APPENDIX G

MADISON EAST-WEST BRT

Documented Categorical Exclusion

Noise and Vibration Technical Report

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Prepared for:

City of Madison

Prepared by:

SRF Consulting Group

Commonwealth Heritage Group

Cross-Spectrum Acoustics

REVISIONS

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1. Introduction

The Madison East-West Bus Rapid Transit (BRT) Project (the project) is a proposed 15-mile route serving east-west travel needs in central Madison, Wisconsin. The project extends from East Springs Drive on the east side of Madison to a proposed new park-and-ride at Junction Road on the west side of Madison. Operating primarily via East Washington Avenue, University Avenue, and Mineral Point Road, the BRT line would serve the major regional destinations of the isthmus (downtown Madison), the University of Wisconsin-Madison (UW) campus, Madison Area Technical College, and major employers and several shopping centers located throughout the corridor. BRT buses would use a combination of center-running bus lanes, side bus lanes, and mixed-traffic lanes. The project also includes electric bus charging infrastructure at the Sun Prairie Park-and-Ride and the Metro Satellite Maintenance Facility where BRT layovers will occur.

This technical report contains the noise and vibration impact assessment for the project. Noise and vibration have been assessed in accordance with guidelines specified in the Federal Transit Administration's (FTA's) Transit Noise and Vibration Impact Assessment guidance manual[1]. The assessment was conducted to document project noise and vibration impacts at sensitive locations and identify any potential mitigation measures. This technical report is intended to be a supplement to the documented categorical exclusion.

A summary of the assessment results is described below. The report includes a description of the existing noise and vibration conditions near the project, the noise and vibration assessment for sensitive receptors near the build alternatives, and mitigation options for impacts identified in the assessment. Section 2describes the regulatory setting, including noise and vibration basics, the noise and vibration impact criteria for the project and the methodology for the impact assessment, Section 3 describes the existing conditions, including a description of noise and vibration sensitive land uses and the measurements conducted to determine the existing noise and vibration conditions. Section 4 includes environmental consequences, including the results of the noise and vibration impact assessment and potential mitigation measures are described in Section 5.

The results of the noise and vibration assessment indicate that there would be no impacts due to the proposed project, and therefore, no mitigation would be required.

2. Regulatory Context and Methodology

2.1. Operational Noise

2.1.1. Noise Basics

Sound is defined as small changes in air pressure above and below the standard atmospheric pressure, and noise is usually considered to be unwanted sounds. The three parameters that define noise include:

- **Level:** The level of sound is the magnitude of air pressure change above and below atmospheric pressure and is expressed in decibels (dB). Typical sounds fall within a range between 0 dB (the lower limits of human hearing) and 120 dB (the highest sound levels experienced in the environment). A 3 dB change in sound level is perceived as a barely noticeable change outdoors and a 10 dB change in sound level is perceived as a doubling (or halving) of the sound level.

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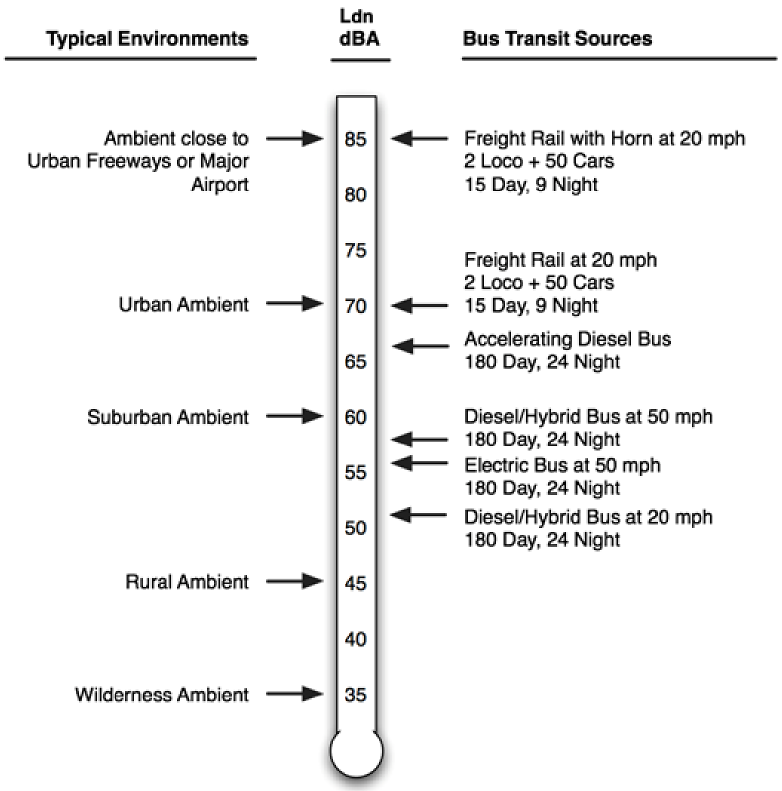
[1] Federal Transit Administration (FTA). 2018. Transit Noise and Vibration Impact Assessment Manual. FTA Report No. 0123. Federal Transit Administration, John A. Volpe National Transportation System Center and Cross-Spectrum Acoustics, Inc.

- **Frequency:** The frequency (pitch or tone) of sound is the rate of air pressure changes and is expressed in cycles per second, or Hertz (Hz). Human ears can detect a wide range of frequencies from around 20 Hz to 20,000 Hz; however, human hearing is not effective at high and low frequencies, and the A weighting system (dBA) is used to correlate with human response to noise. The A-weighted sound level has been widely adopted by acousticians as the most appropriate descriptor for environmental noise.
- **Time pattern:** Because environmental noise is constantly changing, it is common to condense all of this information into a single number, called the "equivalent" sound level (Leq). The Leq represents the changing sound level over a period of time, typically one hour or 24 hours in transit noise assessments. For transit projects, the Day-Night Sound Level (Ldn) is the common noise descriptor used and has been adopted by most agencies as the best way to describe how people respond to noise in their environment. Ldn is a 24-hour cumulative A-weighted noise level that includes all noises that happen within a day, with a 10 dB penalty for nighttime noise (10 p.m. to 7 a.m.). This nighttime penalty means that any noise events at night are equivalent to 10 similar events during the day. Typical Ldn values for various transit and freight operations are shown in Figure 1.

Figure 1: Cumulative Noise Levels from Transportation Sources



Source: CSA, 2021

2.1.2. FTA Operational Noise Impact Criteria

The noise impact criteria used for the project are based on the information in Section 4 of the FTA noise and vibration guidance manual (FTA, 2018). The FTA noise impact criteria are based on well-documented research on community response to noise and are based on both the existing level of noise and the change in noise exposure due to a project. The FTA noise criteria compare the project noise with the existing noise (not the No Build Alternative noise). This is because comparison of a noise projection with an existing noise condition is more accurate than comparison of a projection with another noise projection. Because background noise may increase by the time the project is operational, this approach of using existing noise conditions is conservative.

The FTA noise criteria are based on the land use category of the sensitive receptor and use Ldn for locations where people sleep (Category 2) and Leq for locations with daytime and/or evening use (Category 1 or 3), as shown in Table 1.

Table 1: Land Use Categories and Metrics for Transit Noise Impact Criteria

Land Use Category	Land Use Type	Noise Metric (dBA)	Description of Land Use Category
1	High Sensitivity	Outdoor Leq(h)[1]	Land where quiet is an essential element of its intended purpose. Example land uses include preserved land for serenity and quiet, outdoor amphitheaters and concert pavilions, and National Historic Landmarks with considerable outdoor use. Recording studios and concert halls are also included in this category.
2	Residential	Outdoor Ldn	This category is applicable to all residential land use and buildings where people normally sleep, such as hotels and hospitals.
3	Institutional	Outdoor Leq(h)[1]	This category is applicable to institutional land uses with primarily daytime and evening use. Example land uses include 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 included in this category.

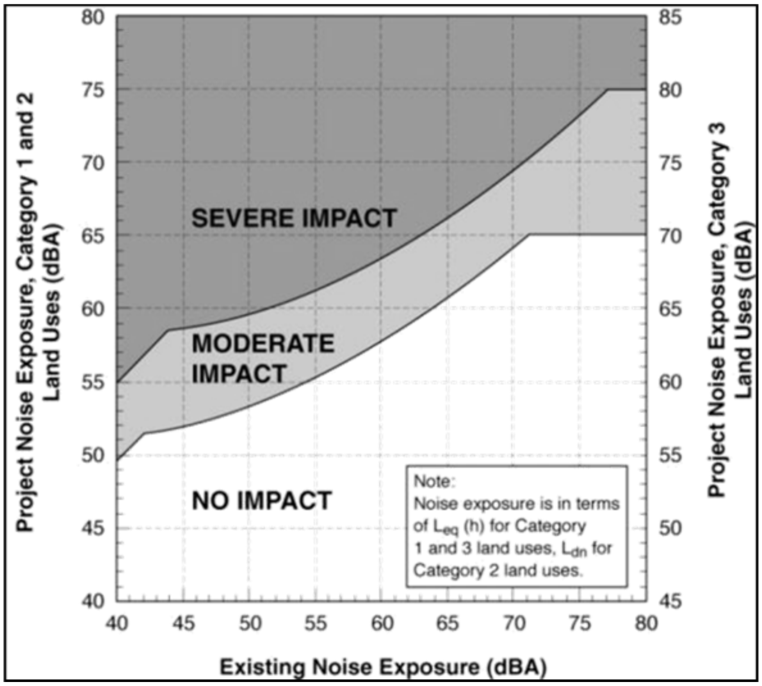
Source: FTA, 2018.

Note: (1) Leq (1hr) for the loudest hour of project-related activity during hours of noise sensitivity.

The noise impact criteria are defined by the two curves shown in Figure 2, which allow increasing project noise as existing noise levels increase, up to a point at which impact is determined based on project noise alone. The FTA noise impact criteria include three levels of impact, as shown in Figure 2. The three levels of impact include:

- No impact: Project-generated noise is not likely to cause community annoyance. Noise projections in this range are considered acceptable by FTA and mitigation is not required.
- Moderate Impact: Project-generated noise in this range is considered to cause impact at the threshold of measurable annoyance. Moderate impacts serve as an alert to project planners for potential adverse impacts and complaints from the community. Mitigation should be considered at this level of impact based on project specifics and details concerning the affected properties.
- Severe Impact: Project-generated noise in this range is likely to cause a high level of community annoyance. If it is not practical to avoid severe impacts by changing the location of the project, mitigation measures must be considered.

Figure 2: FTA Noise Impact Criteria



Source: FTA, 2018

2.2. Operational Vibration

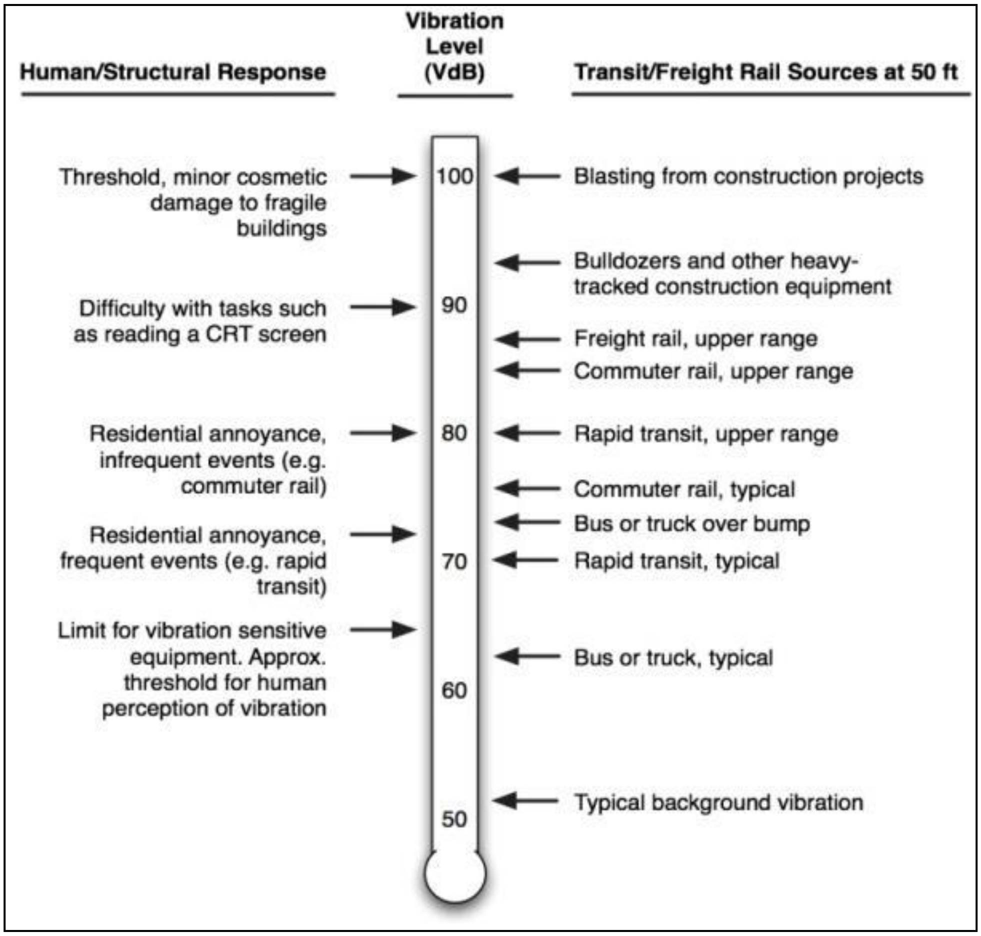
2.2.1. Vibration Basics

Ground-borne vibration is the motion of the ground transmitted into a building that can be described in terms of displacement, velocity, or acceleration. Vibration velocity is used in transit and is defined by the following:

- Level: Vibration is expressed in terms of vibration velocity level, using vibration decibel (VdB), with a reference of 1 micro-inch per second. The level of vibration represents how much the ground is moving. The threshold of human perception to transit and freight rail vibration is approximately 65 VdB and annoyance begins to occur for frequent events at vibration levels over 70 VdB.
- Frequency: Vibration frequency is expressed in Hertz (Hz). Human response to vibration is typically from about 6 Hz to 200 Hz.
- Time pattern: Environmental vibration changes all the time and human response is roughly correlated to the number of vibration events during the day. The more events that occur, the more sensitive humans are to the vibration.

Figure 3 shows typical ground-borne vibration levels for transit projects as well as the corresponding human and structural responses to vibration.

Figure 3: Typical Vibration Levels



Source: CSA, 2021.

2.2.2. FTA Operational Vibration Criteria

The vibration screening procedure for BRT projects is detailed in Section 6 of the FTA's noise and vibration guidance manual. The vibration screening procedure is designed to identify locations where a project has the potential to cause vibration impact. This approach identifies areas for further vibration analysis at later stages of the project where impacts are likely and eliminates locations where no impacts would be identified. The screening procedure is conservative enough to include all locations with the potential for vibration impact and provide assurance that any areas outside the screening distances would have no vibration impacts.

For projects that involve rubber-tire vehicles, such as a BRT or bus project, vibration impact is unlikely except in unusual situations, including vibration sensitive land uses near expansion joints, speed bumps, uneven road surfaces, or buses operating in or very close to a vibration sensitive building, such as a research facility or hospital. If these scenarios do not exist on a BRT or bus project, then the vibration screening procedure does not need to be conducted, and no vibration impacts would be expected for the project.

2.3. Construction Noise and Vibration

Construction activities associated with a project often generate noise and vibration complaints even though they only take place for a limited time. For the project, construction noise and vibration impact is assessed where the exposure of noise- and vibration-sensitive receivers to construction-related noise or vibration is projected to occur at levels exceeding standards established by FTA and established thresholds for architectural and structural building damage (FTA, 2018).

2.3.1. Construction Noise Impact Criteria

Table 2shows the FTA noise assessment criteria for construction. The last column applies to construction activities that extend over 30 days near any given receiver. Day-night sound level, Ldn, is used to assess impacts in residential areas and 24-hour Leq is used in commercial and industrial areas. The 8-hour Leq and the 30-day average Ldn noise exposure from construction noise calculations use the noise emission levels of the construction equipment, their location, and operating hours. The construction noise limits are normally assessed at the noise-sensitive receiver property line.

Table 2: FTA Construction Noise Assessment Criteria

Land Use	8-Hour Leq, dBA Day	8-Hour Leq, dBA Night	Noise Exposure, dBA 30-Day Average
Residential	80	70	75
Commercial	85	85	80
Industrial	90	90	85

Source: FTA, 2018.

2.3.2. Construction Vibration Impact Criteria

Guidelines in the FTA guidance manual provide the basis for the construction vibration assessment. FTA provides construction vibration criteria designed primarily to prevent building damage, and to assess whether vibration might interfere with vibration-sensitive building activities or temporarily annoy building occupants during the construction period. The FTA criteria include two ways to express vibration levels: (1) root-mean-square (RMS) vibration velocity level (Lv, in VdB) for annoyance and activity interference, and (2) peak particle velocity (PPV), which is the maximum instantaneous peak of a vibration signal used for assessments of damage potential.

To avoid temporary annoyance to building occupants during construction or construction interference with vibration-sensitive equipment inside special-use buildings, such as a magnetic resonance imaging (MRI) machine, FTA recommends using the long-term operational vibration criteria which is applied to rail transit projects shown below in Table 3.

Table 3 shows the FTA building damage criteria for construction activity. The table lists PPV and approximate Lv limits for four building categories. These limits are used to estimate potential problems that should be addressed during final design.

Table 3: Construction Vibration Damage Criteria

Building Category	PPV (in/sec)	Appropriate Level[1] (VdB)
I. Reinforced-concrete, steel, or timber (no plaster)	0.5	102
II. Engineered concrete and masonry (no plaster)	0.3	98
III. Non-engineered timber and masonry buildings	0.2	94
IV. Buildings extremely susceptible to vibration damage	0.12	90

Source: FTA, 2018.

Notes: (1) RMS velocity in VdB re 1 micro-inch/second.

Table 4 shows the FTA vibration criteria for the rail transit general assessment, which is also applied to assess annoyance in construction vibration assessments. The table lists the vibration criteria levels based on land use and event frequency. The criteria listed under the "frequent events" column were used to assess annoyance at buildings during construction.

Table 4: Ground-Borne Vibration Impact Criteria

Land Use Category	Ground-Borne Vibration Impact Levels (VdB re 1 micro-inch/sec) for Frequent Events[1]	Ground-Borne Vibration Impact Levels (VdB re 1 micro-inch/sec) for Occasional Events[2]	Ground-Borne Vibration Impact Levels (VdB re 1 micro-inch/sec) for Infrequent Events[3]
Category 1: Buildings where vibration would interfere with interior operations.	65[4]	65[4]	65[4]
Category 2: Residences and buildings where people normally sleep.	72	75	80
Category 3: Institutional land uses with primarily daytime use.	75	78	83

Source: FTA, 2018

NOTES:

(1) "Frequent Events" is defined as more than 70 vibration events of the same source per day.

(2) "Occasional Events" is defined as between 30 and 70 vibration events of the same source per day.

(3) "Infrequent Events" is defined as fewer than 30 vibration events of the same kind per day.

(4) This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Vibration-sensitive manufacturing or research would require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the HVAC systems and stiffened floors.

2.4. Impact Assessment Methodology

2.4.1. Noise

Noise impacts were assessed in accordance with guidelines specified in the FTA's Transit Noise and Vibration Impact Assessment manual. This section describes the methodology for assessing the potential impact from the project.

The noise assessment methodology for assessing noise impact from BRT operations included the following steps:

- Identify noise-sensitive land uses in the corridor using aerial photography, GIS data, and field surveys, typically within 200 feet of the route (see Section 3.1.2).
- Measure or estimate existing noise levels in the corridor near sensitive receptors (see Section 3.1.1).
- Predict future project noise levels from transit operations, using preliminary engineering plans and information on speeds, headways, and vehicle type. The project noise level assessment includes BRT

operations and station noise. Details regarding the information used to predict future project noise levels can be found below.
- Assess the impact of the project by comparing the projected future noise levels with existing noise levels using the FTA noise impact criteria in section 2.1.2.
- Recommend mitigation at locations where projected future noise levels exceed the FTA impact criteria.

In addition, a construction noise impact assessment was conducted using the methodology in Section 7 of the FTA guidance manual.

Project noise levels from operations are based on source reference levels found in the FTA guidance manual and the current design of the proposed project. This information was used to project noise levels at sensitive locations from the proposed route. Specific inputs used in the noise impact assessment include the following:

- Location of the noise sensitive receivers in relation to the roadway
- A bus source reference noise level for electric buses of 80 dBA SEL at 50 feet and 50 mph
- Speed of buses along the roadway, which vary from 15 mph to 40 mph
- The operating schedule for the buses is as follows:
    - 5:30 a.m. to 7:30 p.m.: 15-minute headways
    - 7:30 p.m. to 12 a.m.: 30-minute headways
- The only significant source of noise at stations is buses idling; however, the noise levels generated by idling electric buses are not high enough to contribute to project noise levels.

2.4.2. Vibration

Because the Madison East-West BRT Project includes a rubber-tired vehicle, a vibration screening assessment would only be conducted under unusual circumstances, as described in section 2.2.2. There are possible vibration-sensitive research and medical buildings along the proposed route; however, adding additional rubber-tired vehicles to an existing roadway that is already in use by other buses and trucks would not significantly increase the vibration levels above those already experienced at sensitive locations.

3. Existing Conditions

The affected noise environment in the vicinity of the proposed project was investigated based on a review of current project and land use information, GIS data, a windshield survey, and measurements conducted during August 2021. Land use in the study area includes a combination of residential, institutional, commercial, and industrial zones. Noise-sensitive and vibration-sensitive land uses (as defined in Table 1) in the study area were identified based on route drawings, aerial photographs, visual surveys, and land use information. Sensitive receptors located near the proposed alternatives include single-family and multi-family residences, hotels, and places of worship.

A summary of noise-sensitive land uses adjacent to the proposed project is provided below, followed by descriptions of the existing noise conditions in the study area.

3.1. Noise Measurement Procedures and Equipment

The noise measurement program was conducted in August 2021 and consisted of long-term (24-hour) and short-term (one-hour) monitoring of the A-weighted sound levels. All the measurement sites were in or near noise-sensitive areas and were selected to represent a range of existing noise conditions near the proposed project.

At each of the measurement sites, the A-weighted sound levels were continuously monitored during the measurement periods. The noise measurements were performed with NTi Audio Model XL2 noise monitors that conform to American National Standards Institute (ANSI) Standard S1.4 for Type 1 (Precision) sound level meters. Calibrations, traceable to the U.S. National Institute of Standards and Technology (NIST), were carried out in the field before and after each set of measurements using an acoustical calibrator.

In all cases, the measurement microphone was protected by a windscreen and supported on a tripod at a height of 4 to 6 feet above the ground and was positioned to characterize the exposure of the site to the dominant noise sources in the area. For example, microphones were located at the approximate setback lines of the receptors from adjacent roads and were positioned to avoid acoustic shielding by landscaping, fences, or other obstructions.

3.2. Existing Noise Conditions

Existing noise sources in the project area include traffic on local roadways, aircraft overflights, and local community activities. The existing ambient sound levels vary by location, depending on the proximity to local roadways, and are generally typical of a suburban environment near a busy arterial roadway. Existing ambient noise levels were characterized through direct measurements at selected sites in the area near the proposed project during August 2021. Long-term noise measurements were conducted at four locations, and short-term noise measurements were conducted at 11 locations near the proposed project.

Table 5 summarizes the results of the existing noise measurement program for the project, and Figure 4 shows the locations of the noise measurements for the project. The results of the existing noise measurements were used to characterize the existing noise levels at all noise-sensitive locations in the project vicinity.

- **Site LT-1: 4849 Sheboygan Avenue.** The Ldn measured at this location was 61 dBA, and the measured peak hour Leq was 59 dBA. This location is representative of the noise-sensitive land uses along Sheboygan Avenue and Segoe Road. The ambient noise levels were dominated by traffic on Sheboygan Avenue and community noise.
- **Site LT-2: 2110 University Avenue.** The Ldn measured at this location was 73 dBA, and the measured peak hour Leq was 71 dBA. This location is representative of the noise sensitive land uses between University Bay Drive and University Avenue. The ambient noise levels were dominated by traffic on Campus Drive and University Avenue.
- **Site LT-3: 1954 Washington Avenue.** The Ldn measured at this location was 68 dBA, and the measured peak hour Leq was 65 dBA. This location is representative of the noise sensitive land uses between Baldwin Street to WI-30. The ambient noise levels were dominated by traffic on Washington Avenue.
- **Site LT-4: 4402 E Washington Avenue.** The Ldn measured at this location was 64 dBA, and the measured peak hour Leq was 59 dBA. This location is representative of noise-sensitive land uses along Washington Avenue between Anderson Street and I-90. The ambient noise levels were dominated by traffic on Washington Avenue, aircraft and parking lot activity.
- **Site ST-1: Yorktown Apartments.** The Leq measured at this location was 58 dBA, and the estimated Ldn was 56 dBA. This location is representative of noise-sensitive land uses along Mineral Point Road. The ambient noise levels were dominated by traffic on Mineral Point Road.
- **Site ST-2: Mount Olive Lutheran Church.** The Leq measured at this location was 60 dBA, and the estimated Ldn was 58 dBA. This location is representative of noise sensitive land uses along Whitney Way. The ambient noise levels were dominated by traffic on Whitney Way.
- **Site ST-3: 3902 University Avenue.** The Leq measured at this location was 64 dBA, and the estimated Ldn was 62 dBA. This location is representative of noise-sensitive land uses along University Avenue

between Segoe Road and University Bay Drive. The ambient noise levels were dominated by traffic on University Avenue.

- **Site ST-4: 1509 University Avenue.** The Leq measured at this location was 71 dBA, and the estimated Ldn was 69 dBA. This location is representative of the noise-sensitive land uses at the intersection of University Avenue and Campus Drive. The ambient noise levels were dominated by traffic on University Avenue and Campus Drive.
- **Site ST-5: 437 W Gorham Street.** The Leq measured at this location was 69 dBA, and the estimated Ldn was 67 dBA. This location is representative of noise-sensitive land uses along University Avenue and Gorham Street. The ambient noise levels were dominated by traffic on Gorham Street and pedestrians.
- **Site ST-6: 430 Johnson Street.** The Leq measured at this location was 68 dBA, and the estimated Ldn was 66 dBA. This location is representative of noise-sensitive land uses along Johnson Street between Orchard Street and State Street. The ambient noise levels were dominated by traffic on Johnson Street and pedestrians.
- **Site ST-7: St John's Lutheran Church.** The Leq measured at this location was 66 dBA, and the estimated Ldn was 68 dBA. This location is representative of noise-sensitive land uses along Capitol Square and Washington Avenue between Capitol Square and Dickinson Street. The ambient noise levels were dominated by traffic on Washington Avenue and light construction activities.
- **Site ST-8: Ridgeway Church.** The Leq measured at this location was 70 dBA, and the estimated Ldn was 68 dBA. This location is representative of noise-sensitive land uses along Washington Avenue between WI-30 and Wright Street. The ambient noise levels were dominated by traffic on Washington Avenue.
- **Site ST-9: 1501 Wright Street.** The Leq measured at this location was 58 dBA, and the estimated Ldn was 56 dBA. This location is representative of the noise-sensitive land uses along Wright Street, Anderson Street, and Mendota Street. The ambient noise levels were dominated by traffic on Wright Street and aircraft.
- **Site ST-10: Grand Stay Hotel and Suites.** The Leq measured at this location was 65 dBA, and the estimated Ldn was 63 dBA. This location is representative of the noise-sensitive land uses along the route to the Sun Prairie Park-and-Ride. The ambient noise levels were dominated by air traffic and traffic on I-90, RT 151 and High Crossing Boulevard.
- **Site ST-11: Cambria Hotel Madison.** The Leq measured at this location was 58 dBA, and the estimated Ldn was 56 dBA. This location is representative of the noise-sensitive land uses north of the terminus. The ambient noise levels were dominated by traffic on I-90, RT 151 and Eastpark Boulevard.

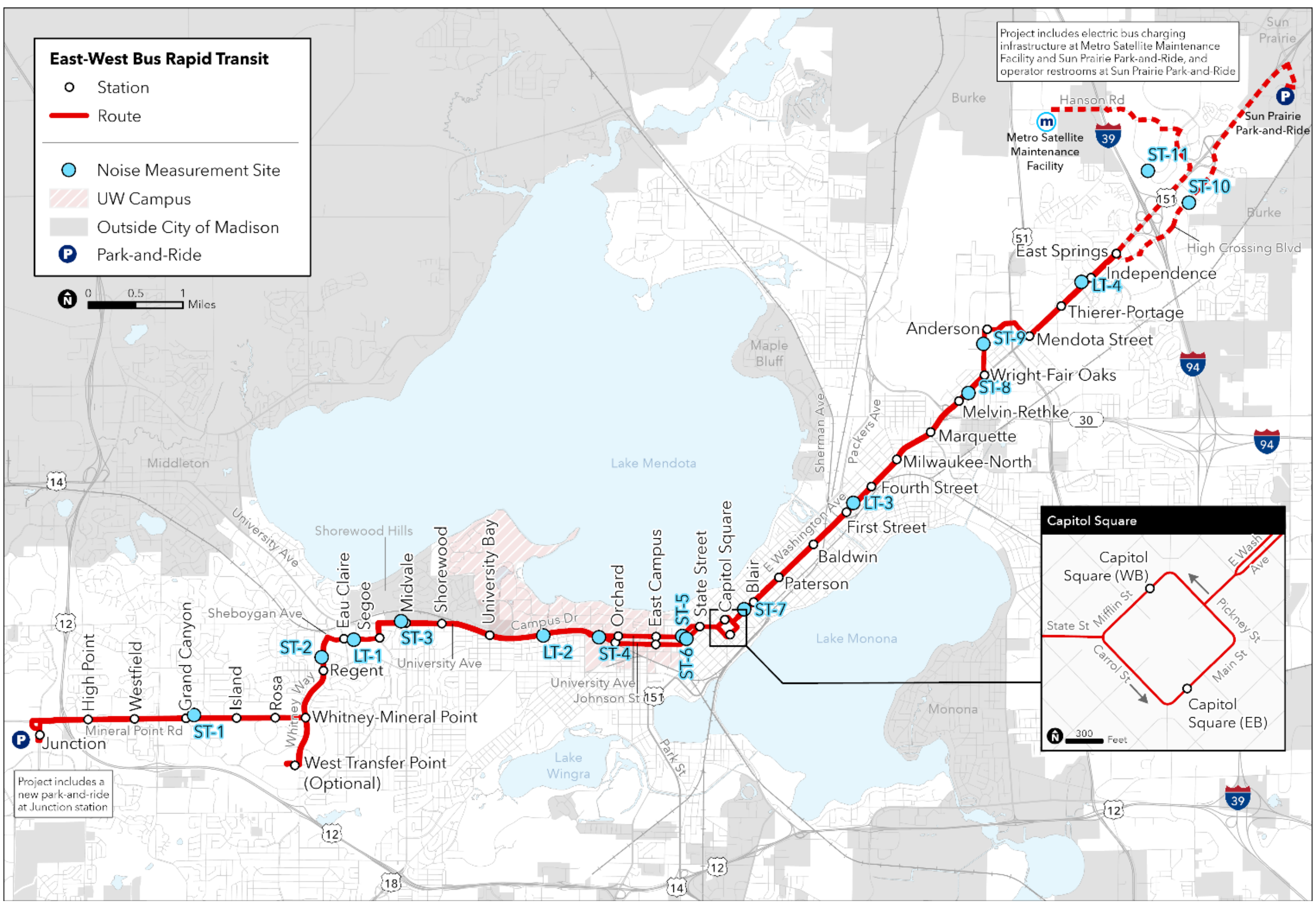
Table 5: Summary of Existing Ambient Noise Measurements Results

Site No.	Measurement Location Description	Start Date	Start Time	Meas. Duration (hours)	Noise Exposure (dBA) Ldn	Noise Exposure (dBA) 1-hour Leq
LT-1	4849 Sheboygan Avenue	8/10/2021	16:00	24	61	59
LT-2	2110 University Avenue	8/10/2021	16:00	24	73	71
LT-3	1954 Washington Avenue	8/9/2021	14:00	24	68	65
LT-4	4402 E Washington Avenue	8/9/2021	15:00	24	64	59
ST-1	Yorktown Apartments	8/12/2021	10:35	1	56	58

Site No.	Measurement Location Description	Start Date	Start Time	Meas. Duration (hours)	Noise Exposure (dBA) Ldn	Noise Exposure (dBA) 1-hour Leq
ST-2	Mount Olive Lutheran Church	8/12/2021	11:50	1	58	60
ST-3	3902 University Avenue	8/11/2021	15:11	1	62	64
ST-4	1509 University Avenue	8/11/2021	13:47	1	69	71
ST-5	437 W Gorham Street	8/11/2021	11:40	1	67	69
ST-6	430 Johnson Street	8/12/2021	10:36	1	66	68
ST-7	St John's Lutheran Church	8/12/2021	14:02	1	66	68
ST-8	Ridgeway Church	8/10/2021	11:24	1	68	70
ST-9	1501 Wright Street	8/9/2021	15:25	1	56	58
ST-10	Grand Stay Hotel and Suites	8/9/2021	16:44	1	63	65
ST-11	Cambria Hotel Madison	8/9/2021	18:04	1	56	58

Source: CSA, 2021

Figure 4: Noise Measurement Locations



3.3. Noise Sensitive Land Uses

For the purposes of this analysis, the study area for noise is within 200 feet of the route centerline. Noise-sensitive land uses within the study area were identified based on GIS data, aerial photography, drawings, and project plans. The noise-sensitive land uses are described below.

Mineral Point Road

The noise-sensitive land uses in this section of the proposed project on Mineral Point Road include single- and multi-family homes.

Whitney Way

The noise-sensitive land uses in this section of the proposed project on Whitney Way between Mineral Point Road and Sheboygan Avenue include Mt Olive Lutheran Church and single- and multi-family homes.

Sheboygan Avenue and University Avenue to University Bay Drive

The noise-sensitive land uses in this section of the proposed project between Sheboygan Avenue and University Bay Drive include single- and multi-family homes.

Campus Drive, University Avenue and West Johnson Street

The noise-sensitive land uses in this section of the proposed project between University Bay Drive and State Street include hotels, the Madison Fire Department Station 1, single- and multi-family homes and the University of Wisconsin campus. The campus noise-sensitive land uses include buildings within 200 feet of the route including classrooms, laboratories, libraries, and other noise sensitive areas.

State Street and Capitol Square

The noise-sensitive land uses in this section of the proposed project on State Street and Capitol Square include The Orpheum Theater, Overture Center, Wisconsin Veterans Museum, The State Historical Museum, Madison Children's Museum, Bartell Theatre, Grace Episcopal Church, Department of Justice Law Library, hotels, and multi-family homes.

East Washington Avenue to Wright Street

The noise-sensitive land uses in this section of the proposed project between Capitol Square and Wright Street include St John's Lutheran Church, East High School, Assumption Greek Orthodox Church, hotels, and single- and multi-family homes.

Wright Street, Anderson Street and Mendota Street

The noise-sensitive land uses in this section of the proposed project on Wright Street, Anderson Street and Mendota Street include the Madison Area Technical College and single- and multi-family homes.

East Washington Avenue to Terminus

The noise-sensitive land uses in this section of the proposed project between Mendota Street and the terminus include hotels and single- and multi-family homes.

North of Terminus

The noise-sensitive land uses in this section of the proposed project north of the terminus include hotels and single-family homes.

4. Environmental Consequences

A general noise impact assessment was carried out based on the criteria and prediction methodology discussed in Section 2. The assessment results are presented below.

4.1. No Build Alternative

There would be no changes in the noise levels with the No Build Alternative and, therefore, no noise impacts.

4.2. Build Alternative

4.2.1. Operating Phase Impacts

Comparisons of the existing and future noise levels are presented in Table 6 and Table 7. Table 6 includes the results for FTA Category 2 (residential) receptors with both day and nighttime use. Table 7 includes the results for the FTA Category 3 (institutional) receptors with primarily daytime use. In addition to the distances to the route and proposed bus speeds, Table 6 and Table 7 include the modeled existing noise levels and the projected noise levels from bus operations for each location along the project. Based on a comparison of the predicted project noise levels with the impact criteria, the table also includes an inventory of the moderate and severe noise impacts in each section.

The noise assessment was conducted using the assumption that all East-West BRT vehicles would be electric buses. There is a possibility that some diesel buses would be used. If diesel buses are used for some or all of the fleet, there would be an increase in operational noise, but no change to the impact designations. Idling buses at the terminal stations would generate additional noise. Because there are no sensitive receptors near these stations, there would not be a noise impact from buses idling.

As shown in Table 6 and Table 7, the project would result in no noise impacts at either residential or institutional land uses.

Table 6: Summary of FTA Category 2 (Residential) Noise Impacts

Location	Side of Road	Dist. To Near Lane (feet)	Existing Noise Level (Ldn, dBA)	Project Noise Level (Ldn, dBA)	Moderate Noise Criteria	Severe Noise Criteria	# of Moderate Impacts	# of Severe Impacts
Highway 14 to Randolph Drive	EB	316	59	38	57	63	0	0
Highway 14 to Randolph Drive	WB	115	56	45	56	62	0	0
Gammon Road to Nautilus Drive	EB	*	*	*	*	*	*	*
Gammon Road to Nautilus Drive	WB	83	56	47	56	62	0	0
Nautilus Drive to Rosa Road	EB	154	56	43	56	62	0	0
Nautilus Drive to Rosa Road	WB	119	56	44	56	62	0	0
Mineral Point Road to Marathon Drive	EB	73	58	44	57	62	0	0
Mineral Point Road to Marathon Drive	WB	69	58	44	57	62	0	0
Marathon Drive to Sheboygan Avenue	EB	76	58	43	57	62	0	0
Marathon Drive to Sheboygan Avenue	WB	60	58	45	57	62	0	0
Whitney Way to University Avenue	EB	56	61	47	58	64	0	0
Whitney Way to University Avenue	WB	59	58	46	57	62	0	0
Segoe Road to Midvale Boulevard	EB	*	*	*	*	*	*	*
Segoe Road to Midvale Boulevard	WB	45	62	49	59	65	0	0
Midvale Boulevard to Schmitt Place	EB	69	62	46	59	65	0	0
Midvale Boulevard to Schmitt Place	WB	*	*	*	*	*	*	*
Schmitt Place to University Bay Drive	EB	70	62	46	59	65	0	0
Schmitt Place to University Bay Drive	WB	137	62	42	59	65	0	0
University Bay Drive to Walnut Street	EB	46	73	50	65	72	0	0

Location	Side of Road	Dist. To Near Lane (feet)	Existing Noise Level (Ldn, dBA)	Project Noise Level (Ldn, dBA)	Moderate Noise Criteria	Severe Noise Criteria	# of Moderate Impacts	# of Severe Impacts
University Bay Drive to Walnut Street	WB	*	*	*	*	*	*	*
Walnut Street to University Avenue	EB	42	73	51	65	72	0	0
Walnut Street to University Avenue	WB	*	*	*	*	*	*	*
University Avenue to North Charter Street	EB	*	*	*	*	*	*	*
University Avenue to North Charter Street	WB	*	*	*	*	*	*	*
North Charter Street to Park Street	EB	32	66	45	62	67	0	0
North Charter Street to Park Street	WB	19	67	49	62	67	0	0
Park Street to Bassett Street	EB	18	66	49	62	67	0	0
Park Street to Bassett Street	WB	20	67	49	62	67	0	0
Bassett Street to State Street	EB	20	66	49	62	67	0	0
Bassett Street to State Street	WB	12	67	52	62	67	0	0
Gorham Street to Capitol Square	EB	35	66	40	61	67	0	0
Gorham Street to Capitol Square	WB	20	66	44	62	67	0	0
Capitol Square	EB	51	66	42	61	67	0	0
Capitol Square	WB	54	66	42	61	67	0	0
Capitol Square to Blount Street	EB	50	66	48	61	67	0	0
Capitol Square to Blount Street	WB	47	66	48	61	67	0	0
Blount Street to Brearly Street	EB	71	66	46	61	67	0	0
Blount Street to Brearly Street	WB	60	66	47	61	67	0	0
Brearly Street to Baldwin Street	EB	*	*	*	*	*	*	*
Brearly Street to Baldwin Street	WB	53	66	48	61	67	0	0

Location	**Side of Road**	**Dist. To Near Lane (feet)**	**Existing Noise Level (Ldn, dBA)**	**Project Noise Level (Ldn, dBA)**	**Moderate Noise Criteria**	**Severe Noise Criteria**	**# of Moderate Impacts**	**# of Severe Impacts**
Baldwin Street to First Street	EB	77	68	45	63	68	0	0
Baldwin Street to First Street	WB	50	66	48	61	67	0	0
First Street to 4th Street	EB	67	68	46	63	68	0	0
First Street to 4th Street	WB	52	68	48	63	68	0	0
4th Street to Milwaukee Street	EB	63	68	47	63	68	0	0
4th Street to Milwaukee Street	WB	55	68	48	63	68	0	0
Milwaukee Street to Marquette Street	EB	63	68	47	63	68	0	0
Milwaukee Street to Marquette Street	WB	62	68	47	63	68	0	0
Marquette Street to Melvin Court	EB	138	68	42	63	68	0	0
Marquette Street to Melvin Court	WB	64	68	43	63	68	0	0
Melvin Court to Wright Street	EB	189	68	40	63	68	0	0
Melvin Court to Wright Street	WB	63	68	47	63	68	0	0
Wright Street to Anderson Street	EB	50	56	44	56	62	0	0
Wright Street to Anderson Street	WB	*	*	*	*	*	*	*
Anderson Street to Washington Avenue	EB	42	56	45	56	62	0	0
Anderson Street to Washington Avenue	WB	61	56	43	56	62	0	0
Mendota Street to Thierer Road	EB	*	*	*	*	*	*	*
Mendota Street to Thierer Road	WB	44	64	50	60	65	0	0
Thierer Road to Independence Lane	EB	111	64	44	60	65	0	0
Thierer Road to Independence Lane	WB	145	64	42	60	65	0	0
Springs Drive to I-90	EB	*	*	*	*	*	*	*

Location	Side of Road	Dist. To Near Lane (feet)	Existing Noise Level (Ldn, dBA)	Project Noise Level (Ldn, dBA)	Moderate Noise Criteria	Severe Noise Criteria	# of Moderate Impacts	# of Severe Impacts
Springs Drive to I-90	WB	133	64	43	60	65	0	0
Eastpark Boulevard	EB	*	*	*	*	*	*	*
Eastpark Boulevard	WB	138	56	42	56	62	0	0
High Crossing Boulevard	EB	145	63	39	59	65	0	0
High Crossing Boulevard	WB	109	63	41	59	65	0	0

Source: CSA, 2021

Note: (*) There are no noise sensitive receivers in this location.

Table 7: Summary of FTA Category 3 (Institutional) Noise Impacts Without Mitigation

Name	Location	Side of Road	Dist. to Near Lane (feet)	Existing Noise Level (Leq, dBA)	Project Noise Level (Leq, dBA)	Moderate Noise Criteria	Severe Noise Criteria	# of Moderate Impacts	# of Severe Impacts
Mt Olive Lutheran Church	Marathon Drive to Sheboygan Avenue	WB	68	60	42	63	68	0	0
UW-Madison Department of Biomedical Engineering	University Avenue to North Charter Street	EB	143	71	36	70	75	0	0
UW-Madison Department of Biochemistry	University Avenue to North Charter Street	WB	109	71	39	70	75	0	0
UW-Madison Babcock Hall	Walnut Street to University Avenue	WB	150	71	39	70	75	0	0

Name	Location	Side of Road	Dist. to Near Lane (feet)	Existing Noise Level (Leq, dBA)	Project Noise Level (Leq, dBA)	Moderate Noise Criteria	Severe Noise Criteria	# of Moderate Impacts	# of Severe Impacts
UW-Madison Department of Mechanical Engineering	University Avenue to North Charter Street	EB	77	71	40	70	75	0	0
UW-Madison Department of Materials Science and Engineering	University Avenue to North Charter Street	EB	53	71	41	70	75	0	0
UW-Madison DeLuca Biochemistry Building	University Avenue to North Charter Street	WB	52	71	44	70	75	0	0
UW-Madison Biotechnology	University Avenue to North Charter Street	WB	75	71	38	70	75	0	0
UW-Madison Computer Aided Engineering Center	University Avenue to North Charter Street	EB	92	71	37	70	75	0	0
UW-Madison Medical Sciences Center	University Avenue to North Charter Street	WB	77	69	37	68	74	0	0
UW-Madison Brogden Psychology Building	University Avenue to North Charter Street	WB	174	69	33	68	74	0	0
UW-Madison Hyde Janet S	University Avenue to North Charter Street	EB	65	68	39	68	73	0	0
UW-Madison Computer Sciences	University Avenue to North Charter Street	EB	117	68	34	68	73	0	0
AMP Library	North Charter Street to Park Street	WB	83	69	37	68	74	0	0
Geneva Campus Church	North Charter Street to Park Street	WB	103	69	36	68	74	0	0
UW-Madison Department of Chemistry	North Charter Street to Park Street	EB	67	68	38	68	73	0	0

Name	Location	Side of Road	Dist. to Near Lane (feet)	Existing Noise Level (Leq, dBA)	Project Noise Level (Leq, dBA)	Moderate Noise Criteria	Severe Noise Criteria	# of Moderate Impacts	# of Severe Impacts
UW-Madison Chemistry Building	North Charter Street to Park Street	WB	96	69	36	68	74	0	0
UW-Madison Lathrop Hall (Dance Hall)	North Charter Street to Park Street	WB	44	69	41	68	74	0	0
Luther Memorial Church	North Charter Street to Park Street	WB	95	69	36	68	74	0	0
UW-Madison Educational Sciences	North Charter Street to Park Street	EB	29	68	44	68	73	0	0
Zoological Museum Research Library	North Charter Street to Park Street	EB	160	68	32	68	73	0	0
MERIT Library	North Charter Street to Park Street	EB	209	68	28	68	73	0	0
UW-Madison Mosse Humanities Building	Park Street to Bassett Street	WB	88	69	36	68	74	0	0
Business Library	North Charter Street to Park Street	WB	79	69	37	68	74	0	0
UW-Madison Grainger Hall	North Charter Street to Park Street	EB	50	68	40	68	73	0	0
Journalism Reading Room	Park Street to Bassett Street	EB	50	68	40	68	73	0	0
UW-Madison Vilas Hall	Park Street to Bassett Street	WB	91	69	36	68	74	0	0
Art Library	Park Street to Bassett Street	WB	121	69	34	68	74	0	0

Name	Location	Side of Road	Dist. to Near Lane (feet)	Existing Noise Level (Leq, dBA)	Project Noise Level (Leq, dBA)	Moderate Noise Criteria	Severe Noise Criteria	# of Moderate Impacts	# of Severe Impacts
Chazen Museum of Art	Park Street to Bassett Street	WB	117	69	34	68	74	0	0
UW-Madison Hamel Music Center	Park Street to Bassett Street	WB	48	69	41	68	74	0	0
UW-Madison Fluno Center for Executive Education	Park Street to Bassett Street	WB	87	69	37	68	74	0	0
The Orpheum Theater	Gorham Street to Capitol Square	WB	23	68	41	68	73	0	0
Overture Center	Gorham Street to Capitol Square	EB	35	68	38	68	73	0	0
Comedy on State	Gorham Street to Capitol Square	WB	15	68	44	68	73	0	0
Wisconsin Veterans Museum	Capitol Square	WB	65	68	39	68	73	0	0
The State Historical Museum	Capitol Square	EB	43	68	43	68	73	0	0
Madison Children's Museum	Capitol Square	WB	165	68	30	68	73	0	0
Bartell Theatre	Capitol Square	WB	189	68	32	68	73	0	0
Grace Episcopal Church	Capitol Square	EB	47	68	41	68	73	0	0
Dept of Justice Law Library	Capitol Square	EB	52	68	40	68	73	0	0
St John's Lutheran Church	Capitol Square to Blount Street	WB	48	68	46	68	73	0	0
High Noon Saloon	Blount Street to Brearly Street	EB	65	68	44	68	73	0	0
East High School	4th Street to Milwaukee Street	WB	101	65	42	65	71	0	0

Name	Location	Side of Road	Dist. to Near Lane (feet)	Existing Noise Level (Leq, dBA)	Project Noise Level (Leq, dBA)	Moderate Noise Criteria	Severe Noise Criteria	# of Moderate Impacts	# of Severe Impacts
Assumption Greek Orthodox Church	4th Street to Milwaukee Street	WB	56	65	45	65	71	0	0
Truax-Health Education and Info Tech Building	Anderson Street to Washington Avenue	WB	172	58	34	62	67	0	0
Madison College	Anderson Street to Washington Avenue	WB	134	58	35	62	67	0	0

Source: CSA, 2021

4.2.2. Construction Phase Impacts

Construction Noise

Elevated noise levels from construction activities are, to a degree, unavoidable for a project. For most construction equipment, diesel engines are typically the dominant noise source. For other activities, such as impact pile driving and jackhammering, noise generated by the actual process dominates. Short-term noise during construction of the project can be intrusive to residents near the construction sites. Most of the construction would consist of site preparation, modifying the roadways, and other minor construction and should occur primarily during daytime hours. At some locations, more extensive work could occur. Nighttime work may be required in some location or for specific activities. City noise ordinance procedures would be followed, and waivers or noise variances would be obtained as required.

Construction noise predictions at noise-sensitive locations depend on the amount of noise during each construction phase, the duration of the noise, and the distance from the construction activities to the sensitive receptor. Conducting a construction noise impact assessment requires knowledge of the equipment likely to be used, the duration of its use, and the way it would be used by a contractor.

Specific construction scenarios would be developed during the preparation of the construction noise and vibration plan, when more information on methods, equipment, and durations is available. For typical roadway construction activities, which would be expected for the project, the potential for construction noise impacts would extend to within 80 feet of the roadway for daytime construction and up to 200 feet from the roadway for nighttime construction.

Construction Vibration

With construction vibration, there is the potential for damage to nearby structures at close distances due to construction activities, such as pile driving, hoe rams, vibratory compaction, and loaded trucks. Most limits on construction vibration are based on reducing the potential for damage to nearby structures. Although construction vibrations are only temporary, it is still reasonable to assess the potential for human annoyance and damage.

As a conservative approach, the non-engineered timber and masonry construction category (Category III) has been used to assess the potential for damage from construction vibration. A vibration criterion of 94 VdB has been used to assess potential damage impact. With no pile driving expected for the project, the highest levels of construction vibration would be generated by vibratory compaction and the potential for damage from this activity is limited to within 25 feet, and the potential for human annoyance is limited to within 135 feet. All other activities would have lesser screening distances for both the potential for damage and human annoyance.

Because the exact location of construction equipment is important in projecting vibration levels, a more detailed assessment of potential vibration damage would be performed during final design when more accurate equipment locations are known.

5. Mitigation Measures

5.1. Operational Noise and Vibration

There are no noise or vibration impacts identified due to the operational phase of the project. Therefore, mitigation is not required.

5.2. Construction Noise and Vibration

Construction activities would be carried out in compliance with all applicable local noise regulations. Specific construction noise and vibration mitigation measures would be developed during the design phase of the project when more detailed construction information is available. The following mitigation measures would be applied as needed to minimize temporary construction noise and vibration impacts:

- Avoiding nighttime construction in residential neighborhoods.
- Locating stationary construction equipment as far as possible from noise-sensitive sites.
- Constructing noise barriers, such as temporary walls or piles of excavated material, between noisy activities and noise-sensitive receivers.
- Routing construction-related truck traffic to roadways that would cause the least disturbance to residents.
- Using alternative construction methods to minimize the use of impact and vibratory equipment (e.g., pile-drivers and compactors).

The primary means of mitigating noise from construction activities is to require the contractors to prepare a detailed Noise Control Plan. A noise control engineer or acoustician would work with the contractor to prepare a Noise Control Plan in conjunction with the contractor’s specific equipment and methods of construction. Key elements of a plan include:

- Contractor’s specific equipment types.
- Schedule and methods of construction.
- Maximum noise limits for each piece of equipment with certification testing.
- Prohibitions on certain types of equipment and processes during the nighttime hours without local agency coordination and approved variances.
- Identification of specific sensitive sites where near construction sites.
- Methods for projecting construction noise levels.
- Implementation of noise control measures where appropriate.
- Methods for responding to community complaints.