Division Street Bus Rapid Transit Project

Noise and Vibration Impact Assessment

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EXECUTIVE SUMMARY

The Spokane Transit Authority (STA) began the Division Street Bus Rapid Transit (BRT) project (Project) to increase overall mobility in Spokane County by providing a high-quality, fast, and frequent bus service along the Division Street corridor. This technical report presents a noise and vibration impact study for the Project. The objective of the study was to assess potential noise, and vibration impacts of the planned BRT Project.

Figure S-1. Vicinity Map with Proposed Project Overlay



Source: Spokane Transit Authority, 2024.

Land use along the proposed BRT corridor consists of a variety of uses including single- and multi-family residential uses, parks, schools, churches, medical facilities, and various commercial uses. For the analysis, the corridor was divided into three segments; Northend, along E Hastings with connections to the Hasting Park and Ride and/or a new proposed transit center; Central Area, between E Hastings and the Spokane River; and Downtown, covering the area south of the Spokane River.

Existing background noise levels were measured at 13 locations along the Project corridor. The noise monitoring locations were selected using several criteria, including the site's ability to establish a representative background, or ambient, noise level for multiple noise-sensitive receiver locations. The monitoring sites are also used to provide an understanding of the existing environment along the corridor and establish the FTA noise impact criteria, which is based on the measurements and projection of the existing conditions noise environment.

Measurements included the 24-hour Ldn (average equivalent sound level over a 24 hour period), which has a 10 decibel (dB) penalty for nighttime noise sources, and the peak hour Leq (equivalent continuous sound level). The Ldn is used for residential and similar uses and the Leq is used for land uses with primarily daytime use. Overall noise levels ranged from 68 to 72 dBA for the 24-hour Ldn and 63 to 70 dBA Leq during daytime hours. Noise levels in this range are typical along major arterial roadways and near urban downtown areas.

With the No-Build Alternative, noise levels in the Project corridor would continue to be dominated by transportation-related noise sources including cars and trucks along with noise from existing and future bus routes. Vibration under the No-Build Alternative will continue to be caused by heavy trucks and buses along public roadways and local area construction activities. Under the No-Build Alternative, there would be no Project-related construction and, therefore, no Project-related short-term noise or vibration impacts or mitigation.

Potential noise and vibration impacts from the proposed BRT Project were evaluated using the Federal Transit Administration's (FTA) current *Transit Noise and Vibration Impact Assessment* (September 2018). Information used for the study was provided by the Project design and engineering team at STA and Parametrix, Inc.

Because this Project consists of modifications to existing bus route along an existing main arterial (Division Street) four-lane roadway, the method of analysis under FTA criteria is to determine the change in total noise caused by the proposed Project. The analysis process was as follows:

1. Determine the existing noise levels throughout the corridor using noise measurements.

2. Determine the noise from the proposed project, which is due to a change in headways, location of bus stops, and the types of buses.

3. Add the noise from Step 2 to the existing noise levels from Step 1 to predict the total noise and then subtract the new total noise from the existing noise to determine the overall change (increase) in noise levels.

4. Compare the change in noise levels to the FTA criteria. Locations that exceed the allowable increase would be considered for noise mitigation.

Under the Build alternative, noise levels along the proposed BRT corridor will continue to be dominated by traffic along N Division Street and other major arterial roadways. Noise levels may increase slightly over time as volumes of traffic increase. However; based on existing and predicted future traffic volumes, overall increases in traffic noise would not be expected to exceed 2 to 3 dB by the year 2050. In general, traffic volumes along most of the proposed BRT corridors are sufficiently high so that slight changes in transit operations would not be expected to result in a measurable change in the overall noise levels. For reference, it typically takes a doubling of traffic volumes (100% increase) to cause an increase in noise levels of 3 dB.

Under the Build alternative existing bus operations will be replaced with the new BRT system. Therefore, the change in noise level is related to the changes in bus service, bus noise levels (based on type of propulsion system), and location of bus stops. The new BRT system will increase service, with the number of daily bus trips increasing from 59 northbound and 63 southbound to approximately 67 northbound and southbound daily. Because the typical average daily traffic volumes along the BRT corridors range from 14,000 to over 40,000, the noise emissions from the operations of an additional 134 buses daily would not be expected to have a discernible effect on the overall noise levels.

Finally, the proposed BRT fleet of battery electric buses (BEB) are up to 10 dB quieter than standard diesel buses when leaving bus stops. The buses are also slightly quieter when running at speeds of 30 to 35 mph, where noise from tire-roadway interaction and wind noise become notable.

As stated, based on the overall low percentage of bus traffic when compared to the total traffic along the project corridors, the small change in bus volumes would not be expected to have a measurable effect on the total noise in the corridor. To verify this and show that the new BRT Project would meet the FTA noise criteria, 125 representative receiver locations within 125 feet of the corridor were selected and modeled to verify compliance with the FTA criteria. Land uses of the representative receiver locations include several single and multi-family residences, schools, churches, and parks, at varying distances from the project corridors with varying existing noise levels. The analysis was performed by adding 135 BEB's to the existing conditions noise measured levels to determined what increase, if any, in noise would be related to the project.

A summary of the noise analysis results, broken down by area, is provided in Table S-1, Complete details on the noise analysis for the representative receivers are provided in this report and Appendix C.

Table S-1. Summary of Existing and Future Noise Levels and Potential Impacts				
Project Segment	**Existing Ldn/Leq dBA**	**Future Ldn/Leq dBA with BRT Project**	**Change in Total Noise (dB)**	**Impacts**
North End: Hasting Park and Ride connection and E Hastings and E Farwell Roads connection to the east	66.8 – 74.7	66.9 – 74.8	0.1 – 0.3	None
Central Area: Spokane River to E Hastings Road	66.6 – 76.4	66.7 – 76.6	0.1 – 0.2	None
Downtown: South of the Spokane River	69.9 – 78.3	70.0 – 78.4	0.1 – 0.6	None
Source. MM&A 2025 Noise modeling, see Appendix C for detailed results.				

Because this project is essentially replacing existing bus services with a new, zero emission BEB BRT service, no measurable noise increase would be expected, and no noise impacts were identified. Because there are no noise impacts, no Project specific noise mitigation measures are recommended.

No vibration impacts are predicted due to the use of rubber tired vehicles and, therefore, no vibration mitigation is recommended.

Noise from construction would be similar to other highway construction projects. Maximum noise levels for construction activities can be expected to range from 70 to 90 dBA as measured at sites 50 feet from the construction activities. Construction activities would be required to meet the City of Spokane noise control ordinance.

1. INTRODUCTION

This technical report presents a noise and vibration impact study for the Spokane Transit Authority (STA) Division Street Bus Rapid Transit (BRT) Project. The objective of the study was to assess any potential noise or vibration impacts related to the planned BRT Project.

Section 2 of this report describes the BRT Alternative (Project); Section 3 discusses environmental noise and vibration basics; and Section 4 describes the criteria used to assess noise and vibration impacts, and any contacts and coordination required to complete the study. The methods of analysis are described in Section 5. Section 6 summarizes the affected environment, existing noise and vibration conditions, and noise measurement results. The results of the future noise and vibration projections and impact assessment are reported in Section 7. Finally, Section 8 outlines any potential noise and vibration mitigation.

There are several appendices included with this report: Appendix A provides references; Appendix B is a detailed introduction to acoustics; and Appendix C contains noise modeling details.

2. PROJECT INTRODUCTION

STA began the Division Street Bus Rapid Transit (BRT) project to increase overall mobility in Spokane County by providing a high-quality, fast, and frequent bus service along the Division Street corridor. This project aims to transform the existing Route 25 into a BRT line, featuring new stations and roadway enhancements that will offer quicker and more dependable service. Stretching approximately 10 miles from downtown Spokane to the Mead area north of the "Wye" at U.S. Highways 2 and 395, the Division Street BRT will be the region's second BRT line.

The project is being rolled out in multiple phases. The Division Street BRT project builds on the collaborative efforts of STA and its partners, including the Spokane Regional Transportation Council, City of Spokane, Spokane County, and the Washington State Department of Transportation. These efforts began with the DivisionConnects study from 2019 to 2021, which explored improvements for the Division Street corridor and the benefits of the forthcoming North Spokane Corridor. This study's Phase 1 identified the vision for converting Route 25 to BRT, leading to the adoption of the Locally Preferred Alternative (LPA) for the corridor. In Fall 2022, STA's project team launched public outreach to raise awareness and gather community feedback on station placements and route alternatives. This engagement included surveys, in-person presentations, and consultations with neighborhood councils along the Division corridor.

2.1. Project Description

The full Division BRT corridor spans approximately 10-miles along North Division Street (U.S. Highway 2 and US 395) through the City of Spokane and parts of unincorporated Spokane County (Figure 2-1). It begins at the future Mead Transit Center, in the vicinity of

the intersection of US 2 and Farwell Road, and continues west along Farwell Road/Hastings Road, where it intersects with North Division Street. The corridor continues southbound along North Division Street to the Spokane River. This segment includes a couplet (two one-way streets) along North Division Street and North Ruby Street between North River Drive and East Cleveland Avenue. The project also includes improvements on parcel 35182.2812 (Boone Northwest Garage), which is located west of the Division Street corridor at the STA campus. The project corridor continues to the southern terminus in downtown Spokane at 2nd Avenue between Wall Street and Howard Street.

Project Implementation Strategy

To optimize delivery and address timing considerations such as federal funding cycles, regional construction schedules, and design progression, the project will advance through a Minimum Operable Segment (MOS) approach. The initial implementation focuses on the highest-priority segments and foundational infrastructure, while remaining corridor elements will be advanced as design and funding milestones are met.

Initial Implementation Scope (Phase 1) will include:

- A true BRT experience on the Division Street corridor
- Smoother and more reliable service, with buses coming every 15 minutes on weekdays for at least 14 hours daily
- Zero-emission, battery-electric buses (BEB) five-door 60-foot buses, like the one shown to the right.
- 39 new stations at major intersections with enhanced amenities
- Business Access and Transit (BAT) lanes along the Division and Ruby couplet



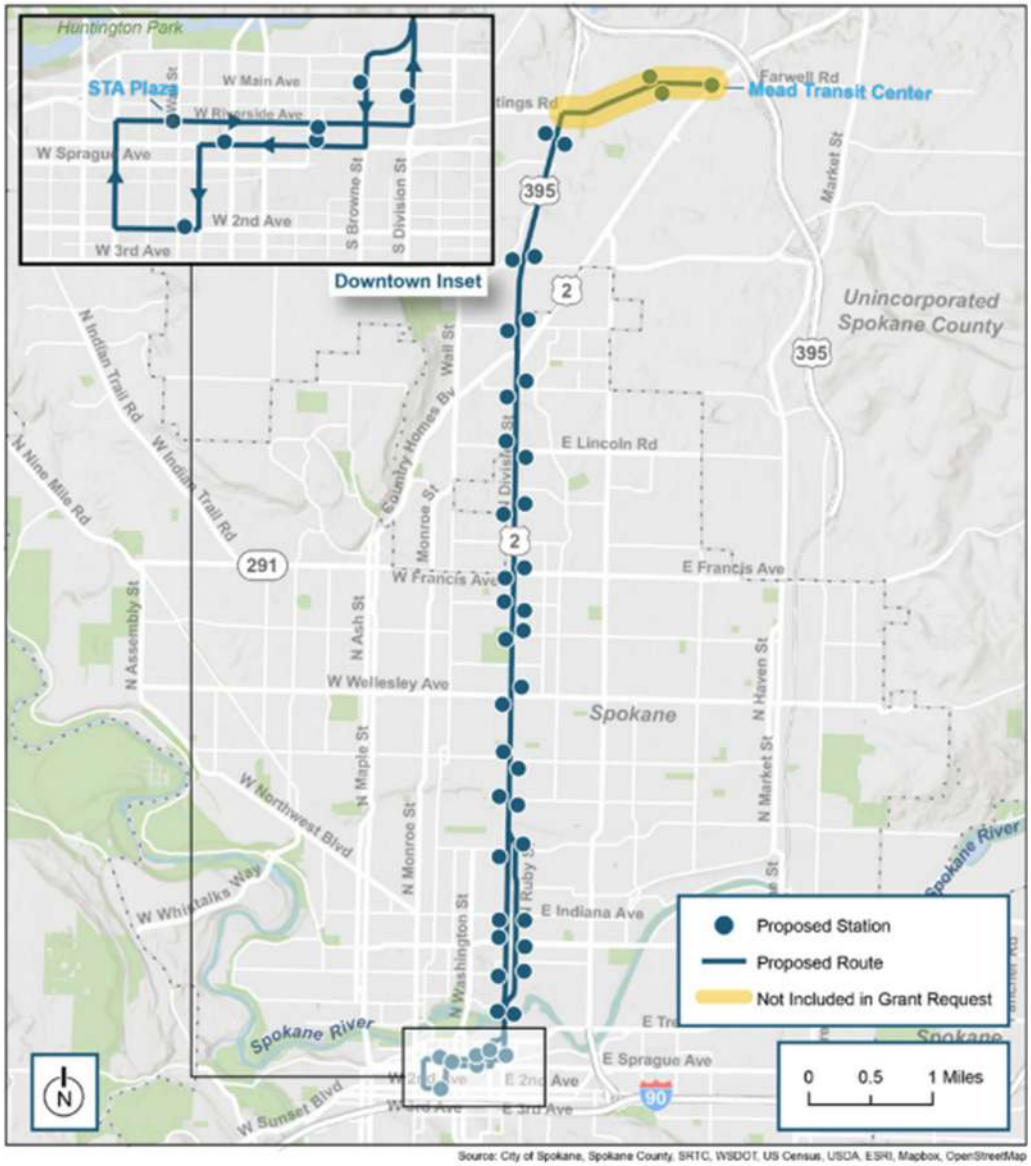
Typical Spokane Transit Battery-Electric Bus

- The system is compatible with a new transit center near Farwell Road and US 2, which will be constructed in a future phase of the project. Although this study covers the entire potential project corridor, Phase 1 of the project will end at the existing Hastings Road Park and Ride.
- Operational improvements for speed and reliability may include off-board fare payment, transit signal priority, all-door boarding, and near-level platforms.

- Protected bicycle and pedestrian facilities, including two-way bicycle lanes, cycle-tracks, or multi-use paths, where practicable, with pedestrian and ADA improvements throughout the corridor.

- Downtown bus layover and charging location.

Figure 2-1. Division Street BRT Alternative



Source: Spokane Transit Authority. 2024.

3. INTRODUCTION TO ACOUSTICS AND VIBRATION

This section provides an introduction to acoustics and vibration. This section includes 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.

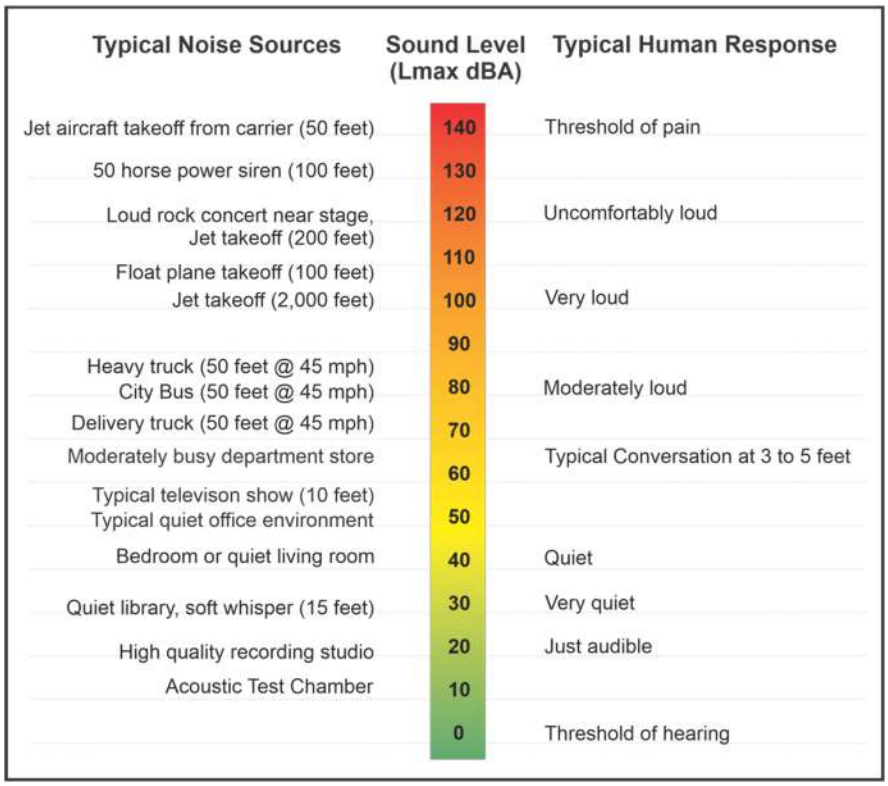
Sound is measured using a sound level meter with a microphone designed to respond accurately to all audible frequencies. The human hearing system does not respond equally to all frequencies. Low frequency sounds below about 400 Hz are progressively and severely attenuated as are high frequencies above 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 noise level increase 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 10:00 p.m. to 7:00 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 is lower, and most people are sleeping.

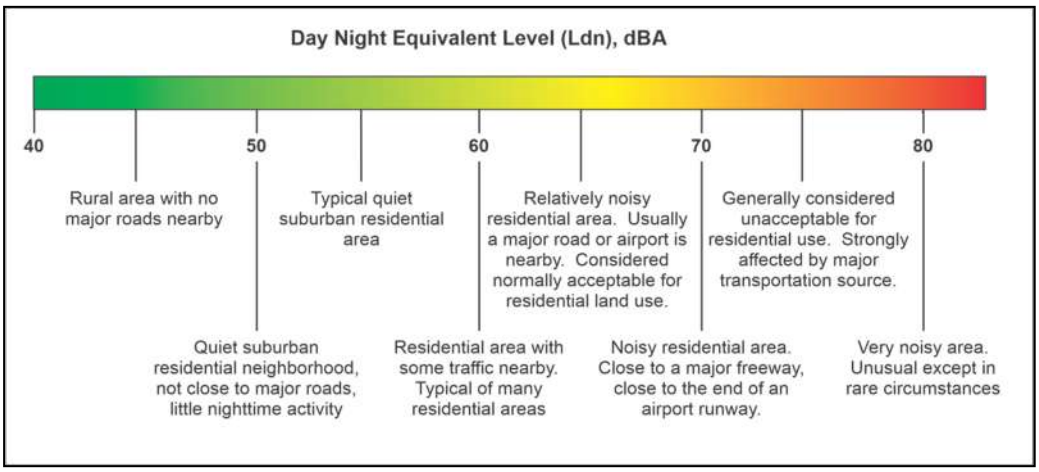
Figure 3-1. Typical A-Weighted Sound Levels



Source: Michael Minor & Associates, Inc. 2019.

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 defines typical community noise levels in terms of Ldn. Most urban and suburban neighborhoods will be in the range of Ldn 50 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 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 to 65 dBA.

Figure 3-2. Typical Ldn Levels



Source: FTA. 2018.

3.1.1. General Rules for Traffic and Community Noise

- A 3-decibel (dB) change in broadband noise, like that from traffic, is the minimum change in noise most people will notice in urban environments, and a 5-dB change in noise levels is typically perceivable by most people. 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.
- 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 between the noise source and receiver. 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.
- Traffic noise from busy roadways, like N Division Street, typically reduce at 3 dB per doubling of distance. For example, if the noise level at 50 feet was 70 dBA, at 100 feet it would be reduced to 67 dBA. Conversely, at 25 feet it would increase by 3 dB to 73 dBA.
- Combining two 60 dB noises 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 televisions. Section 3.3 provides more information on how to add decibels.
- Vehicle speeds: A 10 mile per hour (mph) increase in speed typically results in an increase in traffic noise levels of 3 dB, and conversely, a reduction of 10 mph would reduce the noise levels by 3 dB. For speeds under 25 to 30 mph this is no longer true because engine noise tends to dominate and no reduction in noise can be expected for speeds lower than 25 mph (except for battery electric vehicles).
- Traffic volumes: Maintaining the travel speeds and vehicle mixture of passenger cars, medium trucks, and heavy trucks the same, it takes a doubling of the traffic volume to increase noise by 3 dB, and, conversely, if traffic volumes are cut in half, noise would be reduced by 3 dB.

3.1.2. Decibel Addition

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 below for reference, as they will aid in the understanding of the total project noise and impact analysis.

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 as it is used to add the new noise, related to the BRT Project, to the existing measured noise levels along the corridor, providing the new total noise with the BRT Project.

3.2. 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 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 suspension system, and vibration is usually only a problem if the roadway surface is very rough or has potholes and other abnormalities.

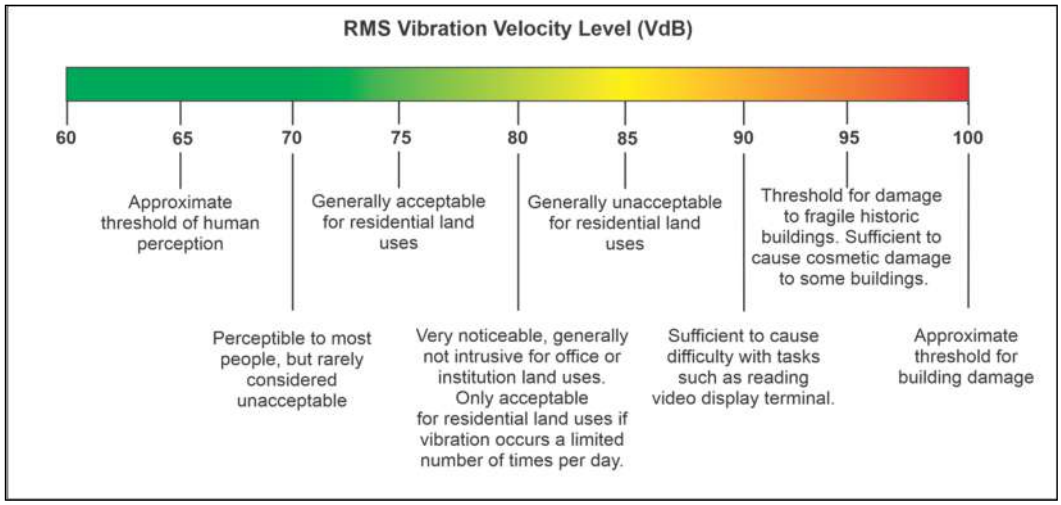
Vibration velocity is usually given in terms of either inches per second or decibels. The following equation defines the relationship between vibration velocity in inches per second and decibels:

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 gives a general idea of human and building response to different levels of vibration. Existing background building vibration is usually in the range of 40 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.

Figure 3-3. Typical RMS Vibration Levels



Source: FTA. 2018.

4. REGULATIONS AND STANDARDS

This section of the report describes the regulations and criteria the Project team used to assess potential direct and indirect long-term noise and vibration impacts of the proposed Project. Note that vibration is unlikely to be an issue for this Project; however, a screening for potential vibration-sensitive locations was performed.

4.1. Regulatory Information

The Project's assessment of potential noise impacts from the alternatives under study was based on the Federal Transit Administration's (FTA) current *Transit Noise and Vibration Impact Assessment* (September 2018) ((FTA Manual (2018)). Based on FTA's guidance and a review of the design specifics of the Division Street BRT, the study team followed the General Assessment as defined in the FTA Manual (2018) for the noise analysis. Because the Project will use only rubber-tired vehicles and vibration impacts are unlikely, the vibration analysis used the Screening Assessment methods as defined in the FTA Manual (2018).

The significance thresholds for the noise impact analysis were determined by the FTA criteria. Any locations identified with Project-related noise or vibration impacts were considered for mitigation measures.

Construction noise and vibration analysis is also discussed. The methods for analyzing construction noise and vibration also follow the methods given in the FTA Manual (2018). Construction is regulated by the local noise control ordinances for the City of Spokane.

4.1.1. FTA Transit Noise Regulations

Transit noise impacts for this Project are 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 such land uses 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 associated with 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 there are no criteria for noise impacts to commercial or industrial uses, including most office building, restaurants, or other commercial uses, 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 uses.

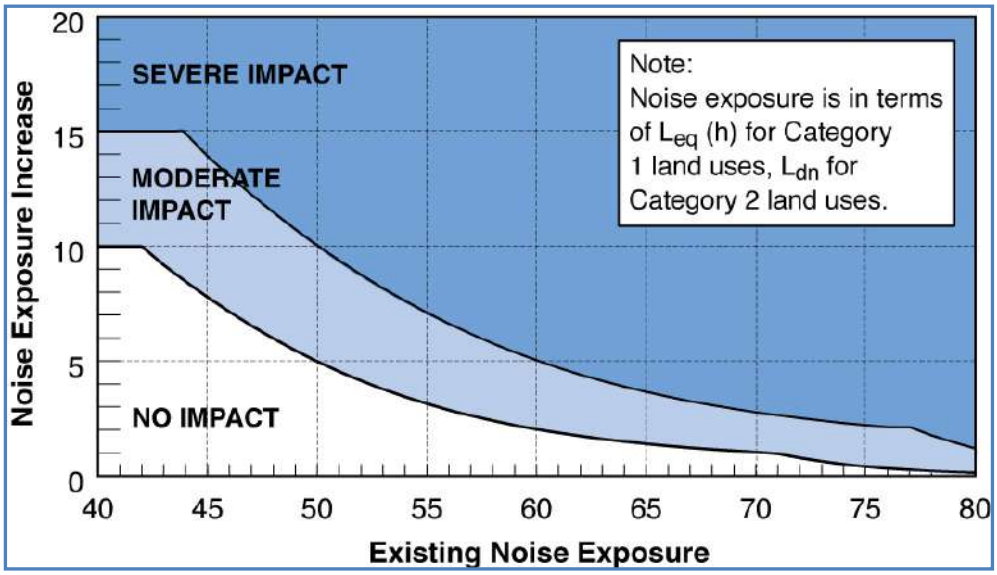
There are two levels of impact included in the FTA criteria: severe and moderate, interpreted as follows:

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 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 and Table 4-1 provide the FTA impact criteria in terms of the allowable increase in cumulative noise exposure (noise from existing sources plus project noise) as a function of existing noise exposure. Note that Figure 4-1 is only applicable for Category 1 and Category 2 land uses. For Category 3 land use, see Table 4-1.

Figure 4-1. FTA Noise Impact Criteria (Category 1 and 2 Land Use)



Source: FTA. 2018.

To aid in the understating of the FTA criteria and determination of noise impacts, the following two examples are provided:

1. A residence with an existing noise level of 64.0 dBA Ldn is predicted to have a future noise level of 65.0 dBA Ldn with the proposed project. This is an increase of 1.0 dB. Based on Figure 4-1 and Table 4-1, a residence (FTA Category 2) with an existing Ldn of 64.0 dBA would experience a moderate impact if noise levels increased by 1.5 dB, and a severe impact if noise levels increase by 4 dB. Therefore, there is no impact at this location.

2. A residence with an existing noise level of 72.0 dBA Ldn is predicted to have a future noise level of 72.9 dBA Ldn with the proposed project. This is an increase of 0.9 dB. Based on Figure 4-1 and Table 4-1, a residence (FTA Category 2) with an existing Ldn of 72.0 dBA would experience a moderate impact if noise levels increased by 0.8 dB, and a severe impact if noise levels increased by 3.0 dB. Therefore, there would be an impact at this location because the increase of 0.9 dB is greater than the allowable increase of 0.8 dB, and mitigation would be considered.

This last example was provided to show that as the existing noise levels increase, the allowable increase in noise levels is decreased. The FTA criteria are designed to prevent areas that already have high existing noise levels from having notable increases in the total noise. As previously stated, the higher the existing noise levels, the less noise the project is allowed to add before an impact is identified.

Table 4-1. FTA Allowable Increase Noise Impact Criteria
(all noise levels in dBA)

Existing Noise Exposure L_{eq} or L_{dn} [1]	Allowable Cumulative Noise Level Increases, Leq or Ldn [1]			
	Category 1 or 2 Sites		*Category 3 Sites*	
	Impact	Severe Impact	Impact	Severe Impact
55	3	7	6	12
56	3	7	6	11
57	3	6	6	10
58	2	6	5	10
59	2	5	5	9
60	2	5	5	9
61	1.9	5	4	9
62	1.7	4	4	8
63	1.6	4	4	8
64	1.5	4	4	8
65	1.4	4	3	7
66	1.3	4	3	7
67	1.2	3	3	7
68	1.1	3	3	6
69	1.1	3	3	6
70	1.0	3	3	6
71	1.0	3	3	6
72	0.8	3	2	6
73	0.6	2	1.8	5
74	0.5	2	1.5	5
75	0.4	2	1.2	5

Note:

1. L_{dn} is used for land uses where nighttime sensitivity is a factor; Daytime L_{eq} is used for land use involving only daytime activities.

Source: FTA. 2018.

4.1.2. FTA Vibration Criteria

The FTA vibration impact criteria are based on the maximum indoor vibration level as the bus passes. There are no impact criteria for outdoor spaces such as parks. The FTA Guidance Manual provides two sets of criteria: one based on the overall vibration velocity level for use in a General Vibration Impact Assessment and one based on the maximum vibration level in any 1/3-octave band (the band maximum level) for use with a Detailed Vibration Assessment. The second set of criteria (the band maximum level) is only used if impacts are identified under the General Vibration Impact Assessment. An FTA vibration impact exists when vibration levels meet or exceed both criteria.

The FTA General Assessment criteria for groundborne vibration from transit systems is 72 VdB for residences and other locations where people sleep, and 75 VdB for vibration sensitive land uses with daytime use. As previously discussed, vibration impacts from bus systems almost never occur, and vibration levels in the BRT corridor are dominated by heavy truck traffic, not bus traffic. Also, the BRT Project will install new concrete pads at all stops, further reducing the potential for vibration levels exceeding the FTA criteria.

4.1.3. Federal Highway Administration Regulations

Under FTA criteria, an analysis using the Federal Highway Administration (FHWA) and Washington Department of Transportation (WSDOT) regulations may be required for any highway project receiving federal funds, if it includes any of the following elements:

- The construction of a highway on a new location; or,
- The physical alteration of an existing highway where there is either:
    a) Substantial Horizontal Alteration. A project that halves the distance between the traffic noise source and the closest receptor between the existing condition to the future build condition; or,
    b) Substantial Vertical Alteration. A project that removes shielding therefore exposing the line-of-sight between the receptor and the traffic noise source. This is done by either altering the vertical alignment of the highway or by altering the topography between the highway traffic noise source and the receptor; or,
- The addition of a through-traffic lane(s). This includes the addition of a through-traffic lane that functions as a HOV lane, High-Occupancy Toll (HOT) lane, bus lane, or truck climbing lane; or,
- The addition of an auxiliary lane, except when the auxiliary lane is a turn lane; or,
- The addition or relocation of interchange lanes or ramps added to a quadrant to complete an existing partial interchange; or,
- Restriping existing pavement for the purpose of adding a through-traffic lane or an auxiliary lane; or,
- The addition of a new or substantial alteration of a weigh station, rest stop, rideshare lot or toll plaza.

The proposed BRT Project will not include any of the conditions listed above. Because there are no public roadway improvements meeting the FHWA requirements, a traffic noise analysis using the FHWA and WSDOT methods is not required and was not performed.

4.1.4. Local Noise Control Regulation

There are no Project-specific construction noise or vibration regulations from the FTA. Noise related to construction activities are regulated by Title 10, Chapter 10.70 of the Spokane Municipal Code. The noise code has no specific restrictions on construction, however, the State of Washington limits construction activities to the hours of 7:00 am to 10:00 pm with

no restrictions on days of the week. Construction outside these hours is prohibited and would require a noise variance from the City of Spokane, as defined in Title 10, Chapter 10.70.120, Noise Variance, of the Spokane Municipal Code.

4.2. Contacts and Coordination

This section provides Project-related contacts, coordination, and data sources that were used for this analysis. Information used for the study is provided below in Section 4.2.1, and all Project data was obtained from the Project design and engineering team at STA and Parametrix, Inc.

4.2.1. Data Sources and Collection Methods

There are several sources of data required for this noise study. The following data sets were obtained from the Project design and engineering team:

- Existing and proposed transit routes, bus headways and schedules, locations of stops, and stations.
- Ambient noise monitoring results (sampling methods comply with the FTA noise assessment guidance).
- Project design files in electronic format (CAD Files) that were used to construct the noise models used in this analysis.
- Land use information from Project engineers, the City of Spokane, and on-site inspections.
- General operational information on the proposed buses to be used for this Project, including the use of zero emission BEBs.

4.3. Project-related Displacement

There are no Project-related displacements that have any effect on the transmission of noise.

4.4. Planned and Permitted Projects

There are no new planned FTA Category 2 or 3 land use developments along the corridor. There may be some commercial developments, including retail and office use; however, because there are no criteria for noise impacts to most commercial or retail operations, these developments are not considered in this analysis.

5. METHODS

This section provides an overview of the methods used to predict noise and vibration levels related to the Division Street BRT Project. Long-term operational impacts are related to system operation after construction. Short-term construction impacts are only related to noise and vibration during Project construction.

5.1. Long-Term Operational Impact Analysis Approach

Because this Project consists of modifications to existing bus routes that are mostly along an existing major four-to six-lane arterial roadways and an eight lane couplet, the method of analysis under FTA criteria is to determine the change in total noise caused by the proposed Project. The analysis process is as follows:

1. Determine the existing noise levels throughout the corridor using noise measurements and noise predictions that follow FTA methods.

2. Determine the noise from the proposed project. In this case, the change in noise level is related to two changes in operations: first, changes of headways and location of bus stops, and second, the types of buses used along the corridor. The analysis assumes zero emission BEBs. BEBs are notably quieter at slower speeds and when accelerating from a bus stop, stop sign, or signalized intersection than diesel hybrid or diesel buses.

3. Add the noise from Step 2 to the existing noise levels from Step 1, to predict the total noise and then subtract from the existing noise to determine the overall change (increase or decrease) in noise levels.

4. Compare the change in noise levels for areas with increases to the allowable increase provided by the FTA, which is determined by the existing noise levels from Step 1.

5. If the noise level increase exceeds the allowable increase provided in Table 4-1 (shown graphically in Figure 4-1), then an impact occurs, and noise mitigation will be considered. If the change in noise level is below the allowable increase, then no impact occurs, and no mitigation would be required or considered. Based on the existing noise levels in the corridor, the project will not increase the noise by an amount that would be noticeable to most people.

5.2. Study Area

The area of potential effect for noise from the Division Street BRT Project is taken from the FTA Manual (2018). For transit-only projects, the analysis area distance is based on the type of transit project and on the level of service the transit project is providing. For the Division Street BRT Project, revenue service will be performed by bus rapid transit systems utilizing existing roadway facilities. The Project headways will range from 30 to 15 minutes, depending on the time of day, and the system will operate from 5:00 am to 1:00 am the following day on weekdays, with slightly reduced services on weekends. Because the weekdays have the highest service rates, weekday services was used for the noise analysis.

Based on the proposed headways, this system is considered an Intermediate Capacity Transit system with rubber tire vehicles. The minimum recommended screening distance for this type of system is 90 feet in areas with an unobstructed view of the roadway, and 40 feet for

areas with intervening buildings. To assure all noise impacts were identified, the analysis area was extended to 125 feet for all FTA Category 2 land used along the entire corridor.

5.3. Short-Term Construction Impact Analysis Approach

Construction noise predictions were also performed using the methods described in the FTA Manual (2018). In addition to information provided by the FTA, the noise analysts also relied on their experience and work on major construction projects to assist in providing the most accurate information available. Information provided includes descriptions of the types of construction activities required for this type of project, noise levels associated with specific construction equipment, and overall construction-related noise and vibration projections.

5.4. Cumulative and Indirect Impact Analysis Approach

The noise level projections for this Project include actual measured noise levels from local area traffic on major roadways. For most areas, traffic is the dominant noise source and, therefore, the predicted noise levels are a cumulative level that includes the proposed Project and local area traffic noise. Other noise sources, such as short-term construction projects, commercial and industrial activities, and aircraft are either local in nature or not predicted to be a major noise source. Therefore, this analysis is a cumulative analysis for noise along and near the Project corridors.

5.5. Noise Mitigation Approach

When project-related noise impacts are identified, noise mitigation measures must be examined and follow the requirements provided by the FTA. Mitigation measures that are considered feasible and reasonable may be recommended for inclusion in the Project. Feasibility deals primarily with engineering considerations, such as whether substantial noise level reductions can be achieved or whether there would be a negative effect on property access. Reasonableness assesses the practicality of the mitigation given a number of factors, including cost, noise reduction, future noise levels, and community support. Complete details on noise mitigation are provided in Section 8.

5.6. Vibration Mitigation Measures

Because this Project only includes rubber tired vehicles, and all operational vibration levels are predicted to be below the FTA criteria, no operational vibration mitigation was recommended. Potential mitigation for short-term construction related vibration is discussed in Section 8.

6. AFFECTED ENVIRONMENT

This section provides information on the affected environment. This information includes details on the analysis area, land use, and measured noise levels along the corridor. The study area, as previously described, was increased to approximately 125 feet from the curbline. A

discussion of the land use is provided in Section 6.1, with noise measurement and results in Section 6.2. Figures 6-1 through 6-5, which provide an overview of the full corridor, land use categories and noise measurement locations, are provided at the end of this section.

6.1. Land Use Summary

Noise-sensitive properties in the Division Street Bus Rapid Transit (BRT) Project study area are mostly residential uses (Cat 2), with some hotels (Cat 2), parks (Cat 3), schools/daycares (Cat 3), a library (Cat 3), a church (Cat 3), and a museum (Cat 3). The remaining land use is predominately commercial and industrial, which have no FTA criteria and are not considered noise sensitive.

Single- and multi-family residences (Cat 2) are throughout the Project corridor along E Hastings Road and along N Division Street. The Wandermere Kindercare and Farwell Elementary School (Cat 3) are both located in the north part of the Project corridor along the north side of E Hastings Road. Whitworth College (Cat 3) is located along the west side of N Division Street at the intersection of W Hawthorne Road.

There is one church, St Luke Lutheran Church (Cat 3), located on the east side of N Division Street at the corner of Westview Avenue. Several hotels are located on the west side of N Division Street between E/W Hawthrone road and E/W Francis Avenue. Franklin Park and Parkview Early Learning Center, both Cat 3, are at the intersection of N Division Street and E/W Queen Avenue. The Exhibition Hub Spokane Arts Center (Cat 3) is located near the waterfront on N Ruby Street.

Noise sensitive land uses in the downtown core area, south of the Spokane River, is a mix of residences and hotels (Cat 2), a church (Cat 3), and commercial. There are several mixed use multi-family residences along the BRT route, including the Warren Apartments and Morgan Lofts on W Riverside Avenue and the Freeman Center Condominiums on S Lincoln Street. Other sensitive land uses include the Courtyard Hotel and the Double Tree Hotel and Convention Center on the Spokane River, as well as a Best Western hotel along N Brown Street, the Davenport Hotel along W Sprague Avenue, the Hotel Ruby on W 1st Avenue, and the Pilgrim Slavic Baptist Church along W 2nd Street.

6.2. Measured Noise Levels

Noise monitoring locations were selected using several criteria, including the site's ability to establish a representative background, or ambient, noise level for multiple noise-sensitive receiver locations. The monitoring sites are also used to provide an understanding of the existing environment along the corridor and establish the FTA noise impact criteria, which is based on the measurements and projection of the existing conditions noise environment. Because noise from traffic reduces at a rate of approximately 3 dB per doubling of distance (see Section 3.1, *Introduction to Acoustics*), measured noise levels can be corrected to provide noise levels at noise sensitive properties with similar traffic levels, but at different distances from the roadway. This allows the modeling sites to be used to predict noise levels at other nearby sites with the appropriate distance correction factor.

All on-site noise measurements were taken in accordance with FTA procedures for community noise measurements. The equipment used for noise monitoring, Bruel & Kjaer Type 2238 Sound Level Meters, are calibrated prior to and after the measurement period using a reference sound level calibrator. Complete system calibration is performed on an annual basis, and the system meets or exceeds the requirements for an ANSI Type 1 noise measurement system.

Noise levels were measured at thirteen locations along the Project corridor. The thirteen monitoring locations are shown on vicinity maps on Figures 6-1 through 6-5 with area land use. Eleven of the sites consist of short-term measurements of 15 minutes, performed at least twice over a three day period. Two of the sites were long-term monitoring sites, where measurements were taken over a 44-45 hour period. All monitoring was performed between April 23 to April 25, 2024.

Overall noise levels ranged from 67 to 72 dBA Ldn and 63 to 70 dBA Leq during daytime hours. During nighttime hours, noise levels range from 59 to 65 dBA Leq. Noise levels in this range are typical along major arterial roadways and in urban downtown areas. Table 6-1 provides a summary of the measured levels.

Table 6-1. Summary of On-Site Noise Measurements				
Site#[1]	**General Location[2]**	**Leq[3]**	**Ldn[4]**	**Notes[5]**
M-1	E Hasting/Farwell Rd.	69	71	ST on the north side of E Hastings at N Perry St.
M-2	N Division St @ E Regina Rd	69	72	LT in the open space, east of N Division St, west of E Regina Rd.
M-3	N Division St @ W Westview Ave			ST west side of Division, north of W Westview in empty lot.
M-4	N Division St @ E Magnesium Rd.	70	72	ST east of Division at the Northside Lofts parking area, south of Magnesium Rd.
M-5	Franklin Park	63	68	LT along N Division St, south of W Nebraska Ave, set back 75 feet from N Division St.
M-6	Clark Playfield and Park	69	71	ST on the west side of Division St, south of W Lacrosse Ave
M-7	E Euclid Ave @ Division St	66	68	ST on north side of E Euclid Ave, east of N Division St, near closest residence.
M-8	N Division St @ W Montgomery Ave	68	70	ST in the parking area of Hennessey Funeral Home & Crematory
M-9	N Ruby Ave @ W Cataldo Ave	67	69	ST in the parking area across from the 940 North Apartment Building
M-10	N Division St @ E Olive Ave	70	72	ST near Courtyard Hotel and Fairfield Inn Hotel, east of N Division St, north of E Olive Ave.
M-11	W Riverside Ave, between N Browne St and N Bernard St.	65	67	ST near the Warren Apartment Complex and Delaney Retirement home, north side of W Riverside Ave.
M-12	S Lincoln St @ W 1st Ave	69	71	ST near the Davenport Hotel and Ruby Hotel, north of W 1st Ave and west of S Lincoln St.
M-13	2nd Ave @ Post St	68	70	ST at the northeast corner of 2nd Ave and Post St

Source: MM&A measured noise levels. 2025

1. Noise measurement sites are shown in Figures 6-4 through 6-6.
2. Cross street description.
3. Average daytime Leq, using two to three measured noise levels over a three day period.
4. Calculated Ldn for site long-term sites and estimated Ldn using FTA methods for short-term monitoring sites.
5. ST = short-term measurement and LT = long-term measurement site; general description of measurement site.



Figure 6-1. Land Use and Noise Monitoring (1 of 5)

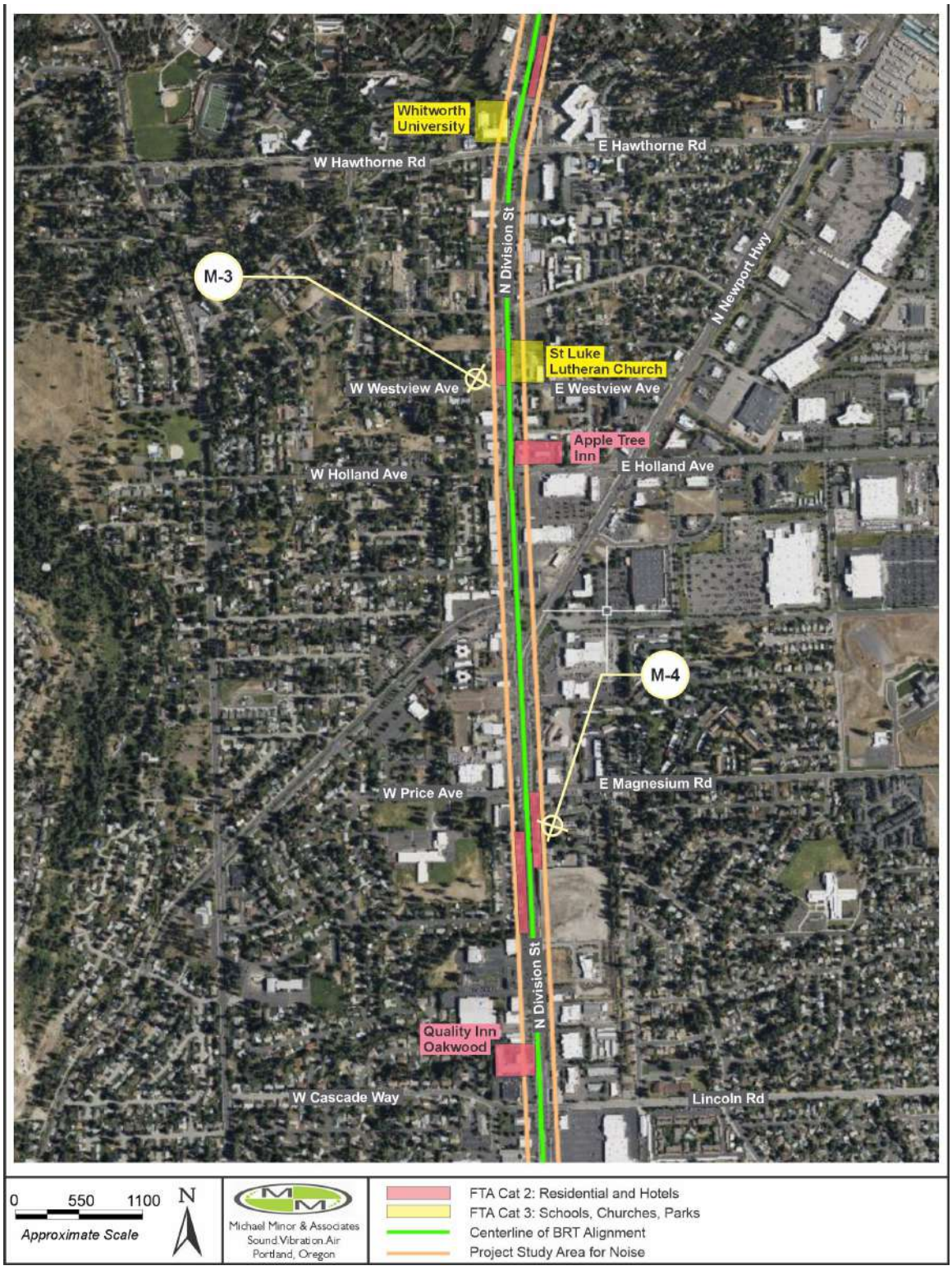


Figure 6-2. Land Use and Noise Monitoring (2 of 5)



Figure 6-3. Land Use and Noise Monitoring (3 of 5)

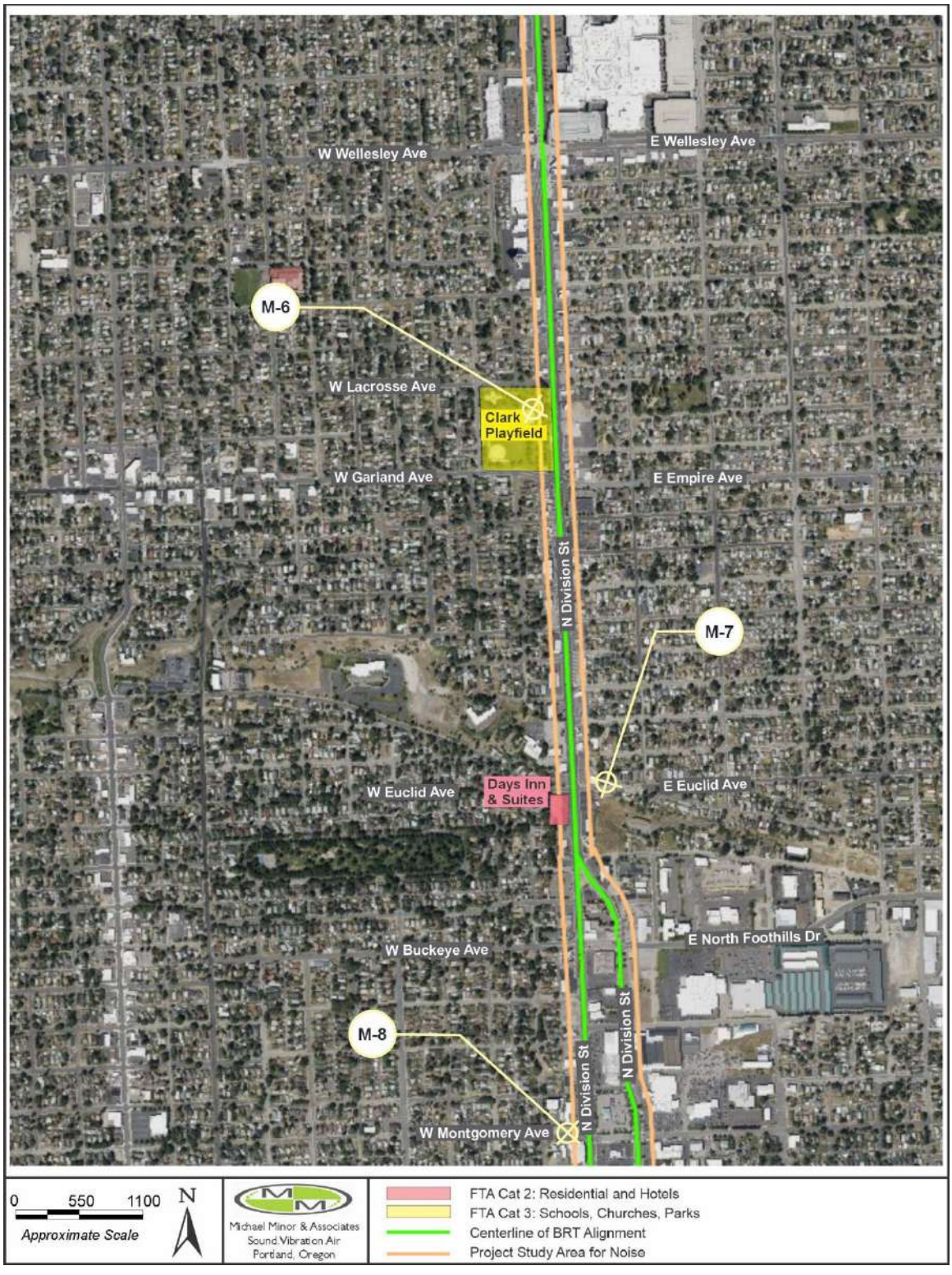


Figure 6-4. Land Use and Noise Monitoring (4 of 5)

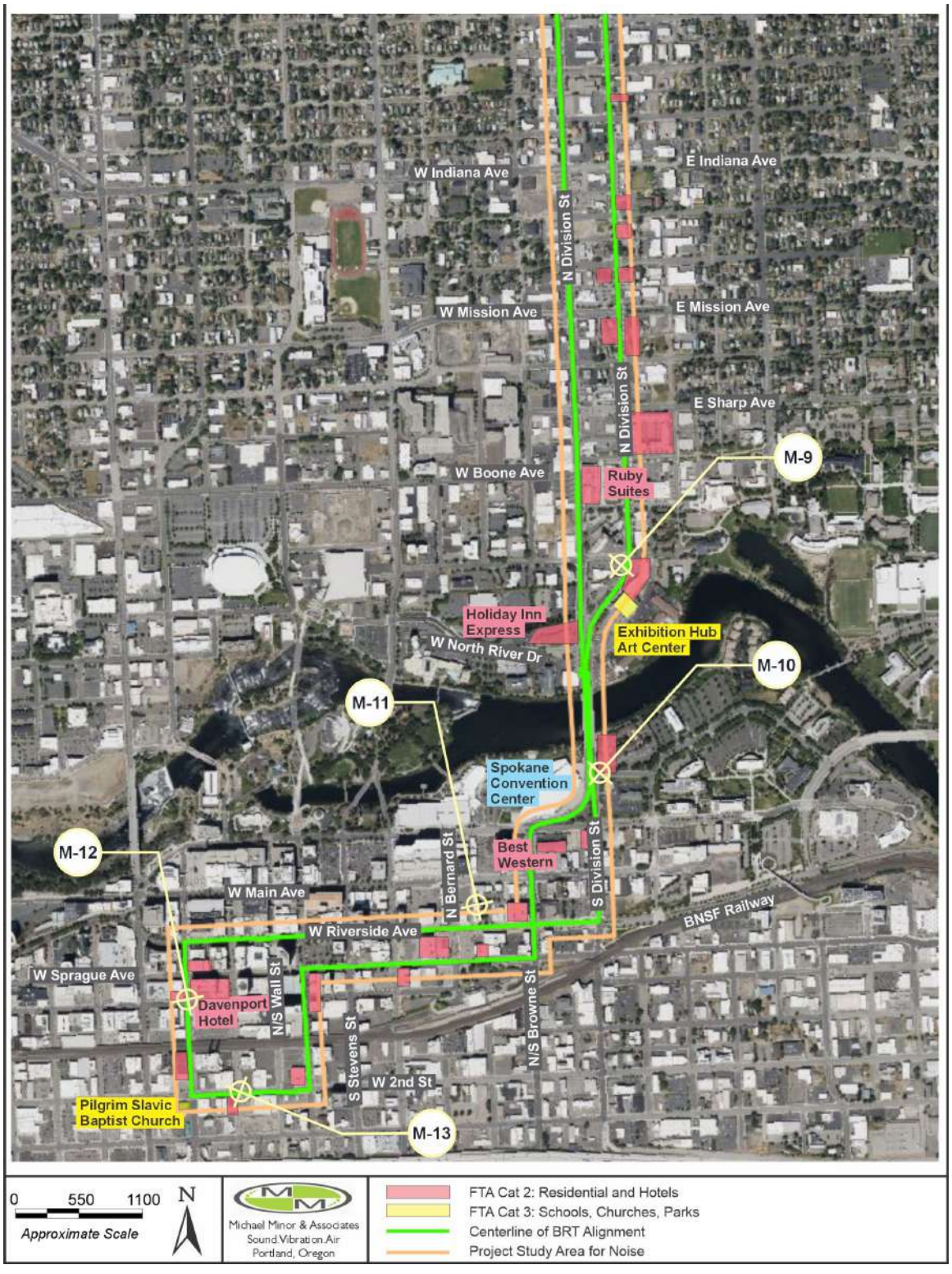


Figure 6-5. Land Use and Noise Monitoring (5 of 5)

7. ENVIRONMENTAL CONSEQUENCES

This section provides the results of the noise and vibration analysis for the No-Build Alternative and the Preferred BRT Alternative.

7.1. No-Build Alternative

Under the No-Build Alternative the Division BRT Project would not be constructed and noise along the corridors would be governed by traffic, commercial and industrial activities, and other local area construction projects as described below.

7.1.1. Long-Term Noise Impacts

With the No-Build Alternative, noise levels in the Project corridor would continue to be dominated by transportation-related noise sources including cars and trucks along with noise from existing and future bus routes. Other noise sources include miscellaneous commercial activities and local unrelated construction projects. With the No-Build Alternative, there would be no BRT Project; however, other bus routes would likely continue to serve the community. Under the No-Build Alternative there is also the potential for additional bus trips on existing routes to meet rider demand, which could also increase noise levels.

7.1.2. Long-Term Vibration Impacts

Vibration levels under the No-Build Alternative will continue to be caused by heavy trucks and buses along public roadways and local area construction activities.

7.1.3. Short-Term Construction Related Impacts

Under the No-Build Alternative, there would be no Project-related construction and, therefore, no Project-related short-term noise or vibration impacts. Other projects could result in increased noise and vibration along the corridor; those projects would be responsible for meeting regulations and criteria along with any Project-specific criteria related to noise and vibration.

7.2. Proposed Build Alternative

This section provides the results of the noise analysis for the Division Street BRT Build Alternative. Discussions include noise and vibration related to system operations and the short-term construction related noise and vibration.

7.2.1. Long-Term Noise Impacts

This section reports the long-term impacts associated with the operation of the proposed BRT Project. Some acoustical related items to keep in mind:

- There are no impact criteria for most business, and no noise sensitive business were identified within the study area.

- Noise from traffic and the BRT systems reduce at a level of 3 dB per doubling of distance. Therefore, a measured noise level of 70 dBA at 50 feet would be reduced to 67 dBA at 100 feet.

- Maintaining the vehicle mixture and speeds constant, it takes a doubling of the traffic volumes to increase noise levels by 3 dB. Therefore, based on the traffic volumes in most locations along the proposed corridor, the BRT system would not be expected to have a measurable change in the overall noise environment.

- As the existing noise levels increase, the amount of noise the project can add before an impact is identified decreases. See Table 4-1 and Figure 4-1 for the impact criteria.

Noise levels along the Project corridor are currently dominated by traffic along major and minor arterial roadways, along with increased traffic noise at intersections; and these conditions are anticipated to continue in the foreseeable future. Traffic volumes along most of the proposed BRT corridors are sufficiently high so that the BRT bus would not be expected to have a measurable change in the overall noise levels. For reference, it typically takes a doubling of traffic volumes (100% increase) to cause an increase of 3 dB.

Typical PM peak hour traffic volumes along the BRT related intersection ranges from 1,917 to 5,015 vehicles, each way, during the peak hour with average daily volumes along both direction of Division of 44,321 vehicles (WSDOT 2024). The noise emissions from the operations of an additional 134 buses daily would not be expected to have a discernible effect on the overall noise levels.

The analysis follows the FTA methods and used reference noise levels calculations for a BEB system. Noise levels were predicted for 125 representative receiver locations based on distance from the roadway, land use type, and existing noise environment. The existing noise environment, described in Section 6.2, were corrected to account for the varying distance between the roadways and the monitoring sites and the roadways to the representative receiver locations.

To predict the future total noise, the BRT operational noise levels were logarithmically summed with the distance corrected existing noise levels at each representative receiver location. This calculation provides the new total noise level at the representative receivers with the BRT system in operation. The total future noise levels were then subtracted from the ambient noise levels to provide the total change in noise levels caused by the new BRT operations. The change in total noise was compared to the allowable increase in noise that a project is allowed to generate under FTA criteria, which is based on the corrected ambient noise levels, and provided in Table 4-1 and Figure 4-1.

For example, if a receiver has an existing Ldn of 67.5 dBA, and the noise from BRT operations would produce 57.5 dBA at that receiver, then the total noise at that receiver would be 67.9 dBA Ldn (logarithmic addition of 67.5 dBA plus 57.5 dBA = 67.9 dBA, See Section 3.1.1, *Decibel Addition* for estimation methods). This amounts to an increase of 0.4 dB over the existing conditions. For a site with an existing Ldn of 67.5 dBA, an impact

occurs if the total noise increases by more than 1.2 dB, and the impact is severe with an increase of 3.0 dB or more. Therefore, in this example there is no noise impact.

A summary of the results, divided into three segments, is provided in Table 7-1. The north end segment includes the potential alignments along E Hastings Road to the Hasting Park and Ride and connections to the east to serve a potential future transit center near N Newport Highway (Highway 2). The central segment covers those receivers north of the Spokane River and south of E Hastings, and the downtown segment covers the area south of the Spokane River.

Table 7-1. Summary of Existing and Future Noise Levels and Potential Impacts

Project Segment	Existing Ldn/Leq	Future Ldn/Leq with BRT Project	Change in Total Noise	Impacts
North End: Hasting Park and Ride connection and E Hastings and E Farwell Roads connection to the east	66.8 – 74.7	66.9 – 74.8	0.1 – 0.3	None
Central Area: Spokane River to E Hastings Road	66.6 – 76.4	66.7 – 76.6	0.1 – 0.2	None
Downtown: South of the Spokane River	69.9 – 78.3	70.0 – 78.4	0.1 – 0.6	None

Source. MM&A Noise modeling, see Appendix C for detailed results.

Complete details on the noise analysis for the representative receivers are provided in Appendix C. Figures 7-1 through 7-5 shows selected representative receiver locations used to determine the potential for noise impacts along the Project corridor. The following sections, which are organized by figure numbers, provide the results of those projections.

Figure 7-1 provides the impacts analysis for the parts of the BRT route north of the powerline corridor, also shown in Figure 7-1. This area also provides an analysis of receivers along the future corridor to the potential transit center at the Newport Highway, which is not part of this project, but could be constructed in the future. Under this project, the BRT would turn left on E Hastings Road and service the existing Hastings park and ride. The BRT's would pass in front of three residential structures, one single-family and two duplex multi-family residences (see R-40, R-41, and R-42). BRT operations are predicted to increase noise levels at these residences by 0.1 to 0.3 dB, with the highest increase at the duplexes farthest from E Hastings Road.

If the BRT extension to the east is included in the future, noise levels at single and multi-family residence along E Hastings Road and E Farwell Road are predicted to increase by 0.1 dB (see receivers R-3 through R-39). Noise levels at the Kindercare daycare and Farwell

Elementary School are also predicted to increase by 0.1 dB. There are also several residences along E Regina that are within the 125 foot study area, with similar increases with the BRT project of 0.1 dB (see R-43 through R-46). There are no noise impacts identified in this sections of the corridor.

Figures 7-2 through 7-4 cover the area south of the power line corridor to just north of W Montgomery Avenue. The first set of receivers within the 125 foot study area are several single family residences along Nelson Road (see R-43 through R-46). Due to the high noise levels along N Division Street, noise increases are maintained at 0.1 dBA. Noise level at the other residential land uses in the study area also have the same predicted noise level increase of 0.1 dB (R-48 through R-52, R-54 to R-79, and R-85).

Other sensitive land uses within the 125 foot study area shown on Figures 7-2 through 7-4 include the Withworth University (R-47), St Luke Lutheran Church (R-53), Franklin Park (R-80 and R-81), the Parkview Early Learning Cener (R-82), and Clark Playfield (R-83 and R-83). Again, due to the high existing noise levels all have increase of 0.1 dB. No noise impact were identified at sensitive land uses shown on Figures 7-2 through 7-4.

Figure 7-5 covers the area just north of the Spokane River and the downtown area south of the Spokane River. Residential land uses north of the Spokane River are represented by receiver R-87, R-90 through R-105, with two hotels, R-88, and R-89. All of these FTA category 2 land uses have predicted increase of 0.1 to 0.2 dB, with no noise impacts. The Exhibition Hub Spokane Art Center, also north of the Spokane River, was represented by receivers R-106 and has a predicted increase of 0.1 dB.

South of the Spokane River there are several multi-family residences, hotels, the convention Center and one church. The convention center (R-108) has a predicted increase of 0.1 dBA, as does a hotel (R-107) and multi-family building (R-109) on S Division Street. The Best Western Hotel (R-110) and several multi-family buildings along W Riverside Avenue, W Howard Street and W Sprague Street (R-111 to R-114 and R-123 to R-125) have lower existing noise levels and therefore increase in 0.6 dB, which is still well below the impact criteria.

Multi-family units on W 2nd Avenue, S Post Street and S Lincoln, also with slightly lower existing noise levels, have predicted increase of 0.4 dB to .06 dB. The Pilgrim Slavic Baptist church (R-117) has a predicted increase of 0.3 dB, and two hotels (R-120 and R-121) have increase of 0.4 dB predicted. There were no noise impacts identified at sensitive uses shown in Figure 7-5.

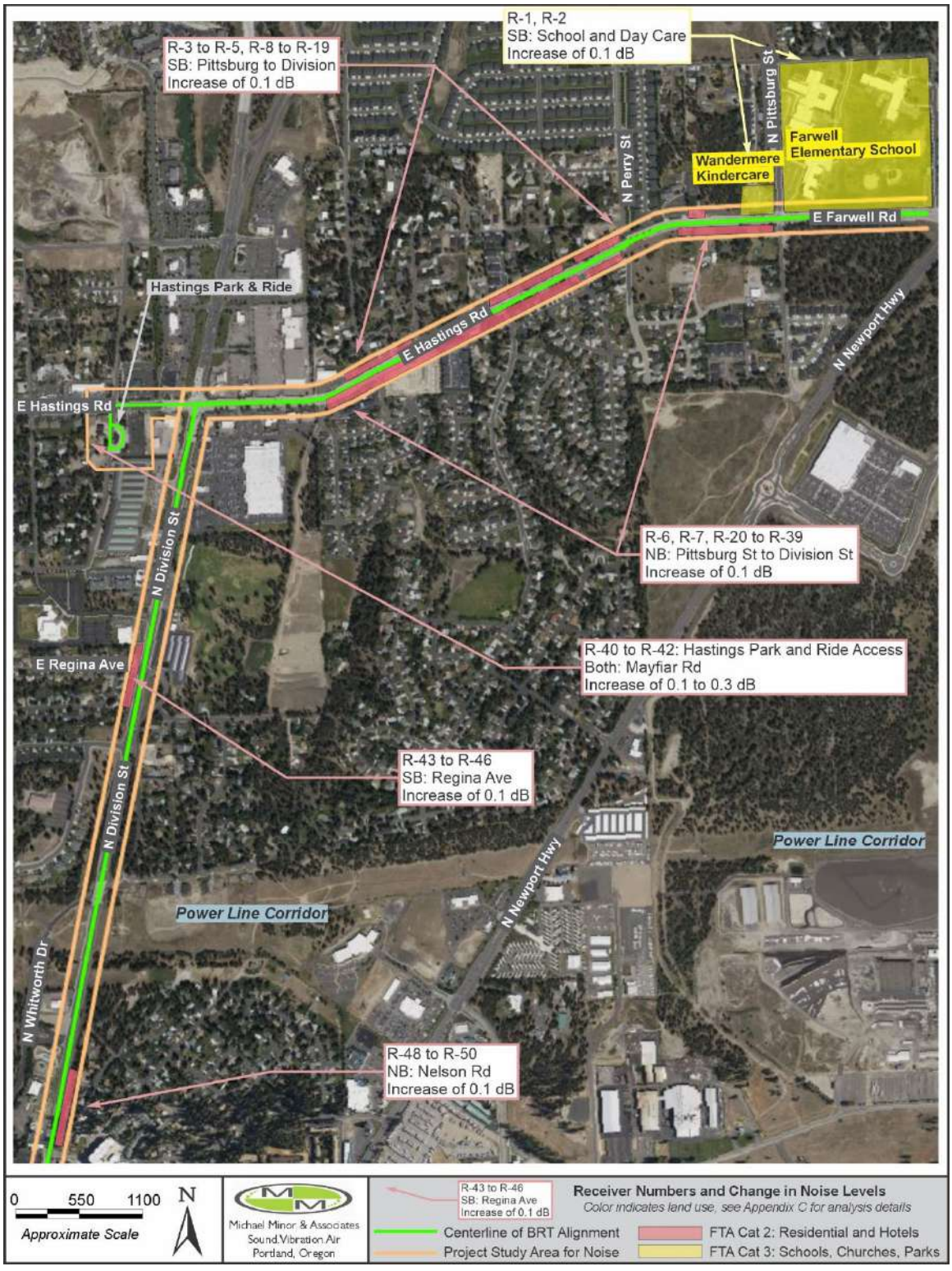


Figure 7-1. Representative Noise Modeling Receivers (1 of 5)



Figure 7-2. Representative Noise Modeling Receivers (2 of 5)



Figure 7-3. Representative Noise Modeling Receivers (3 of 5)

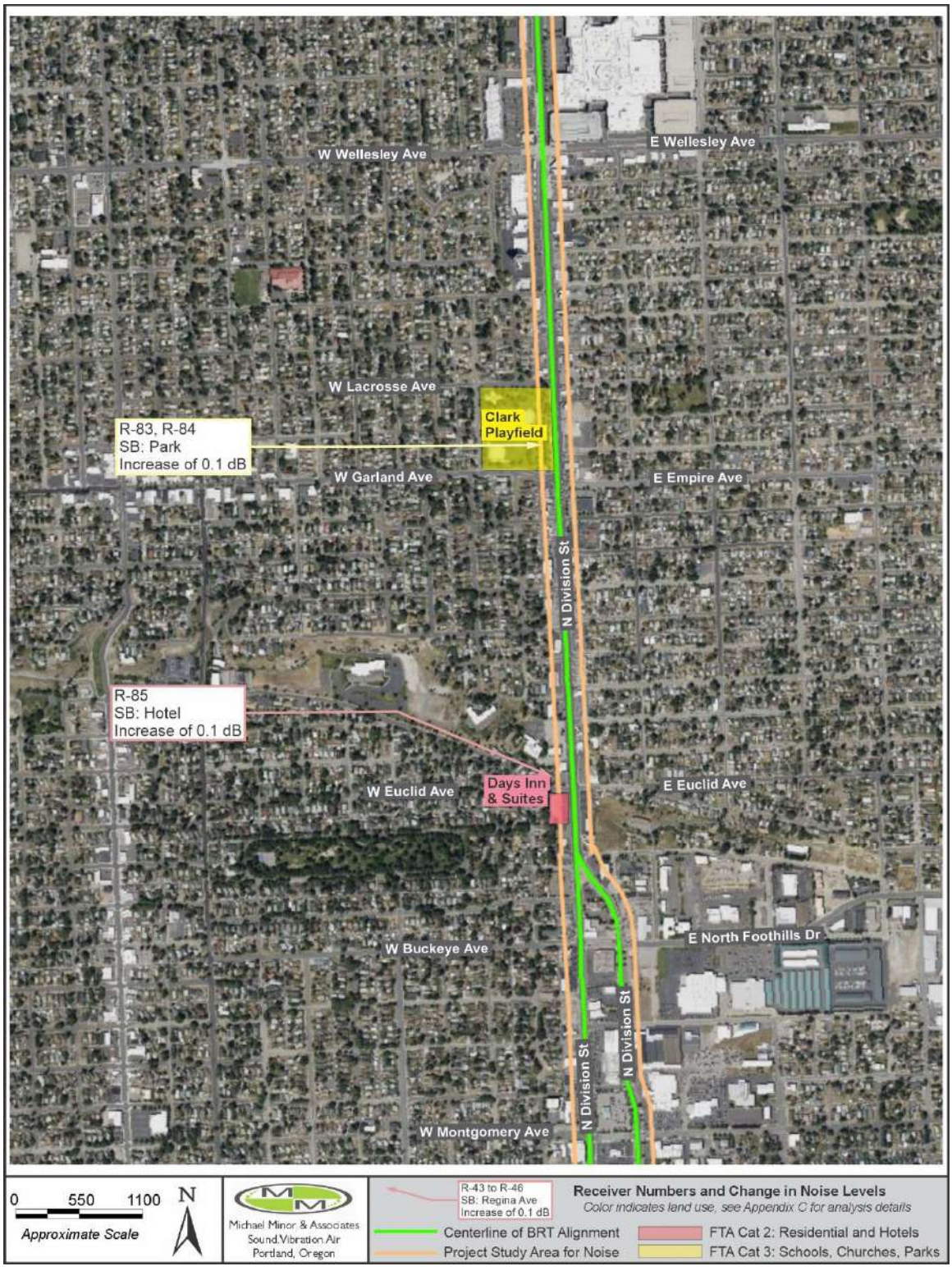


Figure 7-4. Representative Noise Modeling Receivers (4 of 5)

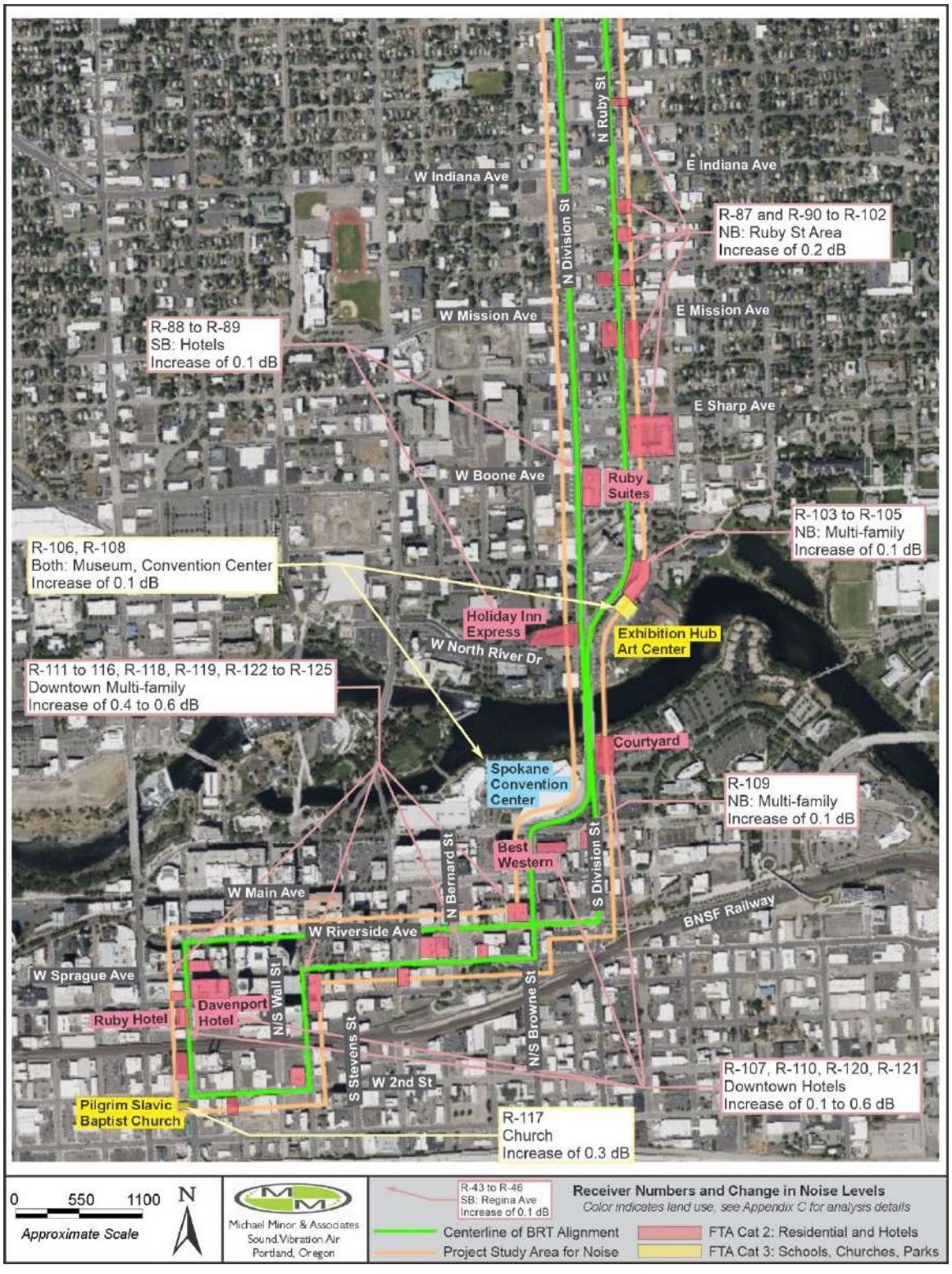


Figure 7-5. Representative Noise Modeling Receivers (5 of 5)

7.2.2. Long-Term Vibration Impacts

The BRT Project will use rubber tired vehicles, and all bus pullouts will be newly paved slabs to prevent wear and maintain a smooth surface. In addition, the maximum predicted vibration levels from the BRT Project were projected to range from 55 VdB to 57 VdB at the nearest residences (10 to 20 feet). Therefore, the FTA vibration criteria of 72 VdB would not be exceeded, and no vibration impacts are predicted.

7.2.3. Short-Term Construction Related Impacts

Noise related to project construction would only occur for a short period and move along the corridor as improvements are completed. In many areas, there would be little to no construction as most project construction would be focused on stations and BRT stops. A review of construction noise and vibration is provided in the following sections.

7.2.3.1. Construction Noise Impacts

Noise related to construction varies greatly depending on the type of construction activity, duration of the activity, the distance between the receiver and the source, and the topographical conditions between the source and receiver. In general, noise levels produced for this Project will be similar to noise produced for most roadway paving projects. Consistent with the guidance in the FTA Manual (2018), typical construction noise levels were predicted using the FHWA Roadway Construction Noise Model (RCNM, FHWA, 2006). These predictions use reference noise levels from typical construction equipment and account for typical equipment operation, including typical noise levels under load and typical operational times.

Major noise-producing equipment for construction of the new transit center, concrete pads and bus stops could include backhoes, haul trucks, loaders, tractor-trailers, and vibratory equipment. Maximum noise levels could reach 78 to 86 dBA at the nearest residence (50 feet from the activity). Other less notable noise-producing equipment expected to be used during this phase would be small backhoes, air compressors, forklifts, and utility trucks. Construction noise during daytime hours is exempt from the noise control codes, however, construction during nighttime hours would require a variance from the City of Spokane.

7.2.3.2. Construction Vibration Impacts

Vibration associated with general construction activities can result in increased vibration levels at nearby residences. Vibration sources for the BRT Project could include excavation equipment, soil compactors, jackhammers, and haul-trucks. The only construction activities that may cause high levels of vibration include jackhammering, demolition, and soil compacting. Other construction related vibration is rarely high enough to cause any sort of structural damage, although it may at times be noticeable inside the structures. Areas with the highest potential for construction-phase vibration impacts include areas near proposed stations and located within the first 50 to 100 feet of the construction site.

8. NOISE AND VIBRATION MITIGATION

This section provides a summary of any noise or vibration mitigation measures that are recommended for operations and construction of the BRT Project.

8.1. No-Build Alternative

8.1.1. Noise Mitigation

Noise abatement measures are only considered under the Preferred BRT Alternative. Under the No-Build Alternative, there would be no changes to the Project roadways; therefore, no noise abatement would be proposed.

8.1.2. Vibration Mitigation

Vibration mitigation measures are only considered under the Preferred BRT Alternative and, therefore, no vibration mitigation is recommended under the No-Build Alternative.

8.2. Preferred BRT Alternative

Noise and vibration mitigation for construction and operation of the Preferred BRT Alternative, are provided in this section.

8.2.1. Long-Term Operational Noise and Vibration Mitigation

STA is committed to maintaining a quiet and effective transit system. This commitment includes using state-of-the-art vehicles, vehicle maintenance and operator training, all of which help to reduce noise levels along transit corridors. For noise impacts that would still exist, potential noise mitigation measures that are consistent with the FTA requirements would be considered. During final design, any modifications in the location of bus operations may result in a review of the modification to assure the Project remains in compliance with FTA criteria.

8.2.1.1. Noise

Because this Project is replacing existing bus services with a new BRT service in most locations, the noise increase from the proposed action was less than 1.0 dB, and no potential for noise impacts was identified. Because there are no noise impacts, no Project-specific noise mitigation measures were considered or recommended for inclusion with the Preferred BRT Alternative.

8.2.1.2. Vibration

No vibration impacts are predicted due to the use of rubber tired vehicles and, therefore, no vibration mitigation is recommended.

8.2.2. Short-Term Construction Related Noise and Vibration Mitigation

Short-term abatement is for Project-related construction. The section below provides several construction-related noise and vibration abatement measures that could be used for the Project.

8.2.2.1. Construction Noise

Construction noise impacts can be reduced with operational methods and scheduling, equipment choice, and acoustical treatments. Project construction noise also must meet the local noise-control regulations, as defined in Section 4. Any potential nighttime construction would control noise levels by applying noise-level limits established through the variance process and would use noise-control measures where necessary. The contractor would have the flexibility of either prohibiting certain noise-generating activities during nighttime hours or providing additional noise-control measures to meet these noise limits.

Noise-control for nighttime or daytime work could include the following measures, as necessary, to meet the required noise limits:

- During nighttime work, use smart backup alarms that automatically adjust or lower the alarm level or tone based on the background noise level.
- Use low-noise emission equipment.
- Implement noise-deadening measures for truck loading and operations.
- Conduct monitoring and maintenance of 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.
- Prohibit or limit the use of jackhammering during nighttime hours.
- Minimize the use of generators or use quiet generators to power equipment.

8.2.2.2. Construction Vibration

Measures to minimize short-term annoyance from construction vibration include the use of alternative methods with less vibration, such as the use of static roller compactors rather than vibratory roller compactors. Activities with potential for annoyance could also be restricted to shorter periods and daytime hours when vibrations and noise are less noticeable.

8.3. Unavoidable Impacts

There are no unavoidable noise, or vibration impacts under the FTA criteria because no project related noise or vibration impacts were identified.

Appendix A: References

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

Washington State Department of Transportation. 2020 Traffic Noise Policy and Procedures. WSDOT. October 2012.

Appendix B: Introduction to Acoustics

Sound is defined as any pressure variation that the human ear can detect, from barely perceptible sounds to sound levels that can cause hearing damage. The magnitude of the variations of the air pressure from the static air pressure is a measure of the sound level. The number of cyclic pressure variations per second is the frequency of sound. When sounds are unpleasant, unwanted, or disturbingly loud, we tend to classify them as noise.

Compared with the static air pressure, the audible sound pressure variations range from the threshold of hearing, a very small 20 μPa (20 x 10^{-6} Pascal), to 100 Pa, a level so loud it is referred to as the threshold of pain. Because the ratio between these numbers is more than a million to one, using Pascal to describe sound levels can be awkward. The "dB" measurement is a logarithmic conversion of air pressure level variations from Pascal to a unit of measure with a more convenient numbering system. This conversion not only allows for a more convenient scale but is also a more accurate representation of how the human ear reacts to variations in air pressure. Measurements made using the decibel scale will be denoted dB.

The smallest noise level change that can be detected by the human ear is approximately 3 dB. A doubling in the static air pressure amounts to a change of 6 dB, and an increase of 10 dB is roughly equivalent to a doubling in the perceived sound level. Under free-field conditions, where there are no reflections or additional attenuation, sound 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, or 58 dB at 400 feet. The mathematical definition of sound pressure level in dB is listed below.

L_p (sound pressure level). The sound pressure in dB is 20 times the log of the ratio of the measured pressure, p, to the static pressure, p_o, where p_o is 20 μPa.

$$L_{pa} = 20 Log_{10}\left(\frac{p}{p_o}\right) dB \quad (re\ 20\,\mu Pa)$$

In acoustic measurements where the primary concern is the effect on humans, the sound readings are sometimes compensated by an "A"-weighted filter. The A-weighted filter accounts for people's limited hearing response in the upper and lower frequency bands. Sound pressure level measurements made using the A-weighted filter are denoted dBA.

General Measurement Descriptors

- **Leq (equivalent continuous sound level).** The constant sound level in dBA that, lasting for a time "T," would have produced the same energy in the same time period "T" as an actual A-weighted noise event.

$$L_{eq} = 20\,Log_{10}\frac{1}{T}\int_{T}^{0}\left(\frac{p(t)}{p_o}\right)^2 dt$$

- **MaxPeak (maximum A-weighted sound level).** The greatest continuous sound level, in dBA, measured during the preset measurement period.
- **Lmax (maximum A-weighted RMS sound level).** The greatest RMS (root-mean square) sound level, in dBA, measured during the preset measurement period.
- **Lmin (minimum A-weighted RMS sound level).** The lowest RMS (root-mean square) sound level, in dBA, measured during the preset measurement period.

Statistical Noise Level Descriptors

Public response to sound depends greatly upon the range that the sound varies in a given environment. For example, people generally find a moderately high, constant sound level more tolerable than a quiet background level interrupted by high-level noise intrusions. In light of this subjective response, it is often useful to look at a statistical distribution of sound levels over a given time period. Such distributions identify the sound level exceeded and the percentage of time exceeded. Therefore, it allows for a more complete description of the range of sound levels during the given measurement period.

The sound level descriptor L_{xx} is defined as the sound level exceeded XX percent of the time, where XX is a percentage from 0.1 percent to 99.9 percent. Some of the more common versions of this descriptor and their corresponding definitions are listed below:

- L01 The sound level is exceeded 1 percent of the time. This is a measure of the loudest sound levels during the measurement period. Example: During a 1-hour measurement, an L01 of 95 dBA means the sound level was at or above 95 dBA for 36 seconds.
- L50 The sound level is exceeded 50 percent of the time. This level corresponds to the median sound level. Example: During a 1-hour measurement, an L50 of 67 dBA means the sound level was at or above 67 dBA for 30 minutes.
- L90 The sound level is exceeded 90 percent of the time. This is a measure of the nominal background level. Example: During a 1-hour measurement, an L90 of 50 dBA means the sound level was at or above 50 dBA for 54 minutes.

Other commonly used L_{XX} values include $L_{2.5}$, $L_{8.3}$, and L_{25}. These correspond to the 5-, 10-, and 15-minute time levels for a 1-hour measurement period, respectively.

Typical Sound Levels

Two figures are included as sound level reference material. Table B-1 contains some common noise sources, their nominal maximum sound level in dBA, and the usual public response. The levels in this graph are comparable to the Lmax noise level descriptor. This graph would be useful when comparing the loudest noise produced with other familiar noise sources a person may have experienced.

Table B-1. Typical Maximum Sound Levels

Noise Source or Activity	Sound Level (dBA)	Subjective Impression	Relative Loudness (human judgment of different sound levels)
Jet aircraft takeoff from carrier (50 feet)	140	Threshold of pain	64 times as loud
50-horse power siren (100 feet)	130		32 times as loud
Loud rock concert near stage, Jet takeoff (200 feet)	120	Uncomfortably loud	16 times as loud
Float plane takeoff (100 feet)	110		8 times as loud
Jet takeoff (2,000 feet)	100	Very loud	4 times as loud
Heavy truck or motorcycle (25 feet)	90		2 times as loud
Garbage disposal, food blender (2 feet), Pneumatic drill (50 feet)	80	Moderately loud	Reference loudness
Vacuum cleaner (10 feet), Passenger car at 65 mph (25 feet)	70		1/2 as loud
Large store air-conditioning unit (20 feet)	60		1/4 as loud
Light auto traffic (100 feet)	50	Quiet	1/8 as loud
Bedroom or quiet living room Bird calls	40		1/16 as loud
Quiet library, soft whisper (15 feet)	30	Very quiet	
High quality recording studio	20		
Acoustic Test Chamber	10	Just audible	
	0	Threshold of hearing	

Sources: Beranek (1988) and U.S. EPA (1971).

Appendix C: Noise Modeling Results

Rec #	Block	Address	Land Use	FTA Land Use	Side of Roadway	SB Near Lane Dist	NB Near Lane Dist	Existnig Noise	Increase Critiera	BRT Noise	Total Noise	Increase	Impacts
R-1	N Crestline to N Perry	Farewell Elementary School	School	3	SB	109	151	66.8	3	50.6	66.9	0.1	No
R-2	N Crestline to N Perry	Wandermere Kindercare	School	3	SB	74	116	68.5	3	52.3	68.6	0.1	No
R-3	N Crestline to N Perry	1523 E Farwell	SF	2	SB	41	83	73.1	0.6	56.9	73.2	0.1	No
R-4	N Crestline to N Perry	12702 N Palomino	MF	2	SB	55	97	71.8	1	55.6	71.9	0.1	No
R-5	N Crestline to N Perry	12701 N Palomino	MF	2	SB	93	135	69.5	1.1	53.3	69.6	0.1	No
R-6	N Crestline to N Perry	12525 N Pittsburg	SF	2	NB	95	53	72.0	1	55.7	72.1	0.1	No
R-7	N Crestline to N Perry	1524 E Farwell	SF	2	NB	82	40	73.2	0.6	57.0	73.3	0.1	No
R-8	N Perry to N Standard	1318 E Farwell	MF	2	SB	66	108	71.0	1	54.8	71.1	0.1	No
R-9	N Perry to N Standard	1312 E Farwell	MF	2	SB	76	118	70.4	1	54.2	70.5	0.1	No
R-10	N Perry to N Standard	1307 E Hastings	SF	2	SB	86	128	69.8	1.1	53.6	70.0	0.1	No
R-11	N Perry to N Standard	1305 E Hastings	MF	2	SB	34	76	73.9	0.6	57.7	74.0	0.1	No
R-12	N Perry to N Standard	1115 E Hastings	MF	2	SB	47	89	72.5	0.8	56.3	72.6	0.1	No
R-13	N Perry to N Standard	1115 E Hastings	MF	2	SB	47	89	72.5	0.8	56.3	72.6	0.1	No
R-14	N Perry to N Standard	1107 E Hastings	MF	2	SB	71	113	70.7	1	54.5	70.8	0.1	No
R-15	N Perry to N Standard	1101 E Hastings	MF	2	SB	40	82	73.2	0.6	57.0	73.3	0.1	No
R-16	N Perry to N Standard	1723 E Hastings	SF	2	SB	38	80	73.4	0.6	57.2	73.5	0.1	No
R-17	N Perry to N Standard	707 E Hastings	SF	2	SB	48	90	72.4	0.8	56.2	72.5	0.1	No
R-18	N Perry to N Standard	617 E Hastings	SF	2	SB	53	95	72.0	1	55.7	72.1	0.1	No
R-19	N Perry to N Standard	525 E Hastings	SF	2	SB	41	83	73.1	0.6	56.9	73.2	0.1	No
R-20	N Perry to N Standard	12527 N Perry	MF	2	NB	79	37	73.5	0.6	57.3	73.6	0.1	No
R-21	N Perry to N Standard	12525 N Perry	MF	2	NB	120	78	70.3	1	54.1	70.4	0.1	No
R-22	N Perry to N Standard	12524 N Denver	MF	2	NB	80	38	73.4	0.6	57.2	73.5	0.1	No
R-23	N Perry to N Standard	12522 N Denver	MF	2	NB	120	78	70.3	1	54.1	70.4	0.1	No
R-24	N Perry to N Standard	1217 E Chantel	MF	2	NB	99	57	71.6	1	55.4	71.7	0.1	No
R-25	N Perry to N Standard	1209 E Chantel	MF	2	NB	96	54	71.9	1	55.7	72.0	0.1	No
R-26	N Perry to N Standard	1201 E Chantel	MF	2	NB	98	56	71.7	1	55.5	71.8	0.1	No
R-27	N Perry to N Standard	1123 E Chantel	SF	2	NB	79	37	73.5	0.6	57.3	73.6	0.1	No
R-28	N Perry to N Standard	1115 E Chantel	SF	2	NB	97	55	71.8	1	55.6	71.9	0.1	No
R-29	N Perry to N Standard	1107 E Chantel	SF	2	NB	90	48	72.4	0.8	56.2	72.5	0.1	No
R-30	N Perry to N Standard	12411 N Guinevere	SF	2	NB	102	60	71.4	1	55.2	71.5	0.1	No
R-31	N Perry to N Standard	904 E Hastings	SF	2	NB	114	72	70.6	1	54.4	70.7	0.1	No
R-32	N Perry to N Standard	824 E Hastings	MF	2	NB	70	28	74.7	0.5	58.5	74.8	0.1	No
R-33	N Perry to N Standard	824 E Hastings	MF	2	NB	73	31	74.3	0.5	58.1	74.4	0.1	No
R-34	N Perry to N Standard	724 E Hastings	MF	2	NB	104	62	71.3	1	55.1	71.4	0.1	No
R-35	N Perry to N Standard	724 E Hastings	MF	2	NB	110	68	70.9	1	54.7	71.0	0.1	No
R-36	N Perry to N Standard	724 E Hastings	MF	2	NB	93	51	72.1	0.8	55.9	72.2	0.1	No
R-37	N Perry to N Standard	724 E Hastings	MF	2	NB	70	28	74.7	0.5	58.5	74.8	0.1	No
R-38	N Perry to N Standard	514 E Hasting	MF	2	NB	125	83	70.0	1	53.8	70.1	0.1	No
R-39	N Perry to N Standard	514 E Hasting	MF	2	NB	125	83	70.0	1	53.8	70.1	0.1	No
R-40	West of Division	12227/12229 Mayfair Rd	MF	2	NB	47	63	72.5	0.8	56.3	72.6	0.1	No
R-41	West of Division	12235 Mayfair Rd	MF	2	NB	49	65	72.3	0.8	56.1	72.4	0.1	No
R-42	West of Division	12231/12233 Mayfair Rd	SF	2	NB	29	45	74.6	0.5	58.4	74.7	0.1	No
R-43	E Regina Ave	1207 E Regina	SF	2	SB	27	70	75.1	0.4	58.7	75.2	0.1	No
R-44	E Regina to E Falcon	126 E Salmon	SF	2	SB	93	136	69.7	1.1	53.3	69.8	0.1	No
R-45	E Regina to E Falcon	124 E Salmon	SF	2	SB	93	136	69.7	1.1	53.3	69.8	0.1	No
R-46	E Regina to E Falcon	120 E Salmon	SF	2	SB	97	140	69.5	1.1	53.1	69.6	0.1	No
R-47	E Elcliff to E Hawthorne	44 W HAWTHORNE Rd	School	3	SB	32	75	71.9	3	55.9	72.0	0.1	No

Rec #	Block	Address	Land Use	FTA Land Use	Side of Roadway	SB Near Lane Dist	NB Near Lane Dist	Existnig Noise	Increase Critiera	BRT Noise	Total Noise	Increase	Impacts
R-48	E Elcliff to E Hawthorne	10605 N Nelson	SF	2	NB	157	114	68.8	1.1	52.4	68.9	0.1	No
R-49	E Elcliff to E Hawthorne	10521 N Nelson	SF	2	NB	166	123	68.5	1.1	52.1	68.6	0.1	No
R-50	E Elcliff to E Hawthorne	10411 N Nelson	SF	2	NB	127	84	70.1	1	53.7	70.2	0.1	No
R-51	E Hawthrone to W Holland	9825 N Division	SF	2	SB	61	104	70.6	1	55.1	70.8	0.1	No
R-52	E Hawthrone to W Holland	9815 N Division	SF	2	SB	67	110	70.2	1	54.7	70.3	0.1	No
R-53	E Hawthrone to W Holland	9704 N Division	Church	3	NB	122	79	67.5	3	52.0	67.6	0.1	No
R-54	E Hawthrone to W Holland	9508 N Division	Hotel	2	NB	84	41	72.4	0.8	56.9	72.5	0.1	No
R-55	E Hawthrone to W Holland	9508 N Division	Hotel	2	NB	82	39	72.6	0.8	57.1	72.7	0.1	No
R-56	W Price/E Magnesium to W Cascade/ E	8522 N Atlantic	SF	2	SB	91	144	68.5	1.1	53.4	68.6	0.1	No
R-57	W Price/E Magnesium to W Cascade/ E	8514 N Atlantic	SF	2	SB	98	151	68.2	1.1	53.1	68.3	0.1	No
R-58	W Price/E Magnesium to W Cascade/ E	8508 N Atlantic	SF	2	SB	96	149	68.3	1.1	53.2	68.4	0.1	No
R-59	W Price/E Magnesium to W Cascade/ E	8426 N Atlantic	SF	2	SB	58	111	70.5	1	55.4	70.6	0.1	No
R-60	W Price/E Magnesium to W Cascade/ E	8420 N Atlantic	SF	2	SB	92	145	68.4	1.1	53.4	68.6	0.1	No
R-61	W Price/E Magnesium to W Cascade/ E	8412 N Atlantic	SF	2	SB	96	149	68.3	1.1	53.2	68.4	0.1	No
R-62	W Price/E Magnesium to W Cascade/ E	8406 N Atlantic	SF	2	SB	85	138	68.8	1.1	53.7	68.9	0.1	No
R-63	W Price/E Magnesium to W Cascade/ E	8318 N Atlantic	SF	2	SB	75	128	69.3	1.1	54.2	69.5	0.1	No
R-64	W Price/E Magnesium to W Cascade/ E	15 W St Thomas More	SF	2	SB	95	148	68.3	1.1	53.2	68.4	0.1	No
R-65	W Price/E Magnesium to W Cascade/ E	7919 N Division St	Hotel	2	SB	22	75	74.7	0.5	59.6	74.8	0.1	No
R-66	W Price/E Magnesium to W Cascade/ E	7920 N Division St	Hotel	2	SB	60	113	70.3	1	55.2	70.4	0.1	No
R-67	W Price/E Magnesium to W Cascade/ E	9 E Pine Ride	MF	2	NB	116	63	70.1	1	55.0	70.2	0.1	No
R-68	W Price/E Magnesium to W Cascade/ E	9 E Pine Ridge	MF	2	NB	117	64	70.0	1	54.9	70.2	0.1	No
R-69	W Price/E Magnesium to W Cascade/ E	10 E Pine Ridge	MF	2	NB	110	57	70.5	1	55.4	70.7	0.1	No
R-70	W Price/E Magnesium to W Cascade/ E	20 E Pine Ridge	MF	2	NB	133	80	69.1	1.1	54.0	69.2	0.1	No
R-71	W Price/E Magnesium to W Cascade/ E	20 E Pine Ridge	MF	2	NB	118	65	70.0	1.1	54.9	70.1	0.1	No
R-72	W Price/E Magnesium to W Cascade/ E	19 E Mayfair	MF	2	NB	134	81	69.0	1.1	53.9	69.1	0.1	No
R-73	W Price/E Magnesium to W Cascade/ E	9 E Mayfair	MF	2	NB	113	60	70.3	1	55.2	70.4	0.1	No
R-74	W Price/E Magnesium to W Cascade/ E	10 E Mayfair	MF	2	NB	131	78	69.2	1.1	54.1	69.3	0.1	No
R-75	W Rhodes to E Francis (SR 291)	6801 N Division	SF	2	SB	67	120	69.6	1.1	54.7	69.8	0.1	No
R-76	W Rhodes to E Francis (SR 291)	6801 N Division	Hotel	2	SB	14	67	76.4	0.4	61.5	76.6	0.1	No
R-77	SR 291 to W Nebraska Ave	5817 N Division	MF	2	SB	15	68	76.1	0.4	61.2	76.3	0.1	No
R-78	SR 291 to W Nebraska Ave	5 W Joseph	SF	2	SB	24	77	74.1	0.5	59.2	74.2	0.1	No
R-79	SR 291 to W Nebraska Ave	6 W Nebraska	SF	2	SB	18	71	75.3	0.4	60.4	75.5	0.1	No
R-80	W Nebraska to W Queen	302 W Queen (Franklin Park)	Park	3	SB	27	80	71.3	3	56.7	71.5	0.1	No
R-81	W Nebraska to W Queen	302 W Queen (Franklin Park)	Park	3	SB	23	76	72.0	2	57.4	72.2	0.1	No
R-82	W Nebraska to W Queen	5122 N Division	School	3	NB	122	69	67.3	3	52.6	67.4	0.1	No
R-83	W Lacrosse to W Euclid	3922 N Normandie (Clark Playfield)	Park	3	SB	81	134	66.6	3	51.9	66.7	0.1	No
R-84	W Lacrosse to W Euclid	3922 N Normandie (Clark Playfield)	Park	3	SB	34	87	70.3	3	55.7	70.5	0.1	No
R-85	W Euclid to W Indiana	3033 N Division	Hotel	2	SB	51	104	72.3	0.8	55.9	72.4	0.1	No
R-86	W Euclid to W Indiana	2012 N Ruby	SF	2	NB	81	28	74.9	0.5	58.5	75.0	0.1	No
R-87	W Indiana to Spokane River Waterfron	1120 N Division	Hotel	2	SB	12	362	75.3	0.4	62.2	75.5	0.2	No
R-88	W Indiana to Spokane River Waterfron	1120 N Division	Hotel	2	SB	15	365	74.4	0.5	61.2	74.6	0.2	No
R-89	W Indiana to Spokane River Waterfron	801 N Division	Hotel	2	SB	33	383	70.9	1	57.8	71.2	0.2	No
R-90	W Indiana to Spokane River Waterfron	1810 N Ruby	SF	2	NB	381	31	73.4	0.6	58.1	73.5	0.1	No
R-91	W Indiana to Spokane River Waterfron	101 E Nora	SF	2	NB	395	45	69.6	1.1	56.5	69.8	0.2	No
R-92	W Indiana to Spokane River Waterfron	102 E Nora	MF	2	NB	388	38	70.3	1	57.2	70.5	0.2	No
R-93	W Indiana to Spokane River Waterfron	24 E Augusta	MF	2	NB	432	82	67.0	1.3	53.9	67.2	0.2	No
R-94	W Indiana to Spokane River Waterfron	108 E Augusta	SF	2	NB	434	84	66.9	1.3	53.7	67.1	0.2	No

Rec #	Block	Address	Land Use	FTA Land Use	Side of Roadway	SB Near Lane Dist	NB Near Lane Dist	Existnig Noise	Increase Critiera	BRT Noise	Total Noise	Increase	Impacts
R-95	W Indiana to Spokane River Waterfron	28 E Mission	MF	2	NB	373	23	72.5	0.8	59.4	72.7	0.2	No
R-96	W Indiana to Spokane River Waterfron	22 E Mission	MF	2	NB	437	87	66.7	1.3	53.6	66.9	0.2	No
R-97	W Indiana to Spokane River Waterfron	104 E Mission	SF	2	NB	383	33	70.9	1	57.8	71.2	0.2	No
R-98	W Indiana to Spokane River Waterfron	1413 N Ruby	MF	2	NB	378	28	73.8	0.6	58.5	74.0	0.1	No
R-99	W Indiana to Spokane River Waterfron	101 E Sinto	SF	2	NB	392	42	69.9	1.1	56.8	70.1	0.2	No
R-100	W Indiana to Spokane River Waterfron	117 E Boone	MF	2	NB	369	19	73.3	0.6	60.2	73.6	0.2	No
R-101	W Indiana to Spokane River Waterfron	117 E Boone	MF	2	NB	379	29	71.5	1	58.4	71.7	0.2	No
R-102	W Indiana to Spokane River Waterfron	117 E Boone	MF	2	NB	371	21	72.9	0.8	59.8	73.1	0.2	No
R-103	W Indiana to Spokane River Waterfron	940 N Ruby	MF	2	NB	422	72	69.7	1.1	54.4	69.9	0.1	No
R-104	W Indiana to Spokane River Waterfron	940 N Ruby	MF	2	NB	453	103	68.2	1.1	52.9	68.3	0.1	No
R-105	W Indiana to Spokane River Waterfron	940 N Ruby	MF	2	NB	376	31	73.4	0.6	58.1	73.5	0.1	No
R-106	W Indiana to Spokane River Waterfron	808 N Ruby	Public	2	NB	364	34	73.0	0.6	57.7	73.1	0.1	No
R-107	Riverpoint to E Spokane Blvd	401 N Riverpoint Blvd	Hotel	2	NB	106	70	69.7	1.1	54.5	69.8	0.1	No
R-108	Riverpoint to E Spokane Blvd	334 W Spokane Falls Blvd	Public	3	SB	48	84	71.3	3	54.2	71.4	0.1	No
R-109	Downtown	225 N DIVISION St	MF	2	NB	41	17	75.8	0.4	60.7	76.0	0.1	No
R-110	Downtown	33 W SPOKANE FALLS Blvd	Hotel	2	SB	35	59	65.5	1.4	57.5	66.2	0.6	No
R-111	Downtown	206 W RIVERSIDE Ave	MF	2	SB	28	52	66.5	1.3	58.5	67.1	0.6	No
R-112	Downtown	236 W SPRAGUE Ave	MF	2	SB	20	44	68.0	1.2	60.0	68.6	0.6	No
R-113	Downtown	9 S HOWARD St	MF	2	NB	54	30	66.2	1.3	58.2	66.8	0.6	No
R-114	Downtown	107 S HOWARD St	MF	2	NB	42	18	68.4	1.1	60.4	69.1	0.6	No
R-115	Downtown	608 W 2ND Ave	MF	2	SB	21	45	69.8	1.1	59.8	70.2	0.4	No
R-116	Downtown	206 S POST St	MF	2	SB	18	42	68.4	1.1	60.4	69.1	0.6	No
R-117	Downtown	212 S LINCOLN St	Church	3	NB	65	41	67.0	3	54.9	67.3	0.3	No
R-118	Downtown	906 W 2ND Ave	MF	2	NB	34	10	73.0	0.8	63.0	73.4	0.4	No
R-119	Downtown	152 S LINCOLN St	MF	2	NB	39	15	69.2	1.1	61.2	69.9	0.6	No
R-120	Downtown	10 S POST St	Hotel	2	NB	45	21	69.9	1.1	59.8	70.3	0.4	No
R-121	Downtown	901 W 1st Ave	Hotel	2	NB	45	21	69.9	1.1	59.8	70.3	0.4	No
R-122	Downtown	902 W 1ST Ave	MF	2	NB	45	21	69.8	1.1	59.8	70.2	0.4	No
R-123	Downtown	822 W SPRAGUE Ave	MF	2	NB	45	21	67.7	1.2	59.8	68.4	0.6	No
R-124	Downtown	319 W RIVERSIDE Ave	MF	2	NB	47	23	67.4	1.2	59.4	68.0	0.6	No
R-125	Downtown	311 W RIVERSIDE Ave	MF	2	NB	39	15	69.2	1.1	61.2	69.9	0.6	No