Appendix A

Noise and Vibration Technical Analysis

SEPA Enviromental Checklist

SoundTransit

Noise and Vibration Technical Analysis

Lakewood Station Access Improvements Project

AE 0145-17 LSAI 02.02

August 2023

Lead Noise and Vibration Specialist:
Michael Minor
Michael Minor and Associates

David Evans and Associates, Inc.
801 Second Avenue, Suite 200
Seattle, WA 98104

SOUNDTRANSIT

Table of Contents

Figures

Tables

Acronyms and Abbreviations

ADA	Americans with Disabilities Act
dB	decibels
dBA	A-weighted decibel sound levels
EDNA	Environmental Designation for Noise Abatement
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
Hz	Hertz
I-5	Interstate 5
JBLM	Joint Base Lewis-McChord
Ldn	Day-Night Equivalent Sound Level
Leq	equivalent sound level
Lv	Velocity in decibels
Mph	miles per hour
PPV	peak particle velocity
RMS	Root Mean Square
VdB	Vibration Velocity Level
WAC	Washington Administrative Code

1 INTRODUCTION

The purpose of this memorandum is to summarize the results of the noise and vibration analysis for the Lakewood Station Access Improvements Project (project). The analysis follows the methods for a general noise assessment as provided in the *Transit Noise and Vibration Impact Assessment Manual*, Federal Transit Administration (FTA), September 2018 (FTA Manual, 2018). In addition, because project construction is the main noise source, the maximum permissible sound levels from construction activities are governed by the Lakewood Municipal Code, Chapter 8.36, Noise Control and the Washington State Administrative Code (WAC), Chapter 173-60 (Maximum Environmental Noise Levels).

2 PROJECT BACKGROUND

The Central Puget Sound Regional Transit Authority's (Sound Transit) current Sounder Commuter Rail System includes two operating lines, Sounder North and Sounder South.

Sound Transit is planning to expand Sounder South rail capacity to meet future anticipated demand in King and Pierce Counties, Washington. In its capacity as lead agency, Sound Transit is reviewing this Project under the State Environmental Policy Act (SEPA). SEPA requires that project proponents identify possible environmental impacts that may result from government decisions, including impacts from noise and vibration.

The improvements included in this analysis are a result of the alternative analysis conducted in Phase 1 of the Lakewood Station Access Improvements Project (Sound Transit 2021). The Phase 1 analysis identified two tiers of projects identified as Potential Improvements (herein titled Priority 1) and Possible Alternates (herein titled Priority 2). Three key criteria were used to identify Priority 1 and Priority 2 projects. These criteria were:

- Improves connections for underserved communities
- Addresses a substantial travel barrier
- Located within proximity of the station

For the purposes of the environmental analysis, all Priority 1 and Priority 2 projects are included.

Sound Transit proposes to improve access to the Lakewood Sounder Station and surrounding area by improving walking, bicycling, and bus facilities. Proposed improvements include new and updated sidewalks, Americans with Disabilities Act (ADA) compliant ramps, and bike lanes.

Figure 2-1 provides an overview of the study area with descriptions of the improvements outlined in the following sections.

2.1 Bridgeport Way non-motorized connections (A8, A20, A38, B5, B6, C1, D6) – Priority 1

The improvements proposed at 115th Street Court SW would facilitate non-motorized movement from the Bridgeport Way SW bus station and the 115th Street Court SW cul-de-sac to the Lakewood Sounder Station. They would allow for dropoff and pickup of passengers at the street end and access to the station via a trail along the north side of the tracks to the north station entrance.

Sharrows would be added to 115th Street Court SW from Bridgeport Way SW to the end of the cul-de-sac. Sharrows are lanes designated for sharing between vehicles and bikes – these are not separate bike lanes. Curb, gutters, and sidewalks would be constructed at the cul-de-sac and a portion of the north side of 115th Street Court SW. An approximately 1,620 feet long by 10-foot-wide shared use path would be constructed from the end of the cul-de-sac along the north side of the rail right-of-way to just past the pedestrian overpass allowing passengers to access the overpass bridge to the station. The path would be bordered on both sides with a chain link fence for security and be extended beyond the overcrossing to reduce ground level crossing of the tracks.

The bus stop on the south side of Bridgeport Way SW at 115th Street SW would receive shelter improvements, a pedestrian half signal would be added, as well as improved lighting and crosswalks to improve access to the bus shelters. ADA curb ramps would be added in several areas.

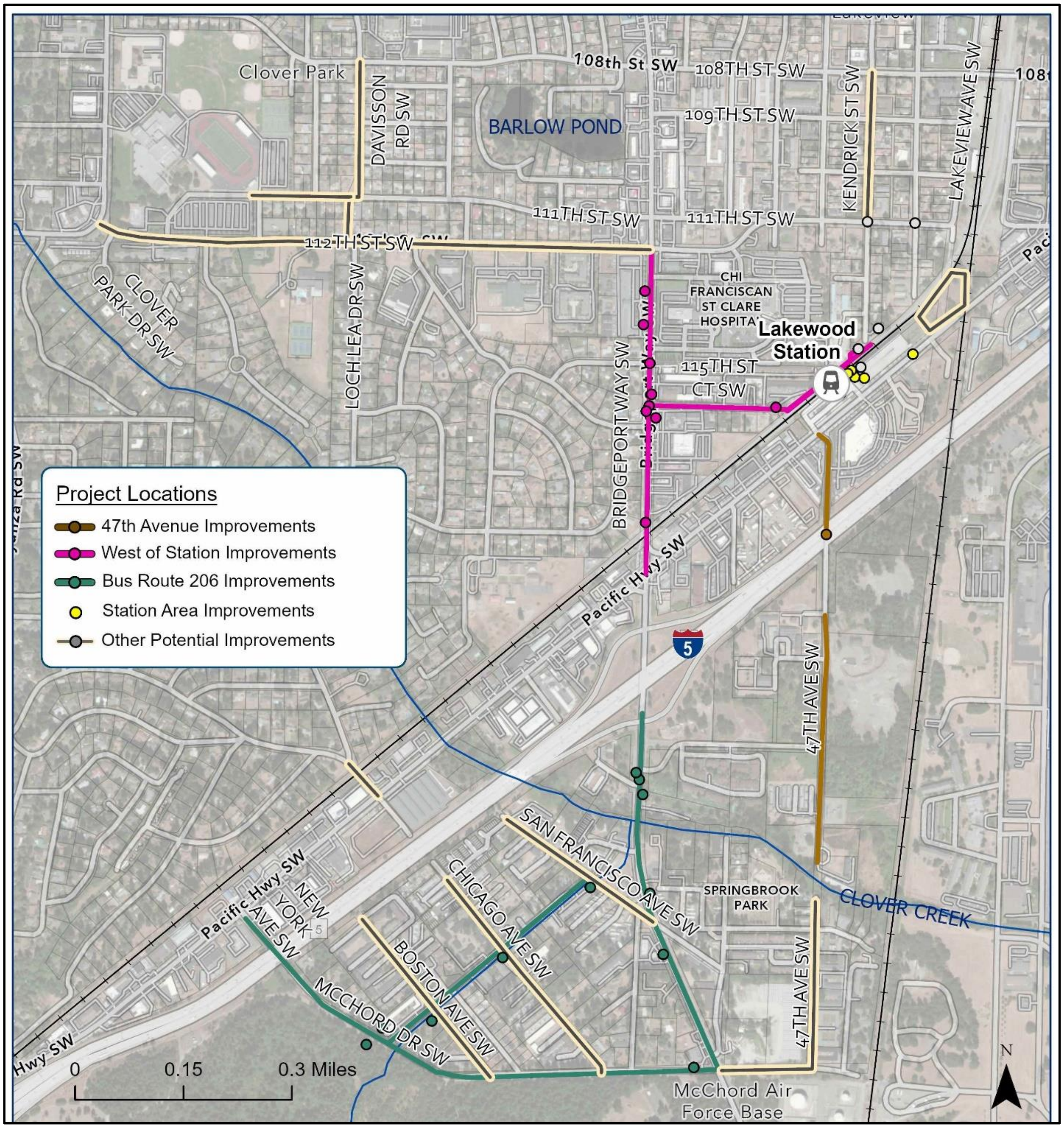


Figure 2-1 General overview and proposed improvements

2.2 Route 206 bus stops and sidewalks (A14, A23, A34, B4, B12, B13, B14, B15, B16, B19, B20) – Priority 1

Pierce Transit Route 206 runs down Bridgeport Way from the Lakewood Towne Center and extends south through the project area serving the access improvements project area.
A number of transit stops, right-of-way, and intersections in this area are proposed for improvements. These are described in more detail below.

Curb, gutter, and a 6-foot-wide sidewalk would be constructed on the north side of New York Avenue SW and McChord Drive SW between Bridgeport Way SW and Pacific Highway SW over a distance of approximately 3,800 feet. Several new utility poles for lighting would be added to this road segment at various points along the route. Near the intersection of McChord Drive SW and Lincoln Avenue SW a concrete bus stop pad would be installed on both sides of the street with a shelter, bench, and pedestrian level lighting. New crosswalk striping would be added at Lincoln Avenue SW to access the southbound bus stop on McChord Drive SW. Another bus shelter would be added to the north side of McChord Drive SW near Bridgeport Way SW.

At the New York Avenue SW crossing of I-5, the sidewalks on the north and south sides would be removed. A new sidewalk would be constructed on the north side, which would be slightly over 6 feet wide. On the north side a concrete barrier and pedestrian railing would be installed between the street and the sidewalk and a new railing at the bridge edge.

New curb, gutter, and sidewalks would be constructed on Lincoln Avenue SW between McChord Drive SW and San Francisco Avenue SW for a distance of approximately 1,900 feet. Sidewalks would be added to both sides of Lincoln Avenue SW between McChord Drive SW and Chicago Avenue SW. From Chicago Avenue SW to San Francisco Avenue SW sidewalks would only be added to the north side of Lincoln Avenue SW.

New transit shelters, pedestrian level lighting, benches, and trash receptacles would be added to Bridgeport Way SW at the transit stops at San Francisco Avenue SW, Seattle Avenue SW, and Pacific Highway SW. A new pedestrian crossing signal and median pedestrian refuge would be added at the Bridgeport Way SW/Seattle Avenue SW intersection.

2.3 Route 206 bus connection to the station (B8) – Priority 1

The project would reconstruct the existing right turn lane from southbound Pacific Highway SW to northbound Bridgeport Way SW to better accommodate transit turning movements and facilitate Route 206 access to the station. This includes removing the existing island, adjusting the lanes on Bridgeport Way SW by removing the median and constructing new curbs on Bridgeport Way SW and in the new turn lane.

2.4 47th Avenue SW bridge and sidewalk connections (A7, A17, A16.D) – Priority 1

South of I-5, sidewalks and sharrows would be constructed on the westside of 47th Avenue SW from Clover Creek to 120th Street SW. North of I-5, sidewalk, curbs and gutter would be added to the west side of 47th Avenue SW extending across Interstate 5 (I-5) to Pacific Highway SW. Sharrows would be constructed on the eastside of 47th Avenue SW. At the I-5 crossing the sidewalk on the east side would be removed and the sidewalk on the west side would be widened to 5 feet with a pedestrian barrier between the road and sidewalk and a pedestrian railing at the edge of the bridge. Enough room would be available to add sharrows across the bridge.

2.5 Sounder station improvements (A21, A41, B17, E1, E2, E4, E5 – Priority 1) / (A27, A28, D8.B, E3 – Priority 2)

Sounder station projects are proposed to improve access conditions for sight impaired, non-English speaking, and disabled persons, as well as support non-motorized access. The following upgrades are proposed:

- Provide parking for micromobility uses such as scooters and bicycles.
- Add bird deterrent system.
- Provide ADA mini-high shelter (mini-high provides a level train boarding surface).
- Retrofit stairs and other station components that are currently collecting trash.
- Install a public address system.
- Provide accessible wayfinding for sight impaired persons including:
  - Brail for ticketing.
  - Tactile strips between platform and drop-off areas.
- Provide signage for non-English speaking persons.
- In addition, ADA compliant curb ramps would be retrofitted at 35 sidewalk locations within ½ mile of the station.
- Bike Storage—Upgrades would be made to the internal station bike parking to a bike cage or other more secure bike Parking. Bicycle lockers at the pickup/drop-off location on Kendrick Street SW north of the station and near overcrossing elevators would be installed.
- Surface Parking—A completely new surface parking area (Northeast Surface Parking C) would be constructed north of the station. The parking area would be bordered by an 8-foot landscaped buffer that is bounded by a retaining wall. The entire parking area would be fenced. At the southern end of the parking area a 6-foot sidewalk would be constructed that connects to the Lakewood Sounder Station. There would be approximately 24 compact parking spaces and 46 standard size parking spaces and the parking area would include lighting.
- Wayfinding to Pickup/Drop-off Locations—Wayfinding signage would be added at several locations including near the intersection of Bridgeport Way SW and Pacific Highway SW, Bridgeport Way SW and 112th Street SW, and at Kendrick Street SW and 111th Street SW. Station access signage would be added to Pacific Highway SW near the station.

2.6 Non-motorized improvements (A10, A12, A18, A29, A30, A35, A36, A27, A39) – Priority 2

Various other station access improvements are proposed to enhance non-motorized travel in the project area. These are described below.

- 112th Street SW Connection - Sidewalks would be improved on 112th Street SW for a length of approximately 4,000 feet by adding curbs and gutters. Bike lanes would also be added.
- Kendrick Street SW Connection – There would be a full rebuild of approximately 1,000 feet of curbs, gutters, sidewalks, bicycle lanes and lighting.

- Clover Creek Drive SW Connection – Provide sidewalks on Clover Creek Drive SW between Hillcrest Drive SW and Pacific Highway SW. Improve accessibility and safety at the at-grade rail crossing by providing sidewalks, signage, and crossing arms.
- Clover Park High School Connection—Install bike lanes and rebuild curb, gutter, and sidewalks on 111th Street SW between 60th Avenue SW and Davisson Road SW.
- Davidson Road SW Connection—Construct bike lanes, curb, gutter, and sidewalk on Davison Road SW between 108th Street SW and 111th Street SW, and on Highland Street SW between 111th Street SW and 112th Street SW. Potential replacement of power pole outside the right of way.
- Springbrook Area Connections—Provide sidewalks, curb, gutter, pavement, and shared bicycle markings on 47th Avenue SW and McChord Drive SW for a distance of approximately 1,800 feet. Construct curb, gutter, sidewalks, and install street lighting on Chicago Avenue SW between McChord Drive SW and Springbrook Lane SW and Boston Avenue SW between McChord Drive SW and 57th Avenue Ct SW for a distance of approximately 1,900 feet. Construct curb, gutter, sidewalks, and install street lighting on San Francisco Avenue SW between Springbrook Lane SW and Bridgeport Way SW for a distance of approximately 1,300 feet.

3 INTRODUCTION TO NOISE AND VIBRATION

This section introduces acoustics and vibration. It also includes discussion of the typical noise and vibration measurement descriptors that are used in this report to document the noise and vibration levels for the construction and operation of the proposed project.

3.1 Introduction to acoustics

What we hear as sound is a series of continuous air pressure fluctuations superimposed on the atmospheric pressure that surrounds us. The amplitude of fluctuation is related to the energy carried in a sound wave; the greater the amplitude, the greater the energy and the louder the sound. The full range of sound pressures encountered in the world is so great that it is more convenient to compress the range by using a logarithmic scale, resulting in the fundamental descriptor used in acoustics, the sound pressure level, in decibels (dB). When sounds are unpleasant, unwanted, or disturbingly loud, we tend to classify them as noise.

Another aspect of sound is the quality described as its pitch. Pitch is established by frequency, which is a measure of how rapidly a sound wave fluctuates as measured in cycles per second or Hertz (Hz). Most sounds are a composite of many individual frequencies. When a sound is analyzed, its energy content at individual frequencies is displayed over the frequency range of interest, usually the range of human audibility, from about 20 Hz to about 20,000 Hz. This display is called a frequency spectrum.

Sound is measured using a sound level meter with a microphone designed to respond accurately to all audible frequencies. The human hearing system does not respond equally to all frequencies. Low frequency sounds below about 400 Hz are progressively and severely attenuated, as are high frequencies above 8,000 Hz. To approximate the way humans interpret sound, a filter circuit with frequency characteristics similar to the human hearing mechanism is built into sound level meters. Measurements with this filter enacted are called A-Weighted Sound Levels, expressed in dBA.

Community noise is usually characterized in terms of the A-weighted sound level. Figure 3-1 illustrates the A-weighted levels of common sounds. When sounds exceed 110 dBA, there is a potential for hearing damage, even with relatively short exposures. In quiet suburban areas far from major freeways, the noise levels during the late-night hours will drop to about 30 dBA. Outdoor noise levels lower than this only occur in isolated areas where there is a minimum of natural noises such as leaves blowing in the wind, crickets, or flowing water.

Another characteristic of environmental noise is that it is constantly changing. The increase in noise level that occurs when a train passes is an example of a short-term change. The lower average noise levels during nighttime hours, when human activities are at a minimum, and the higher noise levels during daytime hours are daily patterns of noise level fluctuation. The instantaneous A-weighted sound level is insufficient to describe the overall acoustic “environment.” A more useful descriptor is the Day-Night Equivalent Sound Level, Ldn, which is defined as the 24-hour equivalent sound level (Leq) but with a 10 dB penalty assessed to noise events occurring at night (defined as 10 p.m. to 7 a.m.). The effect of this penalty is that any event during the nighttime hours is equivalent to 10 events during the daytime hours. This strongly weights Ldn toward nighttime noise to reflect the fact that most people are more easily annoyed by noise during the nighttime hours, when background noise levels are lower and most people are sleeping.

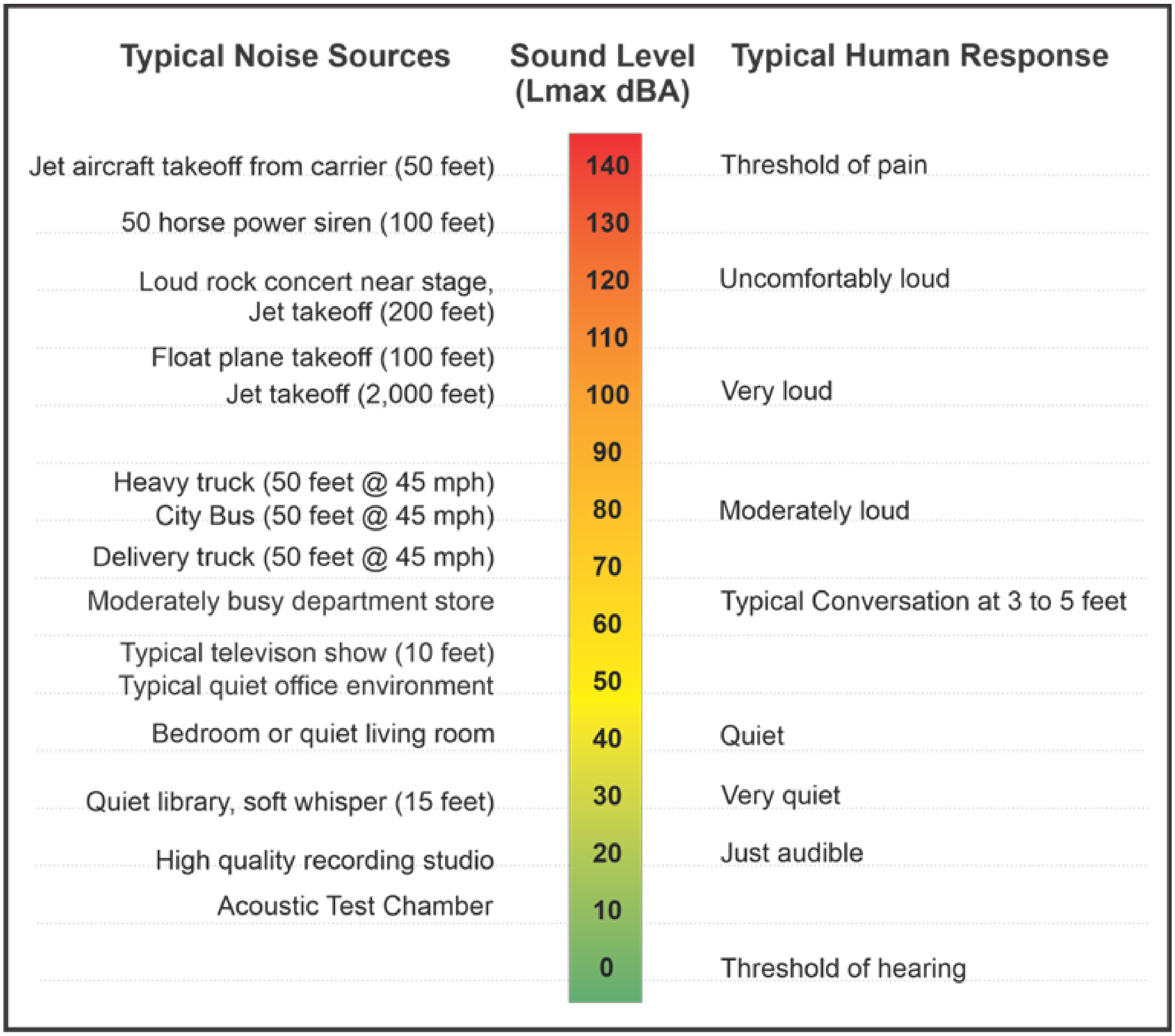
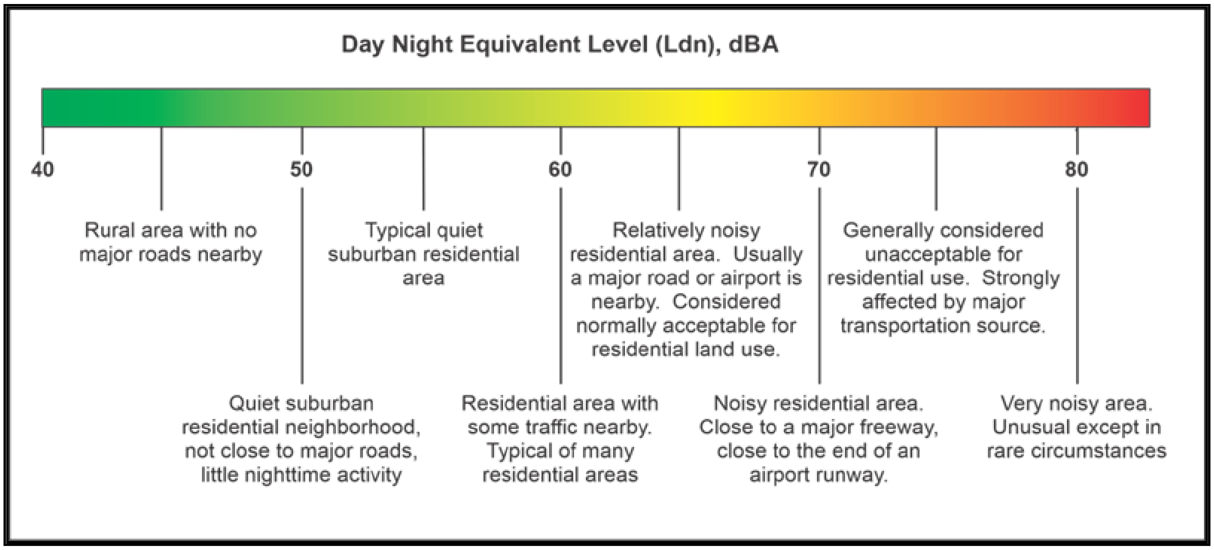


Figure 3-1 Typical a-weighted sound levels

Environmental impact assessments for high-capacity transit projects in the United States typically use Ldn to describe the community noise environment. Studies of community response to a wide variety of noises indicate that Ldn is a good measure of the noise environment. Efforts to derive measures that are better correlated to community response have not been successful, although there are still efforts in the acoustical community to develop improved measures.

Figure 3-2 shows typical community noise levels in terms of Ldn. Most urban and suburban neighborhoods will be in the range of Ldn 50 dBA to 70 dBA. An Ldn of 70 dBA is a relatively noisy environment that might be found at buildings on a busy surface street, close to a freeway or near a busy airport. It would usually be considered unacceptable for residential land use without special measures taken to enhance outdoor-indoor sound insulation. Residential neighborhoods that are not close to major sound sources will usually be in the range of Ldn 55 dBA to 60 dBA. If there is a freeway or moderately busy arterial nearby or any nighttime noise, Ldn is usually in the range of 60 dBA to 65 dBA.



Source: FTA 2018.

Figure 3-2 Typical Ldn levels

3.1.1 General rules related to community noise

Some general rules related to community noise are:

- A 3 dB change is the minimum most people can detect in most environments.
- Under free-field conditions, where there are no reflections or additional attenuations, a point sound source is known to decrease at a rate of 6 dB for each doubling of distance. This is commonly known as the inverse square law. For example, a sound level of 70 dB at a distance of 100 feet would decrease to 64 dB at 200 feet. However, traffic on a busy roadway is a line source, which reduces at approximately 3 dB for each doubling of distance.
- Sounds such as sirens, bells and horns are more noticeable and more annoying than normal noise.
- A 10 dB increase in sound level is perceived as an approximate doubling of the loudness of the sound and represents a substantial change in loudness.

3.1.2 Decibel mathematics

An important factor to recognize is that noise is measured on a decibel scale and combining two noise sources is not achieved by simple addition. For example, combining two 60 dB noise sources does not give 120 dB (which is near the pain threshold), but yields 63 dB, which is lower than the volume at which most people listen to their TVs. For reference, if two noise sources are 10 dB apart, for example 50 dB and 60 dB, the sum of the two noise levels will simply be the louder of the two, in this case 60 dB. This is to say that for similar noise sources that are 10 dB apart in magnitude, a person would only be able to hear the louder of the two sources.

Examples of simplified decibel addition, based on the difference between the two levels, are provided in Table 3-1 below for reference, to aid in the understanding of the total project noise and impact analysis presented in this report.

Table 3-1 Examples of simplified decibel addition

Difference between the two noise sources	Amount added to the higher of the two noise levels
0 to 1 dB	3 dB
2 to 3 dB	2 dB
4 to 9 dB	1 dB
10 dB or more	0 dB

This information is important, because it is used to add the new noise (the noise related to the project) to the existing measured noise levels along the project corridor, providing the new total noise with the project. For example, if the proposed project would generate noise was 4 dB to 9 dB below the existing noise levels, the project-related increase would be approximately 1 dB or less, an increase which is not perceptible to an average person.

3.1.3 Introduction to vibration

Ground-borne vibration consists of oscillatory waves that propagate from the source through the ground to adjacent buildings. Although the vibration is sometimes noticeable outdoors, it is almost exclusively an indoor problem. The primary concern is that the vibration and radiated noise can be intrusive and annoying to building occupants.

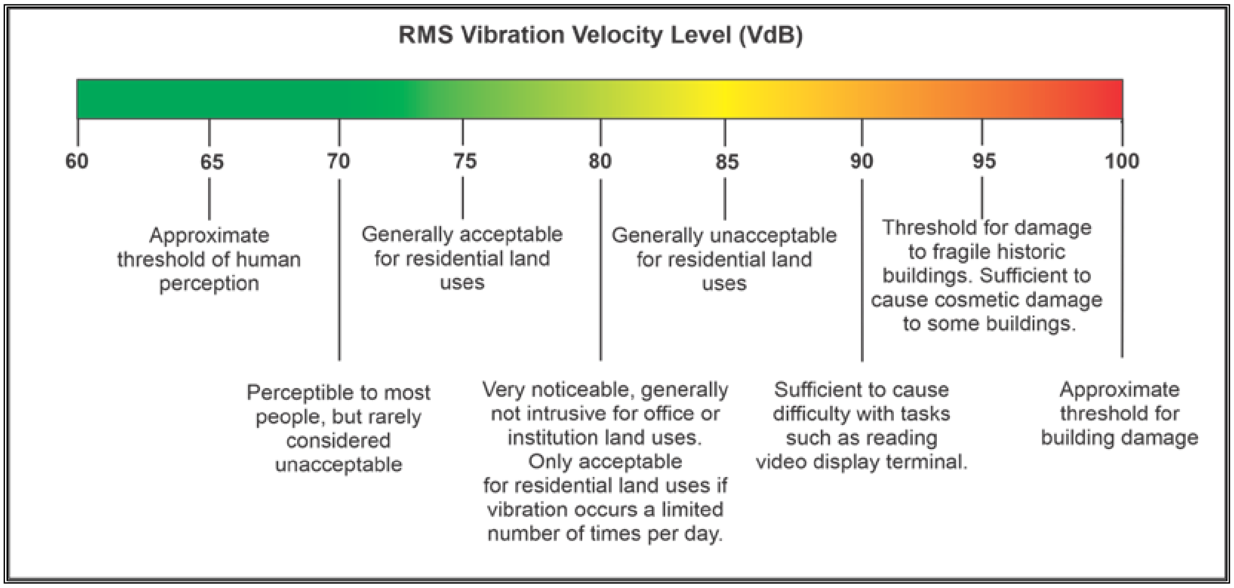
Factors that influence the amplitude of ground-borne vibration from vehicles include vehicle suspension parameters, condition of the wheels, type of building foundation, the properties of the soil and rock layers through which the vibration propagates, and the condition of the roadway.

Although all vehicular traffic causes some level of ground-borne vibration, the vibration is not usually perceptible because of the vibration isolation characteristics of the pneumatic tires and suspension systems. For vehicles with rubber tires, most of the vibration produced is absorbed by the tires and the suspension system, and vibration is usually only a problem if the roadway surface is very rough or has potholes and other abnormalities.

Vibration velocity is usually given in terms of either inches per second or decibels. The following equation defines the relationship between vibration velocity in inches per second and decibels:

Lv = 20 x log (V/Vref):
where V is the velocity amplitude in inches/second; Vref is 10-6 inches/second; and Lv is the velocity level in decibels.

The abbreviation VdB is used for vibration decibels in this report, to minimize confusion with sound decibels. Figure 3-3 provides a general idea of human and building response to different levels of vibration. Existing background building vibration is usually in the range of 40 VdB to 50 VdB, which is well below the range of human perception. Although the perceptibility threshold is about 65 VdB, human response to vibration is usually not bothersome unless the Root Mean Square (RMS) vibration velocity level exceeds 70 VdB. Buses and trucks rarely create vibration that exceeds 70 VdB unless there are large bumps or potholes in the road and the travel lanes are close to the structure.



Source: FTA 2018.

Figure 3-3 Typical RMS vibration levels

4 METHODS

This section provides an overview of the methods used to predict noise and vibration levels related to the project, as well as criteria used to determine project related impacts. The ambient noise measurement methods used complied with the FTA noise assessment guidance. The methodology addresses both the long-term operational impacts and the short-term construction impacts related to the project. Long-term operational impacts are related to system operation after construction. Short-term construction impacts are related only to noise and vibration generated during project construction.

The assessment of potential noise and vibration impacts from the project was based on the current FTA Transit Noise and Vibration Impact Assessment (September 2018), which this report refers to as the FTA Manual (2018). Other regulatory information and ordinances reviewed and applicable to the project include the Washington Administrative Code (WAC) and the noise control ordinance from the city of Lakewood.

In addition to analyzing noise and vibration from operation of the project, this report discusses noise and vibration from construction of the project. The methods for analyzing construction noise and vibration follow the methods given in the FTA Manual (2018) and the Federal Highway Administration (FHWA) Roadway Construction Noise Model (FHWA 2006) was used to provide an estimate of the project construction noise levels. Local noise control regulations and ordinances for construction noise were reviewed and summarized in the following sections.

4.1 FTA Transit operational noise criteria

Transit operational noise impacts of the project were determined based on the criteria defined in the FTA Manual (2018). The FTA noise impact criteria are based on documented research on community reaction to noise and on change in noise exposure rated using a sliding scale. Although more transit noise is allowed in neighborhoods with high levels of existing noise, as existing noise levels increase, smaller increases in total noise exposure are allowed than in areas with lower existing noise levels. The FTA noise impact criteria group noise-sensitive land uses into the following three categories:

Category 1: Tracts of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet, and land uses that rely upon a quiet background, such as outdoor amphitheaters and concert pavilions, as well as National Historic Landmarks with significant outdoor use. Also included in this category are recording studios and concert halls.

Category 2: 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: 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, cemeteries, monuments, museums, campgrounds, and recreational facilities are also considered to be in this category. Certain historical sites and parks are also included, but their sensitivity to noise must be related to their defining characteristics, and generally parks with active recreational facilities are not considered noise sensitive.

It is important to note that no criteria exist for noise impacts to commercial or industrial uses, including most office buildings, restaurants or other commercial uses, because activities within these buildings are compatible with higher noise levels; unless sensitivity to noise is assumed to be of utmost importance for operations of that facility, for example, an audiology laboratory.

The Ldn is used to characterize noise exposure for residential areas (Category 2). For other noise-sensitive land uses, such as outdoor amphitheaters and school buildings (Categories 1 and 3), the maximum 1-hour Leq during the facility's operating period is used. There are no noise impact criteria for most commercial and industrial land use.

There are two levels of impact included in the FTA criteria—severe and moderate—interpreted as follows:

Severe Impact: Project-generated noise in the severe impact range can be expected to cause a large percentage of people to be highly annoyed by the new noise and represents the most compelling need for mitigation. Noise mitigation will normally be specified for severe impact areas unless there are truly extenuating circumstances that prevent mitigation.

Moderate Impact: In this range of noise impact, the change in the cumulative noise level is noticeable to most people but may not be sufficient to cause strong, adverse reactions from the community. In this transitional area, other project-specific factors must be considered to determine the magnitude of the impact and the need for mitigation. These factors include the existing noise level, the projected level of increase over existing noise levels, the types and numbers of noise-sensitive land uses affected, the noise sensitivity of the properties, the effectiveness of the mitigation measures, community views and the cost of mitigating noise to more acceptable levels.

Figure 4-1 provides the FTA impact criteria. As shown in the figure, the impact level is based on the existing noise environment. As the existing noise levels increase, the allowable noise from transit operations decreases. The following two examples help provide an understanding of the FTA criteria and determination of noise impacts:

A residence with an existing noise level of 64 dBA Ldn and a predicted project noise level of 63 dBA Ldn: For a residential land use (FTA Category 2) with an existing Ldn of 64 dBA, a moderate impact occurs if the project noise exceeds 61 dBA Ldn, or a severe impact occurs if the project noise exceeds 65 dBA Ldn. Because the project is predicted to produce 63 dBA Ldn, this would be a moderate noise impact.

A residence with an existing noise level of 72 dBA Ldn and a predicted project noise level of 63 dBA Ldn: For a residential land use (FTA Category 2) with a 72 dBA Ldn the moderate criteria is 66 dBA, and the severe criteria is 71 dBA. Because the project is predicted to produce 63 dBA Ldn, no noise impact is predicted.

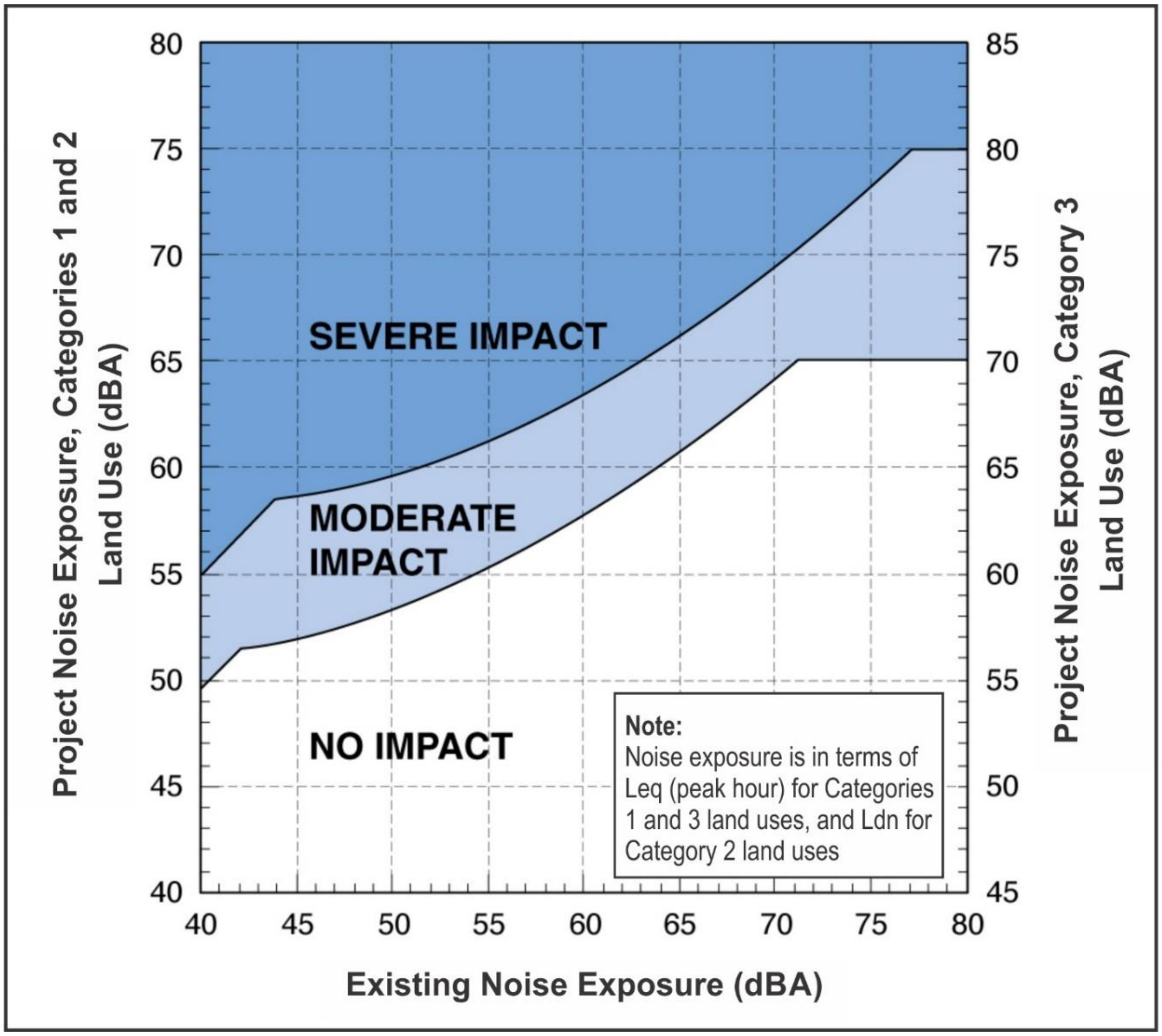


Figure 4-1 FTA noise impact criteria

4.2 Local noise control ordinance

Sound Transit also follows the local noise control ordinances for some project related noise sources. Construction noise and noise from ancillary facilities, such as maintenance facilities, are governed by applicable state laws and regulations and local ordinances. In the case of the Sounder Stations, the City of Lakewood Municipal Code Chapter 8.36, Noise Control, would be applicable to the Sounder improvements, as well as to construction of the project. However, because the Lakewood noise control ordinance is a public disturbance code, and has no measurable limits, the WAC was considered for this analysis.

4.2.1 WAC noise control ordinance

WAC Chapter 173-60 (Maximum Environmental Noise Levels) defines three classes of property use, called Environmental Designation for Noise Abatement (EDNA), and states maximum allowable noise levels for each, as shown in Table 4-1 (Washington state noise control regulations). For example, the noise caused by a commercial property must be less than 57 dBA at the closest residential property line. From 10 p.m. to 7 a.m., the allowable maximum sound levels shown in Table 4-3 are reduced by 10 dBA in Class A EDNAs (residential zones). Although not specified in these regulations, the noise analysis assumes the hourly Leq for comparison with the noise levels in Table 4-1. The WAC contains short-term exemptions to the property line noise standards shown in Table 4-1 based on the minutes per hour that the noise limit is exceeded. These exceedances are outlined in Table 4-2 (Washington state exemptions for short-term noise exceedances).

Table 4-1 Maximum allowable noise levels by land use type

EDNA Source of Noise	EDNA Receiver of Noise (Maximum Allowable Sound Level in dBA1)		
	Residential	Commercial	Industrial
Class A Residential	55	57	60
Class B Commercial	57	60	65
Class C Industrial	60	65	70

Note(s): 1 Between 10 p.m. and 7 a.m., the levels given above are reduced by 10 dBA in Class A EDNAs.

The WAC contains short-term exemptions to the property line noise standards shown in Table 4-1 based on the minutes per hour that the noise limit is exceeded. These exceedances are outlined in Table 4-2 (Washington state exemptions for short-term noise exceedances).

Table 4-2 WAC exemptions for short-term noise exceedances

Minutes per Hour	Adjustment to Maximum Sound Level
15	+5 dBA
5	+10 dBA
1.5	+15 dBA

4.2.2 WAC construction noise criteria

Sounds received in Class A EDNAs that originate from construction sites are exempt from the limits of the WAC regulations during normal daytime hours (7 a.m. to 10 p.m.). If construction is performed during the nighttime, the contractor must still meet the WAC noise-level requirements for sounds received in Class A EDNAs, as presented in Table 4-3 or obtain a noise variance from the governing jurisdiction.

The WAC also contains a set of construction-specific allowable noise-level limits. These construction noise regulations are organized by type of noise and, among other things, include criteria for haul trucks and backup safety alarms.

4.2.3 Construction haul truck noise criteria

Maximum permissible sound levels for haul trucks on public roadways are limited to 86 dBA for speeds of 35 miles per hour (mph) or less, and 90 dBA for speeds over 35 mph when measured at 50 feet (Chapter 173-62, WAC). For trucks operating within staging areas, the general construction equipment noise criteria would be used to determine compliance during nighttime hours in Class A EDNAs.

4.2.4 Construction noise related to backup alarms

Sounds created by backup alarms are essentially prohibited by the WAC during nighttime hours (between 10 p.m. and 7 a.m.) in Class A EDNAs, and during these hours, other forms of backup safety measures would need to be used. These measures could include using smart backup alarms, which automatically adjust the alarm level based on the background level, or switching off backup alarms and replacing them with spotters.

No other city or county noise regulations are applicable to construction of the project.

4.3 Vibration impact criteria

Because the proposed project will not change the Sounder Operations, and there are no track modifications included as part of this project, there is no predicted change in the vibration levels in the project area. However, there may be some construction-related vibration and this section briefly defines criteria for vibration that might be produced by construction.

4.3.1 Construction vibration

There are no formal vibration criteria from the FTA or any state or local agencies. The primary concern regarding construction vibration relates to risk of damage. Vibration is generally assessed in terms of peak particle velocity (PPV) for risk of building damage. PPV is the appropriate metric for evaluating the potential for building damage and is often used when monitoring blasting and construction vibration because it relates to the stresses that are experienced by the buildings. Vibration damage risk thresholds to assess potential for damage from construction are taken from the FTA Manual (2018). Table 4-3 presents the vibration damage risk thresholds for different building categories.

Table 4-3 Cosmetic structural damage criteria

Building Category	PPV (in./sec)[a]	Approximate Lv [a]
I. Reinforced concrete, steel, or timber (no plaster)	0.50	102
II. Engineered concrete and masonry (no plaster)	0.30	98
III. Non-engineered timber and masonry buildings	0.20	94
IV. Buildings extremely susceptible to vibration damage	0.12	90

Notes:

Source: FTA, 2006.
[a] Root mean square velocity level in decibels 1 micro-in./sec.
in./sec. = inch per second
Lv = vibration velocity level
PPV = peak particle velocity
The damage risk criterion of 0.5-inch per second (in./sec.) PPV is appropriate for single- and multi-family residences along the alignment and the criterion of 0.12 in./sec. PPV is appropriate for extremely fragile buildings.

Construction vibration, unlike vibration from operations, has the potential to cause damage to structures at very close distances, from activities such as impact hammering and soil compacting. Generally, because of the short duration of construction vibration activities, annoyance is usually not an issue. The thresholds for damage for even the most sensitive buildings are one to two orders of magnitude higher than the criteria for annoyance from vibration.

5 AFFECTED ENVIRONMENT

Sound Transit examined the project corridor to identify noise- and vibration-sensitive locations and select locations where noise monitoring would be performed. The potential area of affect for the noise study was determined by modeling the worst-case operational noise levels and including all noise-sensitive properties within that area that have a potential for experiencing a noise impact. For noise this was only applicable to new project components that have the potential to produce noise. Because most improvements are for non-motorized transportation, most of the project components would not be predicted to change the noise environment by a measurable amount. In addition, any new hard surfaces installed as part of the project, including new pavement for bike lanes and sidewalks, would not be predicted to cause a measurable increase in noise levels at any noise sensitive properties. The only potential exception is the proposed new northern parking area, where the added traffic and new hard surfaces could affect the noise environment.

For the vibration analysis, impacts normally only occur within 50 to 150 feet of the trackway, depending on speed, type of track, and geological factors. However, as stated, the Sounder operations are not changing with these improvements, and therefore no detailed vibration analysis related to rail operations was required.

The following sections describe the land use along the project corridor, the existing noise-level measurements, and the current noise sources in the project corridor.

5.1 Existing land uses

Land use in the project area is a mix of residential housing, healthcare, churches, childcare facilities, and motels/hotels. Northwest of Pacific Highway SW includes single- and multi-family dwelling units throughout the area, the Lakewood Meadows Senior Apartments, the Oaks at Lakewood acute care facility, Assurecare Adult Family Home, St. Clare Hospital, Tyee Park Elementary School, First Baptist Church of Lakewood, Abundant Life Church, Agape Christian Fellowship Ministries, Tacoma Church of Christ, Set Free Ministries, AME Higher educational facility, West Pierce Fire Station #20, Gingerbread House Day Care, and America’s Best Value Inn.

Southeast of Pacific Highway SW and west of I-5 includes a multi-family residential building along 112th Street SW, Emerald City Enhanced Services assisted living facility, WoodSpring Suites Tacoma-Lakewood, Home Motel, TownePlace Suites by Marriott, Holiday Inn Express and Suites, and Madigan Motel.

Southeast of I-5 includes Lakewood and Joint Base Lewis-McChord (JBLM). Within the Lakewood area are several multi-family residential buildings. JBLM includes a park and possible barracks.

The remaining land uses in the area are commercial and military. Figure 5-1 is an index figure showing the outline of the nine figures used to identify land use and noise monitoring locations in the project area. The overall project area land uses and noise monitoring sites are shown in Figure 5-2, Figure 5-3, Figure 5-4, Figure 5-5, Figure 5-6, Figure 5-7, Figure 5-8, Figure 5-9, and Figure 5-10.

Figure 5-1. Index Map

Figure 5-1 Index map

Figure 5-2 Northeast land use map

Figure 5-3 East Central land use map

Figure 5-4 Southeast land use map

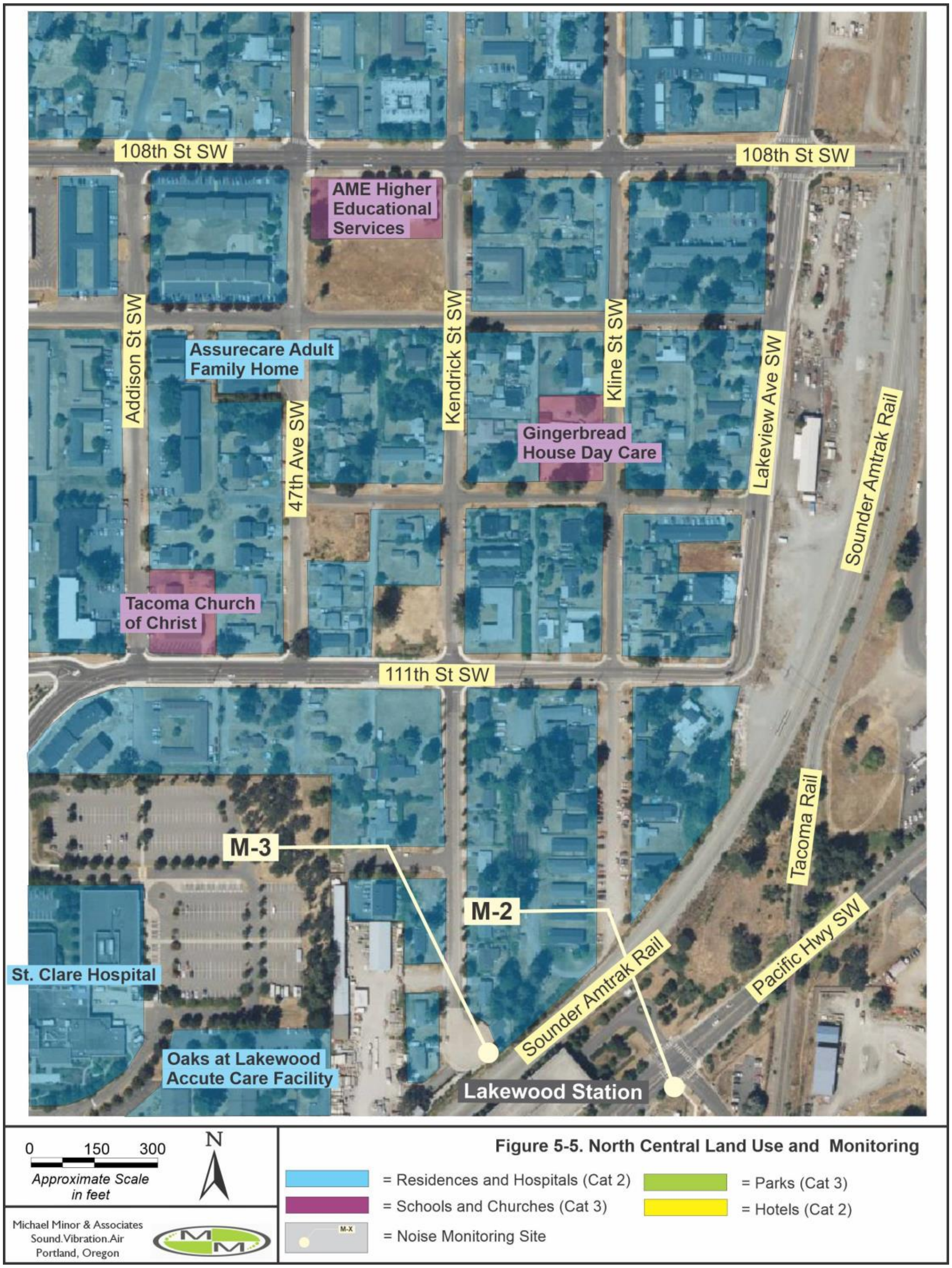


Figure 5-5 North Central land use map

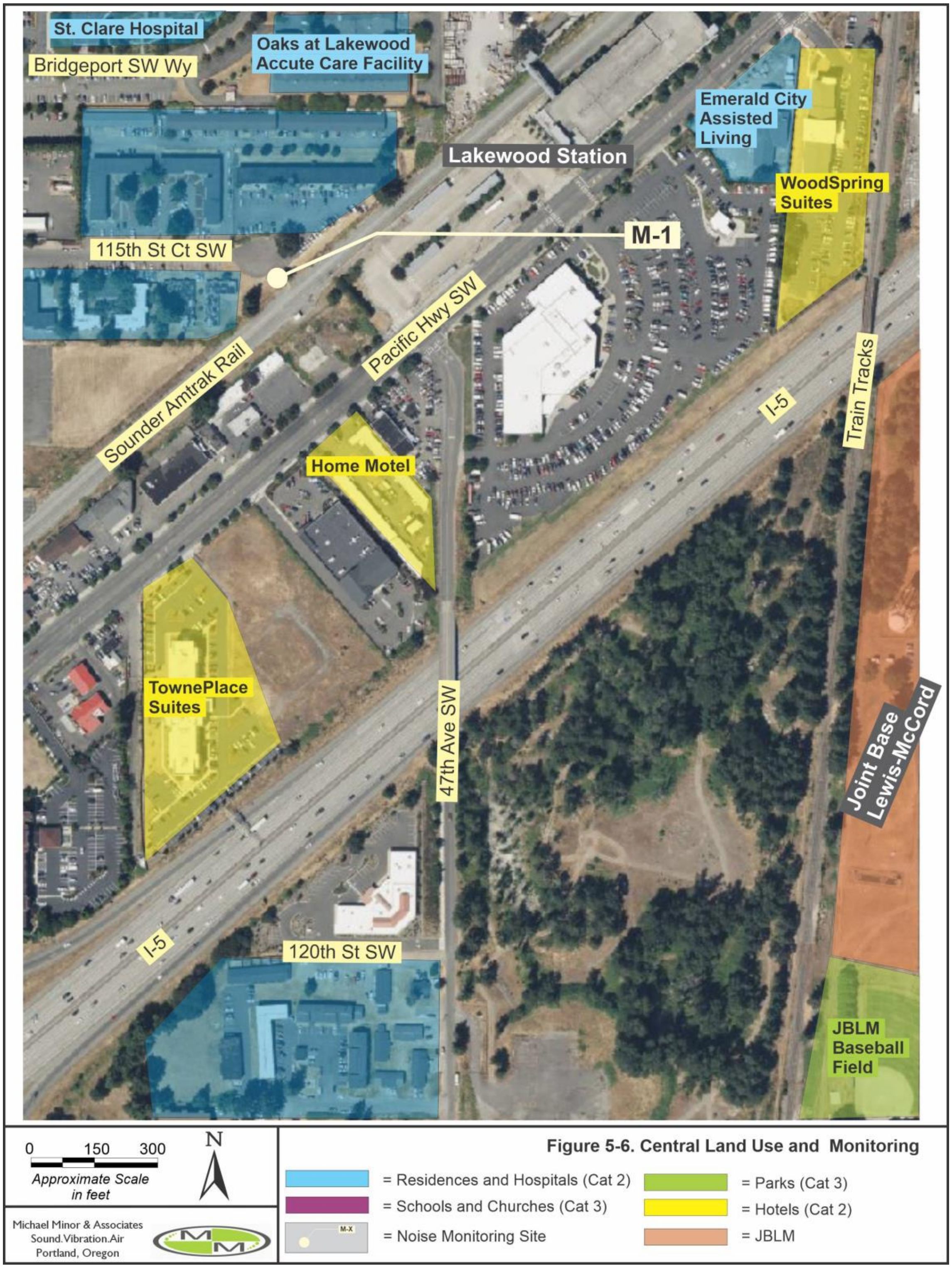


Figure 5-6 Central land use map

Figure 5-7 South Central land use map

Figure 5-8 Northwest land use map

Figure 5-9 West Central land use map

Figure 5-10 Southwest land use map

5.2 Zoning and comprehensive land use plan design

A study of the project area indicated that the area is a mix of high density to medium density residential, schools, healthcare, churches, and commercial and federal lands. There are currently no planned or approved land use changes that would affect this noise study.

5.3 Planned and permitted projects

At the time of this analysis, no planned and permitted developments were identified that are sensitive to noise and/or vibration that would affect the results of this noise and vibration analysis.

5.4 Structure removal due to project construction

There are no displacements or associated building demolition planned that would affect the transmission of noise, noise impacts, or noise abatement measures.

5.5 Measured noise levels and sources

Noise levels were measured over a two-day period at four sites near the station. The measurements were taken over a two-day period, on May 9 and 10, 2023, with all measurement sessions at least 30 minutes long, except at M-4, where measurements were taken for slightly over an hour. Measurement site M-1 was located near the cul-de-sac on 115th Court SW, just west of the Lakewood Sounder Station (see Figure 5-6). The measurement site was near the Twin Oaks apartment building at 4801 115th Court SW and several multiplex multifamily units along 115th Court SW. Site M-2 was located near the entrance to the WoodSpring Suites Tacoma – Lakewood hotel at 11329 Pacific Highway SW (see Figure 5-2 and Figure 5-5).

Site M-3 was in the cul-de-sac on Kendrick Street SW, near the north station access sidewalks (see Figure 5-5). At the time of the monitoring the final scope of the project was not clear and therefore pass-by measurements of the Sounder commuter rail were taken at site M-4. Site M-4 was on 110th Street SW, along Halcyon Road SW. A pass-by of an Amtrak train was also captured during the measurement at site M-4.

Noise levels at M-1 ranged from 59 dBA during the evening hours, with early morning noise levels of 63 dBA Leq. The daytime levels were 66 dBA. The Ldn of 63 dBA for this area was predicted using the methods in the FTA manual. Main noise sources at M-1 included local area traffic, noise from traffic on Pacific Highway and noise from Sounder Operations when active. For Site M-2, the noise level throughout the morning, daytime and early evening were all similar, ranging from66 to 67 dBA Leq with a calculated Ldn of 65 dBA Ldn. The steady noise levels are due to traffic on Pacific Highway and also from I-5. Noise levels at M-3 were also fairly steady, ranging from 61 to 62 dBA Leq, with most noise from traffic on Pacific Highway, local commercial activities and noise from Sounder operations when active. The Ldn at M-3 was calculated at 59 dBA Ldn.

Data from site M-4 was evaluated with and without the noise from Sounder operations. The background noise levels excluding the Sounder operations ranged from 58 to 61 dBA Leq with most noise from traffic along Pacific Highway and other local noise sources. With the Sounder operations included, noise levels are fairly steady at 61 dBA Leq. The calculated Ldn at site M-4 is 59 dBA Ldn. Table 5-1 provides a summary of the measured noise levels. To make it easier to review each location, monitoring sites are shaded in different colors within the table. The Ldn is a 24-hour equivalent sound level, and therefore there is only one Ldn per site.

Table 5-1 Noise measurement results

Site[1]	Period[2]	Time of Day	Leq[3]	Ldn[4]	Notes[5]
M-1	Morning	6:50 AM	63	63	No trains, normal traffic
M-1	Daytime	1:15 PM	66		No trains, normal traffic
M-1	Evening	7:10 PM	59		No trains, normal traffic
M-2	Morning	6:10 AM	67	65	No trains, normal traffic
M-2	Daytime	12:30 PM	67		No trains, normal traffic
M-2	Evening	6:30 PM	66		No trains, normal traffic
M-3	Morning	7:30 AM	61	59	No trains, normal traffic
M-3	Daytime	1:45 PM	61		No trains, normal traffic
M-3	Evening	7:30 PM	62		No trains, normal traffic
M-4	Early AM	4:50 AM	58	59	No trains, normal traffic
M-4	Morning	5:40 AM	61		Four Sounder Trains
M-4	Daytime	12:00 PM	61		No trains, normal traffic
M-4	Daytime	5:00 PM	59		No trains, normal traffic
M-4	Daytime	4:30 PM	61		Four Sounder trains, one Amtrak train

Notes:
1. See Figures 5-2, 5-5, and 5-6 for noise monitoring sites.
2. Morning = 5 a.m. to 7 a.m., daytime = 7 a.m. to 7 p.m., evening = after 7 p.m.
3. Leq over the measurement period, 30 minutes sites M-1 through M-3 and one hour or longer for Site M-4.
4. Calculated existing 24-hour Ldn using the methods provided by the FTA.
5. Notes on train operations and traffic.

6 NOISE AND VIBRATION EVALUATION AFFECTED ENVIRONMENT

Sound Transit performed a noise impact assessment for construction and operations based on the criteria and methods described in Section 4.0 of this report.

Project construction was evaluated and compared to the local regulations related to construction noise from the City of Lakewood. If impacts are identified, construction noise mitigation measures may be required. If some work may occur at nighttime to prevent service disruptions, consideration of a noise variance from the City of Lakewood will be required.

Using the measured background levels to establish a criterion, and new future project related operational noise levels, the future total noise can be predicted and compared to the appropriate criteria. The change in noise levels near the station would be related to the projected operational noise, which would include any new noise producing activities related to the improvements.

The predictions will also account for any modifications to the Sounder platforms, platform covers, or other structures that could affect the propagation of noise from the tracks. Safety bells or horns used by the Sounder trains and wayside pedestrian warning bells, which already are in use, would be included in the existing noise predictions.

Project noise impacts, if any exist, would be determined using the methods in the FTA Manual (provided in Figure 4-1). If noise impacts are identified, noise mitigation will be considered and if reasonable and feasible forms of mitigation are available, they may be included with the project.

Vibration analysis uses the maximum pass-by level, and therefore, because there are no changes in Sounder operations, the project related vibration is not predicted to change from the existing conditions.

6.1 Construction noise analysis

Several construction phases would be required to complete the proposed upgrades. The FHWA Roadway Construction Noise Model (FHWA, 2006) was used to provide an estimate of the project construction noise levels, as well as to predict the maximum noise levels for several different construction phases. The analysis assumes the worst-case average and maximum noise levels based on the three major types of construction described below and shown in Table 6-1. The actual noise levels experienced during construction would generally be lower than those described in Table 6-1 because these are the maximum noise levels for each activity. The noise levels presented here are for short periods of maximum construction activity and would occur for a limited period of time.

Table 6-1 Noise levels for typical construction phases

Combined worst-case noise levels for all equipment at a distance of 50 feet from work site			
Scenario [a]	Equipment [b]	Lmax [c]	Leq [d]
Construction preparation and utilities relocation	Air compressors, backhoes, jackhammers, forklifts, haul trucks, loaders, pumps, power plants, service trucks, tractor trailers, utility trucks, and vibratory equipment	88	87
Station parking, paving and general construction activities	Air compressors, backhoes, cement mixers, concrete pumps, forklifts, haul trucks, loaders, pavers, pumps, power plants, service trucks, tractor trailers, utility trucks, vibratory equipment, and welders	88	88
Miscellaneous activities	Air compressors, backhoes, cranes, forklifts, haul trucks, loaders, pumps, service trucks, tractor trailers, utility trucks, and welders	86	83

Note(s):
[a] Operational conditions under which the noise levels are projected.
[b] Normal equipment in operation under the given scenario.
[c] Lmax (dBA) is the highest maximum noise level for the construction equipment listed under the given scenario.
[d] Leq (dBA) is a 1-hour energy average noise emission for construction equipment operating under the given scenario.

6.1.1 Construction preparation and utilities relocation

This is the initial phase of construction and would occur throughout the areas with proposed improvements where necessary, including demolishing curbs to install ADA ramps, saw cutting pavement for installation and relocation of any utilities, preparing for installation of sidewalks, curbs, gutters and bike lanes. Major noise-producing equipment in use during this stage of construction could include saw cutters, jackhammers, backhoes, haul trucks, loaders, tractor-trailers, and vibratory equipment. Maximum noise levels could reach 83 dBA to 88 dBA at the nearest residences (i.e., within 50 to 100 feet) for normal construction activities during this phase. Other less-notable noise-producing equipment expected during this phase would include backhoes, air compressors, forklifts, pumps, power plants, service trucks, and utility trucks.

6.1.2 Station parking, paving and general construction activities

Repaving roadways, paving the new parking lot, adding bike lanes, sidewalks and ADA access construction would occur during this phase of construction. The loudest noise sources in use during this phase of construction would include cement mixers, concrete pumps, pavers, haul trucks, and tractor-trailers. Cement mixers, concrete pumps and pavers would be required for construction of the new northern parking lot, sidewalks, curbs, gutters, and roadway improvements in addition to any improvements at the station. The pavers and haul trucks would also be used to provide the final surface on the parking lot and roadways modified during other phases of construction. Maximum noise levels are predicted to reach 86 to 88 dBA at the closest receiver locations.

6.1.3 Miscellaneous activities

Following heavy construction, general construction would still be required, such as cranes for installation of signage and roadway striping. These less-intensive activities are not expected to produce noise levels above 80 dBA at 50 feet except during rare occasions, such as when construction is in close proximity to a structure, and even then, the elevated noise levels would only occur for short periods of time.

6.1.4 Construction noise summary

Using the information in Table 6-1, typical construction noise levels were projected for several distances from the project work area. Figure 6-1 is a graph of general construction noise level versus distance for phases of construction. Note that the noise levels presented do not include any noise reduction from structures or topographical conditions between the construction activity and the receiving property.

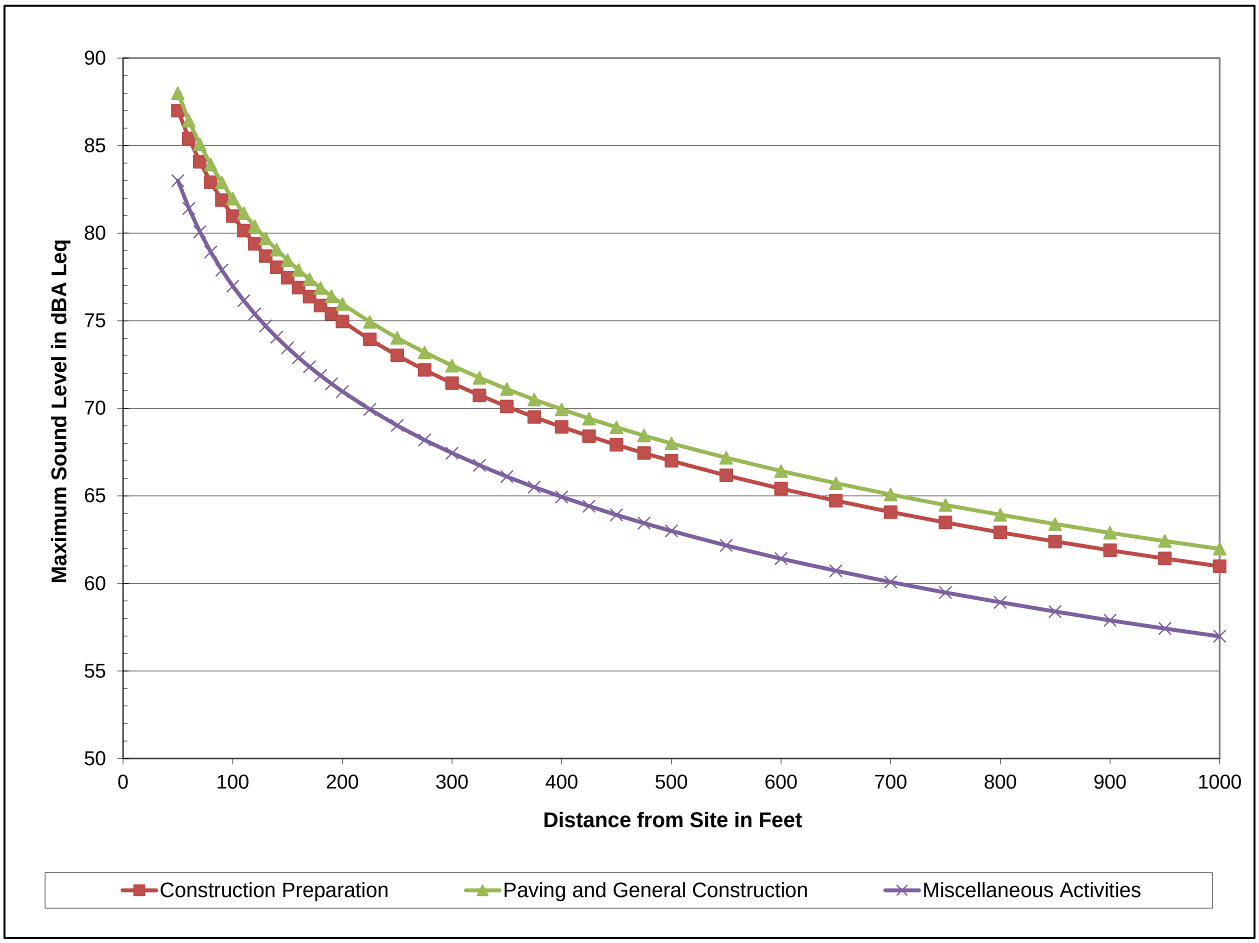


Figure 6-1 Maximum noise level versus distance for typical construction phases

6.2 Construction vibration analysis

Vibration associated with general construction activities can result in increased vibration levels. Project-related vibration sources include soil compactors, excavators, haul trucks, flat-bed tractor-trailers, backhoes, cranes, and jackhammers.

The vibration sources associated with the project, even though they may be noticeable to residents when construction is nearby, are not expected to cause any structural damage.

Vibration levels for construction activities are projected to be the highest during demolition activities and soil compacting. Demolition activities would include removing existing curbs for installation of new ADA compliant ramps and removing existing concrete during utility installation and relocation. Major construction equipment that would be used during demolition includes excavators, haul trucks, backhoes, jackhammers, and saw cutters. Based on information from the U.S. Bureau of Mines, it typically takes vibration levels in excess of 0.5 in./sec. to cause cosmetic damage to plaster walls, and 0.75 in./sec. for cosmetic damage to drywall.

Vibration levels from project construction, including roadway and bike lane paving, are also projected to remain below 0.5 in./sec. at residences along the project corridor because of the distance between the work zones and structures. The main vibration producing equipment in this phase are soil compactors and vibratory rollers. Because of the type of construction, which is the same as typical roadway construction frequently performed by all municipalities, there is only a virtually no potential for any structural damage during construction, and even then, only for structures located within 25 feet of heavy construction activities, like soil compacting or jackhammering. Table 6-2 provides typical vibration levels for several common types of construction equipment.

Table 6-2 Construction vibration impact levels at 25 feet

Equipment	Conditions	Peak Particle Velocity at 25 feet (in./sec.)	Vibration Level in VdB at 25 feet (re: 1 micro-in./sec.)
Loaded haul trucks	Normal operations	0.076	86
Jackhammer	Normal operations	0.035	79
Small Bulldozer	Normal operations	0.003	58
Vibratory Roller	Normal operations	0.210	94

Note(s):

Source: FTA, 2018.
in./sec. = inch(es) per second
VdB = vibration decibels

6.3 Operational noise analysis

The majority of the proposed improvements for the Lakewood Station are related to non-motorized transportation. Other improvements, including new sidewalks, curbs, gutters, bike lanes, and other safety improvements are not predicted to result in any long-term changes in the noise levels. All vehicle travel lanes along roadways that are associated with the project will remain in the same general lane locations.

The one improvement that could result in a noise impact is the new surface parking lot to the north of the station. This proposed site, shown in Figure 6-2, is near several single-family residences and the SpringWood Suites hotel. The new lot would have approximately 24 compact parking spaces and 46 standard size parking spaces, and the parking area will include lighting, ADA improvements, curbs, gutter, sidewalks, bike lands, and lighting. Noise levels from the operation of the parking lot were calculated using the methods for a parking lot as provided in the FTA manual.

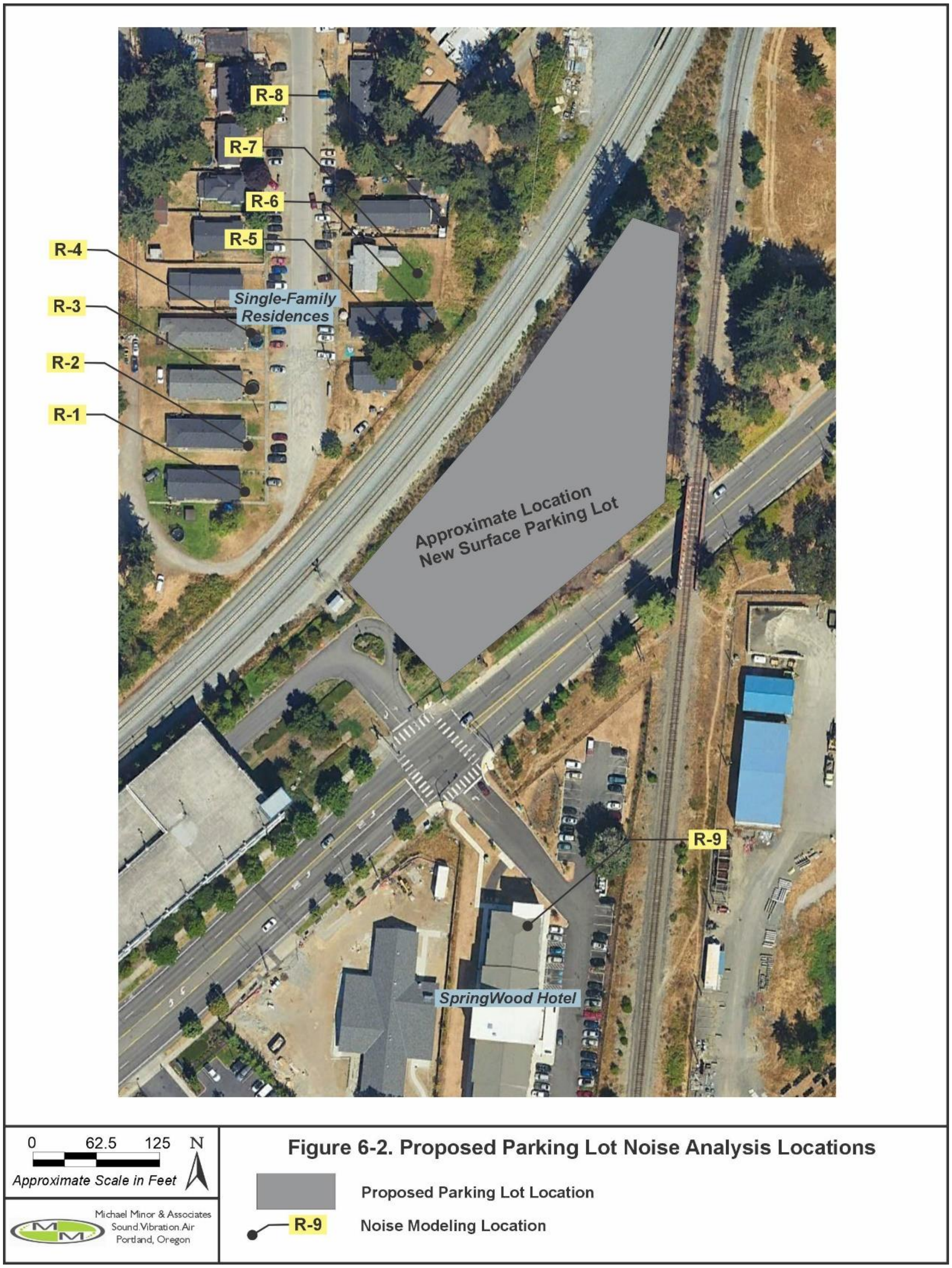


Figure 6-2 Parking lot noise analysis locations

To verify compliance with the FTA and WAC noise control ordinance, noise levels from operation of the new parking lot were predicted assuming all 70 parking spaces would be accessed during a single hour, providing the worst case hourly Leq. A more typical scenario would be cars arriving in the morning and departing in the afternoon. By assuming all spots in a single hour, the analysis produces a worst case volume of traffic and therefore the worst case hourly Leq. Furthermore, for the WAC analysis, the predicted noise level is compared to the nighttime criteria where the maximum allowable noise levels are 10 dB lower than the daytime criteria.

In addition, the Ldn was also calculated using the same worst case noise levels for early morning and daytime hours of operations. Because the analysis assumes all spots used in a single hour twice per day, once before 7:00 am (nighttime hours) and once during daytime hours, the Leq and Ldn are worst case noise levels are likely slightly higher than what would actually occur.

Table 6-3 Proposed parking lot noise analysis

Rec[1]	Rec Type[2]	Dist. (ft)[3]	Background Noise, dBA[4]		Parking Lot Noise, dBA[5]		Future Noise Levels, dBA[6]		Change in Total Noise, dB[7]	
			Leq	Ldn	Leq	Ldn	Leq	Ldn	Leq	Ldn
R-1	Res	140	61	59	42	37	58	59	0	0
R-2	Res	165	61	59	40	35	58	59	0	0
R-3	Res	200	61	59	39	34	58	59	0	0
R-4	Res	230	61	59	38	32	58	59	0	0
R-5	Res	85	61	59	46	41	58	59	0	0
R-6	Res	95	61	59	45	40	58	59	0	0
R-7	Res	150	61	59	41	36	58	59	0	0
R-8	Res	150	61	59	41	36	58	59	0	0
R-9	Hotel	250	61	59	37	32	66	65	0	0

Note(s):

1. Receivers shown in Figure 6-2.
2. Receiver types; Rec= residence, Hotel=Hotel.
3. Distance from the parking area to the receiver.
4. Background noise levels from Table 5-1.
5. Calculated noise levels from worst-case operation of the parking lot.
6. Total noise levels, background plus parking lot operations.
7. Change in total noise, or the future noise minus background noise.

As is shown in Table 6-3, noise levels from parking operations at the nine nearby receivers range from 37 to 46 dBA Leq during peak hour of operations, with an Ldn ranging from 32 to 41 dBA Ldn. The existing noise levels, based on measurements at M-2, M-3 and M-4 show that the existing noise levels are at least 10 dB higher than the noise from the parking lot operations. As described in Section 3.1.2, Decibel Mathematics, if the existing noise levels are 10 dB higher than the new noise source, the new source will not contribute a measurable change in the overall noise levels.

Noise levels from the parking lot were analyzed for impacts using the FTA and WAC criteria. The analysis results, shown in Table 6-3, show that adding the parking lot would not change the noise levels at any of the nearby receiver locations due to the high background noise levels. Therefore, no FTA noise impacts were identified.

The table also shows the worst-case hourly noise levels from the parking lot is 45 to 46 dBA Leq at receivers R-5 and R-6. These worst-case noise levels are below the WAC nighttime code of 47 dBA Leq for a commercial land use next to a residential land use. Therefore, the parking lot is also in compliance with the WAC.

There are no other projected related noise impacts predicted under the proposed Lakewood Station improvement project package.

6.4 Operational vibration analysis

Major vibration related sources include the existing Sounder and Amtrak trains, trains related to the Tacoma rail service and rail service to and from JBLM. Other vibration sources include heavy trucks, industrial activities, and military training activities. Because there are no track modifications or changes in Sounder or Amtrak headways, there is no change predicted in the overall vibration levels in the area. Therefore, no vibration impacts are predicted..

7 PROJECT MITIGATION

7.1 Construction noise mitigation

Potential construction noise impacts can be reduced with operational methods and scheduling, equipment choice, and acoustical treatments. If required for construction outside the allowable hours (see Section 4.2), Sound Transit or its contractor would seek the appropriate noise variance from the City of Lakewood and require the appropriate noise control measures. Noise control mitigation to meet local regulatory requirements, noise ordinances, and permit or variance conditions would be required. These measures could include:

- Use smart back-up alarms during nighttime.
- Use low-noise emission equipment.
- Implement noise-deadening measures for truck loading and operations.
- Monitor and maintain equipment to meet noise limits.
- Use lined or covered storage bins, conveyors, and chutes with sound-deadening material.
- Use acoustic enclosures, shields, or shrouds for equipment and facilities.
- Install high-grade engine exhaust silencers and engine-casing sound insulation.
- Prohibit jack hammering and impact pile driving during nighttime hours.
- Minimize the use of generators or use whisper-quiet generators to power equipment.
- Use movable noise barriers at the source of the construction activity.
- Limit or avoid certain noisy activities during nighttime hours near residential areas.

7.2 Construction vibration mitigation

The primary concern from construction vibration in the project corridor is annoyance inside sensitive spaces. No construction vibration impacts are predicted. However, the following precautionary vibration mitigation strategies could be implemented if construction occurs within 25 feet of a sensitive or historic structure:

- Pre-construction verification: Given the types of construction activities required for completion of the project, as previously stated, no vibration impacts are projected and no pre-construction survey or verification should be required. If, however, during construction, highly sensitive or historic building(s) are identified within 25 feet of a site with heavy construction activities, an inspection of those building may be warranted.

- Vibration limits: The construction contract specifications should limit construction vibration to a maximum of 0.5 in./sec. for all buildings within 25 feet of construction activities.

- Vibration monitoring: Given the types of construction activities required for completion of the project, vibration monitoring should not be necessary. If heavy construction would occur closer than 25 feet to sensitive structures or historic buildings, limited vibration monitoring maybe warranted.

.

7.3 Operational noise mitigation

No operational noise impacts are predicted, and no vibration mitigation is recommended.

7.4 Operational vibration mitigation

No operational vibration impacts are predicted, and no vibration mitigation is recommended.

8 REFERENCES

Lakewood, Washington Municipal Code. Chapter 8.36.

Federal Highway Administration (FHWA). 2006. U.S. Department of Transportation. Roadway Construction Noise Model, August 2006.

Federal Transit Administration (FTA). 2018. U.S. Department of Transportation. Transit Noise and Vibration Impact Assessment. September 2018.

Sound Transit. 2021. *Phase 1 Lakewood Station Access Improvements Report*.

SoundTransit

401 S Jackson St., Seattle, WA 98104 // 1-800-201-4900 / TTY Relay: 711 | main@soundtransit.org | soundtransit.org