13.0 Noise and Vibration

13.1. Introduction

This chapter defines the noise and vibration pertinent to the Long Bridge Project (the Project), and defines the regulatory context, methodology, and Affected Environment. For each Action Alternative and the No Action Alternative, this chapter assesses the potential short-term and long-term impacts due to noise and vibration. This chapter also discusses proposed avoidance, minimization, and mitigation measures to reduce adverse impacts of the Project.

This analysis defines noise as unwanted or undesirable sound. The analysis evaluates noise based on its potential to cause human annoyance. Because humans hear certain frequencies or pitches of sound better than others, the analysis measures and reports sound levels using a descriptor called the **A-weighted sound level,** notated as dBA. Because sound levels fluctuate from moment to moment, the noise assessment for the Project uses the following sound level metrics:

- **Maximum A-weighted Level (Lmax)**, which represents the highest sound level generated by a source. For mobile sources, the maximum level typically occurs when the source is closest to the measurement or analysis location.
- **Energy-average Level (Leq)**, which is a single value that is equivalent in sound energy to the fluctuating levels over a period. The Leq accounts for how loud events are during the period, how long they last, and how many times they occur.
- **Day-night Average Level (Ldn)**, which is a single value that represents the sound energy during a 24-hour period with a 10-decibel (dB) penalty applied to sound that occurs between 10:00 PM and 7:00 AM, when people are more sensitive to noise. Ldn accounts for how loud events are, how long they last, how many times they occur, and whether they occur at night.

Ground-borne vibration is the oscillatory motion of the ground caused by sources such as trains or construction equipment. Trains generate ground-borne vibration when forces associated with the wheel-rail interaction are transmitted through the track structure into the ground and into adjacent buildings. Vibration may be perceptible and disturb people or sensitive activities in nearby buildings. Vibration levels much higher than the thresholds of human perception can increase the risk of structural damage to buildings. Vibration levels are expressed in decibel notation as VdB to differentiate from sound decibels.

13.2. Regulatory Context and Methodology

This section describes the most pertinent regulatory context for evaluating noise and vibration impacts. It summarizes the methodology for evaluating current conditions, operational and construction noise and vibration impact criteria, and the probable consequences of the alternatives. This section also includes a description of the Study Area. **Appendix D1, Methodology Report**, provides the complete list of laws, regulations, and other guidance considered, and a full description of the analysis methodology.

13.2.1. Regulatory Context

The assessment analyzed noise and vibration from the proposed Project according to the Federal Transit Administration (FTA) *Noise and Vibration Impact Assessment* guidance manual.[1,2] This guidance manual describes the technical approach for assessing noise and vibration for railroad and transit projects with train speeds below 90 miles per hour, and the process for evaluating the need for and effectiveness of potential mitigation.

The assessment evaluated construction noise according to the District of Columbia (District) noise ordinance and *Arlington County Noise Control Code, Chapter 15*.[3,4] The noise ordinances impose construction period noise limits during day and nighttime hours and require that contractors implement all feasible procedures and measures customarily used in the industry to minimize noise. Sound generated by trains, other than Washington Metropolitan Area Transit Authority railcars, is specifically exempt from the District ordinance.

13.2.2. Methodology

The process to assess noise and vibration impact included determining the noise and vibration Local Study Area, identifying noise- and vibration-sensitive receptors, understanding the predominant sources of noise and vibration, and characterizing existing noise and vibration conditions through measurements. The assessment then predicted noise and vibration conditions for the No Action and Action Alternatives, compared them to applicable FTA criteria, and evaluated potential mitigation as warranted.

The assessment included a Detailed Noise Assessment based on *Chapter 6* of the FTA Manual to predict future noise conditions from mobile sources.[5] The assessment also included a Detailed Vibration Assessment based on *Chapter 8* of the FTA Manual to predict future vibration conditions from trains.[6] The assessment evaluated construction noise and vibration based on *Chapter 12* of the FTA Manual.[7] The FTA has guideline construction noise impact criteria; however, they are only used in locations where there are no local or state construction noise ordinances. Since there are local noise ordinances in the Local Study Area, FTA guideline criteria have not been used.

As shown in **Figure 13-1**, the Local Study Area for noise and vibration extends up to 750 feet from the Project Area. Analysis does not typically assess noise and vibration at a regional level for this project type, since noise and vibration effects occur more locally to the project footprint. Therefore, this assessment did not include a Regional Study Area.

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[1] FRA. September 2012. *High Speed Ground Transportation Noise and Vibration Impact Assessment*. Report DOT/FRA/ORD-12/15. Accessed from https://www.fra.dot.gov/eLib/Details/L04090. Accessed June 6, 2017.
[2] FTA. May 2006. *Transit Noise and Vibration Impact Assessment*. Report FTA-VA-90-1003-06. Accessed from https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/FTA_Noise_and_Vibration_Manual.pdf. Accessed June 6, 2017.
[3] DC Municipal Regulations Chapters 20–27.
[4] Arlington County. Arlington County Code: Chapter 15, Noise Control Ordinance. Accessed from https://countyboard.arlingtonva.us/wp-content/uploads/sites/22/2016/04/Chapter-15-NOISE-CONTROL.pdf. Accessed May 1, 2018.
[5] FTA. *Transit Noise and Vibration Impact Assessment*.
[6] FTA. *Transit Noise and Vibration Impact Assessment*.
[7] FTA. *Transit Noise and Vibration Impact Assessment*.

Figure 13-1 | Local Study Area and Noise and Vibration Measurement Locations

13.2.2.1. Noise Impact Criteria

FTA noise impact criteria are known as "ambient-based" criteria, which evaluate the impact of a change in the noise environment due to the introduction of new noise sources and/or modification of existing sources. The noise impact criteria for human annoyance compare the existing noise conditions to the future noise conditions with the Action Alternative. Noise is evaluated outdoors based on Ldn levels for residential land uses (FTA Noise Land Use Category 2) and based on peak transit hour Leq for institutional land uses such as schools, museums, libraries, and parks with passive recreation (FTA Noise Land Use Category 1 and 3). The two levels of noise impact include **severe impact**, where a significant percentage of people would be highly annoyed by a project's noise, and **moderate impact**, where the change in the cumulative noise level would be noticeable to most people, but may not be sufficient to generate strong, adverse reactions.

13.2.2.2. Vibration Impact Criteria

FTA vibration criteria are based on maximum levels for a single train pass-by event and depend on the type of land use and the frequency of events. More than one train may pass by a given location at the same time. However, this is a relatively infrequent occurrence and the incremental increase in vibration due to additional trains on tracks farther away from the nearest track is generally less than two decibels for receptors within 50 feet of the tracks according to the FTA generalized ground vibration curves. For projects in an existing railroad corridor, the vibration impact assessment depends on existing vibration conditions in the Local Study Area. The FTA General Assessment vibration threshold for residential and institutional receptors in the Local Study Area is 72 vibration decibels (VdB) and 75 VdB, respectively. FTA also has vibration criteria for a Detailed Assessment, which are the same threshold levels, but applied in each frequency band rather than an overall vibration level.

Since the Project is an in existing railroad corridor with more than 12 trains per day, vibration impact occurs if levels exceed the FTA criteria and the project significantly increases the number of vibration events (approximately doubling the number of events) or increase vibration levels by 3 VdB or more.

13.2.2.3. Construction Noise and Vibration Criteria

The District noise ordinance prohibits construction sound levels above 80 dBA (Leq) (except for pile driving) 25 feet from the outermost limits of the site between 7:00 AM and 7:00 PM unless the District grants a variance. From 7:00 PM to 7:00 AM, the District may limit construction activities to 65 dBA (Lmax) 25 feet from the outermost limits of the construction site for noise originating in an industrial zone.[8]

The Arlington noise ordinance allows construction activity to produce sound greater than 70 dBA in manufacturing zones, 65 dBA in commercial zones, and 55 dBA in residential and special-purpose zones only during daytime hours (7:00 AM to 9:00 PM on weekdays and 10:00 AM to 9:00 PM on weekends and legal holidays). Nighttime noise limits apply to construction at all other periods of the day.[9]

Vibration generated by construction equipment has the potential to cause structural damage to buildings in very close proximity to construction activities and to annoy persons in nearby buildings.

[8] DC Municipal Regulations Chapters 20–27.
[9] Arlington County Code: Chapter 15, Noise Control Ordinance.

Structural damage is typically limited to impact-type construction equipment such as impact-pile driving used at very close distances to buildings (within 30 feet). The most fragile buildings susceptible to vibration damage (such as historic buildings) typically have a vibration threshold of 90 VdB (0.12 inches per second peak particle velocity [PPV]), while buildings with reinforced concrete, steel, and timber may have a vibration threshold of 102 VdB (0.5 inches per second PPV)[10]. The vibration thresholds for potential damage to structures other than buildings, such as the seawall surrounding East Potomac Park and the Jefferson Memorial Ashlar Seawall, are usually substantially higher than the thresholds for potential effects to buildings.

13.3. Affected Environment

This section summarizes the existing noise and vibration conditions in the Local Study Area. For a complete description of the Affected Environment, see **Appendix D2, Affected Environment Report**.

13.3.1. Noise and Vibration Sensitive Land Use

The study identified existing noise- and vibration-sensitive receptors in the Local Study Area based on a review of aerial photography, District Office of Zoning database information, Arlington County Geographic Information Systems database, and field investigations. The study then categorized receptors according to their use as defined by the FTA. **Table 13-1** provides the FTA definitions. Noise receptors typically include residences and institutional land uses such as schools and museums where noise may interfere with activities. Whether a park is noise-sensitive depends on its use. Most parks used primarily for active recreation are not sensitive to noise. The FTA manual generally considers parks used for passive recreation such as talking, reading, or meditating to be sensitive to noise.

Table 13-1 | FTA Land Use Categories and Metrics for Transit Noise Impact Criteria

FTA Land-Use Noise Category	Noise Metric (dBA)	Description of Land-Use Category
1	**Outdoor Leq[1]**	Tracts of land set aside for serenity and quiet, such as outdoor amphitheaters, concert pavilions, and National Historic Landmarks with significant outdoor use.
2	**Outdoor Ldn**	Buildings used for sleeping such as homes, hospitals, hotels, and other areas where nighttime sensitivity to noise is presumed to be of utmost importance.
3	**Outdoor Leq[1]**	Institutional land uses with primarily daytime and evening uses including schools, libraries, theaters, churches, museums, cemeteries, historic sites, parks, and certain recreational facilities where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material.

Notes: ***1 - Leq for the noisiest hour of related activity during hours of noise sensitivity.***

Source: ***FTA. 2006. Transit Noise and Vibration Impact Assessment***

[10] The appropriate vibration threshold for specific buildings is determined as part of a Construction Noise and Vibration Control Plan, which is typically prepared once a contractor is selected and includes an assessment of the buildings by a structural engineer.

Table 13-2 summarizes the identified noise- and vibration-sensitive land uses within the Local Study Area. Other historic districts and historic properties within the Local Study Area, such as the George Washington Memorial Parkway (GWMP), Mount Vernon Memorial Parkway, East and West Potomac Parks, Central Heating Plant, United States Bureau of Engraving and Printing, and United States Department of Agriculture Cotton Annex, are not sensitive to noise because they do not have noise-sensitive uses according to the FTA Noise Categories.

Table 13-2 | Noise and Vibration-Sensitive Receptors

Receptor	FTA Land-Use Noise Category	Noise-Sensitive Use
Mandarin Oriental Hotel	2	Building used for sleeping.
Portals V Residences	2	Residential building currently under construction.
Long Bridge Park	3	Includes areas for passive recreation such as park benches.[1]
Jefferson Memorial	1	A historic landmark with significant outdoor use.
Cuban Friendship Urn	3	Cultural resource within the East and West Potomac Parks and National Mall historic districts; is an area for passive recreation.

[1]FTA considers activities such as reading, conversation, and meditation to be passive activities where noise could have an effect.[11]

13.3.2. Existing Noise and Vibration Conditions

The predominant sources of noise and vibration in the Local Study Area include railroad operations and traffic on roadways. **Figure 13-1** shows noise and vibration measurements conducted following FTA recommended methods and procedures to determine the existing noise and vibration conditions in the Local Study Area. The analysis conducted noise and vibration measurements at a total of eight locations, including four locations with noise only, three locations with noise and vibration, and one location with vibration only. Existing sound levels generally range from 64 to 76 dBA (Leq), which are typical of an urban area near transportation sources. The existing noise conditions at the Mandarin Oriental Hotel are relatively high—up to 76 dBA (Leq)—due to the presence of wheel squeal generated by trains on the curved track.

The analysis conducted vibration measurements at four locations to determine the maximum vibration levels from train pass-bys. The analysis found exterior vibration levels at the Mandarin Oriental Hotel to be 68 VdB (overall) with a maximum level of 60 VdB in any frequency range, which are relatively low relative to human response and annoyance. The analysis used these measurements to evaluate the existing and Action Alternative vibration levels at all receptors.

[11] FTA. May 2006. *Transit Noise and Vibration Impact Assessment*. Report FTA-VA-90-1003-06. Accessed from https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/FTA_Noise_and_Vibration_Manual.pdf. Accessed June 6, 2017.

13.4. Permanent or Long-Term Effects

This section identifies the potential impacts to the resource that are frequent, extend from the end of construction through the life of the Project, or cause a permanent change in the resource. For a complete description of the long-term impacts of the Project, see **Appendix D3, Environmental Consequences Report**.

13.4.1. Noise

13.4.1.1. No Action Alternative

An increase in noise levels in the No Action Alternative because of increased train operations by 2040 from 76 (Existing) trains to 114 (No Action) trains would result in a minor permanent direct adverse impact.

As shown in **Table 13-3**, existing noise levels range from 65 to 83 dBA and No Action noise levels would range from 67 to 86 dBA. The highest existing sound levels are at the northwestern façade of the Mandarin Oriental Hotel, which is approximately 40 feet from the near-track centerline. Some of the existing trains in this area generate wheel squeal due to the curve of the tracks. The increase in train operations from 76 to 114 trains with the No Action Alternative would generally increase noise conditions by 2 to 4 dBA at receptors close to the railroad Corridor. At locations farther from the railroad Corridor, such as the Jefferson Memorial (R5) and Cuban Friendship Urn (R4), there would be very little change in noise with the No Action Alternative because train noise is only a portion of the overall noise environment, which includes other sources such as traffic on I-395 and aircraft activity at Ronald Reagan Washington National Airport.

Table 13-3 | Existing and No Action Alternative Noise Conditions

			Noise Level (Ldn/Leq, dBA)[1]		
Receptor	**Location**	**LUC**	**Existing**	**No Action**	**Increase (dBA)**
R1	Long Bridge Park South	3	64.6	66.8	+2.2
R2	Long Bridge Park Center	3	67.7	69.3	+1.6
R3	Long Bridge Park North	3	65.3	67.1	+1.8
R4[2]	Cuban Friendship Urn	3	67.1	67.2	+0.1
R5[2]	Jefferson Memorial	1	64.2	64.3	+0.1
R6	Mandarin Oriental Hotel	2	82.5	86.4	+3.9
R7	Portals V Residences	2	72.3	76.2	+3.9

[1] Evaluation of land use category 2 receptors is based on the Ldn metric. Evaluation of land use categories 1 and 3 is based on the Leq metric.
[2] Modeled noise level includes measured ambient noise from non-rail noise contributions
LUC – Land Use Category; Ldn- Day Night Level; Leq – Peak Hour Equivalent Noise Level
Source: VHB, 2018.

13.4.1.2. Action Alternative A (Preferred Alternative)

An increase in noise levels in Action Alternative A compared to either the Existing Conditions or No Action Alternative may result in moderate to major permanent direct adverse impacts. Increased noise levels would exceed FTA severe noise criteria at the Portals V Residences, the Mandarin Oriental Hotel,

and Long Bridge Park Center, and would exceed FTA moderate noise criteria at Long Bridge Park North and Long Bridge Park South. Noise levels would not noticeably increase at the Cuban Friendship Urn and Jefferson Memorial and therefore would not permanently directly or indirectly impact the sites. **Table 13-4** and **Figure 13-2** present the noise impact assessment results for Action Alternative A.

Table 13-4 | Existing, No Action, and Action Alternative A Noise Levels

Receptor	Location	LUC[1]	Existing	No Action	Action Alternative A	*Increase Over Existing*	*Increase Over No Action*	Impact
R1	Long Bridge Park South	3	64.6	66.8	**71.4**	+6.8	+4.6	**Moderate[3]**
R2	Long Bridge Park Center	3	67.7	69.3	**76.6**	+8.9	+7.3	**Severe[4]**
R3	Long Bridge Park North	3	65.3	67.1	**71.2**	+5.8	+4.0	**Moderate[3]**
R4[2]	Cuban Friendship Urn	3	67.1	67.2	**67.3**	+0.2	+0.1	**None**
R5[2]	Jefferson Memorial	1	64.2	64.3	**64.4**	+0.2	+0.1	**None**
R6	Mandarin Oriental Hotel	2	82.5	86.4	**86.0**	+3.5	-0.4	**Severe[4]**
R7	Portals V Residences	2	72.3	76.2	**78.7**	+6.4	+2.5	**Severe[5]**

[1] Evaluation of land use category 2 receptors is based on the Ldn metric. Evaluation of land use categories 1 and 3 is based on the Leq metric.

[2] Includes contributions from non-railroad noise sources

[3] Moderate impact based on comparison of future noise in Action Alternative A with existing conditions and the No Action condition.

[4] Severe impact based on comparison of future noise in Action Alternative A with existing conditions, but no impact based on comparison of future noise in Action Alternative A with the No Action Alternative.

[5] Severe impact based on comparison of future noise in Action Alternative A with existing conditions and comparison of future noise in Action Alternative A with the No Action Alternative.

Note: LUC – Land Use Category; Ldn – Day Night Level; Leq – Peak Hour Equivalent Noise Level

Source: VHB, 2018.

The additional capacity added to the Long Bridge Corridor in Action Alternative A would enable Amtrak, Virginia Railway Express (VRE), and Maryland Area Regional Commuter (MARC) to increase operations by 71 percent between Virginia and the District by 2040. The analysis assessed noise impact based on the potential increase in railroad operations because of the increased capacity provided by Action Alternative A. The study evaluated the increase in noise based on a comparison of both the existing and No Action Alternative conditions as a baseline. The comparison of noise conditions between the existing conditions and Action Alternative A accounts for changes in future noise, such as additional freight train operations, that would occur regardless of the proposed Project. The comparison of noise conditions between the No Action Alternative and Action Alternative A accounts for only the changes in noise due to the proposed Project.

Figure 13-2 | Action Alternative A Noise Impact Assessment Results

Action Alternative A would result in noise levels ranging from 67 to 86 dBA. At the Cuban Friendship Urn (R4) and the Jefferson Memorial (R5), there would be very little change in noise due to the contributions of other sources such as traffic on I-395 and aircraft activity at Ronald Reagan Washington National Airport. Therefore, there would be no impact.

Noise levels would increase by 6 to 9 dBA (Leq) relative to the existing condition and 4 to 7 dBA (Leq) relative to the No Action Alternative at Long Bridge Park due to the introduction of new track turnouts and the increase in train operations. There would be a moderate noise impact farther away from the new track turnouts and a severe noise impact near the new turnouts. Long Bridge Park is a public park and therefore has special protection under Section 4(f) of the United States Department of Transportation Act of 1966.[12] Since noise levels would increase more than 3 dBA, this could be a noticeable change in noise that could affect passive recreational activities such as talking, reading, or meditation. As discussed in **Chapter 24, Draft Section 4(f) Evaluation,** these noise impacts would not cause a constructive use as defined by Section 4(f). Long Bridge Park's design integrates the existing railroad Corridor, and the esplanade allows visitors to view the trains. Serenity and quiet are not significant attributes of this section of the park, nor is this section intended for viewing wildlife or other activities that increased noise would disrupt. Therefore, increases in noise would not substantially interfere with the use and enjoyment of the park. Nevertheless, the new track turnouts warrant mitigation to reduce the increase in noise.

Noise levels at the Mandarin Oriental Hotel (R6) would increase with Action Alternative A compared to existing conditions but would decrease slightly compared to the No Action Alternative. Action Alternative A would introduce two new tracks and would increase the number of train operations. These tracks move a portion of the train operations farther away from the Mandarin Oriental Hotel, resulting in a reduction in noise from those pass-bys. Cumulative noise exposure also depends on the number of train operations. These would increase 71 percent compared to the No Action Alternative and would increase 253 percent compared to existing conditions. Compared to the No Action Alternative, cumulative noise exposure would decrease slightly (less than 1 dBA) with Action Alternative A because the new tracks would offset the increase in train operations. Compared to existing conditions, cumulative noise exposure with Action Alternative A would increase by 4 dBA (Ldn) because the additional train operations would not be offset by any new track. Therefore, Action Alternative A would result in a severe noise impact at the Mandarin Oriental Hotel (R6), which warrants an evaluation of potential mitigation.

At the Portals V Residences (R7), noise levels would increase by 3 dBA relative to the No Action Alternative and by 6 dBA relative to Existing Conditions due to the increase in train operations and the introduction of two new tracks closer to the building. Therefore, Action Alternative A would result in severe noise impact at the Portals V Residences, which warrants an evaluation of potential mitigation.

13.4.1.3. Action Alternative B

Action Alternative B would have similar impacts as Action Alternative A. In Action Alternative B, the replacement of the older steel bridge with a new bridge would not affect noise from the trains but may reduce noise that radiates from the structure. Neither the age of the bridge nor the bridge profile would have an appreciable effect on noise emissions, as all noise-sensitive receptors are on land and the slight

[12] 49 USC 303(c)

changes in noise would be over water. Therefore, the results of the noise impact assessment for Action Alternative B are the same as those for Action Alternative A.

13.4.2. Vibration

13.4.2.1. No Action Alternative

The No Action Alternative would result in no permanent direct or indirect vibration impacts. There would be no change in vibration level between the existing condition and the No Action Alternative as there would be no change in the railroad alignment and no change in the speed or train types (**Table 13-5**). The highest vibration levels are at the Mandarin Oriental Hotel (69 VdB overall; 63 VdB maximum in any 1/3-octave band) are below the FTA General Assessment and FTA Detailed Assessment criteria. Vibration levels at other receptors are substantially lower since they are farther from the tracks. Vibration levels are below the FTA impact criteria at all receptor locations in the existing condition and No Action Alternative.

Table 13-5 | Existing, No Action, and Action Alternatives Vibration Levels

			Existing/No Action		Action Alternatives A and B		
Receptor	**Location**	**LUC**	**Overall Level (VdB)**	**1/3-Octave Band Level (VdB)**	**Overall Level (VdB)**	**1/3-Octave Band Level (VdB)**	**Vibration Impact**
R5	Jefferson Memorial	1	39	37	39	37	No
R6	Mandarin Oriental Hotel	2	69	63	69	63	No
R7	Portals V Residences	2	57	52	61	56	No

Note: LUC – Land Use Category; VdB – Vibration Decibels.
Source: VHB, 2018.

13.4.2.2. Action Alternative A (Preferred Alternative)

Action Alternative A would result in no permanent direct or indirect adverse vibration impacts as vibration levels at the receptors would not exceed FTA vibration criteria. The proposed design in Action Alternative A would introduce two new tracks to the railroad Corridor. One of the proposed tracks would be on the south side of the railroad Corridor, located within approximately 36 feet of the Mandarin Oriental Hotel (R6), which is just slightly closer than the existing track locations. Action Alternative A vibration levels would be 69 VdB (overall) and 63 VdB (max 1/3-octave band) and there would be no substantial change in vibration levels at this receptor. The overall vibration level would not exceed the FTA General Vibration Assessment criterion and the vibration spectra would not exceed the FTA Detailed Vibration Assessment criteria. Therefore, there would be no vibration impact at the Mandarin Oriental Hotel. Vibration levels at The Portals V Residences would increase slightly relative to the No Action Alternative but would still be below the FTA vibration criteria. Vibration levels at the Jefferson Memorial would be well below the thresholds of perception and would not change with Action Alternative A.

13.4.2.3. Action Alternative B

Action Alternative B would have similar impacts as Action Alternative A. In Action Alternative B, the replacement of the older steel bridge with a new bridge would not affect vibration from the trains but may reduce vibration which radiates from the structure. Another difference with respect to the operational vibration impact assessment with Action Alternative B is that the replacement bridge profile would be higher compared to the existing bridge. However, this would not have an appreciable effect on vibration emissions since the changes in bridge profile would be approximately 3 to 5 feet. Therefore, the results of the vibration impact assessment for Action Alternative B are the same as those for Action Alternative A.

13.5. Temporary Effects

This section discusses the direct or indirect temporary effects of the No Action Alternative and Action Alternatives during construction, based on conceptual engineering design. For the complete technical analysis of the potential temporary impacts to noise and vibration, see **Appendix D3, Environmental Consequences Report**.

Construction has the potential to increase noise and vibration in the Local Study Area and affect receptors at residential, commercial, and industrial land uses. Construction activities primarily include track work throughout the Corridor, pile driving, sheeting and decking, pier work, and superstructure work. Unlike operational noise and vibration, which is evaluated at residential and institutional receptors based on FTA categories, construction noise is evaluated at all residential, commercial, and industrial receptors. The analysis computed construction vibration at all nearby structures to assess the potential for structural damage.

The energy-average noise level (Leq) resulting from construction over a typical work period—based on all the equipment typically used during each construction activity and their respective utilization factor—is generally 85 to 90 dBA (Leq) at 50 feet depending on activity. Construction vibration generated by construction equipment has the potential to cause structural damage to buildings in very close proximity to the construction work area, and to cause human annoyance to persons inside nearby buildings. Equipment that generates vibration includes loaded trucks, drilling rigs, hoe rams, and impact pile drivers. For most equipment including loaded trucks, drilling rigs, hoe rams, and impact pile drivers, vibration levels would only exceed 0.5 inches per second within 29 feet. For fragile buildings that are particularly susceptible to structural damage, vibration levels may exceed 0.12 inches per second within 73 feet of impact pile driving.

13.5.1. No Action Alternative

The No Action Alternative would result in construction noise and vibration associated with other projects, such as the addition of a fourth track from AF to RO Interlockings in Virginia, the addition of a fourth track from LE to VA Interlockings in the District, the VRE L'Enfant Station Improvements, and the Virginia Avenue Tunnel project. The noise and vibration impacts related to the construction of these projects and any other large capital projects would be assessed within the context of each project.

13.5.2. Action Alternative A (Preferred Alternative)

Action Alternative A would have a potential moderate temporary direct adverse impact as it would exceed the District daytime noise limits at three receptors and would exceed the District and Arlington County nighttime noise limits at several other receptors. Construction noise levels would generally range from 65 to 92 dBA (Leq) at all receptors. Construction noise levels would exceed the District daytime limit of 80 dBA (Leq) at three receptors: the Mandarin Oriental Hotel (R6), National Park Service (NPS) National Mall and Memorial Parks (NAMA) Headquarters (R20), and Rock Creek Trail (R22) (**Figure 13-3**).

The construction noise would exceed daytime limits primarily due to construction activities such as trackwork, superstructure construction, and sheet pile driving in water. If construction occurred at night, noise levels would exceed the District nighttime limit (65 dBA [Lmax]) at all locations within approximately 500 feet from construction activities and would exceed the Arlington County nighttime noise limits at Long Bridge Park (70 dBA [Leq] limit) and the Mount Vernon Trail (MVT), which is in a special-purpose zone S-3A (55 dBA [Leq] limit). Therefore, prior to mitigation, daytime construction noise levels would exceed the District noise ordinance, nighttime construction noise levels would exceed the District noise ordinance and the Arlington County noise ordinance, and there would be a need for mitigation to reduce construction noise.

Action Alternative A would have no construction vibration impact at nearby buildings or the Jefferson Memorial Ashlar Seawall and there is no need for construction vibration mitigation. Construction vibration levels would be up to 0.066 inches per second (84 VdB) at the Mandarin Oriental Hotel. Construction vibration from all equipment and all activities would not exceed even the most stringent criterion for potential damage to fragile buildings (0.12 inches per second, 90 VdB). There is the potential for construction vibration to reach 0.9 inches per second (107 VdB) at the East Potomac Park Seawall due to pile driving at approximately 20 feet. Since the sensitivity of the seawall to vibration is not known at this time, the seawall should be included in the contractor's Construction Noise and Vibration Control Plan.

13.5.3. Action Alternative B

Action Alternative B would have a potential moderate temporary direct adverse impact, as it would exceed the District daytime noise limits at three receptors and would exceed the District and Arlington County nighttime noise limits at several other receptors. The type of construction activities and equipment used for demolition and construction of Action Alternative B would generally be similar to that for Action Alternative A resulting in similar construction noise and vibration levels at all the receptors. The overall duration of construction would be substantially longer (up to 8 years and 3 months compared to up to 5 years for Action Alternative A); however, the construction duration is the same for both Action Alternatives in most portions of the Corridor where there are residences and businesses with the exception of the NAMA Headquarters. The construction noise levels that result in potential daytime impact to the Mandarin Oriental Hotel (R6), NAMA Headquarters (R20), and Rock Creek Trail (R22) and potential nighttime impact at Long Bridge Park and the MVT would be the same in Action Alternative B as in Action Alternative A (**Figure 13-3**).

Figure 13-3 | Construction Noise and Vibration Impact Assessment Results

13.6. Avoidance, Minimization, and Mitigation

13.6.1. Operational Noise Mitigation

This section describes proposed mitigation for noise and vibration impacts. As discussed in **Section 13.4.1, Noise**, there is the potential for permanent moderate to major adverse noise impacts due to the increase in train operations resulting from additional capacity, addition of tracks closer to receptors, and introduction of special trackwork. As discussed in **Section 13.5, Temporary Effects**, there is the potential for construction noise to have a moderate impact on receptors near the Local Study Area. Although construction would take approximately 5 to 8 years and 3 months depending on the alternative, it would be temporary. The potential for operational and construction noise impacts warrants an evaluation of avoidance, minimization, and mitigation measures.

Noise impacts that would exceed FTA severe noise criteria represent the most compelling need for mitigation, and most railroad infrastructure projects will implement mitigation if it is safe, constructible, acoustically effective, and cost effective. Noise impacts that would exceed FTA moderate noise criteria must consider mitigation. However, the recommendation of mitigation depends on several factors such as where within the range of the moderate noise impact criteria receptors would be; whether there are safe, feasible, and acoustically effective mitigation options; the sensitivity of the impact receptors; and whether solutions are cost-effective.

Noise levels at the Long Bridge Park receptors exceed either the moderate or severe noise criteria for both Action Alternatives depending on proximity to the proposed special track work. Long Bridge Park has areas for passive recreation including benches on top of a retained earth section near the railroad Corridor. Noise at Long Bridge Park would increase by 4 to 7 dBA (Leq) relative to the No Action Alternative, and there would be a major impact near the track turnout. The increase in noise is due to the gap in the railroad running surface inherent to a turnout. Turnouts that use either a spring-rail frog or moveable-point frog substantially reduce noise and mitigate potential impacts as they minimize the gap in the railroad.[13]

Noise levels at the Portals V Residences and at the Mandarin Oriental Hotel would exceed FTA severe noise criteria due to the introduction of new tracks and the increase in train operations. The most substantial source of noise at these receptors, however, is wheel squeal generated along the curve. Therefore, the most effective approach to reducing noise levels and mitigating potential impacts would be to minimize wheel squeal from occurring. The most effective means of reducing wheel squeal would be to implement a wayside top-of-rail friction modifier system and use gauge-face lubrication. Such a system would dispense a small amount of a material that optimizes the friction of the rail surface and minimizes the potential for wheel squeal. These systems have shown to substantially reduce the presence of wheel squeal. By eliminating the presence of wheel squeal, noise levels with the Action Alternatives would be approximately 12 dBA lower than existing conditions at the Mandarin Oriental Hotel and approximately 10 dBA lower at the Portals V Residences which would substantially improve the noise conditions. The Virginia Department of Rail and Public Transportation (DRPT), the project sponsor for final design and construction, would continue discussions with CSXT, Amtrak, and VRE, as

[13] A frog is the part of a turnout where the tracks need to cross over each other.

well as any potential future users (such as MARC or Norfolk Southern) to identify risk allocations due to any increased noise that may occur to nearby structures.

13.6.2. Operational Vibration Mitigation

As described in **Section 13.4.2, Vibration**, overall vibration levels at the Mandarin Oriental Hotel would not exceed the FTA General Vibration Assessment criterion and maximum vibration levels in any 1/3-octave band would not exceed the FTA Detailed Vibration Assessment criteria. Therefore, there would not be vibration impact at the Mandarin Oriental Hotel or any other receptor in the Local Study Area and no mitigation is necessary.

13.6.3. Construction Noise and Vibration Mitigation

Since there would be daytime construction noise impacts at three receptors in the District and potential nighttime construction noise impacts at most receptors in the Local Study Area, there is a need for construction noise mitigation. Given the duration of construction activities and the relatively close proximity of sensitive receptors, the contractor would prepare a Construction Noise and Vibration Control Plan prior to beginning construction. This plan would include detailed predictions of construction noise, requirements for conducting construction noise monitoring and, if necessary, detailed approaches that would mitigate potential construction-period noise impact.

Typical construction noise mitigation measures include assuring that equipment is functioning properly and is equipped with mufflers and other noise-reducing features; using quieter construction equipment and methods; using path noise control measures, such as temporary noise barriers and portable enclosures for small equipment; conducting construction noise monitoring to alert the contractors of when noise limits are exceeded and when corrective measures are warranted; and maintaining strong communication and public outreach with adjacent neighbors.

The contractor should use best management practices to minimize construction vibration as feasible and reasonable. The contractor would prepare a Construction Noise and Vibration Control Plan before beginning construction. This plan would include detailed predictions of vibration levels from the proposed construction equipment and detail specific methods to minimize potential vibration effects. The plan would set acceptable vibration limits and address the need to conduct pre-construction crack surveys, install crack detection monitors, and conduct vibration monitoring. It would define a process to alert the contractor of any limit exceedances and take corrective actions. Since the sensitivity of the Jefferson Memorial Ashlar Seawall to vibration is not known at this time, the seawall should be included in the contractor's Construction Noise and Vibration Control Plan.

NPS has plans to relocate staff from the NAMA Headquarters. However, the timeline for this relocation is uncertain. If staff are still present when construction begins, DRPT would relocate remaining staff.