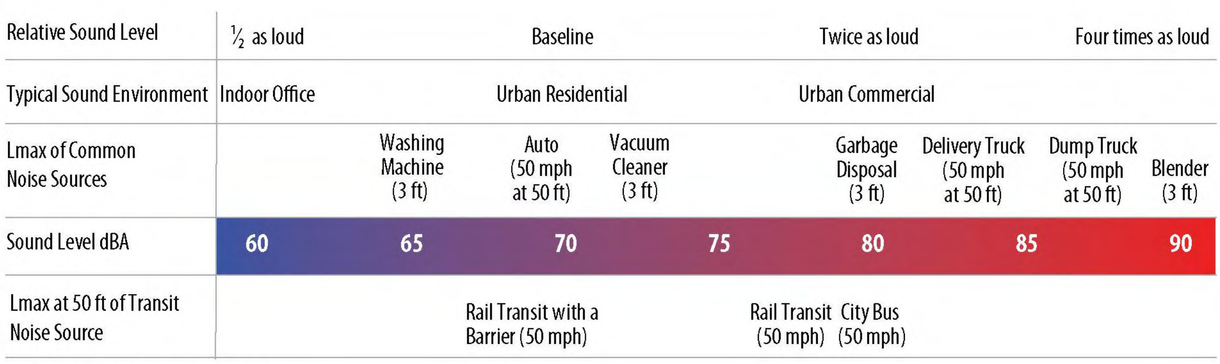
Ldn is the day/night sound level, a 24-hour average with a penalty that makes sounds at night more important

Noise from rail transit operations is generated from the interaction of wheels on track, motive power, and the operation of traction power substations. The interaction of steel wheels on rails generates the following three different types of noise, depending on track work: (1) noise generated by pass-by trains operating on tangent track sections, (2) noise generated from wheel squeal on tightly curved track, and (3) noise generated on special trackway sections, such as at crossovers or turnouts.

Noise Criteria for the Project

Noise impacts from transit projects are evaluated using criteria established by the FTA, which are based on community reaction to environmental noise exposure (FTA 2006a). The FTA noise impact criteria group noise-sensitive land uses into the categories shown in Table 4-16.

The FTA criteria define moderate and severe impacts. The project-generated noise level (project noise exposure) at which an impact will occur depends on the existing noise environment and the category of land use. The noise impact criteria for transit operations are shown on Figure 4-52, with residential noise impacts (measured in Ldn) shown on the left side of the graph and commercial noise impacts (measured in Leq[h]) shown on the right.



Sources: EPA 1971, EPA 1974, FTA 2006

Figure 4-51 Typical Sound Levels

Table 4-16 FTA Transit Project Noise Impact Criteria—Land Use Categories

Category	Metric	Land Use Description
1	Leq(h) (dBA)	Tracts of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet, land uses such as outdoor amphitheaters and concert pavilions, and National Historic Landmarks with substantial outdoor use.
2	Ldn (dBA)	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	Leq(h) (dBA)	Institutional land uses with primary daytime and evening use. This category includes schools, libraries, and churches where it is important to consider interference with such activities as speech, meditation, and concentration on reading material. Buildings with interior spaces where quiet is important, such as medical offices, conference rooms, recording studios, and concert halls, fall into this category. It also includes places for meditation or study associated with cemeteries, monuments, and museums. Certain historical sites, parks, and recreational facilities are also included.

Source: Transit Noise and Vibration Impact Assessment, Final Report (FTA 2006a).

Reading from the graph, if the existing noise level in a residential area is 60 dBA Ldn, then a project that generates less than 58 dBA Ldn will not have an effect. If it generates between 58 and 63 dBA Ldn, it will cause a moderate impact, and if it generates more than 63 dBA Ldn, it will cause a severe impact. Future noise exposure is the combination of existing noise exposure and the additional noise exposure caused by a project.

Severe noise impacts are considered significant within the context of NEPA and HRS Chapter 343. Severe noise impacts require the evaluation of alternative locations/alignments to avoid severe impacts altogether. If it is not practical to avoid severe impacts by changing the location of the Project, mitigation measures must be considered and incorporated into the Project unless there are truly extenuating circumstances that prevent it. Moderate noise impacts also require consideration and adoption of mitigation measures when it is reasonable. The mitigation of moderate impacts should consider the predicted increase over existing noise levels, the type and number of noise-sensitive land uses affected, existing outdoor/indoor sound insulation, community views, special protection provided by law, and the cost-effectiveness of mitigating noise to more acceptable levels.

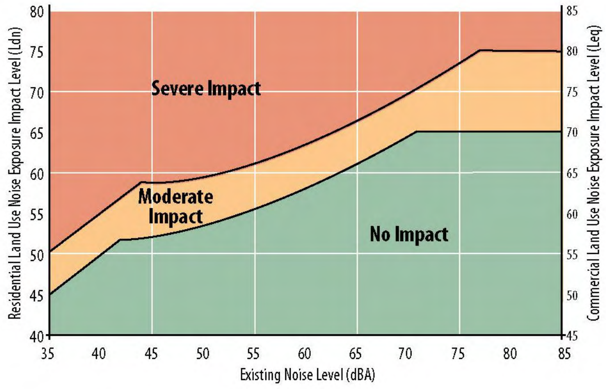


Figure 4-52 FTA Transit Project Noise Exposure Impact Criteria

The State of Hawaiʻi regulates community noise pollution through HAR 11-46. The regulations are applicable to stationary noise sources, such as traction power substations and the vehicle maintenance and storage facility.

Vibration Criteria for the Project

Vibration effects from transit operations are generated by motions/actions at the wheel/rail interface. The smoothness of these motions/actions are influenced by wheel and rail roughness, transit vehicle suspension, train speed, track construction (including types of fixation and ballast), location of switches and crossovers, and the geologic strata (layers of rock and soil) underlying the track.

Vibration from a passing train has the potential to move through the geologic strata, resulting in vibration transferred through the building foundation. The principal concern is annoyance to building occupants.

Ground-borne vibration is usually characterized in terms of vibration velocity. This is because—over the frequency range relevant to ground-borne vibration (about 1 to 200 hertz)—both human and building response tends to be more proportional to velocity than to displacement or acceleration. Vibration velocity is often reported as vibration decibels (VdB) relative to a reference velocity of 10^{-6} inches/second.

The FTA has developed criteria for acceptable levels of ground-borne vibration (FTA 2006a) as shown in Table 4-17.

Noise and Vibration Assessment Methodology

Project-related noise levels were calculated using FTA reference sound levels for rail transit. Potentially noise-sensitive land uses and vibration-sensitive buildings were identified, as well as appropriate locations for noise monitoring.

Ground-level noise levels were measured at locations along the project alignment and near proposed station locations to establish the most sensitive existing environment (i.e., existing baseline noise levels). Noise levels were also measured on the upper floors of residential buildings that have four or more floors. This is done by performing a series of measurements at representative locations. All noise measurements were made in accordance with American National Standards Institute procedures for community noise measurements.

Noise measurements were taken at 45 noise-sensitive locations along the study corridor. Eight of the noise measurements were taken at sites near the Arizona Memorial and Pearl Harbor Naval Base in response to comments received on the Draft EIS. Measurements for 24-hour periods were conducted at 25 sites that included residences and other buildings where people normally sleep (Category 2 sites). These locations were supplemented with short-term 15-minute measurement sites to determine existing noise levels at typical recreational, institutional, and commercial land uses with primarily daytime and evening activity (Category 3 sites). Eight of the 24-hour measurement sites were located on the upper floors of multi-story residential buildings with open lanais. Potential noise effects from traction powered substations, park-and-ride lots, and maintenance and storage facility operations were also identified.

Noise effects from the Project were determined by comparing the project-generated noise exposure level at each representative receptor in the corridor to the appropriate FTA criterion, given the land use

Table 4-17 FTA Ground-borne Vibration Impact Criteria

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

Source: Transit Noise and Vibration Impact Assessment, Final Report (FTA 2006a).

[1] *Frequent Events* are defined as over 70 vibration events per day.
[2] *Infrequent Events* are defined as less than 70 vibration events per day. This includes most commuter rail systems.
[3] This criterion is based on levels that are acceptable for most moderately sensitive equipment, such as optical microscopes. Vibration-sensitive manufacturing or research will require detailed evaluation to define acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the HVAC system and stiffened floors.

and existing noise levels. If the project-generated noise is below the level for moderate impact, no impact will occur. If the noise level is between the level for moderate impact and severe impact, a moderate impact will occur. If the project noise level is equal to or above the severe impact level, a severe impact will occur.

Vibration effects from the Project were determined using the detailed vibration assessment information and procedures contained in the FTA's *Transit Noise and Vibration Impact Assessment* (FTA 2006a). FTA reference levels for a transit vehicle and FTA reference data on ground transmission of vibration energy were used to estimate vibration levels near the fixed guideway.

4.10.2 Affected Environment

This section describes the noise survey used to establish baseline conditions. Ambient vibration levels were not measured as part of this study.

Ambient Noise Conditions in the Study Area

The measurement locations, type of measurement, and existing sound levels are shown in Figures 4-53 through 4-56. These locations represent noise-sensitive land uses along the corridor.

Ambient Vibration Conditions in the Study Area

Ambient vibration levels were not measured as part of this study but are anticipated to be below perceptible levels.

4.10.3 Environmental Consequences and Mitigation

Environmental Consequences

No Build Alternative

Under the No Build Alternative, the Project would not be built and the only source of future noise levels would be traffic movements on local streets and highways. The Project would not generate any new noise impacts. Similarly, no new vibration sources would occur in the absence of the Project. Although the projects in the ORTP will be built, their environmental impacts will be studied in separate documents.

Project

Noise

The Project will include an integrated parapet wall at the edge of the guideway structure that extends 3 feet above the top of the rail.

Figures 4-53 through 4-56 show the measured existing noise level and future project noise exposure at each site. The data table included in these figures for each site is labeled "no impact" or "moderate impact" for each site. No noise impacts will occur for schools, public parks, or historic resources as a result of the Project. There will be no noise impacts at the three sites located at the Arizona Memorial (Figure 4-55).

The Project will cause no severe noise impacts. However, moderate impacts will occur at eight areas (Table 4-18). The moderate impacts to these eight areas will occur at the ground level for 50 residences and between the fifth and eleventh floors of four high-rise buildings.

The greatest noise source from the traction power substations will be air-conditioning equipment, which will not result in substantial noise impacts. Project park-and-ride lots will be located in undeveloped or commercial areas. The closest proximity from a park-and-ride lot to a residential use will be approximately 300 feet to the nearest point and more than 1,000 feet to the center of the park-and-ride site at Pearl Highlands. At these distances, the park-and-ride lots will not cause noise impacts.

Noise sources at the maintenance and storage facility will include trains operating and switching within the facility and maintenance and cleaning activities. These activities will occur over a 24-hour period. The preferred site option for the maintenance and storage facility is a 44-acre vacant site in Waipahu near Leeward Community College.

Table 4-18 Noise Impacts

Area	Receptor Description	Buildings Affected	Level of Impact
West Loch to Waipahu Transit Center	94-340 Pupumomi Street	One 9-floor building	Moderate impact to 5th floor and above
West Loch to Waipahu Transit Center	Hanewai Circle	20 single-family residential	Moderate impact
Waipahu Transit Center to Leeward Community College	Awaiki Place	18 single-family residential	Moderate impact
Aloha Stadium to Pearl Harbor Naval Base	Betio Place	8 single-family residential	Moderate impact
Aloha Stadium to Pearl Harbor Naval Base	Makalapa Guest House	4 single-family residential	Moderate impact
Downtown to Civic Center	700 Richards Street	One 26-floor building	Moderate impact to 7th through 11th floors
Civic Center to Kaka`ako	860 Halekauwila	One 30-floor building	Moderate impact to 6th floor and above
Kaka`ako to Ala Moana Center	1133 Waimanu	One 28-floor building	Moderate impact to 5th through 9th floors

Three noise-sensitive sites are within 1,000 feet of the preferred maintenance and storage site—Leeward Community College, Waipahu High School, and the Pearl Harbor Bike Path. All of these sites are Category 3 (Table 4-17). Maximum daytime operations at the site would occur when vehicles are taken in or out of service to accommodate the change in headways. The maximum noise exposure level at the Waipahu High School football field, the nearest use to the maintenance and storage site, would be 62 dBA Leq(h). That is less than the impact criteria of 67 dBA Leq(h) at that site. The maximum noise exposure level at Leeward Community College would be 55 dBA Leq(h). That is less than the impact criteria of 66 dBA Leq(h) at that site. The maximum noise exposure level at the Pearl Harbor Bike Path would be 52 dBA Leq(h). That is less than the lowest FTA impact criteria of 57 dBA Leq(h) that is applicable to quiet sites. There are no noise-sensitive uses near the alternative Ho'opili maintenance site option.

Vibration

Vibration levels at adjacent properties will not exceed 65 VdB for the elevated rail transit. This level is less than the FTA criterion of 72 VdB for residential buildings and other structures where people normally sleep (Category 2). No land use along the alignment is identified as having vibration-sensitive equipment that will require the use of lower vibration impact criteria; therefore, no vibration effects are anticipated. No long-term vibration impacts will occur to historic resources.

Mitigation

Noise

Without mitigation, noise exposure levels at eight areas would exceed the noise impact criteria. Several measures are available to reduce noise levels during operation. Wheel skirts can reduce noise by as much as 10 dBA and track ballast by up to 5 dBA (FTA 2006).

For the Project, wheel skirts will reduce noise generated from the Project by 3 dBA or more. Wheel skirts have been added to the vehicle specifications. As a result, noise exposure levels from the Project will be 3 dBA less than shown in Figures 4-53 through 4-56. Wheel skirts will reduce noise exposure levels to below the impact criteria at five of the eight locations where impacts are predicted (Table 4-19). With wheel skirts, three of these residential sites still will experience moderate noise impacts on the fifth through eleventh floors. The moderate noise impact that will occur at the high-

Figure 4-53 Noise Measurement Locations and Results (East Kapolei to Fort Weaver Road)

Figure 4-54 Noise Measurement Locations and Results (Fort Weaver Road to Aloha Stadium)

Figure 4-55 Noise Measurement Locations and Results (Aloha Stadium to Kalihi)

Figure 4-56 Noise Measurement Locations and Results (Kalihi to Ala Moana Center)

Table 4-19 Mitigated Noise Levels

Area	Receptor Description	Impact Criteria	Noise Level without Mitigation*	Noise Level with Wheel Skirts	Noise Level with Wheel Skirts and Sound Absorptive Material
West Loch to Waipahu Transit Center	94-340 Pupumomi Street, 5th floor and above	66 dBA Ldn	**71 dBA Ldn**	**68 dBA Ldn**	65 dBA Ldn
West Loch to Waipahu Transit Center	Hanewai Circle	60 dBA Ldn	**60 dBA Ldn**	57 dBA Ldn	n/a
Waipahu Transit Center to Leeward Community College	Awaiki Place	58 dBA Ldn	**59 dBA Ldn**	56 dBA Ldn	n/a
Aloha Stadium to Pearl Harbor Naval Base	Betio Place	59 dBA Ldn	**59 dBA Ldn**	56 dBA Ldn	n/a
Aloha Stadium to Pearl Harbor Naval Base	Makalapa Guest House	59 dBA Ldn	**59 dBA Ldn**	56 dBA Ldn	n/a
Downtown to Civic Center	700 Richards Street, 7th through 11th floors	66 dBA Ldn	**67 dBA Ldn**	64 dBA Ldn	n/a
Civic Center to Kaka`ako	860 Halekauwila, 6th floor and above	66 dBA Ldn	**70 dBA Ldn**	**67 dBA Ldn**	64 dBA Ldn
Kaka`ako to Ala Moana Center	1133 Waimanu, 5th through 9th floors	66 dBA Ldn	**69 dBA Ldn**	**66 dBA Ldn**	63 dBA Ldn

Values in **BOLD** represent a noise impact
n/a – Not applicable, Sound Absorptive Material not proposed in this location.
*Includes 3-foot parapet wall

rise buildings will only be experienced from units above track level on the fifth through ninth floors.

The traction power substations will be designed to be fully enclosed. State noise regulations require stationary sources to meet a property-line maximum sound level of either 45 or 50 dBA at night. The traction power substation buildings will be designed to meet this requirement. The greatest exterior noise will be air conditioning systems. All of the traction power substation sites near residential areas are sited at major highways or arterials where air-conditioning equipment noise will not be audible over background traffic noise.

The use of sound-absorptive materials under the tracks in these three areas will reduce the project noise exposure at upper floors to below the moderate noise impact threshold (Table 4-19). Eight hundred feet of sound-absorptive material will be installed from Pupukahi Street to Pupupuhi Street. For the building at 860 Halekauwila Street, sound-absorptive material will be required from 200 feet ʻEwa of Kamani Street to 100 feet Koko Head of Kamani Street—a total of 300 feet. The building at 1133 Waimanu will require sound-absortive material to be installed between Kamakee Street and Waimanu Street for a total of 920 feet.

Once the Project is operating, field measurements for noise will be conducted at representative sites. Should the Project's noise impacts exceed the FTA noise impact levels, further mitigation may be implemented on the receivers with the authorization of the property owners.

On the track curves between the planned maintenance and storage facility and the nearest Leeward Community College building, FTA and the City commit to installing automatic track lubrication devices capable of eliminating wheel squeal on those curves.

FTA and the City commit to requiring in the specifications for all traction power substations needed for the project that the noise generated by the substations measured at the nearest property line be an hourly Leq of 45 dBA or less in areas zoned single-family residential, conservation, preservation, or similar type and 50 dBA Leq or less in areas zoned multi-family residential, business, resort, or similar type in accordance with Hawai'i state law (HAR Section 11-46).

Vibration

Because no vibration effects are projected, no mitigation is proposed.

4.11 Energy and Electric and Magnetic Fields

This section describes the energy required for operating the Project and analyzes electric and magnetic fields (EMF) as related to the Project's operation. Energy used during the Project's operation will include fuel consumed by buses, electricity used to power transit vehicles, and a negligible amount of energy for signals, lighting, and maintenance. For more information and references, see the *Honolulu High-Capacity Transit Corridor Project Electric and Magnetic Fields Technical Report* (RTD 2008h).

EMFs are a result of the voltage or electric potential of an object. For this Project, the high-capacity transit system will be powered by electricity from a third line located next to the rail tracks. Whenever an electrical current flows, it creates a magnetic field. An analysis of EMFs is included in this Final EIS because of public concern about potential health effects and effects on equipment and machines adjacent to the corridor that may be sensitive to EMFs.

4.11.1 Background and Methodology

Energy

The analysis of operational energy consumption on O'ahu was based on the transportation analysis prepared for the Project. Changes in overall transportation energy use for vehicles traveling on O'ahu were assessed using daily VMT and speed values calculated from the transportation demand forecasting model.

The energy consumed by electrically powered transit operations for the high-capacity transit system was also considered. Fixed guideway high-capacity transit systems require energy for propulsion and to account for energy lost during transmission from the energy-generation site to the transit vehicles. The average energy consumption for a rail transit vehicle in the U.S. is 62,700 BTUs per vehicle-mile of service (USDOE 2007).

Electric and Magnetic Fields

EMFs are produced wherever wires distribute electric power and wherever electrical equipment is used. EMFs decrease with the square of distance away from operating equipment or away from current-carrying electric lines. Sensitive equipment that may be affected by changes to the Earth's geomagnetic field caused by operation of the Project may be located at research, manufacturing, medical, and possibly military facilities. Available data on high-voltage power lines, medical and diagnostic facilities, institutional and research facilities, and military operations were assembled. This information was confirmed through field reconnaissance to verify site locations and identify equipment that may be sensitive to the influence of EMFs associated with the Project.

Research into the health effects of EMFs has not established a link between EMFs and any health effects. National Academy of Sciences National Research Center findings "do not support the contention that the use of electricity poses a major unrecognized public-health danger" (NRC 1999).