

## 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 (L<sub>max</sub>)**, 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 (L<sub>dn</sub>)**, 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. L<sub>dn</sub> 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.

### 36 13.2.1. Regulatory Context

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

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

### 48 13.2.2. Methodology

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

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

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

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<sup>1</sup> 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.

<sup>2</sup> 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](https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/FTA_Noise_and_Vibration_Manual.pdf). Accessed June 6, 2017.

<sup>3</sup> DC Municipal Regulations Chapters 20–27.

<sup>4</sup> 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.

<sup>5</sup> FTA. *Transit Noise and Vibration Impact Assessment*.

<sup>6</sup> FTA. *Transit Noise and Vibration Impact Assessment*.

<sup>7</sup> FTA. *Transit Noise and Vibration Impact Assessment*.

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



67

### 68 13.2.2.1. Noise Impact Criteria

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

### 79 13.2.2.2. Vibration Impact Criteria

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

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

### 93 13.2.2.3. Construction Noise and Vibration Criteria

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

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

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

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<sup>8</sup> DC Municipal Regulations Chapters 20–27.

<sup>9</sup> Arlington County Code: Chapter 15, Noise Control Ordinance.

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

### 113 13.3. Affected Environment

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

#### 116 13.3.1. Noise and Vibration Sensitive Land Use

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

125 **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 <sup>1</sup>	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 <sup>1</sup>	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*

126

<sup>10</sup> 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.

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

133 **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. <sup>1</sup>
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.

<sup>1</sup>FTA considers activities such as reading, conversation, and meditation to be passive activities where noise could have an effect.<sup>11</sup>

134 **13.3.2. Existing Noise and Vibration Conditions**

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

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

<sup>11</sup> 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](https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/FTA_Noise_and_Vibration_Manual.pdf). Accessed June 6, 2017.

149 **13.4. Permanent or Long-Term Effects**

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

154 **13.4.1. Noise**

155 **13.4.1.1. No Action Alternative**

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

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

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

Receptor	Location	LUC	Noise Level (Ldn/Leq, dBA) <sup>1</sup>		Increase (dBA)
			Existing	No Action	
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 <sup>2</sup>	Cuban Friendship Urn	3	67.1	67.2	+0.1
R5 <sup>2</sup>	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

<sup>1</sup> 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.

<sup>2</sup> 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.

170 **13.4.1.2. Action Alternative A (Preferred Alternative)**

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

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

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

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

<sup>1</sup> 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.

<sup>2</sup> Includes contributions from non-railroad noise sources

<sup>3</sup> Moderate impact based on comparison of future noise in Action Alternative A with existing conditions and the No Action condition.

<sup>4</sup> 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.

<sup>5</sup> 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.

179  
 180 The additional capacity added to the Long Bridge Corridor in Action Alternative A would enable Amtrak,  
 181 Virginia Railway Express (VRE), and Maryland Area Regional Commuter (MARC) to increase operations  
 182 by 71 percent between Virginia and the District by 2040. The analysis assessed noise impact based on  
 183 the potential increase in railroad operations because of the increased capacity provided by Action  
 184 Alternative A. The study evaluated the increase in noise based on a comparison of both the existing and  
 185 No Action Alternative conditions as a baseline. The comparison of noise conditions between the existing  
 186 conditions and Action Alternative A accounts for changes in future noise, such as additional freight train  
 187 operations, that would occur regardless of the proposed Project. The comparison of noise conditions  
 188 between the No Action Alternative and Action Alternative A accounts for only the changes in noise due  
 189 to the proposed Project.



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



191

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

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

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

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

### 227 **13.4.1.3. Action Alternative B**

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

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<sup>12</sup> 49 USC 303(c)

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

234 **13.4.2. Vibration**

235 **13.4.2.1. No Action Alternative**

236 The No Action Alternative would result in no permanent direct or indirect vibration impacts. There  
 237 would be no change in vibration level between the existing condition and the No Action Alternative  
 238 as there would be no change in the railroad alignment and no change in the speed or train types (**Table**  
 239 **13-5**). The highest vibration levels are at the Mandarin Oriental Hotel (69 VdB overall; 63 VdB maximum  
 240 in any 1/3-octave band) are below the FTA General Assessment and FTA Detailed Assessment criteria.  
 241 Vibration levels at other receptors are substantially lower since they are farther from the tracks.  
 242 Vibration levels are below the FTA impact criteria at all receptor locations in the existing condition and  
 243 No Action Alternative.

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

Receptor	Location	LUC	Action Alternatives				Vibration Impact
			Existing/No Action		A and B		
			Overall Level (VdB)	1/3-Octave Band Level (VdB)	Overall Level (VdB)	1/3-Octave Band Level (VdB)	
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.

245 **13.4.2.2. Action Alternative A (Preferred Alternative)**

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

### 259 13.4.2.3. Action Alternative B

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

## 268 13.5. Temporary Effects

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

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

280 The energy-average noise level (Leq) resulting from construction over a typical work period—based on  
281 all the equipment typically used during each construction activity and their respective utilization  
282 factor—is generally 85 to 90 dBA (Leq) at 50 feet depending on activity. Construction vibration  
283 generated by construction equipment has the potential to cause structural damage to buildings in very  
284 close proximity to the construction work area, and to cause human annoyance to persons inside nearby  
285 buildings. Equipment that generates vibration includes loaded trucks, drilling rigs, hoe rams, and impact  
286 pile drivers. For most equipment including loaded trucks, drilling rigs, hoe rams, and impact pile drivers,  
287 vibration levels would only exceed 0.5 inches per second within 29 feet. For fragile buildings that are  
288 particularly susceptible to structural damage, vibration levels may exceed 0.12 inches per second within  
289 73 feet of impact pile driving.

### 290 13.5.1. No Action Alternative

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

296 **13.5.2. Action Alternative A (Preferred Alternative)**

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

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

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

321 **13.5.3. Action Alternative B**

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

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



335

## 336 13.6. Avoidance, Minimization, and Mitigation

### 337 13.6.1. Operational Noise Mitigation

338 This section describes proposed mitigation for noise and vibration impacts. As discussed in **Section**  
339 **13.4.1, Noise**, there is the potential for permanent moderate to major adverse noise impacts due to the  
340 increase in train operations resulting from additional capacity, addition of tracks closer to receptors, and  
341 introduction of special trackwork. As discussed in **Section 13.5, Temporary Effects**, there is the potential  
342 for construction noise to have a moderate impact on receptors near the Local Study Area. Although  
343 construction would take approximately 5 to 8 years and 3 months depending on the alternative, it would  
344 be temporary. The potential for operational and construction noise impacts warrants an evaluation of  
345 avoidance, minimization, and mitigation measures.

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

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

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

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<sup>13</sup> A frog is the part of a turnout where the tracks need to cross over each other.

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

### 376 **13.6.2. Operational Vibration Mitigation**

377 As described in **Section 13.4.2, Vibration**, overall vibration levels at the Mandarin Oriental Hotel  
378 would not exceed the FTA General Vibration Assessment criterion and maximum vibration levels in any  
379 1/3-octave band would not exceed the FTA Detailed Vibration Assessment criteria. Therefore, there  
380 would not be vibration impact at the Mandarin Oriental Hotel or any other receptor in the Local Study  
381 Area and no mitigation is necessary.

### 382 **13.6.3. Construction Noise and Vibration Mitigation**

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

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

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

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