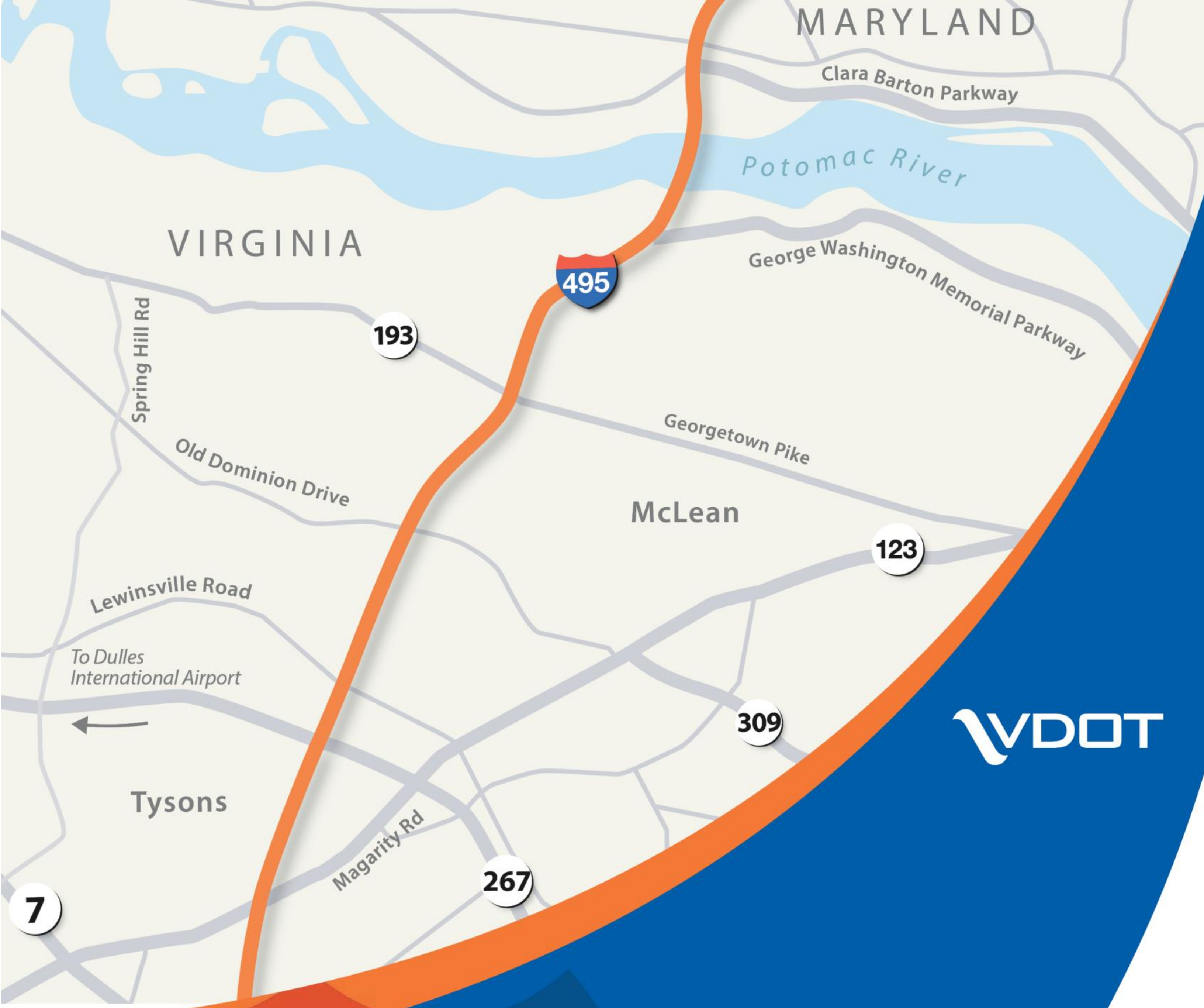

VDOT

ENVIRONMENTAL ASSESSMENT

Noise Technical Report

February 2020

495 ExpressLanes
NORTHERN EXTENSION

I-495 Express Lanes Northern Extension

PRELIMINARY NOISE STUDY

Noise Technical Report

UPC 113414
Project #: 0495-029-419
Fairfax County

February 2020

SUBMITTED BY:

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1.0 EXECUTIVE SUMMARY

The Virginia Department of Transportation (VDOT), in coordination with the Federal Highway Administration (FHWA), as the lead federal agency, is evaluating an extension of the Interstate 495 (I-495) Express Lanes, also referred to as the Capital Beltway, from their current northern terminus in the vicinity of the Old Dominion Drive overpass to the George Washington Memorial Parkway (GWMP) in the McLean area of Fairfax County, Virginia. This Preliminary Noise Study is being prepared in compliance with 23 CFR 772[1]. The results are summarized in the Environmental Assessment (EA) prepared for this project pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended, and in accordance with FHWA regulations[2]. The purpose of these improvements under consideration is to reduce congestion, improve roadway safety, provide additional travel choices, and improve travel reliability throughout the project corridor; therefore, in accordance with 23 CFR 772, this project is considered a Type I project and requires noise analysis. This Noise Technical Report evaluates potential traffic noise impacts and abatement measures associated with the improvements to I-495 Express Lanes Northern Extension Study (I-495 NEXT). Potential traffic noise impacts are assessed within the direct construction limits of the project, in accordance with the procedures and criteria approved by FHWA and VDOT. This report documents predicted noise levels associated with the improvements outlined in the I-495 NEXT Study for the Existing Conditions (2018) and the future design year Build Alternative (2045). Since the future design year Build Alternative noise levels are predicted to exceed the Noise Abatement Criteria (NAC), noise mitigation must be evaluated, regardless of whether or not the proposed project is the cause in accordance with 23 CFR 772.

Short and long-term ambient noise monitoring was conducted to assess the existing noise environment and validate FHWA's Traffic Noise Model (TNM). Short-term noise monitoring was performed at 28 locations; these sites were used solely for noise model validation. Long-term (24-hour) noise monitoring was conducted at five sites to assist with the selection of the loudest hour and evaluate the rail noise contribution associated with the Washington Metropolitan Area Transit Authority's (WMATA) Silver Line.

Noise sensitive properties within approximately 500 feet of the proposed edge of pavement were considered as part of the evaluation. Field reconnaissance, conducted in October 2018, as well as the review of recent aerial photographs of the project study aided in the identification of noise sensitive receptors. Receivers (or modeling sites) were input into TNM to represent these receptors (discrete noise sensitive sites), either individually or in groups. A total of 1,115 noise receivers were modeled representing 1,441 noise sensitive receptors to predict how the proposed improvements would affect the noise levels throughout the project area. Of the modeled receivers, 938 represented 1,263 residential receptors, 130 receivers represented 131 recreational receptors, seven receivers represented seven interior receptors[3], and 40 receivers represented 40 commercial receptors. The modeling effort included

[1] Title 23 of the Code of Federal Regulations (CFR) Part 772, Procedures for Abatement of Highway Traffic Noise and Construction Noise.
[2] NEPA and FHWA's regulations for Environmental Impact and Related Procedures can be found at 42 USC § 4332(c), as amended, and 23 CFR § 771, respectively.
[3] Exterior receptor sites were used to evaluate the interior noise levels within the project area. Since the exterior for the evaluated

undeveloped (permitted) land uses identified through coordination with Fairfax County.

As described in **Section 4.4**, the existing and proposed roadways were identified and added to the noise model. In addition, a comprehensive review of other area transportation noise sources identified the elevated section of WMATA's Silver Line, located at the southeast edge of the noise study area. The rail noise contribution was calculated for Common Noise Environments (CNEs) R, U, and V, under the Existing Conditions and the future design year Build Alternative. For almost all receptors in these CNEs, the predicted rail contribution ($L_{eq(h)}$) was approximately 1 dB(A) or less.

Of the 13 existing noise barriers identified within the noise study area, nine would be physically impacted by the future design year Build Alternative and would be required to be replaced in-kind. The physically impacted noise barriers were shifted closer to the adjacent residences in the noise model to allow for the additional lanes along I-495. A full in-kind barrier replacement extension analysis for the future design year Build Alternative would be conducted during the detailed design phase of the project (i.e. Final Design Noise Analysis) when more detailed engineering and traffic data would be available. Refer to **Section 7.4** for a discussion about the methodology used for modeling these situations.

For all modeled receptors, the Existing Conditions (2018) noise levels are predicted to range from 42 to 72 dB(A), with impacts predicted at 115 receptors including 92 residential receptors, 20 recreational receptors, and three commercial receptors. Under the future design year Build Alternative (2045) noise levels are predicted to range from 43 to 74 dB(A), with impacts predicted at 148 receptors including 123 residential receptors and 25 recreational receptors. **Table 1-1** provides a summary of predicted noise level ranges and total noise impacts. All noise impacts are due to levels approaching or exceeding the applicable NAC. Predicted noise levels for all noise sensitive receptors are discussed for affected CNE in **Section 6.5.**

Table 1-1: Summary of Sound Levels and Traffic Noise Impacts

Range of Predicted Sound Levels (dB(A))		Total Number of Noise Impacts (Receptors with Predicted Noise Levels that Approach or Exceed NAC)	
Existing Conditions (2018)	Future Design Year Build Alternative (2045)	Existing Conditions (2018)	Future Design Year Build Alternative (2045)
42-72	**43-74**	**115**	**148**

Table 1-2 shows the existing dimensions of the noise barriers that were determined to be physically impacted under the Build Alternative. The table only reflects the dimensions and costs of the replacement section of the barrier, not the entire barrier (unless the entire barrier would be replaced), or any additional existing barrier modifications that may be due to in-kind barrier relocation extension analyses. The table based the cost of the replacement barrier using a unit cost of $42/SF (material and installation costs), with the total cost based on the total area of the wall (to be replaced) multiplied by the unit cost. No additional engineering costs (e.g., retaining walls, utility relocation, right-of-way acquisition, drainage

buildings are largely composed of masonry material and appear to have modern air conditioning installed, the reduction in noise levels in the interior as a result of the building is predicted to be 25 dB(A) (FHWA, 2011).

considerations, etc.) were included.

Table 1-2: Physically Impacted Existing Noise Barriers

CNE	Barrier Name[1]	Partial / Full Replacement	Height Range (ft.)	Length (ft.) [1]	Area (SF) [1]	Cost
E	Barrier 10	Full	3-23	1,355	17,391	$730,422
F	Barrier 9	Full	14-22	2,629	51,568	$2,165,856
H	Barrier 13A	Full	19-26	4,066	104,248	$4,378,416
I	Barrier 13E	Partial	13-19	2,414	44,356	$1,862,952
J	Barrier 13B	Partial	17-25	1,244	26,410	$1,109,220
K	Barrier 13D	Full	10-22	3,819	53,767	$2,258,214
L/M	Barrier 13B / NSA 26	Partial	18-33	1,887	52,538	$2,206,596
Q	Barrier 12A2	Full	15-25	1,583	32,505	$1,365,210
1	Does not include the barrier dimensions associated with the in-kind barrier replacement extensions.					

Source: TNM Runs for Build Alternative, 2019.

Four (4) in-kind barrier replacement extensions were evaluated for Barrier 10, Barrier 9, Barrier 13B, and Barrier 12A2. All of the evaluated noise barrier extensions except Barrier 9 were found to be both feasible and reasonable.

Five (5) new noise barriers were evaluated for areas predicted to be impacted by traffic noise under the Build Alternative. Only one of the evaluated noise barriers (Barrier C) met the feasible and reasonable criteria. While Barrier System U met the acoustical feasible criterion, the barrier system was determined to be not feasible, due to engineering constraints as documented in the constructability memo in **Appendix Q**. The noise barrier locations are shown on the graphics located in **Appendix A, Graphics (2045 Design Year)**. Refer to **Section 7.5** for a discussion regarding the design and evaluation of noise abatement, including the in-kind barrier replacement extension details.

Construction activity may cause intermittent fluctuations in noise levels. During the construction phase of the project, reasonable measures will be taken to minimize noise impact from these activities. Construction noise is discussed in **Section 8**.

This preliminary analysis was performed with conceptual engineering data; a more detailed review will be completed during detailed design. As such, noise barriers that were found to be feasible and reasonable during the preliminary design phase (Preliminary Noise Analysis) may be found to be not feasible and/or not reasonable during the Final Design Noise Analysis (FDNA) to be documented in the Noise Abatement Design Report (NADR). Conversely, noise barriers that were not considered feasible and reasonable during preliminary design may meet the established criteria during detailed design and be recommended for construction. Thus, any conclusions derived in this report should be considered preliminary in nature and subject to change.

2.0 INTRODUCTION

2.1 Project Description

The Virginia Department of Transportation (VDOT), in coordination with the Federal Highway Administration (FHWA) as the lead federal agency, is evaluating an extension of the Interstate 495 (I-495) Express Lanes, also referred to as the Capital Beltway, from their current northern terminus in the vicinity of the Old Dominion Drive overpass to the George Washington Memorial Parkway (GWMP) in the McLean area of Fairfax County, Virginia. This Preliminary Noise Study is being prepared in compliance with 23 CFR 772[4]. Pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended, and in accordance with FHWA regulations[5], an Environmental Assessment (EA) is being prepared to analyze the potential social, economic, and environmental effects associated with the improvements being evaluated.

2.2 Project Termini

The project includes an extension of the existing Express Lanes from their current northern terminus south of the Old Dominion Drive Overpass to the GWMP. Although the GWMP provides a logical northern terminus for this study, additional improvements are anticipated to extend approximately 0.3 miles north of the GWMP to provide a tie-in to the existing road network in the vicinity of the American Legion Memorial Bridge (ALMB). The project also includes access ramp improvements and lane reconfigurations along portions of the Dulles Toll Road and the Dulles International Airport Access Highway, on either side of the Capital Beltway, from the Spring Hill Road Interchange to the Route 123 interchange. The proposed improvements entail new and reconfigured express lanes ramps and general purpose lanes ramps at the Dulles Interchange and Route 123/I-495 interchange ramp connections.

2.3 Study Area of the Environmental Assessment (EA)

In order to assess and document relevant resources that may be affected by the proposed project, the study area for this EA extends beyond the immediate area of the proposed improvements described above. The study area for the EA includes approximately four miles along I-495 between the Route 123 interchange and the ALMB up to the Maryland state line. The study area also extends approximately 2,500 feet east along the GWMP. Intersecting roadways and interchanges are also included in the study area, as well as adjacent areas within 600 feet of the existing edge of pavement, as shown in **Figure 2-1**. The study area boundary is a buffer around the road corridor that includes all natural, cultural, and physical resources that must be analyzed in the EA. It does not represent the limits of disturbance (LOD) of the project nor imply right-of-way take or construction impact, but rather extends beyond the project footprint to tie into the surrounding network, including tying into future network improvements. **Figure 2-1** depicts the project termini, study area, and LOD.

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[4] Title 23 of the Code of Federal Regulations (CFR) Part 772, Procedures for Abatement of Highway Traffic Noise and Construction Noise.

[5] NEPA and FHWA's regulations for Environmental Impact and Related Procedures can be found at 42 USC § 4332(c), as amended, and 23 CFR § 771, respectively.

2.3.1 Study Limits of the Preliminary Noise Study

Impacts associated with traffic noise are often of prime concern when evaluating roadway improvement projects. Roadway construction on new location or improvements to the existing transportation network may cause impacts to the noise-sensitive environment located adjacent to the project corridor. For this reason, FHWA has issued guidelines for noise evaluation as established in 23 CFR 772. Highway traffic noise studies, noise abatement procedures, coordination requirements and design noise levels in 23 CFR 772 constitute the noise standards mandated by 23 United States Code (U.S.C.) 109(i). FHWA and VDOT have established a noise analysis methodology and associated noise level criteria to assess the potential noise impacts associated with the construction and use of transportation related projects.

In accordance with 23 CFR 772, this project is considered a Type I project and requires a noise analysis. As part of the project design process, this Preliminary Noise Study evaluates potential traffic noise impacts and abatement measures associated with the improvements to I-495 NEXT. Potential traffic noise impacts are assessed within the direct construction limits of the project, in accordance with the procedures and criteria approved by FHWA and VDOT.

Consistent with FHWA/VDOT noise policy and guidance, the study area of the Preliminary Noise Study (hereafter referred to as "noise study area") is limited to 500 feet of the proposed edge of pavement. This area includes approximately 3.5 miles along I-495 between the Route 123 interchange and the GWMP. The noise study area also extends approximately 2,500 feet east along the GWMP. Intersecting roadways and interchanges included in the noise study area are also shown in **Figure 2-2.**

This Noise Technical Report documents the steps involved in the Preliminary Noise Analysis for the I-495 NEXT study, including a description of noise terminology, the applicable standards and criteria, results of ambient noise monitoring and validation efforts, a description of the computations of existing and future noise levels, identification of potential noise impacts, evaluation of measures to mitigate noise impacts, noise abatement evaluation and design, a discussion of construction noise, and a discussion of the public involvement process. This report documents predicted noise levels associated with the improvements outlined in the I-495 NEXT Study for the Existing Conditions (2018) and the Future Design Year Build Alternative (2045) (hereafter referred to as "Build Alternative"), based on the limits of the noise study area.

2.4 Purpose and Need

The purpose and need for the extension of Express Lanes on I-495 between Route 267 and the GWMP is to:

- Reduce congestion;
- Provide additional travel choices; and
- Improve travel reliability.

Figure 2-1: I-495 Express Lanes Northern Extension Project Limits

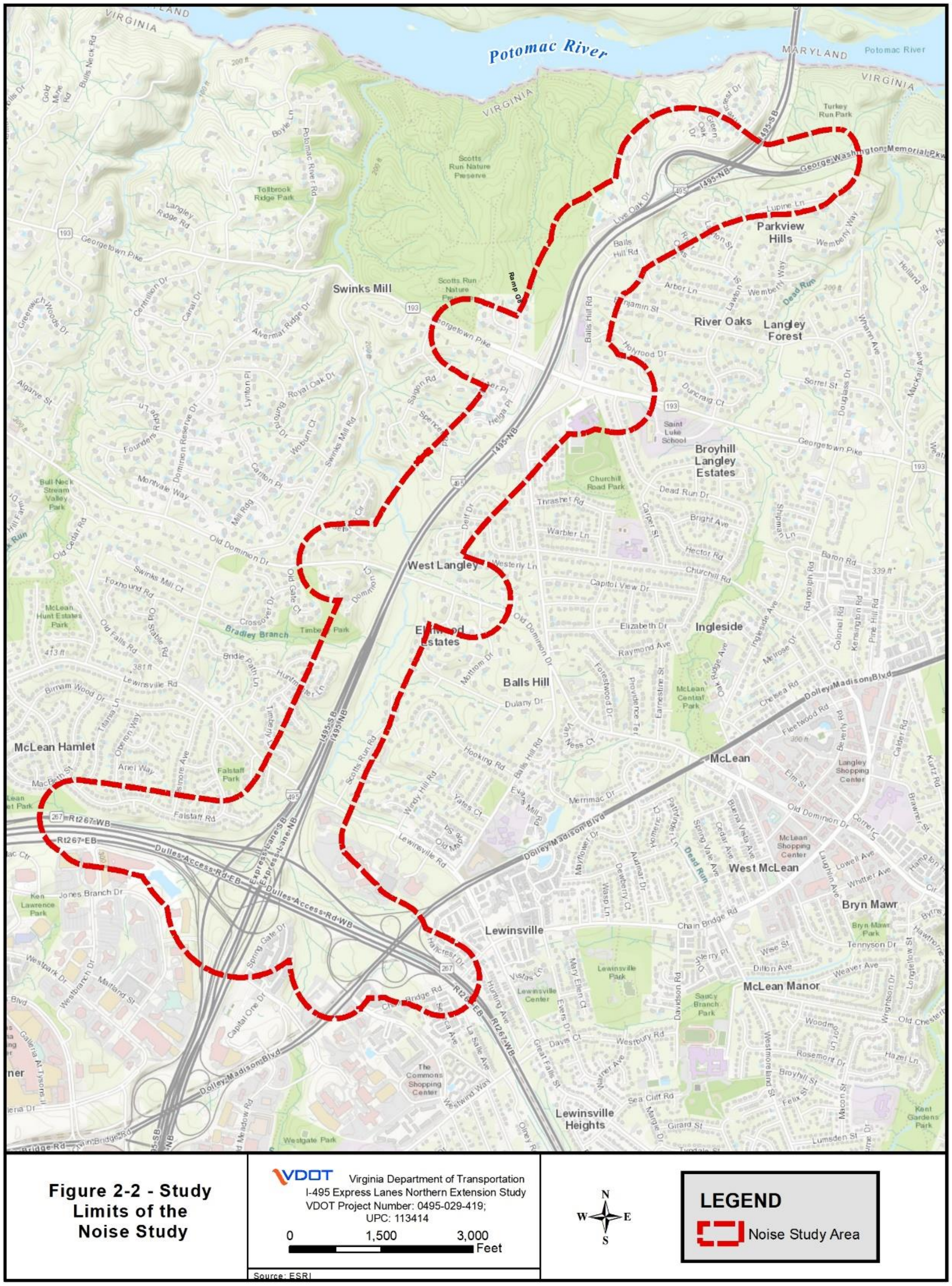

Figure 2-2: Study Limits of the Noise Study

2.5 Existing Conditions

The existing I-495 facility within the study area currently consists of four northbound and four southbound general purpose (GP) lanes, supplemented in several locations by auxiliary lanes, acceleration/deceleration lanes at on/off-ramps, and collector-distributor (CD) roadways. Grade-separated interchanges provide access to and from I-495 and the Jones Branch Connector; Dolley Madison Boulevard (Route 123); the Dulles Toll Road (DTR) and Dulles Airport Access Road (DAAR), collectively referred to as Route 267; Georgetown Pike (Route 193); and the GWMP. North of the noise study area, I-495 at the ALMB is a total of 10 lanes, including eight GP through lanes and two auxiliary lanes that connect to Clara Barton Parkway in Maryland and the GWMP in Virginia.

The southbound entrance and northbound exits for the existing I-495 Express Lanes occur within the study area, approximately 2,000 feet south of Old Dominion Drive. Additionally, drivers are permitted to use the northbound inside shoulder of the GP lanes during peak travel periods (6 AM - 11 AM and 2 PM - 8 PM Mon - Fri). The shoulder lane terminates by merging into the GP lanes just before reaching the GWMP interchange. All buses and vehicles with two axles can access the I-495 Express Lanes 24 hours a day, seven days a week. The I-495 Express Lanes operate as high-occupancy toll (HOT) lanes where vehicles with three or more occupants are not charged a toll. Trucks are currently prohibited from using the I-495 Express Lanes.

The southern portion of the study area surrounding the Route 267 interchange is surrounded by high-density commercial and residential development associated with the Tysons area. The study area between the Route 267 interchange and GWMP is comprised of suburban neighborhoods and supporting recreational areas that border the interstate. North of the GWMP approaching the Maryland state line at the ALMB over the Potomac River is primarily open federal parkland associated with the GWMP to the east and Scotts Run Nature Preserve to the west.

2.6 Alternatives

The proposed typical section along I-495 was developed for the purpose of providing a reasonable estimation of potential impacts and an opinion of probable construction costs associated with the actual design of the alternative. It was assumed the noise study area would generally contain the proposed improvement as defined in the typical section; however, variations in terrain, existing road conditions, and other considerations may exceed the defined width in places.

Two alternatives are being considered in the EA: the No-Build Alternative[6] and the Build Alternative, described below. Additional information on the Build Alternative is included in the *I-495 Alternatives Technical Report* (VDOT, 2019a).

[6] According to FHWA guidelines, the consideration of a No Build Alternative is a requirement under NEPA. The Build Alternative must be reasonable and practicable enough to dismiss the No Build Alternative (FHWA, 1990).

2.6.1 No-Build Alternative

For the Preliminary Noise Study, the No-Build Alternative was qualitatively evaluated for noise impact, to assess "constructive use" for Section 4(f) properties identified within the study area, consistent with 23 CFR 774.15, *Parks, Recreation Areas, Wildlife and Waterfowl Refuges, and Historic Sites (Section 4(f)) - Constructive Use Determinations*. The No-Build Alternative included all planned and programmed transportation improvements in the study area that have been approved and adopted for implementation by 2045, as identified in the Constrained Long-Range Plan (CLRP), developed by the Metropolitan Washington Council of Governments (MWCOG) (refer to **Table 2-1**).

Table 2-1: List of Projects Considered under the No-Build Alternative

CLRP ID	Project Name	Project Description	Completion Date
3186/VI4IHOTA	DAAR/I-495 Capital Beltway Interchange Flyover Ramp Relocation (Phase IV DAAR)	Relocate ramp from EB DAAR to NB I-495 GP	2030
3186/VI4IHOTA	DAAR/I-495 Capital Beltway Interchange Flyover Ramp Relocation (Phase IV DAAR)	Widen ramp from EB DTR ramp to NB I-495 GP to 2 lanes	2030
3186/VI4IRMP1	DAAR/I-495 Capital Beltway Interchange Flyover Ramp Relocation (Phase IV DAAR)	Construct flyover ramp from NB I-495 GP to WB DAAR	2030
3208/VI4IHOTB	I-495 Interchange Ramp Phase II, Ramp 3 DAAR	Construct Ramp from SB I-495 GP to WB DAAR	2020
3272/VI4IAUX19	I-495 Capital Beltway Auxiliary Lanes	Add NB I-495 GP auxiliary lane between on-ramp from WB DTR and off-ramp to Georgetown Pike	2030
3272/VI4IAUX20	I-495 Capital Beltway Auxiliary Lanes	Add SB I-495 GP auxiliary lane from Georgetown Pike on-ramp to WB DTR off-ramp	2030
1182/1186/3281	I-495 Managed Lanes / I-270 Managed Lanes in Maryland	Construct bi-directional Express lanes system on I-495 in Maryland between the ALMB and the Woodrow Wilson Bridge	2025

Source: MWCOG, 2019.

Conceptual design files were obtained for the aforementioned projects and are discussed further in **Section 4.4.1**. **Figure 2-3** shows the 2045 No-Build Alternative design at the GWMP Interchange and **Figure 2-4** shows the 2045 No-Build Alternative design at the DTR Interchange; no additional improvements are planned aside from those identified above at these two interchanges. These designs were qualitatively assessed in this report for the constructive use noise evaluation for Section 4(f) properties. **Appendix C, No-Build Alternative (2045 Design Year)** provides graphics from the I-495 & I-270 Managed Lanes Study website pertaining to the current study alternatives.

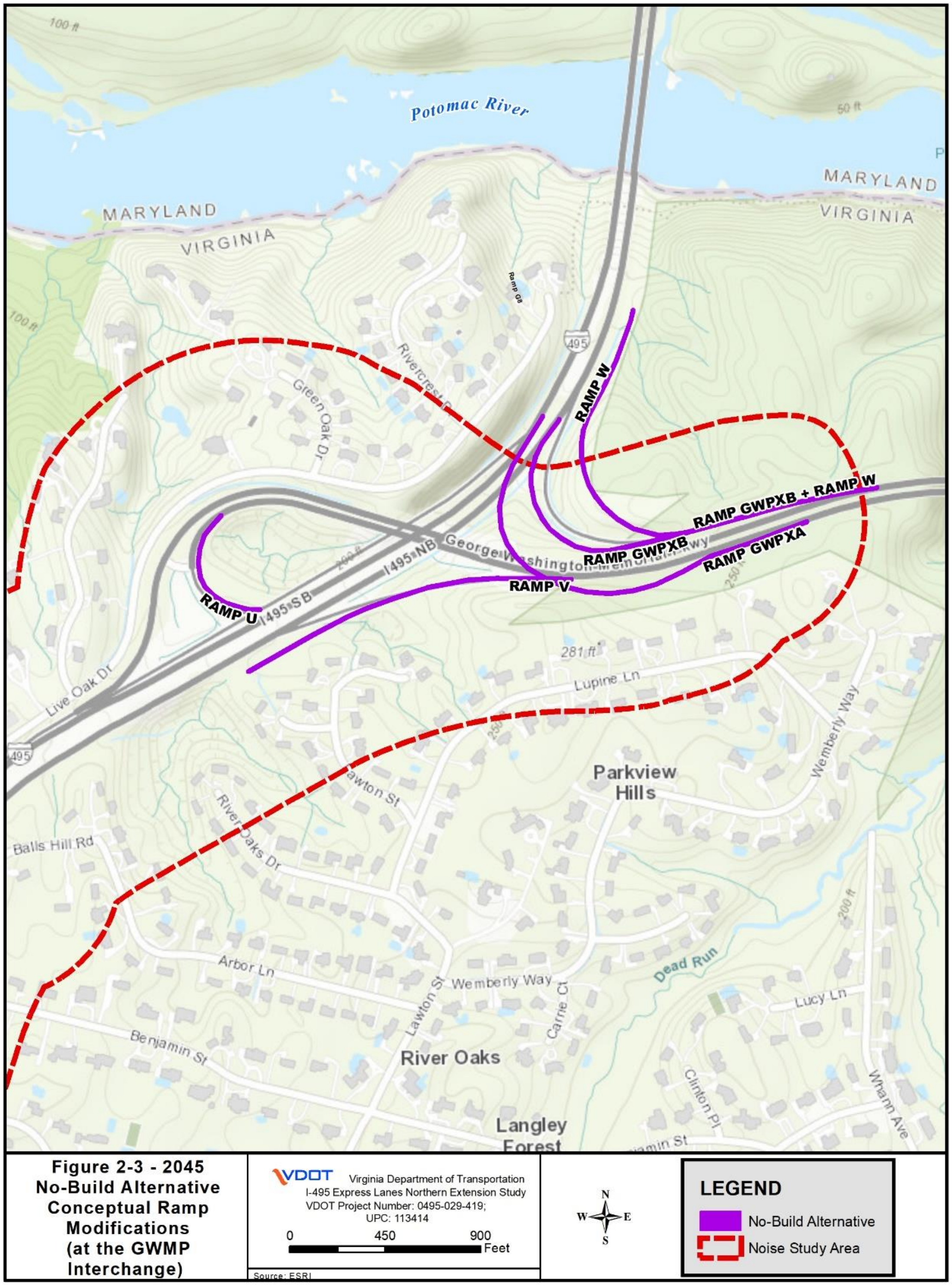

Figure 2-3: 2045 No-Build Alternative Conceptual Ramp Modifications (at the GWMP Interchange)

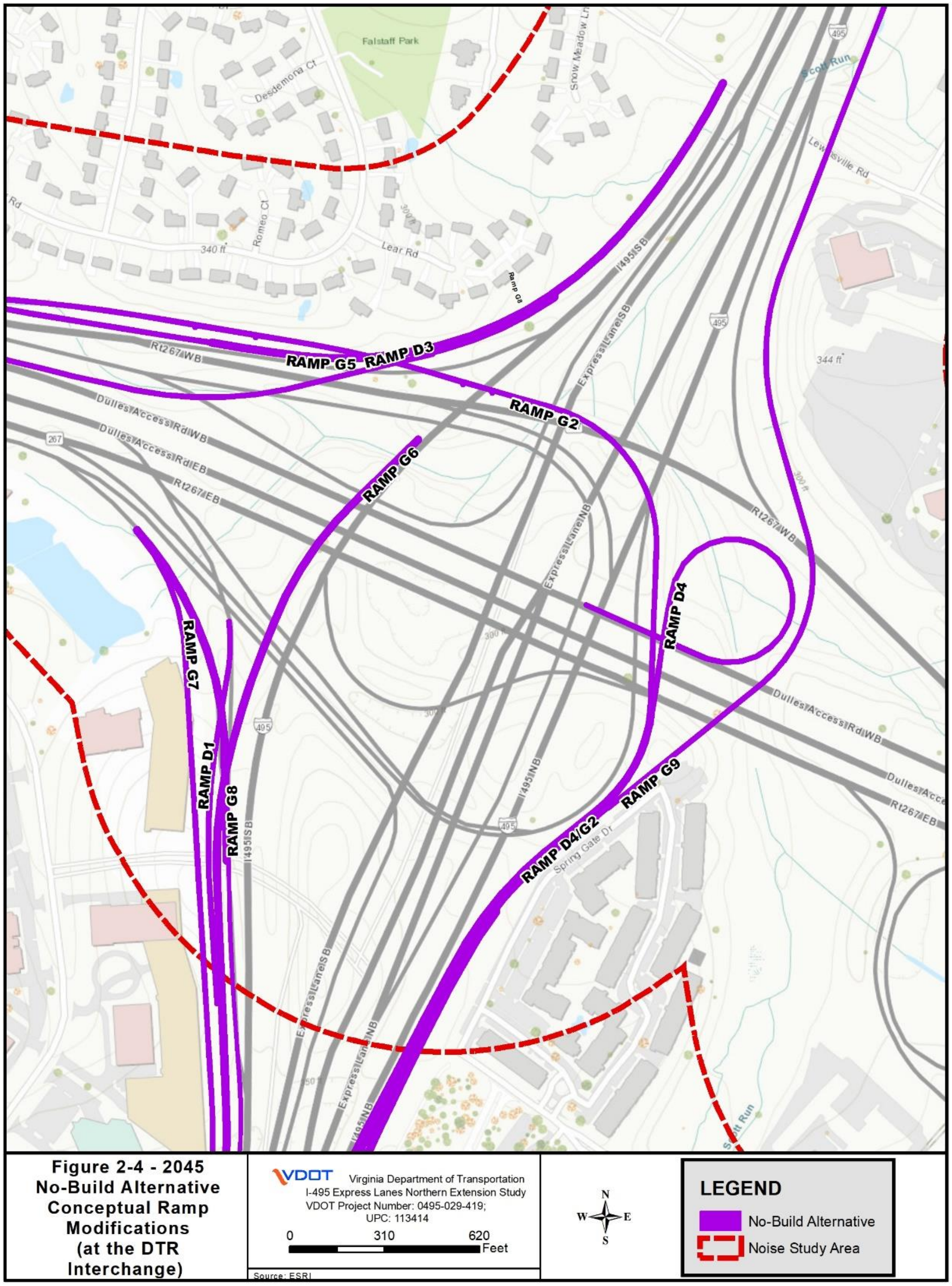

Figure 2-4: 2045 No-Build Alternative Conceptual Ramp Modifications (at the DTR Interchange)

2.6.2 Build Alternative

The Build Alternative would extend the existing four I-495 Express Lanes from their current terminus between the I-495/Route 267 interchange and the Old Dominion Drive Overpass north approximately 2.3 miles to the GWMP. The design concept for the Build Alternative would construct two express lanes in each direction with access at the DTR and GWMP, resulting in the construction of several ramps on new location. It would also include replacements/improvements of existing bridges over I-495 at Live Oak Drive, Georgetown Pike, and Old Dominion Drive. The Build Alternative would also construct shared-used path and bike trails; the locations of which have already been coordinated with Fairfax County. **Figure 2-5** shows the existing and proposed typical sections along I-495.

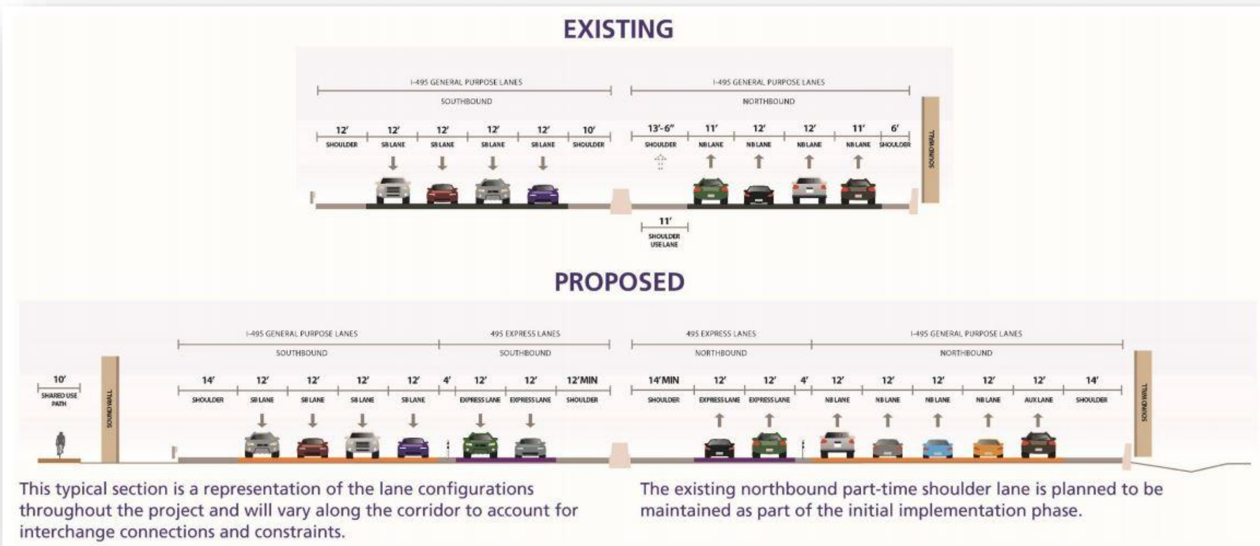

Figure 2-5: Typical Section: I-495 from DTR to Georgetown Pike

2.6.2.1 Build Alternative (2025 Interim Year)

The 2025 Build Alternative would include all of the aforementioned proposed roadway improvements associated with I-495 Express Lanes NEXT. Additional improvements are anticipated to extend approximately 0.3 miles north of the GWMP to tie into the existing road network in the vicinity of the ALMB. The 2025 Build Alternative would retain the existing number of general purpose (GP) lanes within the study area.

Direct access ramps would be provided from the I-495 Express Lanes to the Dulles Toll Road and the GWMP. Access would also be provided between the I-495 GP and Express Lanes at the Route 267 interchange: from northbound GP lanes to northbound Express Lanes, and from southbound Express Lanes to southbound GP lanes, located within the current interchange footprint. These connections have been accounted for in the LOD and are described in more detail in the *I-495 Alternatives Technical Report*

(VDOT, 2019a) and the *I-495 Traffic and Transportation Technical Report* (VDOT, 2019b). The locations of the improvements are shown on the graphics in **Appendix A** and **Appendix D, Build Alternative (2025 Interim Year).**

2.6.2.2 Build Alternative (2045 Design Year)

The 2045 Build Alternative would include all of the proposed roadway improvements associated with the I-495 Express Lanes NEXT Project and the No-Build Projects identified in **Table 2-1**, including (but not limited to) the following improvements:

- I-495 Express Lanes NEXT Project;
- Projects Constructed by Others:
    - I-495 Managed Lanes / I-270 Managed Lanes in Maryland;
        - Interchange Improvements at the GWMP, associated with the I-270/495 Managed Lanes Study (Maryland Department of Transportation State Highway Administration (MDOT SHA) (see **Appendix C**); and
    - DAAR/I-495 Capital Beltway Interchange Flyover Ramp Relocation (Phase IV DAAR), I-495 Interchange Ramp Phase II, Ramp 3 DAAR I-495 Capital Beltway Auxiliary Lanes
        - Interchange Improvements at the DTR:
            - Ramp D2, Ramp D3, Ramp D4;
            - Ramp E1 (full), Ramp E2, Ramp E3; and
            - Ramp G1, Ramp G2, Ramp G3 (full), Ramp G4, Ramp G5, Ramp G6, Ramp G7, Ramp G9, Ramp G10, Ramp GX, and Ramp XG.

The locations of the improvements are shown on the graphics in **Appendix A** and **Appendix E, Build Alternative (2045 Design Year).** The 2045 Build Alternative was modeled to include all of the proposed roadway improvements associated with the I-495 Express Lanes NEXT Project and the No-Build Projects identified in **Table 2-1,** within the noise study area (see **Figure 2-2**), to identify design year noise impacts and evaluate potential noise barriers, where warranted**.** These modeled results are displayed in **Appendix A** The **Appendix A** graphics reflect the limits of the noise study (i.e., noise study area) for the I-495 Express Lanes NEXT Project.

3.0 LEGISLATION AND NOISE FUNDAMENTALS

3.1 Regulatory Requirements

The Noise Control Act of 1972 gives the US Environmental Protection Agency (USEPA) the authority to establish noise regulations to control major noise sources, including motor vehicles and construction equipment. Furthermore, the USEPA is required to set noise emission standards for motor vehicles used for interstate commerce and the FHWA is required to enforce the USEPA noise emission standards through the Office of Motor Carrier Safety. NEPA gives broad authority and responsibility to Federal agencies to evaluate and mitigate adverse environmental impacts caused by Federal actions. FHWA is required to comply with NEPA including mitigating adverse highway traffic noise effects. The Federal-Aid Highway Act of 1970 mandates FHWA to develop standards for mitigating highway traffic noise. It also requires FHWA to establish traffic noise level criteria for various types of land uses. The Act prohibits FHWA approval of federal-aid highway projects unless adequate consideration has been made for noise abatement measures to comply with the standards. FHWA's highway regulation contains Noise Abatement Criteria (NAC), which represent the maximum acceptable level of highway traffic noise for specific types of land uses. The regulation does not mandate that the NAC be met in all situations, but rather require that reasonable and feasible efforts be made to provide noise mitigation when the NAC are approached or exceeded (23 CFR § 772, 2010).

VDOT's State Noise Abatement Policy was developed to implement the requirements of 23 CFR 772[7], FHWA's *Highway Traffic Noise Analysis and Abatement Policy and Guidance*[8], and the noise related requirements of NEPA. The methodologies applied to the noise analysis for the I-495 NEXT Project are in accordance with VDOT's *State Noise Abatement Policy*, and VDOT's *Highway Traffic Noise Impact Analysis Guidance Manual*[9]. This policy is applicable to Type I federal-aid highway projects. Since the proposed project consists of the addition of travel lanes, the proposed project is classified as a Type I project and requires a noise study.

3.2 Sound Level Metrics

Noise is generally defined as unwanted or annoying sound. Airborne sound occurs by a rapid fluctuation of air pressure above and below atmospheric pressure. Sound pressure levels are usually measured and expressed in decibels (dB). The decibel scale is logarithmic and expresses the ratio of the sound pressure unit being measured to a standard reference level.

Most sounds occurring in the environment do not consist of a single frequency, but rather a broad band of differing frequencies. Because the human ear does not respond to all frequencies equally, the method commonly used to quantify environmental noise consists of evaluating all the frequencies of a sound per a weighting system. It has been found that the A-weighted filter on a sound level meter, which includes circuits to differentially measure selected audible frequencies, best approximates the frequency response of the human ear and has been found to strongly correlate with human perceptions of traffic noise. Consequently, A-weighted decibels (dB(A)) are used by FHWA.

Although the A-weighted noise level may adequately indicate the level of environmental noise at any instant in time, community noise levels vary continuously. Most environmental noise includes a conglomeration of noise from distant sources, creating a relatively steady background noise in which no specific source is identifiable. To describe the time-varying character of traffic noise, a statistical noise descriptor called the equivalent hourly sound level, or $L_{eq(1h)}$, is commonly used. $L_{eq(1h)}$ describes a noise sensitive receptor's cumulative exposure from all noise-producing events over a one-hour period (herein referenced as "L_{eq}").

Because decibels are logarithmic units, sound levels cannot be added by ordinary arithmetic means. The

[7] Effective date: July 13, 2011.
[8] Revision date: December, 2011.
[9] Updated: February 20, 2018.

following general relationships provide a basic understanding of sound generation and propagation:

- An increase, or decrease, of 10-dB will be perceived by a receptor to be a doubling, or halving, of the sound level;
- Doubling the distance between a highway and receptor will produce a 3-dB sound level decrease; and
- A 3-dB sound level increase is barely perceptible by the human ear.

4.0 IMPACT CRITERIA AND METHODOLOGY

4.1 Noise Abatement Criteria

The State Noise Abatement Policy has adopted the NAC that has been established by FHWA for determining traffic noise impacts for a variety of land uses. The NAC, listed in **Table 4-1** for various activities, represent the upper limits of acceptable traffic noise. The NAC applies to areas having regular human use and where lowered noise levels are desired. They do not apply to the entire tract of land on which the activity is based, but only to that portion where the activity takes place.

The NAC is given in terms of the hourly (1h), A-weighted, equivalent sound level (L_{eq}), in dB(A). The noise impact assessment is made using the guidelines listed in **Table 4-1**. Receptors potentially affected by this project are classified as Categories B, C, D, and E.

Table 4-1: FHWA Noise Abatement Criteria

Hourly A-Weighted Sound Level Decibels (dB(A))			
Activity Category	**Activity Leq(h)**	**Evaluation Location**	**Description Of Activity Category**
A	**57**	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B*	**67**	Exterior	Residential
C*	**67**	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	**52**	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E*	**72**	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F.
F	**---**	Exterior	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical) and warehousing
G	**---**	---	Undeveloped lands that are not permitted
* Includes undeveloped lands permitted for this activity category			

Source: FHWA, 23 CFR 772

4.2 Definition of Traffic Noise Impact

Traffic noise impacts most frequently occur if either of the following two conditions are met:

- Predicted traffic noise levels approach or exceed the NAC, as shown in **Table 4-1**. The VDOT State Noise Abatement Policy defines that the approach shall be one dB(A) less than the NAC for Activity Categories A to E. For example, for a NAC B receptor, 66 dB(A) would approach 67 dB(A) and would be considered an impact. If predicted design year noise levels "approach or exceed" the NAC, then the receptor is considered to be an impact.

- Predicted design year (Build Alternative) traffic noise levels are substantially higher than the existing year (Existing Conditions) noise levels. VDOT's State Noise Abatement Policy defines a substantial noise increase when the predicted (Build Alternative) traffic noise levels exceed existing year (Existing Conditions) noise levels by 10 dB(A) or more. For example, if a receptor's predicted noise level under the Existing Conditions is 50 dB(A), and if the predicted noise level under the Build Alternative is 60 dB(A), then it would be considered to "substantially exceed" existing year noise levels and would be considered an impact. Predicted noise levels do not have to exceed the appropriate NAC to be considered a substantial increase impact.

If traffic noise impacts are identified under either criterion, within the noise study area, then consideration of noise abatement measures is necessary. The final decision on whether or not to provide noise abatement along a project corridor will take into account the feasibility of the design and overall cost weighted against the environmental benefit of the proposed abatement (FHWA, 2011).

4.2.1 Section 4(f) Noise Impacts

Section 4(f) refers to the original section within the U.S. Department of Transportation Act of 1966 which makes provisions for the preservation of:

- Publicly owned public parks, recreation areas, and wildlife or waterfowl refuges; and
- Publicly or privately-owned historic site listed or eligible for listing on the National Register of Historic Places (NRHP).

Under Section 4(f), FHWA cannot approve a transportation project that uses a Section 4(f) property, as defined in 23 CFR 774.17, unless a determination is made that:

- There is no feasible and prudent avoidance alternative to the use of land from the property, and the action includes all possible planning to minimize harm to the property resulting from such use (23 CFR 774.3(a)); or
- The use of the Section 4(f) property, including any measures to minimize harm (such as avoidance, minimization, mitigation, or enhancement measures) committed to by the applicant, would have a *de minimis* impact on the property (23 CFR 774.3(b)).

Under Section 4(f), a use of a Section 4(f) property occurs (23 CFR 774.17):

- When land is permanently incorporated into a transportation facility;

- When there is a temporary occupancy of land that is adverse in terms of the statute's preservation purpose; or
- When there is a constructive use of land.

A *de minimis* use on a public parkland, recreational area, wildlife and waterfowl refuge, or historic site is defined as that which does not "adversely affect the features, attributes or activities qualifying the property for protection under Section 4(f)." This determination can be made only with the concurrence of the official with jurisdiction and can be made only after an opportunity for public review and comment after the proposed determination has been provided.

The requirements of Section 4(f) are separate from 23 CFR 772, but may also call for consideration of noise impacts to lands subject to Section 4(f). A noise impact does not necessarily constitute a Section 4(f) use. However, even when noise increases do not constitute a Section 4(f) use, noise impacts may still require consideration for abatement under 23 CFR 772. Proposed abatement measures may result in additional impacts that require consideration under Section 4(f), NEPA, and Section 106.

FHWA's regulations governing implementation of Section 4(f) includes specific discussion to aid in assessing whether noise impacts would constitute a constructive use and require a Section 4(f) evaluation. In general, a constructive use occurs when, "The projected noise level increase attributable to the project substantially interferes with the use and enjoyment of a noise-sensitive facility of a property protected by Section 4(f)" (23 CFR § 774, 2018).

Conversely, 23 CFR 774.15(f) states that a constructive use does not occur when:

- The impact of projected (predicted) traffic noise levels of the proposed highway project on a noise-sensitive activity do not exceed the NAC, as shown in **Table 4-1**; and
- The projected (predicted) noise levels exceed the NAC of this section because of high existing noise, but the increase in the projected (predicted) noise levels if the proposed project is constructed (Build Alternative), when compared with the projected noise levels if the project is not built (No-Build Alternative), is barely perceptible (3 dB(A) or less).

As with Section 4(f), the consideration of historic properties under Section 106 is a separate requirement but may be related to the assessment of noise impacts under 23 CFR 772.

- Sites listed on or eligible for the NRHP, results in an agreement of "no historic properties affected" or "no adverse effect."

There is no metric for analyzing when a change in noise constitutes an effect under the regulations implementing Section 106, since that will be dependent on the contributing characteristics and use of the historic resource (36 C.F.R. § 800, 2012). Some properties, such as designed or cultural landscapes where the landscape itself is the significant feature or where the setting is especially important, may be extremely sensitive to any change that can be perceived by the human ear. Refer to **Section 4.4.6** for the discussion of Section 4(f) Properties that were identified. Refer to **Section 6.1** for the results of the Section 4(f) noise analysis.

4.3 Highway Noise Computation Model

A review of the noise study area has established roadway traffic as the dominant source of noise for the project. Since roadway noise can be predicted accurately through computer modeling techniques for areas that are dominated by road traffic, existing and future design year traffic noise calculations have been predicted using FHWA's Traffic Noise Model (TNM) Version 2.5, which is the latest approved version and required under 23 CFR 772[10]. TNM estimates vehicle noise emissions and resulting noise levels based on reference energy mean emission levels. The existing and proposed alignments (horizontal and vertical) are input into the model, along with the receptor locations, traffic volumes of cars, medium trucks (vehicles with two axles and six tires), heavy trucks, average vehicle speeds, pavement type, and any traffic control devices. TNM utilizes acoustic algorithms to predict noise levels at the selected receptor locations by considering sound propagation variables such as atmospheric absorption, divergence, intervening ground, barriers, building rows, and sometimes heavy vegetation (FHWA, 2004).

4.4 Data Sources

4.4.1 Roadways and Design Files

Existing roadways were located and digitized using the "MostRecentImagery_WGS" aerial photography dataset provided through the Virginia Geographic Information Network (VGIN) managed by the Virginia Information Technologies Agency (VITA) (VGIN, 2017). Existing elevations for all existing roadways were obtained using LiDAR[11] data obtained though the USGS website (USGS, 2017). Roadways plans and profiles for the Build Alternative[12] roadways, as well as the conceptual files for the DTR interchange and the Maryland portion of the GWMP, were provided by the project team.

4.4.2 Existing Shielding and Terrain Features

Existing shielding and terrain features such as existing noise barriers, retaining walls, building rows, and terrain lines were incorporated to account for shielding effects of these existing features within the project corridor. Elevation data for these features were generally obtained through a combination of ESRI's ArcGIS Online data, USGS's LiDAR data, and TNM files from previously modeled projects.

This noise study area contains several existing noise barriers which were captured in TNM, summarized below, and labeled on the graphics in **Appendix A**.

- **Barrier 8** - This barrier is located along the I-495 northbound lanes, between Georgetown Pike and the Live Oak Drive Overpass. The barrier's location was imported from the TNM files for the I-495 Shoulder Use Project (UPC 105130) and verified using recent aerial photography. The barrier elevations were developed using survey from 2013 and LiDAR.

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[10] TNM was developed and sponsored by the U.S. Department of Transportation and John A. Volpe National Transportation Systems Center, Acoustics facility.
[11] LiDAR, which stands for *Light Detection and Ranging,* is a remote sensing method that uses light in the form of a pulsed laser to measure ranges (variable distances) to the Earth (NOAA, 2017).
[12] Dated June 2019.

- **Barrier 9** - This barrier is located along the I-495 northbound lanes, north of the Live Oak Drive Overpass, which extends along the GWP eastbound on-ramp. The barrier's location was imported from the TNM files for the I-495 Shoulder Use Project and verified using recent aerial photography. The barrier elevations were developed using survey from 2013 and LiDAR.
- **Barrier 10** - This barrier is located along the I-495 southbound lanes, north of the Live Oak Drive Overpass, which is placed on atop an existing retaining wall. The barrier's location was imported from the TNM files for the I-495 Shoulder Use Project and verified using recent aerial photography. The barrier elevations were developed using survey from 2013 and LiDAR.
- **Barrier 12A2 (1R)** – This barrier was originally constructed under the I-495 Capital Beltway Project (UPC 68805) and revised as part of the Jones Branch Connector Project (JBC) under UPC 103907. This barrier is located along the I-495 northbound lanes, located in the southeast quadrant of the DTR Interchange. The barrier's location was imported from the TNM files for the JBC Project and verified using recent aerial photography. The barrier elevations were developed using TNM files.
- **Barrier 13A** - This barrier was originally constructed under the I-495 13A/13E Sound Wall Project (UPC 94944). This barrier is located along the I-495 southbound lanes, between Old Dominion Drive and Georgetown Pike. The barrier's location was imported from the TNM files for the I-495 Shoulder Use Project and verified using recent aerial photography. The barrier elevations were developed using the plan and profile sheets developed in December 2011.
- **Barrier 13B** - This barrier is located along the I-495 southbound lanes, between Old Dominion Drive and Lewinsville Road. This barrier was previously identified as "Barrier SW13B1" and constructed under the I-495 HOT Lanes Project. The barrier's location was partially imported from the TNM files for the I-495 Shoulder Use Project and the project plans for the I-495 Capital Beltway Project. The barrier's location was verified using recent aerial photography. The barrier elevations were developed using LiDAR.
- **Barrier 13D** - This barrier is located along the I-495 northbound lanes, between Old Dominion Drive and Lewinsville Road. This barrier was previously identified as "Barrier SW13D1" and constructed under the I-495 HOT Lanes Project. The barrier's location was partially imported from TNM files for the I-495 Shoulder Use Project and the project plans for the I-495 Capital Beltway Project. The barrier's location was verified using recent aerial photography. The barrier elevations were developed using LiDAR and TNM files.
- **Barrier 13E** - This barrier was originally constructed under the I-495 13A/13E Sound Wall Project (UPC 94944). This barrier is located along the I-495 northbound lanes, between Old Dominion Drive and Georgetown Pike. A portion of this barrier was constructed under UPC 68805, and later extended in both directions under UPC 94944. The barrier's location was imported from the TNM files for the I-495 Shoulder Use Project and was verified using recent aerial photography. The barrier elevations were developed using plan and profile sheets developed in December 2011 and LiDAR.
- **Barrier 2P**– This barrier is currently being constructed under UPC 103937, along the new section of the JBC, located east of the I-495 northbound lanes. The barrier's location was imported from the TNM files for the JBC Project Final Design Noise Analysis. The barrier elevations were developed using TNM files.

- **Hallcrest Barrier** - This barrier is located along the northeast quadrant of the DAAR/VA 123 interchange. This barrier was constructed under UPC 93602. The barrier's location was imported from project TNM files and shop drawings and was verified using recent aerial photography. The barrier elevations were developed using LiDAR.
- **Barrier EB-1** - This barrier is located along the eastbound lanes of the DAAR, from Chain Bridge Road to Idylwood Road, with grade separations at Chain Bridge Road and Magarity Road. This barrier was constructed under UPC 98232. The barrier's location was imported from project TNM files and verified using recent aerial photography. The barrier elevations were developed using LiDAR and TNM files.
- **Barrier WB-1** - This barrier is located along the westbound lanes of the DAAR, from Chain Bridge Road to Idylwood Road, with grade separations at Chain Bridge Road and Magarity Road. This barrier was constructed under UPC 98232. The barrier's location was imported from project TNM files and verified using recent aerial photography. The barrier elevations were developed using LiDAR and TNM files.
- **NSA 26** - This barrier is located along the westbound lanes of the DTR, located in the northwest quadrant of the I-495/DTR interchange and connects to Barrier 13B. This barrier is maintained by Metropolitan Washington Airports Authority (MWAA) and was originally evaluated under the Dulles Toll Road Noise Policy, (MWAA, 2012). This barrier was referenced as NSA26 as part of a Type II Noise Study / Highway Sound Measurement and Noise Barrier Analysis. The barrier's location was input using recent aerial photography. The barrier elevations were developed using LiDAR.

4.4.3 Traffic Volumes and Flow Control

Traffic data for this noise study was developed using ENTRADA, consisting of hourly peak-hour volumes and interrupted operational speeds by roadway segment for the Existing Conditions and Build Alternative. The ENTRADA also provided hourly medium and heavy truck percentages and operational/posted speeds for each roadway link. ENTRADA was prepared for all interstate mainline segments, CD roadways, express lanes, interchange ramps, and adjacent arterial roadways (i.e. roadways with Average Daily Traffic (ADT)>3000), within the noise study area. Flow control devices such as "onramps" were utilized in the noise modeling efforts.

4.4.4 Rail Traffic

In addition to the proposed highway corridor, a comprehensive review of other area transportation noise sources was performed. This review identified the elevated section of WMATA's Silver Line, located at the southeast edge of the noise study area. The rail information was reviewed relative to the proximity of noise sensitive receptors located within the noise study area and in relation to the effects of the overall noise environment. The number of eastbound and westbound train passbys at the McLean Station (nearest to the noise study area) were calculated based on station times at the McLean Station for the first and last scheduled trains (WMATA, 2019a) and the frequency of the trains shown in **Table 4-2**. On an average weekday there are 114 eastbound trains (heading towards Largo Town Center) and 117 westbound trains (heading towards Wiehle-Reston East).

Table 4-2: Frequency of Trains on Silver Line Metro (Monday-Friday)

WMATA Silver Line	AM Rush (5am - 9:30am)	Midday (9:30am - 3pm)	PM Rush (3pm - 7pm)	Evening (7pm - 9:30pm)	Late Night (9:30pm – close)
Eastbound (Largo Town Center)	8 min	12 min	8 min	12 min	20 min
Westbound (Wiehle-Reston East)	8 min	12 min	8 min	12 min	20 min

Source: WMATA, 2019b

Using the reference levels in and equations cited in the Federal Transit Administration's (FTA) *Transit Noise and Vibration Impact Manual* (FTA, 2018), the Hourly L_{eq} at 50 feet from the Silver Line is predicted to be 61 dB(A) each for the eastbound and westbound trains, for a total of 64 dB(A). These calculations use a reference Sound Exposure Level[13] (SEL) of 82 dB(A) for rapid rail vehicles and assume an average number of 8 rail cars. While the maximum speed limit for the Silver Line is 59 miles per hour (mph) (WMATA, 2014), based upon personal observations during the noise monitoring effort, and correlation of monitored data, 45 mph was used in the calculations. **Table 4-3** summarizes the equivalent reference L_{eq}'s calculated in TNM, using FTA formulas.

Table 4-3: Rail Noise Summary

WMATA Silver Line	Trains per day	Trains per hour	Predicted Equivalent Sound Levels (L_{eq}) in TNM dB(A)
Eastbound (Largo Town Center)	114	4.75	61
Westbound (Wiehle-Reston East)	117	4.875	61
		Total L_{eq}	**64**

To integrate the noise computations of the highway and rail line together, the rail line was modeled in TNM using automobiles (to best match the noise source) on narrow roadways aligned with each direction of the metro line. The computed L_{eq} noise levels at a reference distance of 50 feet from the rail line in TNM were matched to the total predicted value of 64 dB(A) by adjusting the vehicle volumes on TNM roadways.

All rail noise was removed (if it had a noticeable effect) from the noise monitoring sessions to obtain a roadway-only noise reading. Subsequently, rail noise was not included for the noise model validation effort. However, to account for rail noise for all other noise modeling scenarios, the methodology

[13] The SEL represents the cumulative noise exposure from a single noise event, normalized to one second. The SEL contains the same overall sound energy as the actual varying sound energy during the event. It is the primary metric for the measurement of transit vehicle noise emissions and an intermediate noise metric in the measurement and calculation of $L_{eq(h)}$ (see Table 4-10 of FTA's Transit Noise and Vibration Impact Assessment Manual) (FTA, 2018). It is formally defined as the logarithm of the ratio of a given time integral of a squared A-weighted frequency sound pressure over a stated time interval or event such as an aircraft flyover (or a train passby), to the product of the squared reference sound pressure of 20 millipascals (μPa) and the reference duration of one-second (IEC, 1994). The SEL would also differ from L_{max} because the SEL would increase with the duration of the event, while the Lmax would not. Therefore, the SEL allows for a uniform assessment method for all rail noise events.

discussed above was applied to the noise models for the Existing Conditions (2018) and the Future Design Year (2045) Build Alternative. Rail noise was not included for the proposed noise barrier evaluation associated with the I-495 NEXT Project (see **Section 7.5**).

4.4.5 TNM Receivers and Representative Receptors

Receptors are defined as a discrete or representative location of a noise sensitive area(s) for any of the land uses located in **Table 4-1** (VDOT, 2018). TNM receiver inputs were used to represent predicted noise receptors and in some cases were used to represent multiple noise receptors. Receptors were primarily identified within approximately 500 feet of the proposed edge of pavement based on an aerial photo review and confirmed during the site visit associated with the noise monitoring effort. A total of 1,115 noise receivers were modeled to represent 1,441 noise receptors to predict how the proposed improvements would affect the noise levels throughout the project area. Of the modeled receivers, 938 represented 1,263 residential receptors (NAC B), 130 modeled receivers represented 131 recreational receptors (NAC C), seven modeled receivers represented seven interior receptors (NAC D), and 40 receivers represented 40 commercial receptors (NAC E). The location of all the receptors modeled in TNM can be found in **Appendix A, Graphics.** A default height of 4.92 feet above the base ground elevation was used for all ground level receptors; various other heights were used for receptors located on higher floors or balconies[14] on all floors of multi-family housing. Specific receptor placement was generally based on exterior areas where there is frequent human use.

4.4.6 Identification of Section 4(f) Sites

Based on FHWA regulation and guidance, a review of parcel and land use data within the noise study area was conducted to identify potential Section 4(f) sites.

The following resources were evaluated in order to identify Section 4(f) resources in the I-495 noise study area:

- Aerial images and internet resources;
- Virginia Department of Historic Resources (VDHR), Virginia Cultural Resource Information System (V-CRIS) online application;
- Recreational facility/park lists; and
- Comprehensive plans.

It was determined that while there are no wildlife or waterfowl refuges, the following general types of recreational resources were identified:

- Regional and local parks;
- Public recreation facilities; and

[14] Receptor heights for each floor (for multi-story residential buildings) were modeled at heights of 5, 15, and 25, respectively. Additional floors were modeled using the same methodology.

- Historic and archaeological resources.

The following Section 4(f) parks and recreational facilities were identified within the noise study area of the project[15]:

- Scott's Run Nature Preserve
- Timberly Park
- McLean Hamlet Park

Coordination with the project team confirmed the presence of the following historic sites within the noise study area of the project:

- GWMP (identified on V-CRIS)
- Georgetown Pike Road Bed (VA 193) (identified on V-CRIS)

As FHWA determines noise sensitivity based on whether there is active outdoor use, the identified historic resources were reviewed to determine if any active outdoor use is present. As both of the identified historic sites are active roadways (GWMP and Georgetown Pike Road Bed), they are not considered to be noise sensitive and were not evaluated for noise impact under Section 4(f). Similarly, of the four previously identified parks and recreational areas, only Scott's Run Nature Preserve contains recreational trails that would be considered to be noise sensitive. **Section 6.4** of the report discusses the results of the constructive use evaluation for recreational trail receptors located within Scott's Run Nature Preserve.

4.4.7 Undeveloped Lands and Permitted Developments

Highway traffic noise analyses are (and would be) performed for developed lands as well as undeveloped lands if they are considered "permitted." Undeveloped lands are deemed to be permitted when there is a definite commitment to develop land with an approved specific design of land use activities as evidenced by the issuance of at least one building permit. In accordance with the VDOT Traffic Noise Policy and Guidance Manual*,* an undeveloped lot is planned, designed, and programmed if a building permit has been issued by the local authorities prior to the Date of Public Knowledge for the relevant project. VDOT considers the "Date of Public Knowledge" as the date that the final NEPA approval is made. The project currently does not have a NEPA approval date. VDOT has no obligation to provide noise mitigation for any undeveloped land that is permitted or constructed after the date of public knowledge.

Coordination was performed in November 2018 with Fairfax County to identify areas of planned and future development. No additional planned or future developments within the limits of the noise study area were identified. Correspondence regarding active building permits or planned development can be found in **Appendix F, Undeveloped Lands Correspondence***.*

This coordination is required to reoccur again in Final Design to ensure that no new permitted

[15] Recreational areas associated with places of worship are not considered to be Section 4(f) sites because the recreation use is not the primary function of the property. Additionally, recreation areas and trails located on property owned by homeowners' associations (HOA's) are not considered to be Section 4(f) sites because they are not publicly owned.

developments have been approved between the time of the approval of the preliminary noise report and the NEPA document approval (Date of Public Knowledge).

5.0 EXISTING NOISE ENVIRONMENT

5.1 Noise Monitoring

To assess existing noise conditions within the noise study area, short-term and long-term noise monitoring was conducted. Short-term monitoring, described in **Section 5.1.1**, was conducted to evaluate the accuracy of the noise prediction model, described in **Section 5.2**. Long-term monitoring, described in **Section 5.1.2**, was conducted to aid with identifying the loudest hour of the day and provide data on the rail noise contribution associated with the Silver Line Metro, in combination with the ENTRADA data, described in **Section 5.4**. During the noise monitoring efforts, a windshield survey of noise-sensitive land uses and identification of major sources of acoustical shielding was conducted to supplement the mapping provided.

5.1.1 Short-Term Noise Monitoring

The purpose of short-term noise monitoring is to gather data that is used to develop a comparison between the monitored results and the output obtained from the noise prediction model. This validation exercise is required[16] so that TNM can be used with confidence to determine the loudest hour noise levels, predict the existing / future noise levels, assess noise impacts, and design and evaluate potential noise attenuation alternatives (i.e., noise barriers/berms).

A noise monitoring plan consistent with guidance from *FHWA's Noise Measurement Handbook* (FHWA, 2018) was developed to identify candidate noise monitoring sites, access locations, and traffic collection sites. After the noise monitoring plan was submitted and approved by VDOT, a field reconnaissance was then completed to confirm monitoring site access (including scheduling access for selected sites) and address any potential safety issues associated with the monitoring sites. Optimum locations were also confirmed for the placement of the video equipment used for collection of traffic data during the monitoring sessions.

Short-term noise measurements of 20 minutes duration were obtained at 28 locations within the noise study area from October 1 through 3, 2018. The short-term noise measurements were collected using three Rion NL-42 Type 2 (precision) sound level meters. At the beginning and end of each day, the noise meters were calibrated to 94 dB(A) using a Rion NC-74 precision acoustic calibrator. Refer to **Appendix G** for calibration certificates of the sound level meters and calibrator.

Readings were taken on the A-weighted scale and reported in dB(A). The data collection procedure involved the collection of L_{eq} measurements in consecutive 10-second intervals. This method allowed for individual time intervals that include noise events unrelated to traffic noise (such as aircraft over flights) to be excluded from consideration for model validation purposes. Data collected by the noise meter

[16] TNM Validation is required by 23 CFR 772.11(d)(2).

included time, L_{eq}, minimum noise level (L_{min}), maximum noise level (L_{max}), percentile sound levels (e.g. L_5, L_{10}, L_{50}, L_{90}, L_{95}), and the SEL for each interval. $L_{eq(1h)}$ values were derived at each location from the 20-minute L_{eq} values. Existing noise measurements were collected under meteorologically acceptable conditions when the pavement was dry and winds were calm or light. Additional data collected at each monitoring location included atmospheric conditions and the observation of non-traffic noise events. A Kestrel model 4000 Pocket Weather Tracker was used to collect weather conditions (e.g. temperature, humidity, wind speed and direction, etc.) in the field at the time of each monitoring session.

The short-term monitoring sites were divided into 11 traffic count sessions, based upon similar sources of traffic noise. For each session the highway(s) providing the dominant noise source was recorded by video camera. Additionally, traffic was recorded manually on all other roadways which were visible from each monitoring site. Traffic was grouped into one of the three categories: automobiles (Class 2 and 3), medium trucks (Class 5) and heavy trucks (Class 6 through 13), per FHWA vehicle classifications. Buses (Class 4) were combined with the medium trucks and motorcycles (Class 1) were included with the automobiles (FHWA, 2014).

The field data sheets, datalogger outputs (raw and adjusted), and the traffic observed with each monitoring session are presented in **Appendix H, Short-Term Monitoring Data**. The location of each short-term noise monitoring site in relation to the project, is shown on the graphics located in **Appendix A**.

A summary of the short-term noise monitoring results[17] are presented in **Table 5-1.** For each site, the table lists the assigned monitoring site number; the location of the monitoring site; a description of the associated land use for each site; the dominant sources of noise at each site; and the monitored sound level. The monitored L_{eq} in the study corridor ranged from 54.6 dB(A) to 74.5 dB(A). Traffic noise from I-495, GWMP, DTR, and VA 123 were the dominant sources of noise within the noise study area.

Table 5-1: Short-term Noise Monitoring Summary

Site	Location	Land-use Description	Dominant Sources of Noise	Monitored Noise Level L_{eq} (dB(A))
ST-1[1]	611 Live Oak Drive	Residential	I-495	74.5
ST-2[1]	632 Live Oak Drive	Residential	I-495	58.9
ST-3	6708 Lupine Lane	Residential	George Washington Pkwy	55.9
ST-4	720 Lawton Street	Residential	I-495	66.3
ST-5	712 Live Oak Drive	Residential	I-495	63.0
ST-6	7036 Arbor Lane	Residential	I-495	57.6
ST-7	7109 Benjamin Street	Residential	I-495	63.0
ST-8	895 Linganore Drive	Residential	I-495	60.7
ST-9	Basketball court at Holy Trinity Church, 850 Balls Hill Road	Recreational	I-495	59.1
ST-10	Tennis Court across from 910 Helga Place	Recreational	I-495	57.3
ST-11	Playground at McLean Presbyterian	Recreational	I-495	62.2

[17] Short-term noise monitoring is not a process to determine design year noise impacts or barrier locations. Short-term noise monitoring provides a level of consistency between what is present in real-world situations and how that is represented in the computer noise model. Short-term monitoring does not need to occur within every CNE to validate the computer noise model.

Site	Location	Land-use Description	Dominant Sources of Noise	Monitored Noise Level L_{eq} (dB(A))
	Church, 1020 Balls Hill Road			
ST-12	1032 Delf Drive	Residential	I-495	65.5
ST-13	7409 Spencer Court	Residential	I-495	54.6
ST-14	7504 Blaise Trail	Residential	I-495	58.7
ST-15	7619 Huntmaster Lane	Residential	I-495	62.7
ST-16	1396 Scotts Run Road	Residential	I-495	59.6
ST-17	1310 Scotts Run Road	Residential	I-495	61.3
ST-18	1358 Snow Meadow Lane	Residential	I-495	59.4
ST-19	7714 Lear Road	Residential	I-495	55.0
ST-20	7821 Falstaff Road	Residential	DTR	58.3
ST-21	1345 MacBeth Street	Residential	DTR	55.3
ST-23	Basketball court at Freddie Mac Office Building, 8100 Jones Branch Drive	Commercial	DTR	59.5
ST-24	Outdoor seating area of Valo Park Office building, 7950 Jones Branch Drive	Commercial	DTR	60.7
ST-25	Garden area of Valo Park office building, 7950 Jones Branch Drive	Commercial	DTR	68.7
ST-26	Outdoor seating area of Park Place II office building, 7930 Jones Branch Drive	Commercial	I-495	58.2
ST-30	The Gates of McLean multi-family residences at 1530 Spring Gate Drive	Residential	I-495	59.3
ST-31	Haden apartment building at 1575 Anderson Road	Residential	VA 123 / DAAR (VA 267)	68.6
ST-32	Farm Credit office building, 1501 Farm Credit Drive	Commercial	DAAR (VA 267) / VA 123	58.6

[1] These monitoring sites were determined to be located outside the noise study area for the I-495 Express Lanes NEXT Project, as the project advanced.

5.1.2 Long-term Noise Monitoring

The purpose of long-term noise monitoring was to gather data over a 24-hour period to assist with the identification of the loudest hour of the day for the Existing Conditions. The long-term noise monitoring results were considered in conjunction with the ENTRADA data to aid with the determination of the loudest traffic noise hour for the Existing Conditions.

Long-term noise measurements were collected at five locations within the noise study area from October 1 through 3, 2018. Long-term measurements were collected using three Rion NL-21 Type 2 (precision) sound level meters. Prior to the noise monitoring sessions, the noise meters were calibrated to 94 dB(A) using a Rion NC-74 precision acoustic calibrator. Refer to **Appendix G** for calibration certificates of the sound level meters and calibrator.

Readings were taken on the A-weighted scale and reported in dB(A). The data collection procedure involved L_{eq} measurements that were logged in consecutive 5-minute intervals. This method allowed individual time intervals that include noise events recognized (by event duration and monitored SEL ranges) by staff to be unrelated to traffic noise (such as aircraft over flights) to be excluded from consideration. Data collected by the noise meter included time, L_{eq}, L_{min}, L_{max}, L_5, L_{10}, L_{50}, L_{90}, L_{95}, and the SEL for each interval.

The datalogger outputs (raw and adjusted) are presented in **Appendix I, Long-Term Monitoring Data**. The location of each long-term noise monitoring site in relation to the project study area is shown on the graphics located in **Appendix A**. A summary of the long-term noise monitoring results is presented in **Table 5-2**. Refer to **Section 5.4** for a discussion of how the long-term monitoring was evaluated to aid with the determination of the loudest noise hour.

Table 5-2: Long-term Noise Monitoring Summary

Site	Location	Dominant Sources of Noise	Monitored Noise Level $L_{eq(24h)}$ (dB(A))	Monitored Noise Level $L_{min(24h)}$ (dB(A))	Monitored Noise Level $L_{max(24h)}$ (dB(A))
LT-1[1]	Cul-de-sac at the end of Rivercrest Drive	I-495	63.1	54.1	77.9
LT-2	Langley Swim Club	I-495	60.9	49.9	76.1
LT-3	Sharon Masonic Temple	I-495	59.4	47.6	77.8
LT-4	7915 Flagstaff Road	DTR (VA 267)	60.1	53.1	74.2
LT-5	7421 Hallcrest Drive	DAAR (VA 267) / VA 123	55.2	46.9	77.2

[1] This monitoring site was determined to be located outside the noise study area for the I-495 Express Lanes NEXT Project, as the project advanced.

5.2 Noise Model Validation

Computer modeling is the accepted technique for predicting noise levels associated with traffic-induced noise for the Existing Conditions and the Build Alternative. The modeling process begins with model validation, per FHWA/VDOT requirements. This is accomplished by comparing the monitored noise levels and the noise levels predicted by TNM, using traffic volumes and speeds that were observed during the monitoring process (i.e. 20-minute traffic data was converted to one-hour traffic data for validation of the model). This validation ensures that reported changes between the existing and future design-year conditions are due to changes in traffic, and not discrepancies between monitoring and/or modeling techniques. A difference of plus or minus 3 dB(A) or less between the monitored and modeled levels is considered to be acceptable, since this is the limit of change detectable by a typical human ear. A summary of the model validation is provided in **Table 5-3**.

As shown, for all sites, the difference between the modeled and monitored noise levels range from -4.0 to +2.9 dB(A). The predicted levels that were modeled in TNM generally can differ from the recorded levels due to several factors. Such factors include atmospheric conditions[18] (upwind, neutral, or downwind) (NCHRP, 2018), existing shielding by structures that may be difficult to model, limited survey data, pavement properties that differ from the average pavement required for use in TNM, complex

[18] Sound levels on the down-wind side of a sound source are often considerably higher than sound levels on the upwind side. On the downwind side, sound rays are curved downward which could allow multiple sound rays to arrive at a receiver. On the upwind side, sound rays are curved upward, which causes a sound shadow (zone) to occur. Sound rays enter the shadow region primarily due to a scattering of sound waves by atmospheric turbulence. Similar to the influence of wind, sound rays are curved by temperature variations in the atmosphere. Consequently, since specific atmospheric conditions are not modeled in TNM, predicted noise levels would most likely deviate from observed noise monitoring results.

roadway and/or receptor geometry[19] (FWHA, 2004), and the representativeness of louder vehicles which pass-by the sound level meter during the measurement period. Other types of environmental factors (i.e. non-traffic related noise) were witnessed during the monitoring events that cannot be replicated in TNM. These non-traffic related noise even can include the following: airplane overflights, jake brakes (engine brakes), transit events, emergency sirens, HVAC systems, lawnmowers (i.e. motorized lawn care activities), or backup alarms. The noise from these external environmental factors was removed from the noise monitoring data when it had a noticeable effect on the monitored noise levels. There are also factors in the noise model that may cause differences with the measured noise levels including level of detail in terrain modeling, and the degree of inclusion of smaller elements such as hard ground zones, tree zones and sparse rows of buildings.

Table 5-3: Noise Model Validation

Site	Monitored Noise Level L_{eq} (dB(A))	Predicted Noise Level L_{eq} (dB(A))	Difference (Predicted – Monitored) L_{eq} (dB(A))
ST-1[1]	74.5	75.2	+0.7
ST-2[1]	58.9	61.5	+2.6
ST-3	55.9	53.4	-2.5
ST-4	66.3	63.5	-2.8
ST-5	63.0	63.2	+0.2
ST-6	57.6	55.8	-1.8
ST-7	63.0	60.0	-3.0
ST-8	60.7	62.0	+1.3
ST-9	59.1	58.7	-0.4
ST-10	57.3	55.5	-1.8
ST-11	62.2	59.6	-2.6
ST-12	65.5	61.5	-4.0
ST-13	54.6	54.8	+0.2
ST-14	58.7	61.6	+2.9
ST-15	62.7	60.0	-2.7
ST-16	59.6	60.7	+1.1
ST-17	61.3	63.3	+2.0
ST-18	59.4	57.1	-2.3
ST-19	55.0	55.2	+0.2
ST-20	58.3	55.6	-2.7
ST-21	55.3	54.4	-0.9
ST-23	59.5	62.2	+2.7
ST-24	60.7	60.1	-0.6

[19] Limits have been placed on the number of barriers and the number of ground points that are calculated in TNM. TNM has been designed to handle up to two barrier objects (i.e. existing barriers / retaining walls, multi-story residential / commercial / industrial buildings, objects input using TNM's barrier input tool) located within the source-receiver path. If three or more barrier type objects are encountered, TNM will choose the most effective pair of barriers based on their input heights and then discards all other barrier objects for the remainder of the analysis. TNM next determines how many points in the geometry cause the shortest path from the source to receiver to diffract downward. These "highest path points" (HPPs) could be barriers or ground points, which could be associated with berms, terrain lines or roadways. If three or more HPPs are encountered, TNM will not compute diffraction from all of them, and only the most effective pair is retained for calculation.

Site	Monitored Noise Level L_{eq} (dB(A))	Predicted Noise Level L_{eq} (dB(A))	Difference (Predicted – Monitored) L_{eq} (dB(A))
ST-25	68.7	69.2	+0.5
ST-26	58.2	60.0	+1.8
ST-30	59.3	56.5	-2.8
ST-31	68.6	67.1	-1.5
ST-32	58.6	60.5	+1.9
		Average Difference (dB)	**-0.51**
		Standard Deviation of Difference	**2.05**

[1] These monitoring sites were determined to be located outside the noise study area for the I-495 Express Lanes NEXT Project, as the project advanced.

Of the 28 noise monitoring sites, only Site ST-12, did not validate. TNM underpredicted this site by 4.0 dB(A). After a careful review of the monitoring and modeling data, this difference can most likely be attributed to reflection noise. Site ST-12 is located behind Existing Barrier 13E. Additionally, Existing Barrier 13A runs parallel along the on the far side of I-495. In this area, the distance between these barriers is approximately 160 feet, and the barriers are approximately 20 feet high, with the barrier on the far side (Barrier 13A) of the roadway being approximately eight feet higher than the near side barrier (Barrier 13E). As the distance to barrier height ratio is less than 10:1, an image roadways reflection analysis was performed. This evaluation revealed that the reflection contribution, which is not calculated by TNM, from the far side barrier (Barrier 13A) is approximately 3.0 dB(A). By removing this difference from the monitored sound level, the monitored sound level (Site ST-12) would be reduced to 62.5 dB(A), reducing the difference between the modeled and monitored sound levels to 1.0 dB(A). It is also assumed that Site ST-11 also may be partially affected by parallel barrier reflections as well but was not evaluated using image roadways, since it validated.

Since all the monitored sites were validated (Site ST-12 was assumed to be validated based on the results of the reflection analysis) within plus or minus 3 dB(A), the noise models were considered to be an accurate representation of actual existing conditions throughout the project area. Accordingly, the validated noise model was the base noise model used for the remainder of the noise analysis. An adjustment factor was not applied to the predicted results because, under the Build Alternative, the distance to barrier height ratio would be greater than 10:1. A reflections analysis for this area would be conducted during final design.

5.3 Common Noise Environments

For reporting purposes, the project area was divided into 26 Common Noise Environments (CNEs). CNEs are a group of receptors that are exposed to similar noise sources and levels; traffic volumes, traffic mix, and speed; and topographic features.

All residential receptors were modeled under NAC B. Receptors at outdoor playgrounds, recreational areas, and places of worship (with outdoor use areas) were modeled under NAC C. Interior noise levels for receptors at schools, places of worship, and medical facilities were modeled under NAC D[20]. Receptors at outdoor seating areas associated with commercial and office uses were modeled under NAC E. **Appendix A** contains graphics with all the modeled receiver locations by CNE. Refer to **Section 6.2** for a detailed description of each CNE.

5.4 Selection of the Loudest Noise Hour

As required by FHWA and VDOT, the noise analysis was performed for the loudest ("worst noise") hour of the day. Noise levels have been predicted for that hour of the day when the vehicle volumes, interrupted operating speeds, and number of trucks (vehicles with three or more axles) combine to produce the loudest noise conditions. According to FHWA guidance, the "worst hourly traffic noise impact" occurs at a time when truck volumes and vehicle speeds are the greatest, typically when traffic is free flowing and at or near level of service (LOS) C conditions (FHWA, 2011).

While the peak traffic hour often coincides with the loudest noise hour of the day, there are some conditions which would require the evaluation of non-peak traffic hours to determine the loudest noise hour of the day. Specifically, this can occur when the combination of peak hour traffic volumes and operational speeds approach the capacity of a facility (LOS E or worse), or when there are substantial differences in truck percentages between the peak and off-peak hours (FHWA, 2015).

5.4.1 Methodology

ENTRADA sheets were developed by the project team for the Existing Conditions (2018), the No-Build Alternative (2045), and the Build Alternative (2045). This data was imported into VDOT's loudest hour spreadsheet (version 2.2), which was used to help identify loudest candidate hours for noise modeling purposes, that were confirmed through modeling in TNM. VDOT's loudest hour spreadsheet is a predictive screening tool which calculates reference L_{eq}'s at 50 feet for the most common TNM vehicle types (e.g. autos, medium trucks, and heavy trucks), utilizing interrupted operational speeds, hourly peak-hour volumes (for each hour of the day), over flat ground[21].

After the loudest hour spreadsheet identified candidate hours, they were compared against the long-term monitoring data to confirm the loudest candidate hours for further evaluation using TNM. The long-term noise monitoring was only used to aid with the determination of the loudest hour for the Existing Conditions. Representative receptors were then selected from a few CNEs and were then modeled using TNM for each identified candidate hour to determine the most representative loudest noise hour for the project.

[20] Exterior receptors were used to evaluate the interior noise levels within the project area. Since the exterior for the evaluated buildings are largely composed of masonry material and appear to have modern air conditioning installed, the reduction in noise levels in the interior as a result of the building is predicted to be 25 dB(A) (FHWA, 2011).

[21] The spreadsheet calculates the loudest noise hour using only the hourly peak-hour volumes and the interrupted operational speeds. Once the loudest noise hour is selected, the spreadsheet provides TNM inputs based on the following FHWA guidance that highway agencies should either use the posted speed limit or the operational speed, whichever is consistently higher (FHWA, 2011).

5.4.2 Summary of Loudest Noise Hour

Traffic data was imported from ENTRADA sheets for the I-495 general purpose lanes and processed by the loudest hour spreadsheet using hourly peak-hour traffic volumes, commercial truck percentages, and interrupted operational speeds that are necessary for the loudest hour calculation. The spreadsheet combined both directions of the roadway links to predict $L_{eq(1h)}$ values as part of the loudest noise hour screening analysis for each hour of the day.

Under the Existing Conditions, the loudest hour screening worksheet evaluated 17 ENTRADA links associated with the I-495 mainline. Refer to **Appendix K** for figures which show the location of the ENTRADA links for the Existing Conditions and the Build Alternative. **Table 5-4** identified the following loudest hours, based only on the ENTRADA data. **Table 5-5** provides loudest noise hour sound levels based on the most frequent hours, based on the results presented in **Table 5-4**.

Table 5-4: Loudest hour based on ENTRADA data

ENTRADA Roadway Link Name	Loudest Noise Hour	Loudest Noise Hour Sound Level (Leq1h)	2nd Loudest Noise Hour	2nd Loudest Noise Hour Sound Level (Leq1h)	3rd Loudest Noise Hour	3rd Loudest Noise Hour Sound Level (Leq1h)	4th Loudest Noise Hour	4th Loudest Noise Hour Sound Level (Leq1h)
I-495 FGN495GWP01	12:00	78.5	20:00	77.3	21:00	77.1	05:00	76.7
I-495 FGN495GWP02[5]	12:00	78.7	20:00	77.6	21:00	77.3	05:00	77.2
I-495 FGN49519301	12:00	78.2	20:00	76.4	21:00	76.4	05:00	76.3
I-495 FGN49519302	12:00	78.6	20:00	77.0	21:00	76.7	05:00	76.7
I-495 FGN49526701	12:00	77.1	13:00	77.1	06:00	76.6	11:00[1]	76.6
I-495 FGN49526702	13:00	76.8	12:00	76.7	06:00	76.4	11:00[2]	76.4
I-495 FGN49526703	06:00	78.1	13:00	78.0	12:00	78.0	11:00[3]	77.5
I-495 FGN49526704	13:00	78.2	06:00	78.2	12:00	78.2	11:00[4]	77.8
I-495 FGN49526705	13:00	78.5	12:00	78.3	20:00	76.5	05:00	76.4
I-495 FGS495CBP01[5]	13:00	78.3	11:00	78.3	12:00	77.9	14:00	77.8
I-495 FGS495GWP01	11:00	78.2	12:00	78.0	13:00	77.9	14:00	77.6
I-495 FGS49519301	11:00	78.9	12:00	78.3	13:00	78.2	14:00	78.1
I-495 FGS49519302	11:00	78.6	13:00	78.4	10:00	78.1	14:00	78.0
I-495 FGS49526701	13:00	77.9	15:00	77.7	10:00	77.5	14:00	77.5
I-495 FGS49526702	13:00	76.8	11:00	76.4	10:00	76.3	14:00	76.3
I-495 FGS49526703	13:00	76.5	11:00	76.2	10:00	76.2	14:00	76.1
I-495 FGS49526704	13:00	77.3	10:00	77.0	11:00	77.0	12:00	76.9

[1] 05:00 was identified as the 5th loudest noise hour (75.9 dB(A)).
[2] 05:00 was identified as the 5th loudest noise hour (75.5 dB(A)).
[3] 05:00 was identified as the 5th loudest noise hour (76.5 dB(A)).
[4] 05:00 was identified as the 5th loudest noise hour (76.6 dB(A)).
[5] These ENTRADA roadway links were determined to be located outside the noise study area for the I-495 Express Lanes NEXT Project, as the project advanced.

Upon an initial review of the results presented in **Table 5-4**, the spreadsheet shows that there was not a consistently most frequent common loudest hour that was identified for the entire I-495 mainline. It also shows that several of the hours identified are separated by less than a tenth of a decibel. A statistical analysis shows that the difference between the predicted sound levels for the loudest noise hour and the 4th loudest noise hour range from 0.4 to 2.1 dB(A), with an average of 0.9 dB(A). Since a 3 dB(A) change is said to be barely perceptible to the human ear, any of hours identified presented in **Table 5-4** would be good candidate hours to evaluate in TNM.

Based on **Table 5-4**, the two most frequent hours that were identified was 12:00 and 13:00. These hours were further evaluated based on their frequency in the table using ENTRADA data. The long-term noise monitoring results were also considered as part of the loudest hour analysis.

Appendix J, Long-Term Loudest Hour provides detailed summary tables (showing 30-minute and 1-hour Leq's) and noise histograms that were used to determine the loudest hour at each of the long-term monitoring sites. **Table 5-5** identifies the three loudest hours of the day, encountered during a 24-hour monitoring period, for each long-term site. The traffic projection inputs that were developed (from the ENTRADA data) for noise modeling in TNM are provided in **Appendix K, TNM Traffic Inputs.**

Table 5-5: Loudest Noise Hour at Long-term Monitoring Sites

Site	Loudest Noise Hour	Loudest Noise Hour Sound Level (Leq1h)	2nd Loudest Noise Hour	2nd Loudest Noise Hour Sound Level (Leq1h)	3rd Loudest Noise Hour	3rd Loudest Noise Hour Sound Level (Leq1h)
LT-1[1]	05:00 – 06:00	65.5	20:05 -21:00	64.8	10:00 -11:00	64.7
LT-2	05:15 – 06:15	63.3	10:15 -11:15	63.2	06:15 -07:15	63.1
LT-3	07:00 – 08:00	61.8	06:00 -07:00	61.4	08:00 -09:00	60.9
LT-4	07:30 – 08:30	63.0	06:30 -07:30	62.3	08:30 -09:30	62.3
LT-5	06:45 – 07:45	56.8	07:45 -08:45	56.6	08:45 -09:45	56.6

[1] This monitoring site was determined to be located outside the noise study area for the I-495 Express Lanes NEXT Project, as the project advanced.

While the 12:00 and 13:00 loudest noise hours did not correlate from **Table 5-4**, Site LT-1 shows the highest Leq(1h) of 65.5 during the 05:00 hour, which does correlate to the 4th and 5th loudest noise hours in **Table 5-4**. Based on the minor differences in sound levels between the loudest hours (less than 2.1 dB(A)), the 05:00 hour also appears to be a valid candidate loudest noise hour for evaluation in TNM. Based on the long-term noise monitoring Site LT-1 would also be considered to be currently impacted by traffic noise during the 05:00-06:00 hour, as it approaches the noise abatement criteria level of 67 dB(A). While the results for LT-1 correlate to the results shown in **Table 5-4**, it did not reflect the loudest hour of the day.

5.4.2.1 Presentation of TNM Results

A comparison of the candidate hours (05:00, 12:00, and 13:00) show that the 12:00 is most frequently representative of the loudest hour of the day. Even though 13:00 was consistently higher for CNE I, the average difference in predicted sound levels is negligible (0.2 dB(A)) between 12:00 and 13:00 and would likely not meaningfully change the results. Consequently, 12:00 was selected as the loudest hour of the day for the Existing Conditions. Due to the negligible differences between the predicted sound levels identified in **Table 5-4**, the 12:00 hour was also used to represent the loudest hour for the Build Alternative.

6.0 NOISE IMPACT EVALUATION

Assessment of traffic noise impact requires these comparisons:

- The noise levels under Existing Conditions must be compared to those under the Build Alternative. This comparison shows the change in noise levels that would occur between the existing year and the design year if the project is constructed, to determine if the substantial increase impact criteria has been met; and

- The noise levels under Build Alternative must be compared to the applicable NAC. This comparison determines if the impact criteria has been met under the Build Alternative and can be used to assist in noise compatible land use planning.

6.1 Evaluation of the No-Build Alternative

While the evaluation of the No-Build Alternative is typically completed when a project is related to the interstate system under *Section 6.4.7* of *VDOT's Highway Traffic Noise Impact Analysis Guidance Manual*, a noise analysis for the No-Build Alternative is not required under 23 CFR 772. This federal guidance is also acknowledged in FHWA's FAQs, where a distinction is made between the 23 CFR 772 requirements and NEPA requirements, with respect to noise.

Under the NEPA requirements, the No-Build Alternative analysis assists with making informed decisions on whether future increases in noise levels (i.e., associated with the Build Alternative) over the No-Build Alternative would be considered "significant." However, noise impacts are not usually significant because they can potentially be mitigated though noise abatement (i.e., noise barriers).

Future design year noise level increases of 3 dB(A) or more over the No-Build Alternative are not common along existing and heavily traveled Interstate corridors mainly due to the following general rules of thumb, regarding line sources:

- Halving the distance between a highway and receptor would produce a 3 dB(A) sound level increase; and
- A doubling of the traffic on a roadway would produce a 3 dB(A) sound level increase.

Since neither of these conditions would apply to this project, it is not anticipated that a 3 dB(A) increase over the No-Build Alternative would occur. Additionally, FHWA considers changes in noise levels of 3 dB(A) or less to be barely perceptible to the human ear, under normal conditions.

Furthermore, noise mitigation must be evaluated, regardless of whether or not the proposed project is the cause, in accordance with 23 CFR 772, where the Build Alternative noise levels are predicted to exceed the NAC. As such, the No-Build noise analysis is not likely to assist with NEPA decision-making process. Although a quantitative No-Build analysis has not been completed, a Section 4(f) constructive use discussion is provided in **Section 6.4** and in-kind barrier replacement extensions under the No-Build Alternative are discussed in **Section 7.4**.

6.2 Predicted Noise Levels

Noise levels in the noise study area were predicted using separate TNM runs for the Existing Conditions (2018) and the Build Alternative[22] (2045). For all modeled receptors, the Existing Conditions (2018) noise levels are predicted to range from 42 to 72 dB(A); and the Build Alternative (2045) noise levels are predicted to range from 43 to 74 dB(A).

6.3 Presentation of Results

For all modeled sites, the Existing Conditions is predicted to impact 115 receptors – 92 residential receptors, 20 recreational sites, and three commercial sites. The Build Alternative is predicted to impact 148 receptors – 123 residences and 25 recreational sites. None of the sites are predicted to be impacted under the substantial increase criterion. The following is a description of each CNE with a summary of the Existing Conditions (2018) and Build Alternative (2045) sound levels by CNE. **Appendix B: Summary of Predicted Sound Levels,** contains detailed tables by CNE showing the Existing Conditions (2018) and Build Alternative (2045) sound levels for each receptor. This information is summarized in **Table 6-1**. The location of the CNEs and modeled receivers can be found on the graphics in **Appendix A**. The graphics in **Appendix A** also represents the modeled results for the 2045 Build Alternative (which includes other No-Build projects that would be constructed by others). The **Appendix A** graphics reflect the limits of the noise study (i.e., noise study area) for the I-495 Express Lanes NEXT Project.

Table 6-1: Predicted Sound Level Ranges and Noise Impacts by CNE

CNE	Map Page Number(s) - Appendix A	Number of Receptors	NAC	Predicted Range of Sound Levels (dB(A))		Total Number of Impacted Receptors	
				Existing (2018)	Build (2045)	Existing (2018)	Build (2045)
C	1	52	B, C	46-72	46-74	**9**	**13**
D	7	19	B	46-64	49-67	0	**2**
E	1,2	54	B, C	50-67	51-69	**5**	**11**
F	7,8	60	B, C, D[1]	51-62	52-63	0	0
G	2	9	B	56-65	57-67	0	**3**
H	3	53	B, C	49-67	50-65	**2**	0
I	8, 9	71	B, C, D[1]	45-68	46-69	**3**	**8**
J	4	50	B	52-66	53-68	**2**	**4**
K	9,10	29	B, D[1],	59-65	59-70	0	**3**
L	5	12	B	53-65	53-64	0	0
M	5,6	108	B, C	49-59	48-59	0	0
N	5	2	D[1], E	60-71	61-72	0	0
O	6	49	C, E	55-75	54-74	**8**	**5**
P	11	7	D[1], E	59-70	57-71	0	0
Q	11,13	501	B, C	43-69	44-70	**28**	**33**
R	12	68	B, C	42-66	43-66	**1**	**1**
S	9	10	B	49-62	55-67	0	**2**
T	9	17	B	51-60	56-64	0	0
U	12,14	116	B	60-68	61-71	**57**	**58**

[22] The TNM files are retained in VDOT's technical files.

CNE	Map Page Number(s) - Appendix A	Number of Receptors	NAC	Predicted Range of Sound Levels (dB(A))		Total Number of Impacted Receptors	
				Existing (2018)	Build (2045)	Existing (2018)	Build (2045)
V	12	75	B	45-64	46-65	0	0
W	9	18	B	48-58	48-61	0	0
X	2	21	B, C	48-58	51-60	0	0
Y	3	8	B	45-56	45-56	0	0
Z	3,4	14	B	56-62	57-66	0	**2**
AA	4	7	B	57-64	61-69	0	**3**
AB	8	11	B	43-57	45-59	0	0
TOTALS				**42-72**	**43-74**	**115**	**148**

[1] Sound level ranges for interior sites are shown as the exterior equivalent sound level. Since the exterior for the evaluated buildings are largely composed of masonry material and appear to have modern air conditioning installed, the reduction in noise levels in the interior as a result of the building is predicted to be 25 dB(A) (FHWA, 2011). This calculated sound level was compared to the NAC to identify impacts. Refer to Appendix B for the predicted sound levels

CNE C

CNE C is located west of the southbound lanes of I-495, adjacent to the GWMP Interchange (**Appendix A – Page 1**). Front row receptors in this CNE do not have direct line of sight with I-495 and generally range from 20 feet lower in elevation to 20 feet higher in elevation, relative to the GWMP and its associated ramps, which is also the dominant source of noise. This CNE is comprised of 52 receivers (C04 - C55) representing 30 residential receptors (NAC B) along Live Oak Drive, Rivercrest Drive, and Green Oak Drive and 22 recreational receptors for the Potomac Heritage Trail. Existing Conditions noise levels within CNE C are predicted to range from 46 to 72 dB(A). Nine (9) receptors (C17, C45-C52) are predicted to be impacted by traffic noise under the Existing Conditions (2018), due a combination of the terrain and the traffic noise contributions from both the GWMP and I-495. Build Alternative noise levels within CNE C are predicted to range from 46 to 74 dB(A). Thirteen (13) receptors (C17, C24-C26, C45-C53) are predicted to be impacted by traffic noise under the Build Alternative (2045). Since sound levels exceed the NAC, the evaluation of noise abatement is warranted and will be discussed in **Section 7.5** of this report.

CNE D

CNE D is located east of I-495, just south of GWMP **(Appendix A - Page 7)**. Front row receptors in this CNE do not have direct line of sight with I-495 and generally range from 40 feet lower in elevation to 40 feet higher in elevation, relative to the GWMP which is also the dominant source of noise. This CNE is comprised of 19 receivers representing 19 residential receptors (D02 – D20) (NAC B) along Lupine Lane and Wemberly Way. Existing Conditions noise levels within CNE D are predicted to range from 46 to 64 dB(A). No receptors are predicted to be impacted by traffic noise under the Existing Conditions (2018). Build Alternative noise levels within CNE D are predicted to range from 49 to 67 dB(A). Two (2) receptors (D06 and D09) are predicted to be impacted by traffic noise under the Build Alternative (2045). Since sound levels exceed the NAC, the evaluation of noise abatement is warranted and will be discussed in **Section 7.5** of this report.

CNE E

CNE E is located west of the southbound lanes of I-495, between the GWMP and the grade separation at Live Oak Drive over I-495 **(Appendix A - Pages 1,2)**. CNE E contains an existing noise barrier (Barrier 10) that is impacted by the project, and therefore would need to be replaced in-kind. Front row receptors in this CNE do not have direct line of sight with I-495 and are generally at least 10 feet higher in elevation than the interstate mainline. The dominant noise source within CNE E is traffic from I-495. This CNE is comprised of 54 receivers representing three residential receptors (E01 – E03) (NAC B), 39 recreational trail receptors (NAC C) at Scott's Run Nature Preserve (E05 – E07, E09 – E10, E15, E17, E19 – E33, E38 – E54) and 12 recreational receptors (NAC C) at the Langley Swim and Tennis Club (E04, E08, E11 – E14, E16, E34 – E37). Trail receptors at Scott's Run Nature Preserve were identified along sections of the Potomac Heritage Trail, the Laurel Ridge Trail, the Oak Trail, and some unnamed connector trails within the park boundary (Fairfax County, 2015). The trails at Scott's Run are maintained by Fairfax County Park Authority (Fairfax County, 2019). Trail receptors for the Potomac Heritage Trail were also identified along Live Oak Drive. Existing Conditions noise levels within CNE E are predicted to range from 50 to 67 dB(A). Five (5) receptors (E10, E21 – E24) are predicted to be impacted by traffic noise under the Existing Conditions (2018) with the existing noise barrier in place. Build Alternative noise levels within CNE E are predicted to range from 51 to 69 dB(A). Eleven (11) receptors (E10, E13-E14, E20 – E24, E32, and E48-E49) are predicted to be impacted by traffic noise under the Build Alternative (2045) with the existing noise barrier in place. Since sound levels exceed the NAC, the evaluation of noise abatement is warranted and will be discussed in **Section 7.5** of this report.

CNE F

CNE F is located east of northbound lanes of I-495, between the I-495 North on-ramp to eastbound GWMP, near Lupine Lane, ending at Georgetown Pike (VA 193) **(Appendix A - Pages 7,8)**. CNE F contains an existing noise barrier (Barrier 9) that is impacted by the project and therefore would need to be replaced in-kind, and an existing noise barrier (Barrier 8) that is not impacted by the project and is anticipated to remain in place. Front row receptors in this CNE do not have direct line of sight with I-495 (due to existing noise barriers) and generally range from20 feet lower in elevation to 20 feet higher in elevation, relative to the interstate mainline. The dominant noise source within CNE F is traffic from I-495. The CNE is comprised of 60 receivers representing 56 residential receptors (F01 – F43) (NAC B), one receptor (F44) at a place of worship (Holy Trinity Church) (NAC D), and three receptors (F45 – F47) representing outdoor recreational areas (basketball courts at Holy Trinity Church) (NAC C). Existing Conditions exterior noise levels within CNE F are predicted to range from 51 to 62 dB(A)[23]. No receptors are predicted to be impacted by traffic noise under the Existing Conditions (2018) with the existing noise barrier in place. Build Alternative exterior noise levels within CNE F are predicted to range from 52 to 63 dB(A)[19]. No receptors are predicted to be impacted by traffic noise under the Build Alternative (2045) with the existing noise barrier in place.

[23] Sound level ranges for interior sites are shown as the exterior equivalent sound level. Refer to Appendix B for the predicted sound levels

Receptor F44 (NAC D) was used to evaluate the interior noise levels based on a 25 dB(A) reduction because the building is composed of masonry material and has modern air conditioning installed. Based on the interior noise reduction factor, predicted noise levels for the Existing Conditions (2019) and Build Alternative (2045) interior noise levels are predicted to be 37 dB(A) and 38 dB(A), respectively. As a result, receptor F44 is not impacted under either scenario.

Since sound levels do not exceed the NAC, the evaluation of noise abatement is not warranted and will not be discussed further within this report.

CNE G

CNE G is located west of the southbound lanes of I-495, in the northwest quadrant of the Georgetown Pike (VA 193) Interchange, along Linganore Drive **(Appendix A – Page 2)**. Receptors in this CNE do not have direct line of sight with I-495 and are at least 25 feet higher in elevation than the interstate mainline. The dominant noise source within CNE G is traffic from I-495. The CNE is comprised of nine receivers representing nine residential receptors (G01 – G09) (NAC B). Existing Conditions noise levels within CNE G are predicted to range from 56 to 65 dB(A). No receptors are predicted to be impacted by traffic noise under the Existing Conditions (2018). Build Alternative noise levels within CNE G are predicted to range from 57 to 67 dB(A). Three (3) receptors (G04-G06) are predicted to be impacted by traffic noise under the Build Alternative (2045). Since sound levels exceed the NAC, the evaluation of noise abatement is warranted and will be discussed in **Section 7.5** of this report.

CNE H

CNE H is located west of the southbound lanes of I-495, between Georgetown Pike (VA 193) and Old Dominion Drive **(Appendix A - Page 3)**. CNE H contains an existing noise barrier (Barrier 13A) that is impacted by the project, and therefore would need to be replaced in-kind. Front row receptors in this CNE have no direct line of sight with I-495 (due to existing noise barriers) and generally range from 40 feet lower in elevation to 40 feet higher in elevation, relative to the interstate mainline. The dominant noise source within CNE H is traffic from I-495. The CNE is comprised of 52 receivers representing 40 residential receptors (H01 – H13, H15, H17 – H30, H35, H38 – H41, H47 – H53) (NAC B) and two receptors representing a tennis court (H14, H16) at Helga Place (NAC C) and 10 trail receptors (H31 – H34, H36 – H37, H43 – H46) at Scotts Run Stream Valley Park (NAC C). This trail was previously identified and analyzed under the I-495 Shoulder Use Project (UPC 105130). Existing Conditions noise levels within CNE H are predicted to range from 49 to 67 dB(A). Receiver (H37) is predicted to be impacted by traffic noise under the Existing Conditions (2018) with the existing noise barrier in place. Build Alternative noise levels within CNE H are predicted to range from 50 to 65 dB(A). Due to the widening I-495 under the Build Alternative, receptor H37 is located closer to the proposed roadway (on structure). As such, the geometry between the edge of the proposed roadway and Receiver H37 creates a shadow zone that explains why the predicted Build Alternative noise levels are less than the levels under the Existing Conditions. No receptors are predicted to be impacted by traffic noise under the Build Alternative (2045) with the existing noise barrier in place. Since sound levels do not exceed the NAC, the evaluation of noise abatement is not warranted and will not be discussed further within this report.

CNE I

CNE I is located east of the northbound lanes of I-495, between Georgetown Pike (VA 193) and Old Dominion Drive **(Appendix A - Pages 8,9)**. CNE I contains an existing noise barrier (Barrier 13E) that is partially impacted by the project, and therefore a portion of it would need to be replaced in-kind, while the remaining portion is anticipated to remain in place. Front row receptors in this CNE have no direct line of sight with I-495 (due to existing noise barriers) and generally range from 30 feet lower in elevation to 30 feet higher in elevation, relative to the interstate mainline. The dominant noise source within CNE I is traffic from I-495. The CNE is comprised of 71 receivers representing 60 residential receptors (I03 - I10, I12, I15 - I59, I64 – i69) (NAC B), one receptor (I70) that represents a recreational area at Cooper Middle School (NAC C), seven receptors (I11, I13 – I14, I60 – I63) at outdoor recreational areas associated with McLean Presbyterian Church (NAC C), one receptor (I02) representing an interior site at the Sharon Masonic Temple (NAC D), one receptor (I71) representing an interior site at McLean Presbyterian Church (NAC D), and one receptor (I01) representing an interior site at Cooper Middle School (NAC D). Existing Conditions exterior noise levels within CNE I are predicted to range from 45 to 68 dB(A)[24]. Three (3) receptors (I44, I50 and I52) are predicted to be impacted by traffic noise under the Existing Conditions (2018) with the existing noise barrier in place. Build Alternative exterior noise levels within CNE I are predicted to range from 46 to 69 dB(A)[20]. Eight (8) receptors (I22, I26, I28, I41, I46-I47, I50 and I52) are predicted to be impacted by traffic noise under the Build Alternative (2045) with the existing noise barrier in place.

Receptors I02, I70, and I71 (NAC D) were used to evaluate the interior noise levels based on a 25 dB(A) reduction because the buildings are composed of masonry material and has modern air conditioning installed. Based on the interior noise reduction factor, predicted noise levels for Receptors I02, I70, and I71 for the Existing Conditions (2019) and Build Alternative (2045) interior noise levels are predicted to range from 35 dB(A) to 38 dB(A), respectively. As a result, receptors I02, I70, and I71 are not impacted under either scenario.

Since sound levels exceed the NAC, the evaluation of noise abatement is warranted and will be discussed in **Section 7.5** of this report.

CNE J

CNE J is located west of the southbound lanes of I-495, between Old Dominion Drive and Lewinsville Road **(Appendix A - Page 4)**. CNE J contains an existing noise barrier (Barrier 13B) that is partially impacted by the project, and therefore a portion of it would need to be replaced in-kind, while the remaining portion is anticipated to remain in place. Front row receptors in this CNE have no direct line of sight with I-495 (due to existing noise barriers) and are at least 30 feet higher in elevation relative to the interstate mainline. The dominant noise source within CNE J is traffic from I-495. The CNE is comprised of 50 receivers representing 50 residential receptors (J01 – J50) (NAC B) along Huntmaster Lane, Timberly Lane,

[24] Sound level ranges for interior sites are shown as the exterior equivalent sound level. Refer to Appendix B for the predicted sound levels

Timberly Court, and Dominion Court. While Timberly Park is partially located within this CNE; however, there are no active outdoor uses (NAC C) associated with the portion of the park located within the noise study area. Existing Conditions noise levels within CNE J are predicted to range from 52 to 66 dB(A). Two (2) receptors (J1 and J2) are predicted to be impacted by traffic noise under the Existing Conditions (2018) with the existing noise barrier in place. Build Alternative noise levels within CNE J are predicted to range from 53 to 68 dB(A). Four (4) receptors (J1-J4) are predicted to be impacted by traffic noise under the Build Alternative (2045) with the existing noise barrier in place. Since sound levels exceed the NAC, the evaluation of noise abatement is warranted and will be discussed in **Section 7.5** of this report.

CNE K

CNE K is located east of the northbound lanes of I-495, between Old Dominion Drive and Lewinsville Road **(Appendix A – Pages 9,10)**. CNE K contains an existing noise barrier (Barrier 13D) that is impacted by the project, and therefore would need to be replaced in-kind. Front row receptors in this CNE have no direct line of sight with I-495 (due to existing noise barriers) and generally range from 15 feet lower in elevation to 15 feet higher in elevation, relative to the interstate mainline. The dominant noise source within CNE K is traffic from I-495. The CNE is comprised of 58 receivers representing 28 residential receptors (K01 – K04, K16 – K19, K35 – K46, K48 – K50, K52 – K53, K56 – K58) (NAC B) along Dulany Drive and at The Preserve at Scott's Run, , and one receptor (K47) representing an interior site at The Church of Jesus Christ of Latter-day Saints (NAC D). Existing Conditions exterior noise levels within CNE K are predicted to range from 59 to 65 dB(A)[20]. No receptors are predicted to be impacted by traffic noise under the Existing Conditions (2018) with the existing noise barrier in place. Build Alternative exterior noise levels within CNE K are predicted to range from 59 to 70 dB(A)[20]. Three (3) receptors (K1-K2, and K44) are predicted to be impacted by traffic noise under the Build Alternative (2045) with the existing noise barrier in place.

Receptor K47 (NAC D) was used to evaluate the interior noise levels based on a 25 dB(A) reduction because the building is composed of masonry material and has modern air conditioning installed. Based on the interior noise reduction factor, predicted noise levels for the Existing Conditions (2019) and Build Alternative (2045) interior noise levels are predicted to be 40 dB(A) and 41 dB(A), respectively. As a result, receptor K47 is not impacted under either scenario.

Since sound levels exceed the NAC, the evaluation of noise abatement is warranted and will be discussed in **Section 7.5** of this report.

CNE L

CNE L is located west of the southbound lanes of I-495, just south of Lewinsville Road **(Appendix A - Page 5)**. CNE L contains an existing noise barrier (Barrier 13B) that is impacted by the project, and therefore would need to be replaced in-kind. Front row receptors in this CNE have no direct line of sight with I-495 (due to existing noise barriers) and generally ranges from 10 feet lower in elevation to 10 feet higher in elevation, relative to the interstate mainline. The dominant noise source within CNE L is traffic from I-495. The CNE is comprised of 12 receivers at representing 12 residential receptors (L01 – L04, L06 – L07, L09 – L10, L13, L16 – L18) (NAC B) along Snow Meadow Lane. Existing Conditions noise levels within CNE L are predicted to range from 53 to 65 dB(A). No receptors are predicted to be impacted by traffic noise under the Existing Conditions (2018) with the existing noise barrier in place. Build Alternative noise levels within CNE L are predicted to range from 53 to 64 dB(A). No receptors are predicted to be impacted by traffic noise under the Build Alternative (2045) with the existing noise barrier in place. Since sound levels do not exceed the NAC, the evaluation of noise abatement is not warranted and will not be discussed further within this report.

CNE M

CNE M is located west of the southbound lanes of I-495, just north of the westbound lanes of the DTR **(Appendix A - Page 5,6)**. CNE M contains an existing noise barrier (Barrier 13B/NSA 26) that is partially impacted by the project, and therefore a portion of it would need to be replaced in-kind, while the remaining portion is anticipated to remain in place. Front row receptors in this CNE have no direct line of sight with I-495 or the DTR (due to existing noise barriers) and are at least five feet higher in elevation relative to the interstate mainline. The dominant noise source within CNE M is traffic from the DTR. The CNE is comprised of 108 receivers representing 107 residential receptors (M001 – M007, M010 – M050, M052 – M110) (NAC B) in the McLean Hamlet and Wilshyre neighborhoods and one receptor (M051) at an outdoor recreational site in McLean Hamlet Park (NAC C). Existing Conditions noise levels within CNE M are predicted to range from 49 to 59 dB(A). No receptors are predicted to be impacted by traffic noise under the Existing Conditions (2018) with the existing noise barrier in place. Build Alternative noise levels within CNE M are predicted to range from 48 to 59 dB(A). No receptors are predicted to be impacted by traffic noise under the Build Alternative (2045) with the existing noise barrier in place. Since sound levels do not exceed the NAC, the evaluation of noise abatement is not warranted and will not be discussed further within this report.

CNE N

CNE N is located east of the northbound lanes of I-495, in the northeast quadrant of the I-495/DTR interchange **(Appendix A - Page 5)**. The front row receptor in this CNE has direct line of sight with I-495 and is at least 20 feet higher in elevation relative to the interstate mainline. The dominant noise source within CNE N is traffic from I-495. The CNE is comprised of two receivers representing a single receptor (N1) at an interior site (NAC D) at the National Center for Plastic Surgery (medical facility) and a receptor at an outdoor commercial site (NAC E) at U.S. Farm Credit Administration Building (N3). This CNE also contains federal government offices for the Liberty Crossing Intelligence Campus (National Counterterrorism Center), but since there are no apparent outdoor use at this building complex; therefore, it was not modeled. Existing Conditions exterior noise levels within CNE N are predicted to range from 60 to 71 dB(A)[25]. No receptors are predicted to be impacted by traffic noise under the Existing Conditions (2018). Build Alternative exterior noise levels within CNE N are predicted to range from 61 to 72 dB(A)[22]. No receptors are predicted to be impacted by traffic noise under the Build Alternative (2045).

Receptor N1 (NAC D) was used to evaluate the interior noise levels based on a 25 dB(A) reduction because

[25] Sound level ranges for interior sites are shown as the exterior equivalent sound level. Refer to Appendix B for the predicted sound levels

the building is composed of masonry material and has modern air conditioning installed. Based on the interior noise reduction factor, predicted noise levels for the Existing Conditions (2019) and Build Alternative (2045) interior noise levels are predicted to be 46 dB(A) and 47 dB(A), respectively. As a result, receptor N1 is not impacted under either scenario.

Since sound levels do not exceed the NAC, the evaluation of noise abatement is not warranted and will not be discussed further within this report.

CNE O

CNE O is located west of the southbound lanes of I-495, in the southwest quadrant of the DTR **(Appendix A - Page 6)**. Front row receptors in this CNE have limited direct line of sight with I-495 and generally range from30 feet lower in elevation to 30 feet higher in elevation, relative to the interstate mainline. The dominant noise source within CNE O is traffic from the DTR. The CNE is comprised of 49 receivers representing 16 receptors (O01 – O03, O09 – O21) associated with outdoor recreational areas (e.g. ball courts, playgrounds, picnic areas) at the BASIS Independent McLean School (NAC C) and 33 receptors (O22 – O27, O29, O33 – O37, O39 – O59) at commercial areas, (NAC E) including two tennis and basketball courts, outdoor activity areas, outdoor gaming areas, concert areas, and community garden plots associated with the Valo Park office complex (Valo Park, 2019). Existing Conditions noise levels within CNE O are predicted to range from 55 to 72 dB(A). Eight (8) receptors (O1, O03, O14, O19, O20, O41, O46 and O49) are predicted to be impacted by traffic noise under the Existing Conditions (2018). Build Alternative noise levels within CNE O are predicted to range from 54 to 71 dB(A). Five (5) receptors (O01, O03, O14, O19, and O20) are predicted to be impacted by traffic noise under the Build Alternative (2045). Commercial receptors (O41, O46, and O49) are no longer impacted by noise under the Build Alternative because the combination of the proposed design geometry and the design year traffic volumes. As such, the vertical alignment of proposed Ramp DTR_E1 would partially provide shielding of Ramp G3, which carries more traffic in the design year, compared to the traffic combined from Ramps E267_G7-G8 and DTR_E1. Since sound levels exceed the NAC, the evaluation of noise abatement is warranted and will be discussed in **Section 7.5** of this report.

CNE P

CNE P is located west of the southbound lanes of I-495, in the southwest quadrant of the DTR interchange **(Appendix A - Page 11)**. Front row receptors in this CNE have limited direct line of sight with I-495 and generally range between five and 30 feet lower in elevation relative to the interstate mainline. The dominant noise sources within CNE P is traffic from the I-495 and the DTR. The CNE is comprised of seven receivers representing four receptors (P01 – P02, P04 – P05) associated with outdoor activity areas at the Valo Park commercial facility (NAC E), two receptors (P09 – P10) at an outdoor recreational area at the Hilton Worldwide Corporate Headquarters building, and one receptor (P07) at an interior site for the TLC Laser Eye Centers. Existing Conditions noise levels within CNE P are predicted to range from 59 to 70 dB(A)[23]. No receptors are predicted to be impacted by traffic noise under the Existing Conditions (2018).

Build Alternative noise levels within CNE P are predicted to range from 57 to 71 dB(A)[26]. No receptors are predicted to be impacted by traffic noise under the Build Alternative (2045).

Receptor P07 (NAC D) was used to evaluate the interior noise levels based on a 25 dB(A) reduction because the building is composed of masonry material and has modern air conditioning installed. Based on the interior noise reduction factor, predicted noise levels for the Existing Conditions (2019) and Build Alternative (2045) interior noise levels are predicted to be 45 dB(A) and 46 dB(A), respectively. As a result, receptor P07 is not impacted under either scenario.

Since sound levels do not exceed the NAC, the evaluation of noise abatement is not warranted and will not be discussed further within this report.

CNE Q

CNE Q is located east of the northbound lanes of I-495, in the southeast quadrant of the DTR interchange **(Appendix A - Pages 11,13)**. CNE Q contains an existing noise barrier (Barrier 12A2 (1R)) that is impacted by the project, and therefore would need to be replaced in-kind. Front row receptors in this CNE have no direct line of sight with I-495 (due to an existing noise barrier) and are generally 10 feet lower in elevation relative to the interstate mainline. The dominant noise sources within CNE Q is traffic from the I-495 and the DTR. The CNE is comprised of 255 receivers representing 498 residential receptors (Q01 – Q19, Q21 – Q29, Q31 – Q65)[27] (NAC B) within the Gates of McLean Condominium Complex and three receptors (Q20, Q30, Q66) at recreational areas (NAC C). Existing Conditions noise levels within CNE Q are predicted to range from 43 to 69 dB(A). Twenty-eight (28) receptors represented by 15 receivers (Q01B, Q01C, Q01D, Q02D, Q05C, Q05D, Q11D, Q18D, Q19D, Q21D, Q22D, Q23D, Q41D, Q42D, and Q43D) are predicted to be impacted by traffic noise under the Existing Conditions (2018) with the existing noise barrier in place. Build Alternative noise levels within CNE Q are predicted to range from 44 to 70 dB(A). Thirty-three (33) receptors represented by 19 receivers (Q01A, Q01B, Q01C, Q01D, Q02D, Q05C, Q05D, Q11D, Q18D, Q19D, Q21C, Q21D, Q22D, Q23D, Q41D, Q42D, Q43D, Q58D, and Q59D) are predicted to be impacted by traffic noise under the Build Alternative (2045) with the existing noise barrier in place. Since sound levels exceed the NAC, the evaluation of noise abatement is warranted and will be discussed in **Section 7.5** of this report.

CNE R

CNE R is located east I-495, along Chain Bridge Road and the eastbound lanes of the DAAR (VA 267) **(Appendix A - Page 12)**. CNE R contains an existing noise barrier (Barrier EB-1) that is not impacted by the project, and therefore is anticipated to remain in place. Front row receptors in this CNE have direct line of sight with Chain Bridge Road and generally range from 10 feet lower in elevation to 10 feet higher in elevation, relative to the interstate mainline. The dominant noise sources within CNE R is traffic from

[26] Sound level ranges for interior sites are shown as the exterior equivalent sound level. Refer to Appendix B for the predicted sound levels

[27] Receptor names at the Gates of McLean Residential Community also have a letter suffix which denotes the respective modeled floor (e.g. Q01A is located on the first floor, Q01D is located on the fourth floor, etc.) This naming convention also applies to CNE U and CNE R.

Chain Bridge Road and the DAAR. The CNE is comprised of 61 receivers representing 67 residential receptors (R01, R03, R07 – R61) (NAC B), at the Morgan at McLean Condominium Complex, the McLean Ridge neighborhood along Chain Bridge Road, and the residential receptors along LaSalle Avenue) and one recreational receptor (R02) at a recreational area (NAC C) associated with the Morgan at McLean Condominium Complex. Existing Conditions noise levels within CNE R are predicted to range from 42 to 66 dB(A). One (1) receptor (R39) is predicted to be impacted by traffic noise under the Existing Conditions (2018). Build Alternative noise levels within CNE R are predicted to range from 43 to 66 dB(A). One (1) receptor (R39) is predicted to be impacted by traffic noise under the Build Alternative (2045). Since sound levels exceed the NAC, the evaluation of noise abatement is warranted and will be discussed in **Section 7.5** of this report.

CNE S

CNE S is located east of the northbound lanes of I-495 and CNE K, south of Old Dominion Drive **(Appendix A - Page 9)**. Front row receptors in this CNE have direct line of sight Old Dominion Road and generally range from 10 feet lower in elevation to 10 feet higher in elevation, relative to this roadway, which is also the dominant source of noise. The CNE is comprised of 10 receivers representing 10 residential receptors (S01 – S10) (NAC B) along Old Dominion Drive, Mottrom Drive, and Dulany Drive. Existing Conditions noise levels within CNE S are predicted to range from 49 to 62 dB(A). No receptors are predicted to be impacted by traffic noise under the Existing Conditions (2018). Build Alternative noise levels within CNE S are predicted to range from 55 to 67 dB(A). Two (2) receptors (S01-S02) are predicted to be impacted by traffic noise under the Build Alternative (2045). Since sound levels exceed the NAC, the evaluation of noise abatement is warranted and will be discussed in **Section 7.5** of this report.

CNE T

CNE T is located east of the northbound lanes of I-495 and CNE I, north of Old Dominion Drive **(Appendix A - Page 9)**. Front row receptors in this CNE have direct line of sight with Old Dominion Road and generally range from 10 feet lower in elevation to 10 feet higher in elevation, relative to this roadway, which is also the dominant source of noise. The CNE is comprised of 17 receivers representing 17 residential receptors (T01 – T17) (NAC B) located along Old Dominion Drive and Westerly Lane off Balls Hill Road. Existing Conditions noise levels within CNE T are predicted to range from 51 to 60 dB(A). No receptors are predicted to be impacted by traffic noise under the Existing Conditions (2018). Build Alternative noise levels within CNE T are predicted to range from 56 to 64 dB(A). No receptors are predicted to be impacted by traffic noise under the Build Alternative (2045). Since sound levels do not exceed the NAC, the evaluation of noise abatement is not warranted and will not be discussed further within this report.

CNE U

CNE U is located east of I-495 and Dolley Madison Boulevard (VA 123) **(Appendix A - Pages 12,14)**. Front row receptors in this CNE have direct line of sight with Dolley Madison Boulevard (VA 123) / or Chain Bridge Road and are generally at the same elevation. The dominant noise sources within CNE U is traffic from Dolley Madison Boulevard the DAAR, and the elevated section of the Silver Line Metro. The CNE is comprised of 77 receivers representing 116 residential receptors (U01 – U11) (NAC B) associated with the

Haden Apartment Complex. Existing Conditions noise levels within CNE U are predicted to range from 60 to 68 dB(A). Fifty-seven (57) receptors represented by 41 receivers (all floors for receivers U01 – U03, U05, and U10) are predicted to be impacted by traffic noise under the Existing Conditions (2018). Build Alternative noise levels within CNE U are predicted to range from 61 to 71 dB(A). Fifty-eight (58) receptors represented by 42 receivers (all floors for receivers U01 – U03, U05, U10, and U06J) are predicted to be impacted by traffic noise under the Build Alternative (2045). Since sound levels exceed the NAC, the evaluation of noise abatement is warranted and will be discussed in **Section 7.5** of this report.

CNE V

CNE V is located east of the northbound lanes of I-495, north of the DAAR near Chain Bridge Road **(Appendix A - Page 12)**. CNE R contains an existing noise barrier (Barrier WB-1) that is not impacted by the project, and therefore is anticipated to remain in place. Front row receptors in this CNE have limited line of sight with Chain Bridge Road, and no line of sight with the DAAR (due to existing noise barriers) and generally range from 20 feet lower in elevation to 20 feet higher in elevation, relative to the interstate mainline. The dominant noise sources within CNE V is traffic from Chain Bridge Road, the DAAR and the Silver Line Metro. CNE V is comprised of 42 receivers representing 75 residential receptors (V01 – V42) (NAC B). Existing Conditions noise levels within CNE V are predicted to range from 45 to 64 dB(A). No receptors are predicted to be impacted by traffic noise under the Existing Conditions (2018). Build Alternative noise levels within CNE V are predicted to range from 46 to 65 dB(A). No receptors are predicted to be impacted by traffic noise under the Build Alternative (2045). Since sound levels do not exceed the NAC, the evaluation of noise abatement is not warranted and will not be discussed further within this report.

CNE W

CNE W is located east of the northbound lanes of I-495 and CNE F, just east of Balls Hill Road and north of the eastbound lanes of Georgetown Pike (VA 193) **(Appendix A - Page 8)**. Receptors in this CNE do not have direct line of sight with I-495, and front row receptors have some line of sight with Georgetown Pike and generally range up to 20 feet in elevation higher than Georgetown Pike which is also the dominant source of noise. CNE W is comprised of 18 receivers representing 18 residential receptors (W01 – W18) (NAC B) along Georgetown Pike, Holyrood Drive, Countryside Court, and Country Meadow Court. Existing Conditions noise levels within CNE W are predicted to range from 48 to 58 dB(A). No receptors are predicted to be impacted by traffic noise under the Existing Conditions (2018). Build Alternative noise levels within CNE W are predicted to range from 48 to 61 dB(A). No receptors are predicted to be impacted by traffic noise under the Build Alternative (2045). Since sound levels do not exceed the NAC, the evaluation of noise abatement is not warranted and will not be discussed further within this report.

CNE X

CNE X is located west of the southbound lanes of I-495 and CNE G, just north of the westbound lanes of Georgetown Pike (VA 193) **(Appendix A - Page 2)**. Receptors in this CNE do not have direct line of sight with I-495, and front row receptors have limited line of sight with Georgetown Pike and range from five to 40 feet in elevation higher, relative to Georgetown Pike which is also the dominant source of noise.

The CNE is comprised of 21 receivers representing 13 recreational trail receptors (X01 – X13) along Stubblefield Falls Overlook Trail and Parking Lot Connector Trail at Scott's Run Nature Preserve (NAC C) and eight residential receptors (X14 – X21) (NAC B) along Linganore Court (Fairfax County, 2015). The trails at Scott's Run are maintained by Fairfax County Park Authority (Fairfax County, 2019). Existing Conditions noise levels within CNE X are predicted to range from 48 to 60 dB(A). No receptors are predicted to be impacted by traffic noise under the Existing Conditions (2018). Build Alternative noise levels within CNE X are predicted to range from 51 to 60 dB(A). No receptors are predicted to be impacted by traffic noise under the Build Alternative (2045). Since sound levels do not exceed the NAC, the evaluation of noise abatement is not warranted and will not be discussed further within this report.

CNE Y

CNE Y is located west of the southbound lanes of I-495 and CNE H, south of Georgetown Pike **(Appendix A - Page 3)**. Front row receptors in this CNE have limited line of sight with Georgetown Pike and generally range from 10 feet lower in elevation to 10 feet higher in elevation, relative to this roadway, which is also the dominant source of noise. The CNE is comprised of eight receivers representing eight residential receptors (Y01 – Y08) (NAC B). Existing Conditions noise levels within CNE Y are predicted to range from 45 to 56 dB(A). No receptors are predicted to be impacted by traffic noise under the Existing Conditions (2018). Build Alternative noise levels within CNE Y are predicted to range from 45 to 56 dB(A). No receptors are predicted to be impacted by traffic noise under the Build Alternative (2045). Since sound levels do not exceed the NAC, the evaluation of noise abatement is not warranted and will not be discussed further within this report.

CNE Z

CNE Z is located west of I-495 and CNE H, north of Old Dominion Drive **(Appendix A - Pages 3,4)**. Front row receptors in this CNE have limited line of sight with Old Dominion Drive and generally range from 10 feet lower in elevation to 10 feet higher in elevation, relative to this roadway, which is also the dominant source of noise. CNE Z is comprised of 14 receivers representing 14 residential receptors (Z01 – Z14) (NAC B) off Old Dominion Drive, Gelston Circle, and Blaise Trail. Existing Conditions noise levels within CNE Z are predicted to range from 56 to 62 dB(A). No receptors are predicted to be impacted by traffic noise under the Existing Conditions (2018). Build Alternative noise levels within CNE Z are predicted to range from 57 to 66 dB(A). Two (2) receptors (Z07 and Z09) are predicted to be impacted by traffic noise under the Build Alternative (2045). Since sound levels exceed the NAC, the evaluation of noise abatement is warranted and will be discussed in **Section 7.5** of this report.

CNE AA

CNE AA is located west of I-495, Dominion Court, and CNE J and south of Old Dominion Drive **(Appendix A - Page 4)**. Front row receptors in this CNE have limited line of sight with Old Dominion Drive and generally range from 10 feet lower in elevation to 10 feet higher in elevation, relative to this roadway, which is also the dominant source of noise. CNE AA is comprised of seven receivers representing seven residential receptors (AA1 – AA7) (NAC B) off Old Dominion Drive and Dominion Court. Existing Conditions noise levels within CNE AA are predicted to range from 57 to 64 dB(A). No receptors are predicted to be impacted by traffic noise under the Existing Conditions (2018) with the existing noise barrier in place. Build Alternative noise levels within CNE AA are predicted to range from 61 to 69 dB(A). Three (3) receptors (AA5-AA7) are predicted to be impacted by traffic noise under the Build Alternative (2045) with the existing noise barrier in place. Since sound levels exceed the NAC, the evaluation of noise abatement is warranted and will be discussed in **Section 7.5** of this report.

CNE AB

CNE AB is located east of the northbound lanes of I-495, CNE I, and Balls Hill Road, south of Georgetown Pike **(Appendix A - Page 8)**. Front row receptors in this CNE have limited line of sight with Georgetown Pike and generally range from 10 feet lower in elevation to 10 feet higher in elevation, relative to this roadway, which is also the dominant source of noise. CNE AB is comprised of 11 receivers representing 11 residential receptors (AB01 – AB11) (NAC B) along Dead Run Drive. Existing Conditions noise levels within CNE AB are predicted to range from 43 to 57 dB(A). No receptors are predicted to be impacted by traffic noise under the Existing Conditions (2018). Build Alternative noise levels within CNE AB are predicted to range from 45 to 59 dB(A). No receptors are predicted to be impacted by traffic noise under the Build Alternative (2045). Since sound levels do not exceed the NAC, the evaluation of noise abatement is not warranted and will not be discussed further within this report.

6.4 Constructive Use Evaluation of Section 4(f) Properties

The following CNE's were identified to have recreational noise receptors (NAC C) along multiple existing trails located within Scott's Run Nature Preserve, a previously identified Section 4(f) park:

- **CNE E** – Scott's Run Nature Preserve: Potomac Heritage Trail, Laurel Ridge Trail, Oak Trail, and unnamed connector trails; and
- **CNE X** – Scott's Run Nature Preserve: Stubblefield Falls Overlook Trail and the Parking Lot Connector Trail.

A qualitative noise assessment was conducted to confirm that a constructive use does not occur based on the following guidance:

- The impact of projected (predicted) traffic noise levels of the proposed highway project on a noise-sensitive activity do not exceed the NAC, as shown in **Table 4-1**; and
- The projected (predicted) noise levels exceed the NAC of this section because of high existing noise, but the increase in the projected (predicted) noise levels if the proposed project is constructed (Build Alternative), when compared with the projected noise levels if the project is not built (No-Build Alternative), is barely perceptible (3 dB(A) or less).

Recreational trail receptors in CNE X are not predicted to approach or exceed the NAC, therefore based on the guidance in 23 CFR 774.15 (f)(2)(i), a constructive use would not occur at these receptors. As for the recreational receptors in CNE E, similar to the discussion presented in **Section 6.1**, a 3 dB(A) increase over the No-Build Alternative seldom occurs along an existing and heavily traveled Interstate corridor. Based on the guidance in 23 CFR 774.15 (f)(3), a constructive use would not likely occur at these receptors in CNE E because a 3 dB(A) increase is not anticipated between the Build Alternative and No-Build Alternative. Additionally, some of the trail receptors (associated with the Oak Trail and Potomac Heritage Trail in Scott's Run Nature Preserve in CNE E) are currently benefited by an existing noise barrier (Barrier 10). Since the Build Alternative would physically impact this existing noise barrier, a replacement barrier would be constructed, which would potentially benefit additional impacted noise receptors.

6.5 Rail Noise Assessment

Using the modeling methodology discussed in **Section 4.4.4** of the report, the rail noise contribution was calculated in TNM for CNEs R, U, and V under the Build Alternative. For almost all receptors in these CNEs, the predicted rail contribution was approximately 1 dB(A) or less. Since a 3 dB(A) increase is considered to be barely perceptible to the human ear, the rail noise contribution is negligible compared to the traffic noise contribution.

CNE R

Sound levels in this CNE were predicted to experience an increase from 0.1 to 1.3 dB(A) due to the rail noise contribution. Without the rail noise contribution, receiver R39 was no longer predicted to be impacted, under the Build Alternative.

CNE U

Sound levels in this CNE were predicted to experience an increase from 0.1 to 0.7 dB(A) due to the rail noise contribution. Without the rail noise contribution, receiver U06J was no longer predicted to be impacted, under the Build Alternative.

CNE V

Sound levels in this CNE were predicted to experience an increase from 0.1 to 1.0 dB(A) due to the rail noise contribution. The rail noise contribution did not change the number of predicted noise impacts, under the Build Alternative.

7.0 NOISE ABATEMENT DETERMINATION

Noise Abatement Determination is a three-phased approach. ***Phase 1*** of the process is to determine if highway traffic noise abatement consideration is warranted for the affected receptors. The warranted criterion specifically pertains to traffic noise impacted receptors, as defined in **Section 4.2**.

Since, as described in **Section 6**, predicted noise levels for the Build Alternative either approach or exceed the NAC, per VDOT's State Noise Abatement Policy, noise abatement considerations are warranted for these impacted noise receptors (**Table 6-1**). ***Phases 2 and 3*** of the NAC include considering noise abatement measures for determining feasibility and reasonableness; Phases 2 and 3 are discussed in **Sections 7.2** and **7.3**, respectively. Following the completion of all three phases, a determination can be made related to the feasibility and reasonableness of the noise abatement options.

7.1 Abatement Measures Evaluation

FHWA/VDOT guidelines recommend a variety of mitigation measures that should be considered in response to transportation-related noise impacts. While noise barriers and/or earth berms are generally the most effective form of noise mitigation, additional mitigation measures exist which have the potential to provide considerable noise reductions, under certain circumstances. Mitigation measures considered for this project include:

- Traffic control measures;
- Alteration of horizontal and vertical alignments;
- Acoustical insulation of public use and non-profit facilities;
- Acquisition of buffering land;
- Construction of noise barriers; and
- Construction of earth berms.

Additionally, the Noise Policy Code of Virginia (HB 2577, as amended by HB 2025) states: *whenever the Commonwealth Transportation Board or the Department plan for or undertake any highway construction or improvement project and such project includes or may include the requirement for the mitigation of traffic noise impacts, first consideration should be given to the use of noise reducing design and low noise pavement materials and techniques in lieu of construction of noise walls or sound barriers. Vegetative screening, such as the planting of appropriate conifers, in such a design would be utilized to act as a visual screen if visual screening is required. Consideration will be given to these measures during the final design stage, where feasible.* The response from project management is included in **Appendix L.**

Traffic Control Measures (TCM): Traffic control measures, such as speed limit restrictions, truck traffic restrictions, and other traffic control measures that may be considered for the reduction of noise emission levels are not practical for this project. Reducing speeds would not be an effective noise mitigation measure since a substantial decrease in speed is necessary to provide adequate noise reduction. Typically, a 10-mph reduction in speed would result in only a 2 dB(A) decrease in noise level, which is not considered a sufficient level of attenuation reduction to be considered feasible. Likewise, a 2 dB(A) change in noise is not generally perceptible to the human ear. Additionally, the purpose of the proposed project is to increase capacity and improve the overall traffic operations. The prohibition of truck traffic, the reduction of the speed limit below the proposed design speed, or decreasing total traffic volumes would diminish the functional capacity of the roadway facility.

Alteration of Horizontal and Vertical Alignments: The alteration of the horizontal and vertical alignment has been considered to reduce or eliminate the impacts created by the proposed project wherever possible. However, due to the constrained environment, there are no feasible options to deviate from the existing alignment or introduce deep cuts for the roadway widening. However, as a general rule, for a straight-line scenario where noise is unimpeded between the noise source and the receptor, noise levels will only drop off 3 dB(A) if the distance between the noise source and receptor is doubled (i.e. the road is shifted further away from the impacted receptor).

Acoustical Insulation of Public Use and Non-Profit Facilities: This noise abatement measure option applies only to public and institutional use buildings. Since no public use or institutional structures are anticipated to have interior noise levels exceeding FHWA's interior NAC, this noise abatement option will not be applied.

Acquisition of Buffering Land: The purchase of property for the creation of a "buffer zone" to reduce noise impacts is only considered for predominantly unimproved properties because the amount of property required for this option to be effective would create significant additional impacts (*i.e.*, in terms of residential displacements), which were determined to outweigh the benefits of land acquisition.

Construction of Berms / Noise Barriers: Construction of noise barriers can be an effective way to reduce noise levels at areas of outdoor activity. Noise barriers can be wall structures, earthen berms, or a combination of the two. The effectiveness of a noise barrier depends on the distance and elevation difference between roadway and receptor and the available placement location for a barrier. Gaps between overlapping noise barriers also decrease the effectiveness of the barrier, as opposed to a single continuous barrier. The barrier's ability to attenuate noise decreases as the gap width increases.

Noise walls and earth berms are often incorporated into the highway design to mitigate identified noise impacts. The effectiveness of a freestanding (post and panel) noise barrier and an earth berm of equivalent height are relatively consistent. The use of earth berms is not always an option due to the excessive space they require adjacent to the roadway corridor. At a standard slope of 2:1, every one-foot in height would require four feet of horizontal width. This requirement becomes more complex in built up areas where residential and commercial properties abut the proposed roadway corridor. In these situations, implementation of earth berms can require significant property acquisitions to accommodate noise mitigation. Given space restrictions between the proposed roadway and residential communities, earth berms are not considered a viable mitigation option for this project.

As a general practice, noise barriers are most effective when placed at a relatively high point between the roadway and the impacted noise sensitive land use. To achieve the greatest benefit from a potential noise barrier, the goal of the barrier should focus on breaking the line-of-sight (to the greatest degree possible) from the roadway to the receptor. In roadway fill conditions, where the highway is above the natural grade, noise barriers are typically most effective when placed on the edge of the roadway shoulder or on top of the fill slope. In roadway cut conditions, where the roadway is located below the natural grade, barriers are typically most effective when placed at the top of the cut slope. Engineering and safety issues have the potential to alter these typical barrier locations (FHWA, 2000).

The effectiveness of a noise barrier is measured by examining the barrier's capability to reduce future noise levels. Noise reduction is measured by comparing design year pre- and post-barrier noise levels. This difference between unabated and abated noise levels is known as insertion loss (IL).

7.2 Feasibility Criterion for Noise Barriers

All receptors that meet the warranted criterion must progress to the "feasible" phase. Phase 2 of the noise abatement criteria requires that both of the following acoustical and engineering conditions be considered.

(1) At least a 5 dB(A) highway traffic noise reduction at impacted receptors. Per 23 CFR 772, FHWA requires the highway agency to determine the number of impacted receptors required to achieve at least 5 dB(A) of reduction. **VDOT requires that fifty percent (50%) or more of the impacted receptors experience five (5) dB(A) or more of insertion loss to be feasible**; and

(2) **The determination that it is possible to design and construct the noise abatement measure**. Factors related to the design and construction would include: safety, barrier height, topography, drainage, utilities, and maintenance of the abatement measure, maintenance access to adjacent properties, and general access to adjacent properties (i.e., arterial widening projects).

The noise abatement measure is said to be feasible if it meets both criteria.

7.3 Reasonableness Criterion for Noise Barriers

All receptors that meet the feasibility criterion must progress to the "reasonableness" phase. 23 CFR 772.13(d)(2)(iv) requires that all three (noted below) of the following required reasonableness factors be satisfied for a proposed noise abatement measure to be considered reasonable.

7.3.1 Noise Reduction Design Goals

The design goal is a reasonableness factor indicating a specific reduction in noise levels that VDOT uses to identify that a noise abatement measure effectively reduces noise. The design goal establishes a criterion, selected by VDOT, which noise abatement must achieve. **VDOT's noise reduction design goal is defined as at least a seven (7) dB(A) of insertion loss for at least one impacted receptor**, meaning that at least one impacted receptor is predicted to achieve a seven dB(A) or greater noise reduction with the proposed barrier in place.–

It is important to optimize the noise barrier design to achieve the most effective noise barrier in terms of both noise reduction (insertion losses) and cost. Although at least a five dB(A) reduction at 50% or more of the impacted receptors is required to meet the feasibility criteria, the following tiered noise barrier abatement goals should be used to govern barrier design and optimization.

- Reduction of future highway traffic noise by seven dB(A) at one or more of the impacted receptors (required criterion).
- Reduction of future highway traffic noise levels to the low 60-decibel range when practical (desirable).
- Reduction of future highway traffic noise levels to existing noise levels when practical (desirable).

The goal of noise abatement is to provide 100% effectiveness (i.e., provide a benefit for every impacted receptor) (VDOT, 2018). In addition, noise barrier design should make all reasonable attempts to break the line of sight between roadway and receptor and design noise abatement with flanking noise considerations (FHWA, 2000).

7.3.2 Cost-effectiveness

Typically, the limiting factor related to barrier reasonableness is the cost effectiveness value, where the total surface area of the barrier is divided by the number of benefited receptors receiving at least a five dB(A) reduction in noise level. **VDOT's approved cost is based on a maximum square footage of abatement per benefited receptor, a maximum value of 1,600 square feet per benefited receptor (MSF/BR)**.

Where multi-family housing includes balconies at elevations that exceed a 30-foot high noise barrier or the topography causes receptors to be above the elevation of a 30-foot barrier, these receptors are not assessed for barrier benefits and are not included in the computation of the barrier's reasonableness.

7.3.3 The Viewpoints of the Benefited Receptors

During the design phase of the project, a community information meeting is typically held for residents and owners of benefited receptors. VDOT will then solicit the viewpoints of all benefited[28] receptors through certified mailings to obtain responses to document a decision as to whether or not there is a desire for the proposed noise abatement measure. **Fifty percent (50%) or more of the respondents shall be required to favor the noise abatement measure in determining reasonableness**. Community viewpoints in and of themselves are not sufficient for a barrier to be found reasonable if one or both of the other two reasonableness criteria are not satisfied.

7.4 In-Kind Barrier Replacement Extensions

When existing noise barriers are present within a project corridor, VDOT mandates that they be maintained in perpetuity; meaning if a noise barrier is impacted by the project, then it must be replaced in-kind (i.e., when an existing noise barrier is physically impacted and/or relocated, at a minimum the same level of protection must be provided). The I-495 Express Lanes NEXT Project is unique because of the number of separate projects that will be associated with the 2045 Build Alternative, which are planned for construction in multiple phases over several years. Each phase will have unique traffic volumes as well as refined engineering details that will be developed as the phasing progresses. As such, in-kind barrier replacement analyses will be conducted during final design for each individual project and/or phase for all existing noise barriers, as this will allow for more accurate noise levels to be predicted. During the noise analysis for a specific phase, all existing noise barriers located within the noise study area (regardless of whether they are physically impacted by the project) will be evaluated consistent with *Sections 6.3.5* and *6.3.6* of the *Highway Traffic Noise Impact Analysis Guidance Manual* and modified as appropriate. An in-kind barrier replacement analysis for each of the respective Build Alternative phases will be completed under the appropriate build scenario during final design. **Table 7-1** shows the existing noise barriers that were determined to be physically impacted under the Build Alternative. The table only reflects the dimensions and costs of the replacement section of the barrier (partial or full replacement based on the preliminary analysis). The table based the cost of the replacement barrier using a unit cost of $42/SF (material and installation costs), with the total cost based on the total area of the wall (to be replaced) multiplied by the unit cost. No additional engineering costs (e.g., retaining walls, utility relocation, right-

[28] Includes residents and property owners (FHWA, 2011).

of-way acquisition, drainage considerations, etc.) were included. For the dimensions of replacement barriers that consider additional barrier modifications due to the in-kind barrier replacement extensions, see **Table 7-3**.

Table 7-1: Physically Impacted Existing Noise Barriers

CNE	Barrier Name	Partial / Full Replacement	Height Range (ft.)	Length (ft.) [1]	Area (SF) [1]	Cost
E	Barrier 10	Full	3-23	1,355	17,391	$730,422
F	Barrier 9	Full	14-22	2,629	51,567	$2,165,814
H	Barrier 13A	Full	19-26	4,066	104,248	$4,378,416
I	Barrier 13E	Partial	13-19	2,414	44,356	$1,862,952
J	Barrier 13B	Partial	17-25	1,244	26,410	$1,109,220
K	Barrier 13D	Full	10-22	3,819	53,767	$2,258,214
L/M	Barrier 13B / NSA 26	Partial	18-33	1,887	52,538	$2,206,596
Q	Barrier 12A2	Full	15-25	1,583	32,505	$1,365,210
1	Does not include the barrier dimensions associated with the in-kind barrier replacement extensions evaluation					

Source: TNM Runs for Build Alternative, 2019.

A full in-kind noise barrier replacement analysis for the Build Alternative will be conducted during the detailed design phase of each project (i.e., Final Design Noise Analysis) when more detailed engineering and traffic data is available.

7.4.1 In-Kind Barrier Replacement Extensions

Since a full in-kind noise barrier replacement analysis was not conducted at this time for the Build Alternative, the following in-kind barrier replacement methodology was utilized:

- For existing noise barriers that would be physically impacted (or relocated) under the Build Alternative, the affected barriers were shifted laterally to the proposed edge of pavement (keeping the same top of wall elevation) to avoid any modeling conflicts in TNM. CNE Q is the exception, where existing Barrier 12A2 was relocated to the shoulder of proposed Ramp N495_G2. Due to the proposed vertical alignment of that ramp, which is elevated by approximately 15 feet compared to the existing bottom of wall elevation. If the same top of wall elevation was maintained for Barrier 12A2, there would be a significant panel height difference based on the proposed ramp elevations.
- An in-kind noise barrier replacement extension was evaluated for existing barriers (Barrier 10 in CNE E, Barrier 9 in CNEs D/F, Barrier 12A2 in CNE Q, and Barrier 13B in CNE J/AA) that were identified to be physically impacted by the project, and where additional impacts were predicted near either end of the existing barrier.

Locations of the existing barriers and adjusted locations associated with the In-Kind Barrier Replacement Extension Analyses are shown in **Appendix A**.

7.5 Noise Abatement Evaluation

The proposed barrier locations are shown on the graphics located in **Appendix A**. A summary of the evaluated proposed barriers is shown in **Table 7-2**. A summary of the evaluated in-kind replacement barrier extensions is shown in **Table 7-3**. **Appendix M** lists the Build Alternative (2045) noise levels, the abated noise levels, and the net insertion losses for the proposed barriers and barrier systems that were evaluated. **Appendix N** lists the Build Alternative (2045) noise levels, the abated noise levels, and the net insertion losses for the in-kind replacement barrier extensions for CNEs D/F, E, J/AA, and Q. Warranted, Feasible, and Reasonable Worksheets for the evaluated barriers are included in the **Appendix O**.

Noise barriers were evaluated in locations to make the most efficient use of existing topography and were terminated into the existing terrain whenever possible to minimize overall cost. Where applicable, noise barriers were originally evaluated using FHWA's 4:1 noise barrier overlap-to-gap width ratio as a general rule-of-thumb (where applicable) to ensure negligible degradation of barrier performance (insertion loss) (FHWA, 2000). Noise barriers were then shortened when there was a negligible (or no) change in the predicted insertion loss to impacted receptors of an evaluated noise barrier due to noise barrier panels (at either end termini of the noise barrier) that were dropped to a zero height in the TNM barrier analysis. If a noise barrier panel was eliminated from the end termini of the barrier, the adjacent panel was tested using the previously outlined methodology. Consequently, the graphics in **Appendix A** only reflect the final locations of the evaluated noise barriers. The original locations of the evaluated barriers are only available through review of the actual TNM barrier analyses. Noise barrier panel heights were adjusted to maximize the number of benefits to impacted receptors while adhering to VDOT's acoustic feasibility and reasonable (e.g., design goal) criteria. The barrier analysis examined barrier heights in mostly two-foot increments. This process does not allow for fine-tuning of the square footage per benefit value with a variety of barrier heights, which would be carried out in a final design noise analysis during the detailed design phase. As a result, this analysis gives initial impressions of the potential cost-effectiveness of barriers but should not be constructed to be the final determination on the reasonableness of any of the noise barriers evaluated.

Four in-kind noise barrier replacement extensions and five new noise barriers were evaluated for areas predicted to be impacted by traffic noise under the Build Alternative. Of note, impacted receptors I22, I26, I28, I41, I46, I47, I50, I52, K44, Q58D, and Q59D were not evaluated for noise mitigation in this analysis, as they would be evaluated as part of the full in-kind noise barrier replacement analysis that would be completed during final design. Impacted receptors K01, K02, Z07, and Z09 were not analyzed for noise mitigation due to driveway access constraints. Mitigation for several of these receptors would be further evaluated during the in-kind barrier analysis in the detailed design phase of the project. Receptor R39 was not evaluated for noise mitigation because it is already being benefited by Barrier EB-1, which is likely feasible and reasonable. As previously noted, a full in-kind barrier analysis would be completed during final design to verify whether the existing barrier remains feasible and reasonable.

Table 7-2: Proposed Noise Barrier Summary Table

Barrier Name	CNE	Total Benefited Receptors	Average Noise Reduction (dB(A))	Barrier Length (ft.)	Barrier Height Range (ft.)	Barrier Surface Area (SF)	Surface Area per Benefited Receptor (MaxSF/BR)	Barrier Cost ($42/sq.ft.)	Feasible	Reasonable
C	C	12	11	1036	10-22	18,793	1,566	$789,306	YES	YES
G	G	3	6	1,303	6-22	16,623	5,541	$698,166	YES	NO
O	O	14	6	1,713	10-30	35,302	2,522	$1,482,684	YES	NO
S	S	0	N/A	343	30	10,322	N/A	N/A	NO	N/A
U	U	19	11	784	20-30	22,612	N/A	N/A	NO	N/A

Table 7-3: In-Kind Noise Barrier Extension Summary Table

Barrier Name	CNE	Benefits Provided by Existing Barrier	Existing Barrier Surface Area (SF)	Existing Barrier Length (ft.)	Additional Benefits Provided by Barrier Extension	Additional Barrier Surface Area (SF)	Additional Barrier Length (ft.)	Total Benefits Provided by Barrier (with In-Kind Extension)	Total Barrier Surface Area (SF) (with In-Kind Extension)	Total Barrier Length (ft.) (with In-Kind Extension)	MSF/BR	Feasible and Reasonable[1]
Barrier 9 (EXT)	D/F	33	51,568	2,629	9	21,797	1,019	42	73,365	3,648	1,747	F&NR
Barrier 10(EXT)	E	6	17,391	1,355	33	22,067	1,091	39	39,458	2,446	669	F&R
Barrier 13B (EXT)	J/AA	34	87,624	3,665	9	12,082	512	43	99,706	4,177	1,342	F&R
Barrier 12A2 (EXT)	Q	102	32,505	1,583	77	28,706	1,053	179	61,211	2,636	373	F&R

[1] Barriers are shown as Feasible and Not Reasonable (F&NR) or Feasible and Reasonable (F&R)

CNE C

Barrier C was evaluated to provide noise mitigation for the impacted residence and recreational trail receptors within CNE C (see page 1 of 14 in **Appendix A**). Barrier C was modeled within existing VDOT right-of-way along the GWMP. Barrier C consists of a ground mounted noise wall with panel heights ranging from 10 to 22 feet and a total length of 1,036 feet, resulting in a total surface area of 18,793 square feet. The barrier would benefit 10 impacted receivers (C17 and C45-C53), representing a single residence and nine recreational receptors, and two additional non-impacted receivers (C13 and C54), representing a single residence and a recreational receptor. This barrier meets the design goal reduction of at least 7 dB(A) for at least one of the impacted receptors. Based on a total of 12 benefited receptors, the square footage per benefited receptor is 1,566 which is less than the MSF/BR criterion of 1,600. Therefore, this barrier was determined to be feasible and reasonable.

CNE D/F

Barrier 9 is located in CNE F and partially extends into CNE D (see page 7 of 14 in **Appendix A**), and would be physically impacted by the project; therefore, it would be replaced in-kind. While the barrier analysis showed that the replacement barrier was feasible and reasonable, additional noise impacts at the eastern terminus of the replacement barrier were also predicted (located in CNE D).

Barrier 9 (EXT) was evaluated as an in-kind barrier replacement extension to Barrier 9, to provide noise mitigation for the noise impacts within CNE D and CNE F (see page 7 of 14 in **Appendix A**). Barrier 9 (EXT) was modeled as a ground mounted barrier within the existing NPS Park Boundary, offset 10 feet from the existing right-of-way limits along the eastbound GWMP lanes. In order to determine if the barrier extension is feasible and reasonable, an in-kind barrier analysis was conducted which involved the prediction of design year noise levels for receptors in CNE D and CNE F, with and without Barrier 9 in place. Predicted noise levels for the in-kind barrier extension analysis are presented in **Appendix N**.

With Barrier 9 in place, 20 impacted receivers (F04, F07-F08, F10-F17, F19-F22, F24, F27-F29, and F51), representing 20 residences and two recreational receptors are benefited plus an additional 13 non-impacted receivers (F02, F06, F09, F18, F23, F25-26, F30, F49-F50, F52-F54), representing 13 residences are benefited. Barrier 9 does not provide any benefits for receptors in CNE D. Barrier 9 provides a total of 33 benefits and has a total surface area of 51,568 square feet. The results of the in-kind barrier analysis (**Appendix N**) show that **Barrier 9 (EXT)** would benefit two impacted receivers (D06 and D09), representing two residences, and seven additional non-impacted receivers (D11, D13, D19-D20, F01, F03, and F48) representing seven residences. Barrier 9 (EXT) provides a total of nine benefits and would consist of panel heights ranging from 14-24 feet, an additional length of 1,019 feet, and an additional area of 21,797 square feet. As result, the combined barrier system (Barrier 9 and Barrier 9 (EXT)) provides a total of 42 benefited receptors and consists of one ground mounted noise wall system with panel heights ranging from 14 to 24 feet, with a total length of 3,648 feet, and a total surface area of 73,365 square feet. This barrier system meets the design goal reduction of at least 7 dB(A) for at least one of the impacted receptors.

The square footage per benefited receptor for the barrier extension is 1,747, which is based on a total of 42 benefited receptors and a total surface area of 73,365 square feet. In an attempt to see if Barrier 9 (EXT) could be made feasible and reasonable on its own, the number of benefits (nine) was divided into the square footage (21,797). Using this method, the square footage per benefited receptor for the barrier extension is 2,421. Using either method, the square footage per benefited receptor exceeds the MSF/BR criterion of 1,600, and was determined to be feasible but not reasonable. As a result, Barrier 9 would only be replaced in-kind, without the barrier extension (Barrier 9 (EXT)). Additionally, if Barrier 9 (EXT) is found to be feasible and reasonable during final design, additional coordination would need to occur since the alignment for Barrier 9 (EXT) was evaluated within the NPS Park Boundary.

CNE E/CNE C

Barrier 10 is physically impacted by the project; therefore, it would be replaced in-kind. The barrier analysis showed that the replacement barrier was not feasible because it only provides benefits for less than 50% of the impacted receptors. Additional noise impacts at the northern and southern termini of the replacement barrier were also predicted. As a result, it was decided to analyze the replacement barrier with extensions at both termini as a barrier system.

Barrier 10 (EXT) was evaluated as two separate in-kind barrier replacement extensions to Barrier 10, to provide noise mitigation for the impacted receptors near both the northern and southern ends of Barrier 10 within CNE C and CNE E (see pages 1 and 2 in **Appendix A**). Barrier 10 (EXT) was modeled as two ground mounted barriers, located within the existing VDOT right-of-way, adjacent to the end termini of Barrier 10 along the southbound I-495 lanes, north and south of the Live Oak Drive overpass. In order to determine if the barrier extensions are feasible and reasonable, an in-kind barrier replacement analysis was conducted which involved the prediction of design year noise levels for receptors in CNE C and CNE E, with and without Barrier 10 in place. Predicted noise levels for the in-kind barrier extension analysis are presented in **Appendix N**.

With Barrier 10 in place, four impacted receivers (E02, E03, E10, and E13), representing two residences and two recreational receptors are benefited plus an additional two non-impacted receivers (E01 and E05), representing a residence and a recreational receptor are benefited. Barrier 10 provides a total of six benefits and has a total surface area of 17,391 square feet. The results of the in-kind barrier analysis (**Appendix N**) show that Barrier 10 (EXT) would benefit 14 impacted receivers (C24-C26, E06-E08, E14, E19-E24, E32, and E48-E54), representing seven residences and seven recreational receptors, and 19 additional non-impacted receivers (C21, C23, E04, E17, E28, E29, E36, and E45-E47) representing 17 residences and two recreational receptors. Barrier 10 (EXT) provides a total of 33 benefits and would consist of panel heights ranging from 8-24 feet, an additional length of 1,091 feet and an additional area of 22,067 square feet. As result, the combined barrier system (Barrier 10 and Barrier 10 (EXT)) provides a total of 39 benefited receptors and consists of two ground mounted noise walls, which extend along I-495 in both directions, with a break near the Live Oak Drive overpass shown on the **Appendix A** graphics. The southern ground mounted wall is located south of the Live Oak Drive overpass and is approximately 560 feet in length. The northern ground mounted section is located between Live Oak Drive and I-495 and is comprised of the existing wall (approximately 1,355 feet in length) and the northern barrier extension (approximately 531 feet in length). The existing barrier section would be increased an average of 4-6 feet in height. This barrier system is comprised of panel heights ranging from 8 to 26 feet, with a total length of 2,446 feet, and a total surface area of 39,458 square feet. This barrier system meets the design goal reduction of at least 7 dB(A) for at least one of the impacted receptors.

The square footage per benefited receptor for the barrier extension is 669, which is based on the additional 33 benefited receptors and the additional surface area of 22,067 square feet. Since the square footage per benefited receptor meets the MSF/BR criterion of 1,600, the barrier system was determined to be feasible and reasonable.

CNE G

Barrier System G was evaluated to provide noise mitigation for impacted residences within CNE G (see page 2 of 14 in **Appendix A**). Barriers G-1, G-2, and G-3 were modeled within existing VDOT right-of-way and consists of both ground mounted and structure mounted sections. Barrier G-1 was modeled adjacent to the onramp to I-495, Ramp S. Barriers G-2 and G-3 were modeled along the I-495 / Georgetown Pike southbound offramp, Ramp R. A portion of Barrier G-2 would be a structure-mounted section. Barriers G-1 and G-2 were evaluated in the most optimum locations, compared to the proposed vertical alignments of Ramps S and R. If either of these barrier sections are eliminated, the MSF/BR would increase, either due to the loss of benefited receptors, or excessive increases to panel heights and overall barrier length. Barrier System G consists of panel heights ranging from 6 to 22 feet and a total length of 1,303 feet, resulting in a total surface area of 16,623 square feet. The barrier would benefit all three of the impacted receivers (G04-G06), representing three residences, and no additional non-impacted receivers. This barrier meets the design goal reduction of at least 7 dB(A) for at least one of the impacted receptors. Based on a total of three benefited receptors, the square footage per benefited receptor is 5,541, which exceeds the MSF/BR criterion of 1,600. Therefore, this barrier was determined to be feasible but not reasonable.

CNE J/AA

Barrier 13B is physically impacted by the project; therefore, it would be replaced in-kind. While the barrier analysis showed that the replacement barrier was feasible and reasonable, additional noise impacts at the northern terminus of the replacement barrier were also predicted (located in CNEs J and AA). As a result, due to the presence of noise impacts which the replacement barrier does not address, it was decided to analyze the replacement barrier with a northern extension as a barrier system.

Barrier 13B (EXT) was evaluated as in-kind barrier replacement extension to Barrier 13B, to provide noise mitigation for the impacted receptors within CNE J and AA (see page 4 of 14 in **Appendix A**). Barrier 13B (EXT) was modeled a single ground mounted barrier, located within the existing VDOT right-of-way, along the southbound I-495 lanes and the eastbound lanes along Old Dominion Drive. In order to determine if the barrier extension is feasible and reasonable, an in-kind barrier replacement analysis was conducted which involved the prediction of design year noise levels for receptors in CNE J and CNE AA, with and without Barrier 13B in place. Predicted noise levels for the in-kind barrier extension analysis are presented in **Appendix N**.

With Barrier 13B in place, 19 impacted receivers (J03, J05, J07, J11, J14, J16, J19, J21, J23-J24, J26-J27, J29-J31, J34-J35, and J38), representing 19 residences are benefited plus an additional 15 non-impacted receivers (J06, J08, J22, J25, J28, J32-J33, J36, J42, J44-J48, and J50), representing 15 residences are benefited. Barrier 13B provides a total of 34 benefits and has a total surface area of 87,624 square feet. The results of the in-kind barrier analysis (**Appendix N**) show that Barrier 13 (EXT) would benefit six impacted receivers (J01-J02, J04, AA4, and AA6-AA7), representing six residences, and three additional non-impacted receivers (J49 and AA2-AA3) representing three residences. Barrier 13 (EXT) provides a total of nine benefits and would consist of panel heights ranging from 20-29 feet, an additional length of 512 feet and an additional area of 12,082 square feet. As result, the combined barrier system (Barrier 13B and Barrier 13B (EXT)) provides a total of 43 benefited receptors and consists of a ground mounted noise wall with panel heights ranging from 12 to 34[29] feet, with a total length of 4,177 feet, and a total surface area of 99,706 square feet. This barrier system meets the design goal reduction of at least 7 dB(A) for at least one of the impacted receptors.

The square footage per benefited receptor for the barrier extension is 1,342, which is based on the additional nine benefited receptors and the additional surface area of 12,082 square feet. Since the square footage per benefited receptor meets the MSF/BR criterion of 1,600, the barrier was determined to be feasible and reasonable.

There is also a proposed shared use path/sidewalk located in the vicinity of the replacement barrier and extension. The exact location of this replacement/extension barrier (i.e., in front or behind the shared use path and whether gaps within the barrier are needed) would be finalized during detailed design.

CNE O

Barrier System O was evaluated to provide noise mitigation for impacted recreational sites within CNE O (see page 6 of 14 in **Appendix A**) and consists of both ground mounted and structure mounted sections. The barrier system was modeled within existing VDOT right-of-way. Barrier O-1 is a structure mounted section at the edge of proposed express lane Ramp DTR_E1. Barrier O-2 is a ground-mounted section adjacent to the southbound lanes of the DTR, along Ramp E267_G7-G8. Barrier System O consists of panel heights ranging from 10 to 30 feet and a total length of 1,713 feet, resulting in a total surface area of 35,302 square feet. The barrier would benefit all five impacted receivers (O01, O03, O14, and O19-O20), representing five recreational receptors, and nine additional non-impacted receivers (O02, O09, O11-O13, and O15-O18) representing nine recreational receptors. Barriers O-1 and O-2 were evaluated in the most optimum locations with the proposed vertical alignments of Ramps DTR_E1 and E267_G7-G8 being taken into account. If either of these barrier sections is eliminated, the MSF/BR would increase, either due to the loss of benefited receptors, or excessive increases to panel heights and overall barrier length. This barrier meets the design goal reduction of at least 7 dB(A) for at least one of the impacted receptors. Based on a total of 14 benefited receptors, the square footage per benefited receptor is 2,522, which

[29] Sections of Existing Barrier 13B consists of panel heights that exceed VDOT's allowable maximum panel height of 30 feet but would minimally be replaced to the same top of wall height, if physically impacted.

exceeds the MSF/BR criterion of 1,600. Therefore, this barrier was determined to be feasible but not reasonable.

CNE Q

Barrier 12A2 is physically impacted by the project; therefore, it would be replaced in-kind. While the barrier analysis showed that the replacement barrier was feasible and reasonable, additional noise impacts at the northern terminus of the replacement barrier were also predicted. As a result, due to the presence of noise impacts which the replacement barrier does not address, it was decided to analyze the replacement barrier with multiple barrier extensions as a barrier system.

Barrier 12A2 (EXT) was evaluated as two separate in-kind barrier replacement extensions to Barrier 12A2, to provide noise mitigation for the impacted receptors within CNE Q (see page 11 and 13 of 14 in **Appendix A**). Barrier 12A2 (EXT) consists of both ground mounted noise barrier along proposed ramp G4 (VA 267) and a structure mounted noise wall section along proposed ramp N495_G2. In order to determine if the barrier extensions are feasible and reasonable, an in-kind barrier replacement analysis was conducted which involved the prediction of design year noise levels for receptors in CNE Q, with and without Barrier 12A2 in place. Predicted noise levels for the in-kind barrier extension analysis are presented in **Appendix N**.

With Barrier 12A2 in place, 38 impacted receivers (Q18C-Q18D, Q19C-Q19D, Q21B-Q21D, Q22C-Q22D, Q23C-Q23D, Q41-Q42, Q43A-Q43C, Q44, Q45A-Q45C, Q46A-Q46C, Q47A-Q47C, and Q48A-Q48C), representing 86 residences are benefited plus an additional 10 non-impacted receivers (Q18A-Q18B, Q19A-Q19B, Q20, Q21A, Q22A-Q22B, and Q23A-Q23B), representing 15 residences and a recreational site are benefited. Barrier 12A2 provides a total of 102 benefits and has a total surface area of 32,505 square feet. The results of the in-kind barrier analysis (**Appendix N**) show that Barrier 12A2 (EXT) would benefit 12 impacted receivers (Q01B-Q01D, Q05C-Q05D, Q11C-Q11D, Q43D, Q45D, Q46D, Q47D, and Q48D), representing 29 residences, and 24 additional non-impacted receivers (Q01A, Q02A-Q02B, Q03A-Q03B, Q05A-Q05B, Q06A-Q07D, Q11A-Q11B, Q12A-Q12D, and Q13B-Q13D) representing 48 residences. Barrier 12A2 (EXT) provides a total of 77 additional benefits and consists of panel heights ranging from 10-30 feet, an additional length of 1,053 feet and an additional area of 28,706 square feet. As result, the combined barrier system (Barrier 13B and Barrier 13B (EXT)) provides a total of 179 benefited receptors, and consists of a structure mounted wall with panel heights ranging from 10-16 feet in height and two ground mounted noise wall sections with panel heights ranging from 15 to 30 feet, with a total length of 2,636 feet, and a total surface area of 61,211 square feet. This barrier system meets the design goal reduction of at least 7 dB(A) for at least one of the impacted receptors.

The square footage per benefited receptor for the barrier extension is 373, which is based on the additional 77 benefited receptors and the additional surface area of 28,706 square feet. Since the square footage per benefited receptor meets the MSF/BR criterion of 1,600, the barrier was determined to be feasible and reasonable.

CNE S

Barrier S was evaluated to provide noise mitigation for impacted residences within CNE S (see page 9 of 14 in **Appendix A**). The barrier was modeled within existing VDOT right-of-way along the eastbound lanes of Old Dominion Drive, located east of I-495. Barrier S consists of panel heights of 30 feet and a total length of 343 feet, resulting in a total surface area of 10,322 square feet. The barrier would not provide any benefits; therefore, this barrier was determined to be not feasible.

While Barrier S is adjacent to CNE K, the nearby receptors in CNE K (e.g., K01 - K03) would not be benefited. Additionally and as previously noted, impacted receptors K01 and K02 could not be analyzed for noise mitigation due to driveway access constraints.

CNE U

Barrier System U was evaluated to provide noise mitigation for impacted residences within CNE U (see page 12 and 14 of 14 in **Appendix A**). The barrier system was modeled within existing VDOT right-of-way along the eastbound lanes of Dolley Madison Blvd (VA 123). Barrier System U consists of two barriers, U-1 and U-2, with panel heights ranging from 20 to 30 feet and a total length of 784 feet, resulting in a total surface area of 22,612 square feet. The barrier system would benefit all 11 impacted receivers (U01B, U01C, U01D, U02C, U02D, U03C, U03D, U05C, U05D, U10C, and U10D) representing 15 residences, and two additional non-impacted receivers (U04C and U11C) representing four residences. While this barrier system was determined to be acoustically feasible, upon further investigation the barrier system was shown to be not feasible due to engineering constraints as documented in the constructability memo in **Appendix Q**. Barrier U-2 would require the relocation of existing utilities in the vicinity. Further, the barrier would also obstruct drivers' sight distance along the ramp to Rte. 267 and would reduce pedestrian safety at the new crosswalk being installed across the ramp. Without the individual Barrier U-2, Barrier U-1 would not be feasible and reasonable on its own, consequently eliminating the entire Barrier System U from consideration. Therefore, this barrier system was determined to be not feasible.

8.0 CONSTRUCTION NOISE CONSIDERATIONS

VDOT is also concerned with noise generated during the construction phase of the proposed project. While the degree of construction noise impact will vary, as it is directly related to the types and number of equipment used and the proximity to the noise-sensitive land uses within the project area. Land uses that are sensitive to traffic noise, are also potentially considered to be sensitive to construction noise. Any construction noise impacts that do occur as a result of roadway construction measures are anticipated to be temporary in nature and will cease upon completion of the project construction phase. A method of controlling construction noise is to establish the maximum level of noise that construction operations can generate.

In view of this, VDOT has developed and FHWA has approved a specification that establishes construction noise limits. This specification can be found in *VDOT's 2016 Road and Bridge Specifications*, *Section 107.16(b.3), Noise.* The contractor will be required to conform to this specification to reduce the impact of construction noise on the surrounding community. The specifications have been reproduced below:

- The Contractor's operations shall be performed so that exterior noise levels measured during a noise-sensitive activity shall not exceed 80 decibels. Such noise level measurements shall be taken at a point on the perimeter of the construction limit that is closest to the adjoining property on which a noise-sensitive activity is occurring. A noise sensitive activity is any activity for which lowered noise levels are essential if the activity is to serve its intended purpose and not present an unreasonable public nuisance. Such activities include, but are not limited to, those associated with residences, hospitals, nursing homes, churches, schools, libraries, parks, and recreational areas.
- VDOT may monitor construction-related noise. If construction noise levels exceed 80 decibels during noise sensitive activities, the Contractor shall take corrective action before proceeding with operations. The Contractor shall be responsible for costs associated with the abatement of construction noise and the delay of operations attributable to noncompliance with these requirements.
- VDOT may prohibit or restrict to certain portions of the project any work that produces objectionable noise between 10 PM and 6 AM. If other hours are established by local ordinance, the local ordinance shall govern.
- Equipment shall in no way be altered so as to result in noise levels that are greater than those produced by the original equipment.
- When feasible, the Contractor shall establish haul routes that direct his vehicles away from developed areas and ensure that noise from hauling operations is kept to a minimum.
- These requirements shall not be applicable if the noise produced by sources other than the Contractor's operation at the point of reception is greater than the noise from the Contractor's operation at the same point.

9.0 PUBLIC INVOLVEMENT/LOCAL OFFICIALS COORDINATION

FHWA and VDOT policies require that VDOT provides certain information to local officials within whose jurisdiction the highway project is located, to minimize future traffic noise impacts of Type I projects on currently undeveloped lands. (Type I projects involve highway improvements with noise analysis.) This information must include details on noise-compatible land-use planning and noise impact zones for undeveloped lands within the project corridor. Additional information about VDOT's noise abatement program has also been included in this section.

9.1 Noise-Compatible Land-Use Planning

Sections 12.1 and *12.2* of VDOT's *Highway Traffic Noise Impact Analysis Guidance Manual* outlines VDOT's approach to communication with local officials and provide information and resources on highway noise and noise-compatible land-use planning. VDOT's intention is to assist local officials in planning the uses of undeveloped land adjacent to highways to minimize the potential impacts of highway traffic noise (VDOT, 2018).

Entering the Quiet Zone is a brochure that provides general information and examples to elected officials, planners, developers, and the general public about the problem of traffic noise and effective responses to it. A link to this brochure on FHWA's website is provided: http://www.fhwa.dot.gov/environment/noise/noise_compatible_planning/federal_approach/land_use/qz00.cfm

A wide variety of administrative strategies may be used to minimize or eliminate potential highway noise impacts, thereby preventing the need or desire for costly noise abatement structures such as noise barriers in future years. There are five broad categories of such strategies:

- Zoning,
- Other legal restrictions (subdivision control, building codes, health codes),
- Municipal ownership or control of the land,
- Financial incentives for compatible development, and
- Educational and advisory services.

The Audible Landscape: A Manual for Highway and Land Use is a very well-written and comprehensive guide addressing these noise-compatible land use planning strategies, with significant detailed information. This document is available through FHWA's Website, at http://www.fhwa.dot.gov/environment/noise/noise_compatible_planning/federal_approach/audible_landscape/al00.cfm

Also required under FHWA/VDOT noise policy and guidance is to provide the estimation of future design noise levels at distances where they meet NAC approach limits, for exterior land uses. To estimate these distances, noise levels are predicted at various distances from the edge of the project roadways for undeveloped[30] and other exterior noise sensitive areas within the noise study area. Then, the distances from the edge of the roadway to the NAC approach sound levels are determined through interpolation. Distances vary in the project corridor due to changes in traffic volumes, terrain features, or existing structures, and noise barriers. Based on the interpolation of distances to the appropriate NAC approach limits, the approximate location of the 66 dB(A) noise contours is represented in the graphics in **Appendix A,** for NAC B/C receptors[31].

9.2 VDOT's Noise Abatement Program

Information on VDOT's noise abatement program is available on VDOT's Website, at:

[30] With respect to undeveloped lands, future design-year 66 dB(A) noise contours are shown on the graphics based on the existing terrain. If such lands were to be developed (e.g. site grading, cut/fill activities) the location of the impact contour may change. As such, noise contours are only to be used as a planning level tool.

[31] While noise contour lines are useful for screening and to provide information to local officials (23 CFR 772.17), FHWA guidance states that noise contours shall not be used for the determination of traffic-noise impacts (FHWA, 2011). The 66 dB(A) contour line is assumed to represent first floor noise levels, including any existing noise barriers or shielding effects. Due to this fact, future design year impacts identified in **Appendix B** may not always correlate to the color-coding of the receptors shown in the **Appendix A** graphics. Areas with receptors located on the second floor (or higher) or for CNEs where an in-kind noise barrier extension was evaluated (because the existing noise barrier is removed for the analysis) may be different than future design year noise impacts in the study area. The noise contours are only shown where they extend past the proposed right-of-way.

http://www.virginiadot.org/projects/pr-noise-walls-about.asp. The site provides information on VDOT's noise program and policies, noise walls, and a downloadable noise wall brochure.

For noise barriers determined to be feasible and reasonable in the detailed design phase, the affected public that would be benefited by the proposed mitigation will be given an opportunity to decide whether they are in favor of construction of the noise barrier. A final determination to construct a barrier will be made after the design public hearing process. Before final decisions and approvals can be made to construct a noise barrier, a final design noise analysis will be performed. For barriers that are determined to be feasible and reasonable, input from the owners and residents of those receptor units that will be benefited by the proposed mitigation may vote by completing and returning the noise barrier survey form that they receive in the mail. The initial citizen survey is sent out as certified mail so the disposition of the letters can be tracked. Of the votes tallied, 50 percent or more must be in favor of a proposed noise barrier in order for that barrier to be considered further. Upon completion of the citizen survey, the VDOT Noise Abatement staff will make recommendations to the Chief Engineer for approval. Approved barriers will be incorporated into the road project plans. A technical memorandum of the results of the public survey will be prepared and submitted to FHWA.

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