

3.3 Noise



This chapter assesses the potential noise/vibration impacts associated with implementing the alternatives considered in this EIS. The following includes acoustical terminology and background information relevant to the Proposal, a presentation of applicable regulatory standards, assessment of acoustical impacts related to implementing the alternatives considered in this EIS and identification of potentially feasible noise mitigation measures where appropriate.

This analysis evaluates noise conditions and potential impacts on a citywide cumulative basis and, where appropriate according to the EIS analysis sectors described in Chapter 2 and shown in Figure 2-17 and Figure 3.3-1.

3.3.1 Introduction

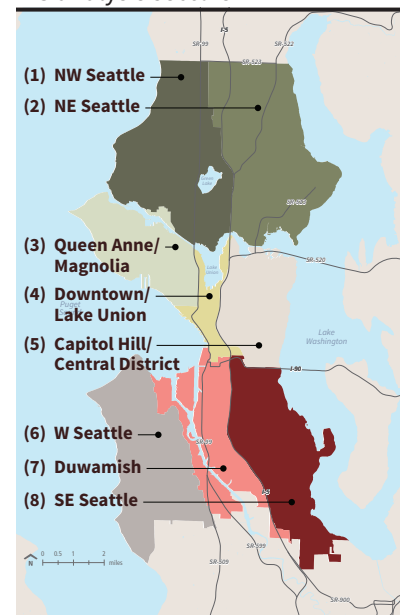
Environmental Noise and Vibration Fundamentals

NOISE EXPOSURE FUNDAMENTALS AND DESCRIPTORS

Sound is mechanical energy transmitted by pressure waves through a medium such as air. Noise is defined as unwanted sound, which is characterized by various parameters that include the rate of oscillation of sound waves (frequency), the speed of propagation and the pressure level or energy content (amplitude). In particular, the sound pressure level has become the most common descriptor used to characterize the loudness of an ambient sound level. Sound pressure level is measured in decibels (dB), a logarithmic loudness scale with 0 dB corresponding roughly to the threshold of human hearing and 120 dB to 140 dB corresponding to the threshold of pain. Because sound pressure can vary by over 1 trillion times within the range of human hearing, the logarithmic loudness scale is used to calculate and manage sound intensity numbers conveniently.

The typical human ear is not equally sensitive to all frequencies of the audible sound spectrum. As a consequence, when assessing potential noise impacts, sound is measured using an electronic filter that de-emphasizes the frequencies below 1,000 hertz (Hz) and above 5,000 Hz in a manner corresponding

Figure 3.3-1
EIS analysis sectors



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to the human ear's decreased sensitivity to low and extremely high frequencies instead of the frequency mid-range. This method of frequency weighting is referred to as A weighting and is expressed in units of A-weighted decibels (dBA). Frequency A-weighting follows an international standard methodology of frequency de-emphasis and is typically applied to community noise measurements.

Given the variation of community noise level from instant to instant, community noise levels must be measured over an extended period of time to characterize a community noise environment and evaluate cumulative sound impacts. This time-varying characteristic of environmental noise is described using statistical noise descriptors. The most frequently used noise descriptors are as follows:

- L_{eq} The equivalent sound level is used to describe noise over a specified period of time, typically 1 hour, in terms of a single numerical value. The L_{eq} is the constant sound level that would contain the same acoustic energy as the varying sound level, during the same time period (i.e., the average noise exposure level for the given time period).
- L_{max} The L_{max} is the instantaneous maximum noise level measured during the measurement period of interest.
- L_{dn} The day-night average sound level (also written as DNL) is the energy average of the A-weighted sound levels occurring during a 24-hour period, accounting for the greater sensitivity of most people to nighttime noise by weighting ("penalizing") nighttime noise levels by adding 10 dBA to noise between 10:00 p.m. and 7:00 a.m.

Steady-state sound is sound for which average characteristics remain constant in time (e.g., sound of an air conditioner, fan or pump) and are typically described using the L_{eq} descriptor. Impulse sound is sound generated over a relatively short duration period (e.g., a car horn or back-up alarm). Impulsive sound is typically characterized using the L_{max} descriptor or a normalized Sound Exposure Level. The City's Noise Ordinance defines "Impulsive sound" as "sound having the following qualities: the peak of the sound level is less than one (1) second and short compared to the occurrence rate; the onset is abrupt; the decay rapid; and the peak value exceeds the ambient level by more than ten (10) dB(A)."

Effects of Noise on People

The effects of noise on people can be placed into three categories: (1) subjective effects of annoyance, nuisance and dissatisfaction; (2) interference with activities such as speech, sleep and learning; and (3) physiological effects such as hearing loss or sudden startling.

Environmental noise typically produces effects in the first two categories. Workers in industrial plants generally experience noise in the third category. There is no completely accurate way to measure the subjective effects of noise or the corresponding reactions of annoyance and dissatisfaction. A wide variation exists in the individual thresholds of annoyance, and different tolerances to noise tend to develop based on an individual's past experiences with noise.

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Because there is such wide variation in individual noise thresholds, an important way of predicting human reaction to a new or changed noise environment is the way the noise levels compare to the existing environment to which one has adapted, or the “ambient” noise level. In general, the more a new noise exceeds the previously existing ambient noise level, the less acceptable the new noise will be to the individual. With regard to increases in A-weighted noise levels, the following relationships occur:

- Except in carefully controlled laboratory experiments, a change of 1 dBA cannot be perceived by the human ear.
- Outside of the laboratory, a 3-dBA change is considered a just-perceivable difference.
- A change in level of at least 5-dBA is required before any noticeable change in human response would be expected.
- A 10-dBA change is subjectively heard as approximately a doubling in loudness and can cause an adverse response.

These relationships occur in part because of the logarithmic nature of sound and the decibel system. The human ear perceives sound in a non-linear fashion; hence, the decibel scale was developed. Because the decibel scale is based on logarithms, two noise sources do not combine in a simple additive fashion, but rather logarithmically. For example, if two identical noise sources produce noise levels of 50 dBA, the combined sound level would be 53 dBA, not 100 dBA.

Health Effects of Environmental Noise

The World Health Organization (WHO) is a major source of current knowledge regarding the health effects of noise impacts. According to WHO, sleep disturbance can occur when continuous indoor noise levels exceed 30 dBA or when intermittent interior noise levels reach 45 dBA, particularly if background noise is low (1999). With a bedroom window slightly open (a reduction from outside to inside of 15 dB), the WHO criteria suggest that exterior continuous (ambient) nighttime noise levels should be 45 dBA or below, and short-term events should not generate noise in excess of 60 dBA. WHO also notes that maintaining noise levels within the recommended levels during the first part of the night is believed to be effective for the ability of people to initially fall asleep.

Other potential health effects of noise identified by WHO include decreased performance for complex cognitive tasks, such as reading, attention span, problem solving and memorization; physiological effects such as hypertension and heart disease (after many years of constant exposure, often by workers, to high noise levels); and hearing impairment (again, generally after long-term occupational exposure, although shorter-term exposure to very high noise levels, for example, exposure several times a year to concert noise at 100 dBA, can also damage hearing). Finally, noise can cause annoyance and can trigger emotional reactions like anger, depression and anxiety. WHO reports that, during daytime hours, few people are seriously annoyed by activities with noise levels below 55 dBA or moderately annoyed with noise levels below 50 dBA.

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Vehicle traffic and continuous sources of machinery and mechanical noise contribute to ambient noise levels. Short-term noise sources, such as truck backup beepers, the crashing of material being loaded or unloaded, car doors slamming and engines revving, contribute very little to 24-hour noise levels but are capable of causing sleep disturbance and severe annoyance. The importance of noise to receptors depends on both time and context. For example, long-term high noise levels from large traffic volumes can make conversation at a normal voice level difficult or impossible, while short-term peak noise levels, if they occur at night, can disturb sleep.

Vibration Fundamentals and Descriptors

As described in the Federal Transportation Administration (FTA) Transit Noise and Vibration Impact Assessment (FTA 2006a), groundborne vibration causes buildings to shake and generates audible rumbling sounds. Vibration levels can also result in interference or annoyance impacts at residences or other land uses where people sleep, such as hotels and hospitals. It is unusual for vibrations from sources such as buses and trucks on a normal roadway to be perceptible by individuals, even in locations close to major roads. However, there are some common sources of groundborne vibration, including trains; buses on rough roads; and construction activities such as blasting, pile driving and operating heavy earth-moving equipment.

The types of construction activities that could be associated with propagation of groundborne vibration typically include pile driving, blasting, use of hoe rams for demolishing large concrete structures and drilling.

There are no adopted state or local policies or standards for groundborne vibration with regard to human annoyance; however, the Federal Transit Administration has established some standards for acceptable levels of vibration associated with impact equipment as experienced by sensitive receptors. Those criteria are established in terms of vibration velocity level (VdB). For frequent events, the criterion is 72 VdB, while for infrequent events the criterion is 80 VdB. Construction-related activity, which is temporary in nature and would typically be restricted to daytime when most people are not sleeping, is generally assessed by applying the 80 VdB criterion, unless such activity were to occur during nighttime when most people would be sleeping.

Effects of Vibration on Structures and People

The effects of groundborne vibration include movement of the building floors, rattling of windows, shaking of items on shelves or hanging on walls and rumbling sounds. In extreme cases, the vibration can cause damage to buildings. Building damage is not a factor for most projects, with the occasional exception of effects from blasting and pile-driving during construction. Annoyance from vibration often occurs when the vibration exceeds the threshold of perception by only a small margin. A vibration level that causes annoyance will be well below the damage threshold for normal buildings.

Vibration intensity is generally expressed as peak particle velocity (the maximum speed that the ground moves while it temporarily shakes, referred to as PPV). Since ground-shaking speeds are very small, PPV is measured in inches per second.

The Federal Transit Administration has published guidance relative to vibration impacts. According to the FTA, fragile buildings can be exposed to groundborne vibration PPV levels of 0.5 inch per second without experiencing structural damage (FTA 2006a).

Regulatory Setting and Impact Assessment Criteria

WASHINGTON STATE NOISE CONTROL ACT OF 1974

The State of Washington recognized the harm that excessive noise can have on public health, safety and well-being and authorized the establishment of rules to abate and control noise pollution (Revised Code of Washington 70.107). The regulations on Maximum Environmental Noise Levels (Washington Administrative Code (WAC) 173-60) apply to a variety of activities and facilities including general construction activities, park-and-rides and maintenance facilities and exempts electrical substations, mobile noise sources and vehicles traveling in public right-of-way, as well as safety warning devices (i.e., bells). The state provisions have been adopted by most cities around the state, including the City of Seattle (SMC 25.08).

SEATTLE MUNICIPAL CODE 25.08 NOISE CONTROL

Operational Noise Standards

Chapter 25.08 of the SMC establishes exterior sound level limits for specified land use zones or “districts,” which vary depending on the district generating the sound and the district affected by the sound (see Table 3.3-1).

Table 3.3-1 Exterior sound level limits (Seattle Municipal Code 25.08.410)

Sound Generating District	Sound Receiving District		
	Residential (dBA L _{eq})	Commercial (dBA L _{eq})	Industrial (dBA L _{eq})
Residential	55	57	60
Commercial	57	60	65
Industrial	60	65	70

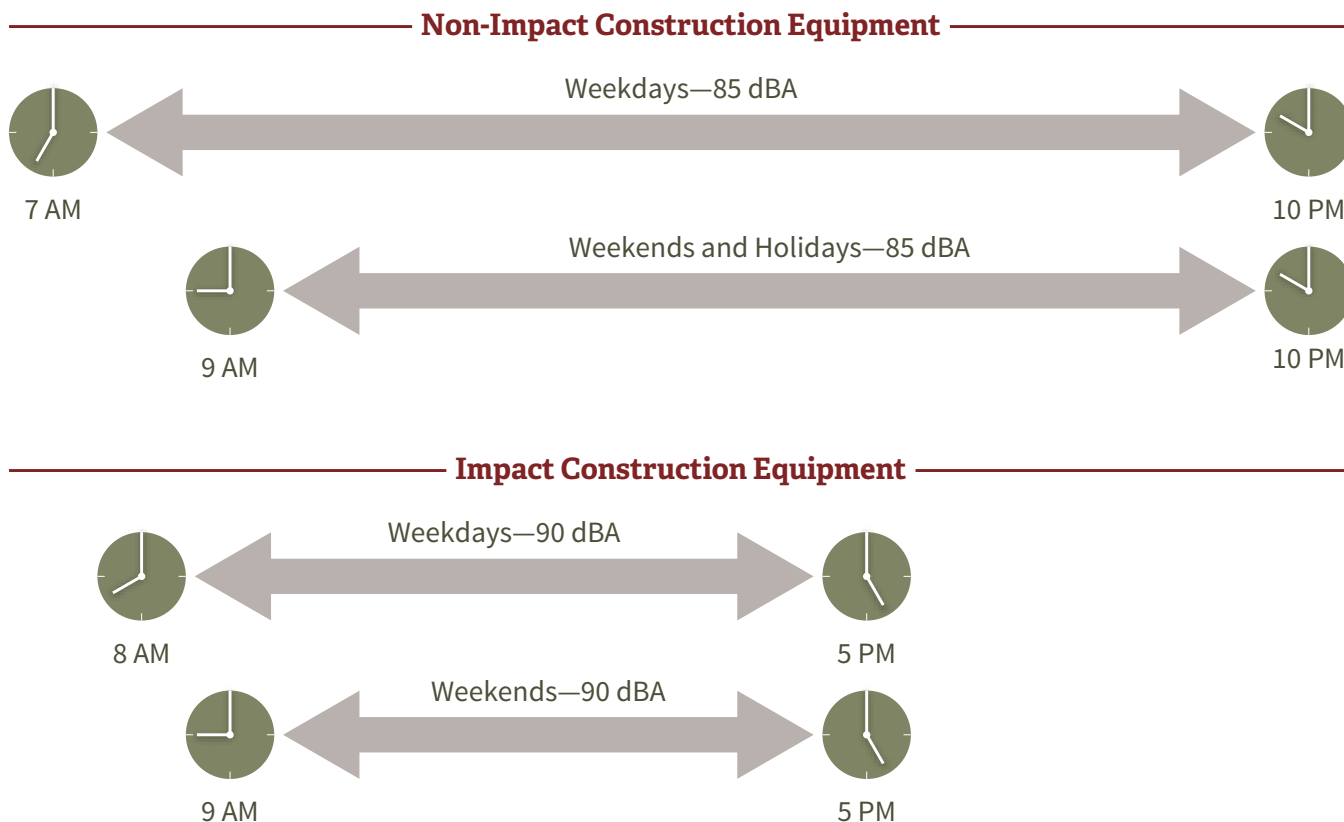
Source: Fehr & Peers, 2014.

Construction Noise Standards

The City’s Noise Ordinance allows the exterior sound level limits to be exceeded by certain types of construction equipment operating in commercial districts between 7 a.m. and 10 p.m. on weekdays and between 9 a.m. and 10 p.m. on weekends and legal holidays, provided

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Figure 3.3-2 Construction noise time limits for public projects in commercial zones under the City of Seattle Noise Ordinance*



* As measures from the property line or at a distance of 50 feet from the equipment, whichever is greater.

that the equipment is being used for a public project (SMC 25.08.425; see Figure 3.3-2). The types of equipment that would usually exceed the exterior sound level limit of 60 dBA are loaders, excavators and cranes. This equipment may exceed the applicable standard by up to 25 dBA (an 85 dBA standard) when measured at a reference distance of 50 feet. Use of impact equipment, such as a concrete breaker, is restricted to 8 a.m. to 5 p.m. on weekdays and 9 a.m. to 5 p.m. on weekends and holidays and limited to a continuous noise level of 90 dBA and a maximum noise level of 99 dBA L_{max} when measured at a reference distance of 50 feet.

Noise and Vibration Sources in Seattle

For this analysis, the existing noise environment in the City of Seattle is divided into two primary categories of noise sources: transportation and non-transportation. Transportation sources include surface vehicle traffic; railroad train operations, including light rail and

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commuter trains; and aircraft operations. Non-transportation, or stationary/fixed sources include commercial/industrial equipment, construction equipment and any other sources not associated with the transportation of people or goods. Existing noise exposure in Seattle associated with these primary noise sources is presented below.

TRAFFIC NOISE SOURCES

Traffic noise exposure is primarily a function of the volume of vehicles per day, the speed of those vehicles, the number of those vehicles represented by medium and heavy trucks, the distribution of those vehicles during daytime and nighttime hours and the proximity of noise-sensitive receivers to the roadway. Existing traffic noise exposure is expected to be as low as 50 dB L_{dn} in the most isolated and less frequented locations of the City, while receivers adjacent to interstate highways are likely to experience levels as high as 75 dB L_{dn} (FTA 2006). Bus transit can also make a meaningful contribution to roadway noise levels. Traffic noise assessment in this analysis is inclusive of bus transit, as buses are an assumed percentage of overall roadway volumes used in the calculation of roadside noise levels. Table 3.3-2 presents the distance to various noise contours for freeways and State Routes in the Seattle area. The values in Table 3.3-2 do not take into consideration the presence of existing sound barriers, topographical conditions or roadway elevation, all of which can vary by location. The 65 L_{dn} contour is important because it represents the exterior noise level which can be reduced to 45 dBA L_{dn} using standard construction techniques. An interior noise level of 45 L_{dn} is the commonly accepted maximum recommended interior noise level for residential uses (HUD 2009, 14).

Table 3.3-2 Existing roadway noise levels

Roadway	Roadway Segment	Distance (feet) from Roadway Center to Noise Contours			
		L_{dn} at 150' from Roadway Center	65 dBA L_{dn}	70 dBA L_{dn}	75 dBA L_{dn}
Interstate 5	At Albro (Sectors 7 & 8)	78.1	1,126	523	243
	At Union (Sector 4)	78.3	1,154	536	249
	At 45th Street (Sector 2)	77.5	1,016	471	219
	At 130th Street (Sector 2)	78.0	1,105	513	238
Interstate 90	At Lakeside Ave. (Sectors 5 & 8)	74.5	643	299	139
State Route 99	At 82nd Street (Sector 1)	69.6	304	141	66
	At 40th Street (Sector 3)	69.6	304	141	66
	At Cloverdale (Sector 7)	68.0	238	110	51
State Route 513	At 45th (Sector 2)	62.0	95	44	21
State Route 520	At SR 513 (Sector 5)	67.6	224	104	48
State Route 522	At 98th (Sector 2)	64.0	130	60	28
State Route 523	At 30th (Sector 2)	62.0	95	44	21

Traffic Information Source: WSDOT, 2013 Annual Traffic Report.
 Table Source: ESA, 2014. Calculation data and results provided in Appendix A.2.

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RAIL NOISE SOURCES

Seattle is also affected by noise from freight and passenger rail operations. While these operations generate significant noise levels in the immediate vicinity of the railways, train operations are intermittent and area railways are widely dispersed. Commuter rail such as Sound Transit's light rail system operate with more frequency than standard gauge rail operations but electrification and lower speeds result in lower noise levels. The contribution of rail noise to the overall ambient noise environment in the Seattle area is relatively minor compared to other sources such as traffic. However, areas near train yards from assembling railcars into long trains and idling engines frequently experience high noise levels. Train operations may be a source of significant groundborne vibration near the tracks. Vibration sensitive receivers within 100 feet of rail operations may be adversely affected by vibration exposure during train events (FTA 2006).

AIRCRAFT NOISE SOURCES

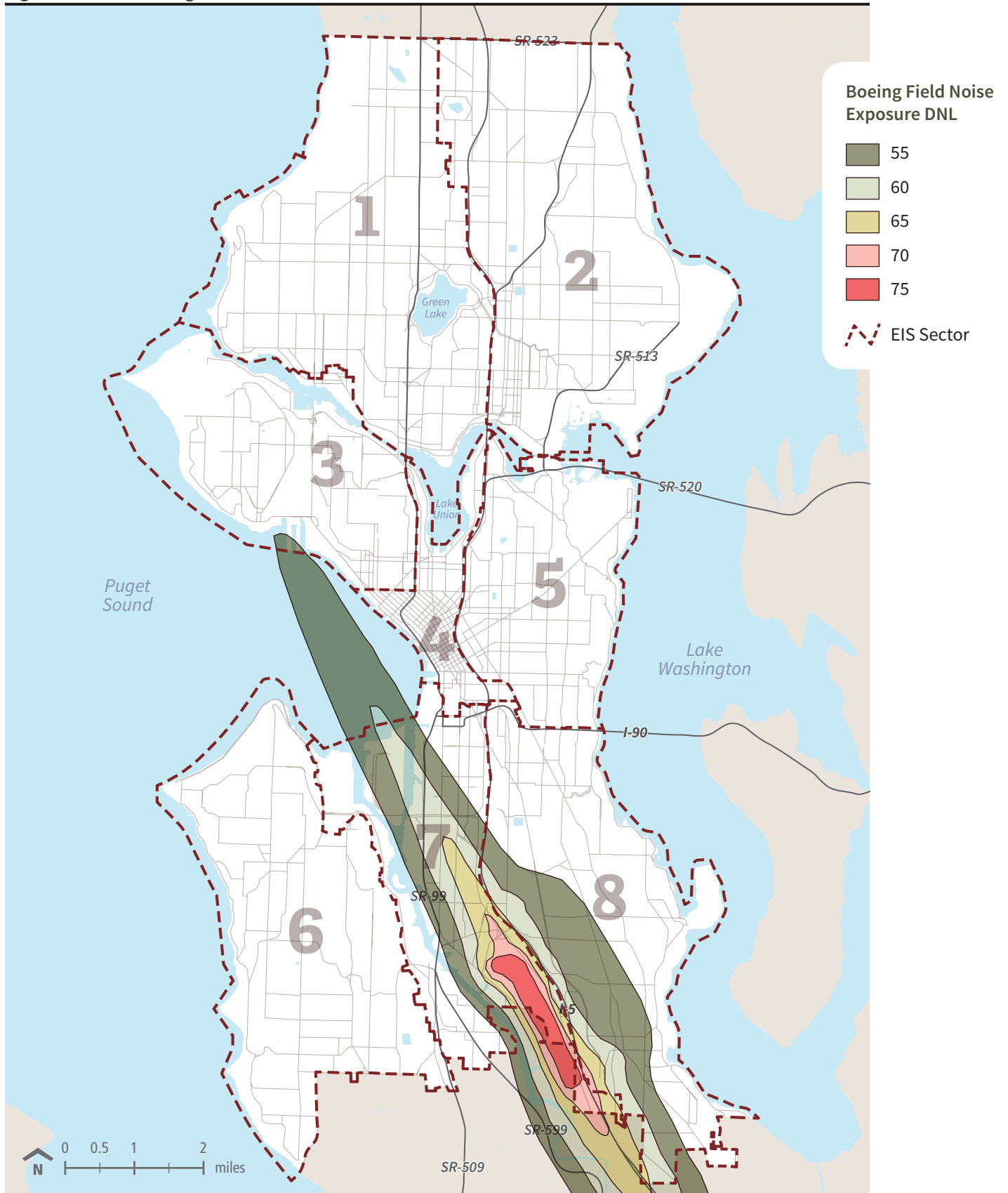
Seattle is home to one public airport—King County International Airport, also known as Boeing Field which generates approximately 500 aircraft operations a day. In addition to the numerous daily aircraft operations originating and terminating at Boeing Field, aircraft originating from other airports such as Seattle-Tacoma International Airport (Sea-Tac) frequently fly over Seattle. All of these operations contribute to the overall ambient noise environment. In general, like rail noise, the proximity of the receiver to the airport and aircraft flight path determines the noise exposure. Other contributing factors include the type of aircraft operated, altitude of the aircraft and atmospheric conditions. Atmospheric conditions may contribute to the direction of aircraft operations (flow) and affect aircraft noise propagation. Figure 3.3–3 presents the noise contours for Boeing Field as of the most recent FAA Noise Study (King County 2005).

CONSTRUCTION NOISE SOURCES

Construction activities for new development and transportation improvements can create high noise levels of relatively short duration. Noise production from construction equipment varies greatly depending on factors such as operation being performed and equipment type, model, age and condition. Noise from heavy equipment diesel engine operations often dominates the noise environment in the vicinity of construction sites. Stationary sources such as generators, pumps and compressors may also produce a significant contribution. However, if present, operations from impact equipment (e.g., pile driving, pavement breaking) will generally produce the highest noise levels, and may also produce significant vibration in the vicinity. Maximum noise exposure from typical construction equipment operations is approximately 75–100 dB (L_{max} at 50 feet) with noise from heavy demolition and pile driving operations having the highest noise production. Please refer to Table 3.3–3 for typical construction noise levels.

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Figure 3.3-3 Boeing Field noise contours



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Table 3.3-3
 Typical noise levels from demolition/construction equipment operations

Construction Equipment	Noise Exposure Level, dB L _{max} @ 50 Feet
Air Compressor	78-81
Backhoe	78-80
Compactor	82-83
Concrete Mixer (Truck)	79-85
Concrete Pump (Truck)	81-82
Concrete Vibrator	76-80
Crane	81-88
Dozer	82-85
Generator	81
Grader	85
Jack Hammer	88-89
Loader	79-85
Paver	77-89
Pile Driver (Impact)	101
Pneumatic Tool	85
Pump	76-81
Shovel	82
Heavy Diesel Truck	88

Source: FTA Guidance Manual (Chapter 12); FHWA RCNM V.1.00.

INDUSTRY AND OTHER NON-TRANSPORTATION NOISE SOURCES

A wide variety of industrial and other non-transportation noise sources are located in Seattle. These include manufacturing plants, landfills, treatment plants (e.g., water), food packaging plants and lumber mills, just to name a few. Noise generated by these sources varies widely, but in many cases may be a significant contributor to a local noise environment.

Noise levels in Seattle

A compilation of available noise data within the City of Seattle was collected from publicly available documents to provide an example of various noise environments throughout the City. These noise levels are presented in Table 3.3-4 and the location of the measurements is presented in Figure 3.3-4.

These data show that ambient noise levels in the urban center of the city (locations 5 and 6 in Figure 3.3-4) are substantially higher than other developed areas of the city. Larger traffic volumes on local roadways and transit bus operations are largely responsible for this phenomenon. Urban areas with low roadway volumes can regularly experience typical ambient noise levels below 50 dBA, L₅₀. Locations adjacent to freeways and highways can experience daytime ambient noise levels of 65–75 dBA, L₅₀ (Caltrans 2009).

Table 3.3-4 Ambient noise level data in the Seattle area

Roadway	Noise Levels in dBA		
	Median L ₅₀	L _{max}	DNL
Location 1: 1515 28th Ave, Magnolia neighborhood (Sector 3)	46	82	57
Location 2: 4117 SW Hill St, West Seattle (Sector 6)	47	79	56
Location 3: 37th Ave W and Smith St, Magnolia neighborhood (Sector 3)	46	91	58
Location 4: 3903 S. Burns St (Sector 8)	61	95	70
Location 5: Boren Ave and E Fir St (Sector 5)	69 ¹	100	73
Location 6: Denny Way at Minor Ave (Sector 4)	67 ²	94	72

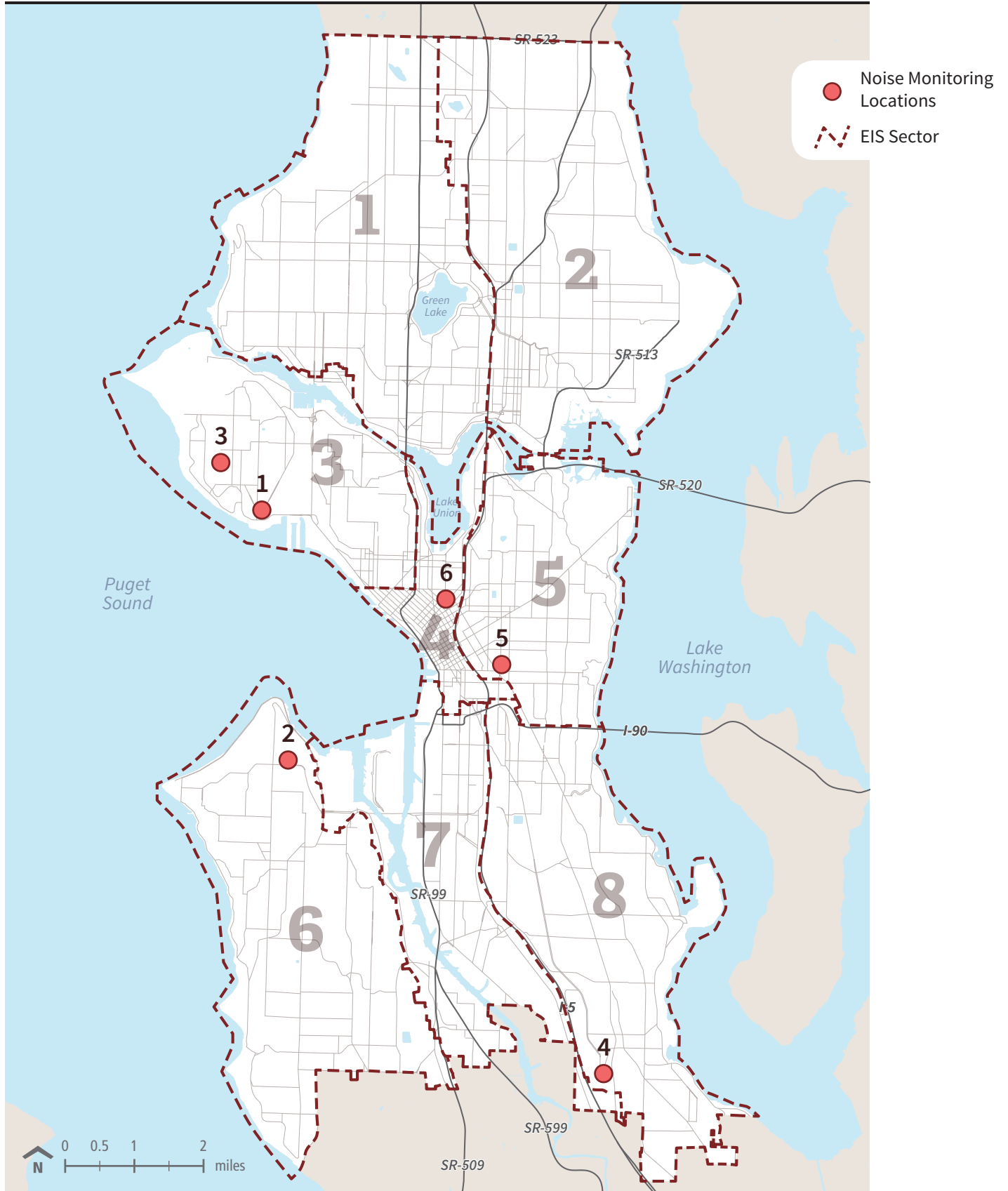
dBA = A-weighted decibels; DNL = day-night average sound level; L_{eq} = equivalent sound level; L_{max} = instantaneous

1 This value is a 24 hour average L_{eq} not L₅₀.

2 This value is a daytime L_{eq} not L₅₀.

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Figure 3.3-4 Noise monitoring locations



Sensitive Receptors

Noise-sensitive land uses are generally defined as locations where people reside or where the presence of unwanted sound could adversely affect the use of the land. Noise-sensitive land uses typically include residences, hospitals, schools, transient lodging, libraries and certain types of recreational uses. Noise-sensitive residential receivers are found throughout the study area.

3.3.2 Impacts

Impacts Common to All Alternatives

CONSTRUCTION NOISE AND VIBRATION IMPACTS

The proposed comprehensive plan alternatives envision future residential and job growth primarily within areas where transit infrastructure either exists or is planned. As such, implementation of the alternatives would result in a concentration of development within existing infill development areas. Resulting construction activities associated with development of new residences and commercial and retail land uses would have the potential to temporarily affect nearby sensitive receivers such as existing residences, schools and nursing homes.

From a regional perspective, temporary construction noise and vibration within these infill development areas would occur in urban or suburban areas where ambient noise and vibration levels are already affected by roadway traffic and other transportation sources and would therefore be less noticeable to receivers than if these activities were to occur on the edges of existing development areas.

Construction noise standards established in Section 25.08.425 of the Seattle Municipal Code limit construction activities to times when construction noise would have the least effect on adjacent land uses, and also restrict the noise generated by various pieces of construction equipment. Development under the alternatives would range from high intensity development of high-rise and mid-rise offices and residences in urban centers to low-rise development both within and outside of villages. Consequently, depending on the extent of construction activities involved and background ambient noise levels, localized construction-related noise effects could vary widely.

Construction activities with the greatest potential for adverse construction-related noise or vibration impacts are those for which pile driving or other similar invasive foundation work would be required. Generally speaking these types of construction activities are associated with high-rise development which all alternatives envision to occur within the urban center.

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The Seattle noise ordinance restricts the use of impact equipment, such as pile drivers, to 8 a.m. to 5 p.m. on weekdays and 9 a.m. to 5 p.m. on weekends and holidays and limits their operation to a continuous noise level of 90 dBA and a maximum noise level of 99 dBA L_{max} when measured at a reference distance of 50 feet.

Because the potential exists for development within urban center areas to require pile driving adjacent (closer than 50 feet) to other buildings that may be occupied by residents or other sensitive receptors, construction noise impacts in excess of 90 dBA within these areas are identified as a potential moderate noise impact and mitigation is identified.

The City of Seattle has not adopted any quantitative standards with regard to vibration. Construction-related vibration impacts from pile driving are generally assessed in environmental review documents by applying the methodology of the FTA which includes standards for structural damage as well as for human annoyance.

Pile driving can result in peak particle velocities (PPV) of up to 1.5 inches per second (in/sec) at a distance of 25 feet (FTA 2006), but typically average about 0.644 PPV. The California Department of Transportation (Caltrans) measure of the threshold of architectural damage for conventional sensitive structures is 0.5 in/sec PPV for new residential structures and modern commercial buildings and 0.25 in/sec PPV for historic and older buildings. Therefore, the potential exists for pile driving to occur within 50 feet of a historic building, resulting in a potential significant vibration impact related to structural damage and mitigation measures are recommended.

Vibration levels can also result in interference or annoyance impacts for residences or other land uses where people sleep, such as hotels and hospitals. FTA vibration annoyance potential criteria depend on the frequency of the events. When vibration events occur more than 70 times per day, as would be the case with pile driving, they are considered “frequent events.” Frequent events in excess of 72 VdB are considered to result in a significant vibration impact. However the time restrictions of the City’s Ordinance are sufficient to avoid sleep interference impacts during times that most people sleep.

LAND USE COMPATIBILITY

As indicated in Table 3.3–2 and Table 3.3–4, exterior noise levels in Seattle close to freeways and highways can exceed 65 dBA L_{dn} . The 65 L_{dn} noise level is important because it represents the exterior noise level which can be reduced to 45 dBA L_{dn} using standard construction techniques. An interior noise level of 45 L_{dn} is the commonly accepted maximum interior noise level for residential uses (HUD 2009, 14). All four alternatives seek to locate residential uses near to transit to reduce vehicle miles traveled within the City. Consequently, if residences or other sensitive receptors are located too close to major roadway or noisy industrial operations additional insulation or window treatments may be warranted to reduce interior noise levels to generally acceptable levels. Conversely, if an active industrial operation is proposed adjacent to sensitive land uses noise compatibility problems could

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also arise. This potential for residents of future development to experience roadway noise of use-adjacency-related noise conditions would be a potential moderate noise impact and mitigation measures could be considered.

For all alternatives, roadside noise levels would increase by less than 0.5 dBA at all locations. As discussed above, outside of the laboratory, a 3-dBA change is considered a just-perceivable difference. Consequently, an increase of less than 0.5 dBA would be considered a minor impact on environmental noise. However, while the impacts of additional noise would not be discernible from background noise levels, all of the alternatives would worsen noise levels that in some areas are already above levels considered healthy for residential and other sensitive uses.

Alternative 1: Continue Current Trends (No Action)

TRANSPORTATION NOISE IMPACTS

Future development under Alternative 1 would result in increased vehicle traffic on roadways throughout the Seattle area. To quantify the degree of noise increases, traffic noise was modeled to assuming an annual growth rate of VMT of 0.4 percent, consistent with the transportation analysis. Resultant noise levels are presented in Table 3.3-5 and compared to existing conditions at the same roadside distance, 150 feet from the roadway center for major roadways throughout the city.

Alternative 2: Guide Growth to Urban Centers

TRANSPORTATION NOISE IMPACTS

Development under Alternative 2 would result in increased vehicle traffic on roadways throughout the Seattle area. To quantify the degree of noise increases, traffic noise was modeled to assuming an annual growth rate of VMT of 0.36 percent, consistent with the transportation analysis. Resultant noise levels are presented in Table 3.3-6 and compared to existing conditions at the same roadside distance, 150 feet from the roadway center for major roadways throughout the city.

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Roadway	Roadway Segment	Existing	2035 with Alternative 1	dBA Difference Over Existing	Significant Increase?
Interstate 5	At Albro (Sectors 7 & 8)	78.1	78.5	0.4	No
	At Union (Sector 4)	78.3	78.6	0.3	No
	At 45th Street (Sector 2)	77.5	77.8	0.3	No
	At 130th Street (Sector 2)	78.0	78.4	0.4	No
Interstate 90	At Lakeside Ave. (Sectors 5 & 8)	74.5	74.8	0.3	No
State Route 99	At 82nd Street (Sector 1)	69.6	70.0	0.4	No
	At 40th Street (Sector 3)	69.6	70.0	0.4	No
	At Cloverdale (Sector 7)	68.0	68.3	0.3	No
State Route 513	At 45th (Sector 2)	62.0	62.4	0.4	No
State Route 520	At SR 513 (Sector 5)	67.6	68.0	0.4	No
State Route 522	At 98th (Sector 2)	64.0	64.4	0.4	No
State Route 523	At 30th (Sector 2)	62.0	62.4	0.4	No

Notes Road center to receptor distance is assumed to be 150 feet for values shown in this table. Noise levels were determined using the Federal Highway Administration (FHWA) traffic noise model. The average speed on these segments is assumed to be the posted speed for each roadway.

Source: ESA, 2014.

Table 3.3-6 Modeled noise (L_{dn}) levels at 150 feet from the roadway center under Alternative 2 (2035)

Roadway	Roadway Segment	Existing	2035 with Alternative 2	dBA Difference Over Existing	Significant Increase?
Interstate 5	At Albro (Sectors 7 & 8)	78.1	78.4	0.3	No
	At Union (Sector 4)	78.3	78.6	0.3	No
	At 45th Street (Sector 2)	77.5	77.8	0.3	No
	At 130th Street (Sector 2)	78.0	78.3	0.3	No
Interstate 90	At Lakeside Ave. (Sectors 5 & 8)	74.5	74.8	0.3	No
State Route 99	At 82nd Street (Sector 1)	69.6	69.9	0.3	No
	At 40th Street (Sector 3)	69.6	69.9	0.3	No
	At Cloverdale (Sector 7)	68.0	68.3	0.3	No
State Route 513	At 45th (Sector 2)	62.0	62.3	0.3	No
State Route 520	At SR 513 (Sector 5)	67.6	67.9	0.3	No
State Route 522	At 98th (Sector 2)	64.0	64.4	0.4	No
State Route 523	At 30th (Sector 2)	62.0	62.3	0.3	No

Notes Road center to receptor distance is assumed to be 150 feet for values shown in this table. Noise levels were determined using the Federal Highway Administration (FHWA) traffic noise model. The average speed on these segments is assumed to be the posted speed for each roadway.

Source: ESA, 2014.

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Alternative 3: Guide Growth to Urban Villages near Light Rail

TRANSPORTATION NOISE IMPACTS

Development under Alternative 3 would result in increased vehicle traffic on roadways throughout the Seattle area. To quantify the degree of noise increases, traffic noise was modeled to assuming an annual growth rate of VMT of 0.38 percent, consistent with the transportation analysis. Resultant noise levels are presented in Table 3.3–7 and compared to existing conditions at the same roadside distance, 150 feet from the roadway center for major roadways throughout the city.

Alternative 4: Guide Growth to Urban Villages near Transit

TRANSPORTATION NOISE IMPACTS

Development under Alternative 4 would result in increased vehicle traffic on roadways throughout the Seattle area. To quantify the degree of noise increases, traffic noise was modeled to assuming an annual growth rate of VMT of 0.4 percent, consistent with the transportation analysis. Resultant noise levels are presented in Table 3.3–8 and compared to existing conditions at the same roadside distance, 150 feet from the roadway center for major roadways throughout the city.

3.3.3 Mitigation Strategies

Strategies to Reduce Construction-Related Noise and Vibration Impacts

Although mitigation strategies are not required due to a lack of significant adverse impact findings, to address the potential moderate adverse noise impact from impact pile driving adjacent (closer than 50 feet) to sensitive land uses or moderate adverse vibration impacts to historic structures, the 2015–2035 Comprehensive Plan could consider adoption of a policy that Seattle Noise Ordinance be updated to require best practices for noise control, including “quiet” pile-driving technology (such as pre-drilling of piles, use of sonic or vibratory drivers instead of impact pile drivers, where feasible); and cushion blocks to dampen impact noise from pile driving).

Measures to Reduce Land Use Compatibility Noise Impacts

Although mitigation strategies are not required due to a lack of significant adverse impact findings, to address the potential for exposure of residences and other sensitive land uses to incompatible environmental noise, the 2015–2035 Comprehensive Plan could consider adoption of a policy that recommends that residences and other sensitive land uses (i.e.,

3.3 Noise**Table 3.3-7** Modeled noise (L_{dn}) levels at 150 feet from the roadway center under Alternative 3 (2035)

Roadway	Roadway Segment	Existing	2035 with Alternative 3	dBA Difference Over Existing	Significant Increase?
Interstate 5	at Albro (Sectors 7 & 8)	78.1	78.5	0.4	No
	at Union (Sector 4)	78.3	78.6	0.3	No
	at 45th Street (Sector 2)	77.5	77.8	0.3	No
	at 130th Street (Sector 2)	78.0	78.3	0.3	No
Interstate 90	at Lakeside Ave. (Sectors 5 & 8)	74.5	74.8	0.3	No
State Route 99	at 82nd Street (Sector 1)	69.6	69.9	0.3	No
	at 40th Street (Sector 3)	69.6	69.9	0.3	No
	at Cloverdale (Sector 7)	68.0	68.3	0.3	No
State Route 513	at 45th (Sector 2)	62.0	62.4	0.4	No
State Route 520	at SR 513 (Sector 5)	67.6	67.9	0.3	No
State Route 522	at 98th (Sector 2)	64.0	64.4	0.4	No
State Route 523	at 30th (Sector 2)	62.0	62.4	0.4	No

Notes Road center to receptor distance is assumed to be 150 feet for values shown in this table. Noise levels were determined using the Federal Highway Administration (FHWA) traffic noise model. The average speed on these segments is assumed to be the posted speed for each roadway.

Source: ESA, 2014.

Table 3.3-8 Modeled noise (L_{dn}) levels at 150 feet from the roadway center under Alternative 4 (2035)

Roadway	Roadway Segment	Existing	2035 with Alternative 4	dBA Difference Over Existing	Significant Increase?
Interstate 5	at Albro (Sectors 7 & 8)	78.1	78.5	0.4	No
	at Union (Sector 4)	78.3	78.6	0.3	No
	at 45th Street (Sector 2)	77.5	77.8	0.3	No
	at 130th Street (Sector 2)	78.0	78.4	0.4	No
Interstate 90	at Lakeside Ave. (Sectors 5 & 8)	74.5	74.8	0.3	No
State Route 99	at 82nd Street (Sector 1)	69.6	70.0	0.4	No
	at 40th Street (Sector 3)	69.6	70.0	0.4	No
	at Cloverdale (Sector 7)	68.0	68.3	0.3	No
State Route 513	at 45th (Sector 2)	62.0	62.4	0.4	No
State Route 520	at SR 513 (Sector 5)	67.6	68.0	0.4	No
State Route 522	at 98th (Sector 2)	64.0	64.4	0.4	No
State Route 523	at 30th (Sector 2)	62.0	62.4	0.4	No

Notes Road center to receptor distance is assumed to be 150 feet for values shown in this table. Noise levels were determined using the Federal Highway Administration (FHWA) traffic noise model. The average speed on these segments is assumed to be the posted speed for each roadway.

Source: ESA, 2014.

3.3 Noise

schools, day care) be separated from freeways, railways and ports and other active industrial facilities where exterior noise environments exceed 65 dBA L_{dn} . If sensitive land uses are proposed in such areas, a policy addressing the need for additional mitigation strategies could be considered to achieve an interior noise performance standard of 45 dBA, L_{dn} . The types of strategies that could help to accomplish this include:

- Coordination with WSDOT on noise wall construction where major highways pass through residential areas.
- Use of appropriate building materials such as walls and floors with an STC rating of 50 or greater as necessary to achieve this performance standard.
- Site design measures, including use of window placement to minimize window exposure toward noise sources, avoid placing balcony areas in high noise areas, and use of buildings as noise barriers.
- Use of acoustically rated additional building materials (insulation and windows).

3.3.4 Significant Unavoidable Adverse Impacts

No significant unavoidable adverse impacts to noise are anticipated.