PRELIMINARY ENGINEERING TECHNICAL NOISE REPORT

S.R. 0001, GROUP 03S, SECTION RC3
RECONSTRUCTION PROJECT PRELIMINARY DESIGN
MIDDLETOWN TOWNSHIP, LANGHORNE BOROUGH,
AND LANGHORNE MANOR BOROUGH
BUCKS COUNTY, PENNSYLVANIA

MPMS 93446

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1.0 EXECUTIVE SUMMARY

The overall purpose of the S.R. 0001, Group 03S U.S. 1 Improvement Project is to replace and repair aging bridges while also incorporating highway and interchange operational and safety enhancements to facilitate safe and efficient inter-modal travel along the S.R. 0001 corridor to meet both current and future transportation needs of the area.

The S.R. 0001, Group 03S U.S. 1 Improvement Project began in the year 2001 and went through preliminary design before being put on hold in the Spring of 2004 for right-sizing. The right-sizing process was completed in 2009 and design recommenced in the Fall of 2009. Due to project funding decisions, the overall project area was divided into three construction contract sections—RC1, RC2, and RC3. This report focuses only on the S.R. 0001 Section RC3 study area, which extends from approximately the northern end of the S.R. 0001 bridge over the CSX railroad to approximately 700 feet north of the S.R. 0413 (PA 413/Pine Street) bridge over S.R. 0001. An initial noise screening analysis for Section RC3 was completed during the Alternative Analysis Phase for a Design Year of 2035, and a draft report prepared in October 2013. The project was put on hold for a few years and restarted in 2020 where interchange options were considered for S.R. 0413 (Pine Street.) and S.R. 2008 (Highland Avenue).

An updated Section RC3 noise screening analysis was conducted in the Spring of 2020 for design year of 2050 for two alternatives. The selected alternative includes roadway improvements, new interchanges, and access points to S.R. 0001. Changes in traffic patterns require the completion of a Type I Highway Traffic Detailed Noise Study. This report summarizes the results of the detailed noise monitoring and analysis performed as part of the S.R. 0001, Section RC3 preliminary design and provides recommendations on the extent of noise abatement required to meet both FHWA and PennDOT noise guidelines and the procedures to be taken to meet these requirements.

Section RC3 noise monitoring was performed in the Spring and Summer of 2021 in conformance with FHWA-PD-96-046, Measurement of Highway-Related Noise. Ambient readings were conducted using Larson Davis LxT and 831 Noise Analyzers. Each analyzer was calibrated at 114 dB(A) before monitoring was conducted. Initial ambient monitoring consisted of performing a 24-hour monitoring session at one location, followed by short-term ambient readings taken at 31 sites. The duration of each short-term monitoring session was 20 minutes. Each site had simultaneous traffic counting performed for model validation.

The ambient monitoring was followed by Traffic Noise Model (TNM) v2.5 noise modeling performed in accordance with the Title 23 United States Code of Federal Regulations, Part 772, Procedures for Abatement of Highway Traffic Noise and Construction Noise and PennDOT Publication 24, Project Level Highway Traffic Noise Handbook.

The 2019 Existing Worst-Case, 2050 No-Build, and 2050 Build Conditions were modeled and documented as part of this Preliminary Technical Noise Report. Abatement options were studied for feasibility and

reasonableness in the Section RC3 Noise Study Areas (NSAs) that warrant abatement in accordance with FHWA and PennDOT noise abatement criteria.

Nine NSAs were identified where abatement is warranted under the 2050 Build Condition and sound barrier designs were investigated for feasibility and reasonableness:

- NSA 1-2 Barrier – NSAs 1 and 2, located along SB S.R. 0001 from north of Highland Ave to Old Lincoln Highway/S.R. 0001 SB interchange
- NSA 3-4 Barrier– NSAs 3 and 4, located along SB S.R. 0001 from south of West Interchange Overpass to the southern limits of Our Lady of Grace Cemetery
- NSA 5 Barrier – NSA 5, located along SB S.R. 0001 from S.R. 0413/Pine Street Interchange to West Interchange Road Overpass
- NSA 6 Barrier – NSA 6, located along SB S.R. 0001 from the northern project limit to S.R. 0413/Pine Street Interchange
- NSA 7 Barrier – NSA 7, located along NB S.R. 0001 from S.R. 0413/Pine Street Interchange to the northern project limit
- NSA 8 Barrier – NSA 8, located along NB S.R. 0001 from West Interchange Road Overpass to S.R. 0413/Pine Street Interchange
- NSA 9 Barrier – NSA 9, located along NB S.R. 0001 from S.R. 2008/W. Highland Avenue Interchange to south of West Interchange Road Overpass

Due to right-of-way constraints and the proximity of receptors to S.R. 0001 and the Frontage Road, earth berms were not feasible and sound barriers were considered to be the only feasible form of noise abatement for this project.

Preliminary noise barrier alignments were set based on the existing and proposed topography and impacted residence locations to provide the most cost-effective layout. When optimizing the height of the noise barriers, PennDOT noise barrier abatement design goals were used as well as consideration to feasibility and reasonableness criteria. Sound barriers were analyzed at constant heights, measured from the ground/gutterline, of 8, 10, 12, 14, 16, 18, and 20 feet and then using the results of the constant height analysis were optimized to determine a cost-effective barrier while meeting the sound barrier abatement goals. A summary of the noise study findings is provided in **Table ES.1**. The results show that all seven Preliminary Sound Barriers are warranted, feasible, and reasonable using PennDOT criteria. Noise specific community meetings and voting for final reasonableness determination will occur during Final Design Phase. Note that both recommended and non-recommended sound barriers may change between these environmental document preliminary findings and final design as a result of changes in the project design. Final determinations on any absorptive barrier surface treatments will be made during the Final Design Phase.

This report outlines the results of the detailed noise monitoring and analysis performed as part of the preliminary design of the S.R. 0001, Section RC3 project and provides recommendations on the extent of noise abatement required to meet both FHWA and PennDOT noise guidelines and the procedures to be taken to meet these requirements.

Table ES.1 Preliminary Noise Analysis Summary

Barrier Name: Noise Study Area Description & Location	Number of Impacted[1] Equivalent Receptor Units (ERU)	Impacted[1] with >= 5 dB(A) Benefit	Non-Impacted with >= 5 dB(A) Benefit	Total Number of Benefited ERU	Optimized Barrier Length (FT)	Height Above Ground from TNM (FT)	Square Footage of Optimized Barrier from TNM (SF)	Square Footage per Benefited Receptor (SF) (Max = 2,000)	Warranted, Feasible, and Reasonable
NSA 1-2 Barrier Southbound S.R. 0001	19	14	1	15	1,780	13'-18'	28,649	1,910	Yes, Yes, Yes
NSA 3-4 Barrier Southbound S.R. 0001	16.56	16.45	10.04	26.49	3,816	10'-14'	46,657	1,762	Yes, Yes, Yes
NSA 5 Barrier Southbound S.R. 0001	14	14	11	25	2,730	9'-14'	34,717	1,389	Yes, Yes, Yes
NSA 6 Barrier Southbound S.R. 0001 Woods School Campus	17.26	14.77	7.12	21.89	1,732	14'-16'	27,417	1,253	Yes, Yes, Yes
NSA 7 Barrier Northbound S.R. 0001 Woods School Campus	16.51	16.51	8.58	25.09	2,331	16'	37,300	1,487	Yes, Yes, Yes
NSA 8 Barrier Northbound S.R. 0001	15	15	10	24	2,364	11'-14'	32,469	1,299	Yes, Yes, Yes
NSA 9 Barrier Northbound S.R. 0001	70	65	55	120	4,968	14'-15'	70,704	589	Yes, Yes, Yes

1. *Impacted receptors are those that warrant the investigation of noise abatement. This occurs where the predicted noise levels meet any of the following PennDOT Criteria: Predicted Highway Traffic Noise levels approach or exceed Noise Abatement Criteria or Predicted Highway Traffic Noise substantially exceeded (by 10 dB(A) or more) the existing Highway Traffic Noise levels*

2.0 INTRODUCTION

2.1 Background and Project Location

The overall S.R. 0001 Improvement Project in Bensalem Township, Middletown Township, Langhorne Borough, and Langhorne Manor Borough, Bucks County began in the year 2001 and went through preliminary design before being put on hold in the Spring of 2004 for right-sizing. The right-sizing process was completed in 2009 and design recommenced in the Fall of 2009.

Due to project funding constraints in 2013, the overall project area was divided into three construction contract sections—RC1, RC2, and RC3, which all have different design/construction schedules. This report focuses only on the S.R. 0001 Section RC3 study area, which extends from approximately the northern end of the S.R. 0001 bridge over the CSX railroad to approximately 700 feet north of the S.R. 0413 (PA 413/Pine Street) bridge over S.R. 0001. Section RC1 is under construction that is anticipated to be completed by the middle of 2022. Section RC2 is also in construction, scheduled for completion in Fall of 2026. Section RC3 is the only contract section that remains in the design phase and is currently in preliminary design. Therefore, this report is a Technical Noise Report for Section RC3 only.

The purpose of this Preliminary Technical Noise Report is to assess and document noise impacts associated with the study area and to determine if abatement is warranted, feasible, and reasonable by analyzing the selected highway alignment for Existing Worst-Case Conditions, Future Design Year No-Build Conditions, and Future Design Year Build Conditions. This report outlines the completed ambient measurement methods, modeling methodologies and procedures, and the preliminary noise impact analysis results for the Section RC3 project corridor.

An initial Preliminary Engineering Phase site visit for Section RC3 was made in January 2021 to establish Noise Study Areas (NSAs), determine Traffic Monitoring Session (TMS) areas, and to determine locations for noise monitoring, traffic counts, and speed checks. The Section RC3 study area extends from the north end of Section RC2 to north of Corn Crib Lane (**Figure 1**).

FIGURE 1 – PROJECT LOCATION MAP
S.R. 0001, Group 03S, Section RC3
Middletown Township, Langhorne Manor Borough,
and Langhorne Borough, Bucks County, Pennsylvania
Type 10 Map

2.2 Project Purpose and Description

The primary purpose of the S.R. 0001 Section RC3 project is to facilitate safe and efficient travel within and through the project area to meet current and future transportation needs of the area while providing a functional and modern roadway that meets current design criteria and driver expectations. The project will alleviate traffic congestion within the corridor, improve vertical clearances on both S.R. 0001 and the underpassing roadways, replace/rehabilitate aging structures, improve roadway geometry to provide acceleration and deceleration lanes and sufficient cross-sectional width of roadway, improve safety, and increase accessibility to multimodal connections.

Based upon JMT's Traffic Analysis Memo dated March 2020, the Final Alternatives Analysis Report dated July 2021 and stakeholder input, improvements are as follows:

1.) S.R. 0001 NB off ramp to W. Highland Avenue
- a.) S.R. 0001 NB on ramp – one lane merge onto S.R. 0001 NB
- b.) S.R. 0001 SB off ramp to Old Lincoln Highway
- c.) S.R. 0001 SB on ramp – one lane merge onto S.R. 0001 SB

2.) S.R. 0413 (Pine Street) Interchange
- a.) Alternative 2A Partial Cloverleaf as the current preferred interchange option for this project area due to the Partial Cloverleaf being less impactful in terms of right-of-way, access, structures and construction cost.
- b.) S.R. 0001 NB off ramp to S.R. 0413 (Pine Street)
- c.) S.R. 0001 NB on ramp – one lane merge onto S.R. 0001 NB
- d.) S.R. 0001 SB off ramp to S.R. 0413 (Pine Street) – auxiliary lane connected to PA 213 (Maple Avenue) S.R. 0001 SB on ramp
- e.) S.R. 0001 SB on ramp – one lane merge onto S.R. 0001 SB

3.) S.R. 0413/Pine Street at S.R 0001
- a.) S.R. 0413/Pine St – 4-Lane Section from south of the Partial Cloverleaf to south of Flowers Avenue
- b.) S.R. 0413/Pine St at NB Ramps/Woods Dr – Dedicated left turn and right turn lanes along Pine Street
- c.) S.R. 0413/Pine St at NB Ramps/Woods Dr – Dedicated left turn and right turn lanes for the NB Off-Ramp and Woods Drive
- d.) S.R. 0413/Pine St at SB Ramps/Gillam Ave – Dedicated left turn and right turn lanes along Pine Street
- e.) S.R. 0413/Pine St at SB Ramps/Gillam Ave – Dedicated left turn and right turn lanes for the SB Off-Ramp and Gillam Avenue

4.) S.R. 0413/Bellevue Ave at West Highland Ave
- a.) Roundabout

5.) S.R. 2008/Highland Ave at Ramp A and Ramp B
   a.) Roundabout

6.) S.R. 2045/Old Lincoln Highway at Ramp CD
   a.) Stop-Controlled Intersection

7.) S.R. 2045/Old Lincoln Highway at S.R. 2008/Highland Ave/T-409/Fairhill Avenue
   a.) Signalized Intersection

8.) Frontage Roads
   a.) NB from Ramp B to T-706/Fox Ct
   b.) NB from North Street to S.R. 2027/Hulmeville Rd
   c.) NB from S.R. 2047/Hulmeville Ave to Hill Ave
   d.) SB from S.R. 2049/Bellevue Ave to Station Ave
   e.) SB from north of S.R. 2027/Hulmeville Rd to Cemetery Entrance

9.) Turnarounds
   a.) NB - T-659/Fee Ave
   b.) NB - T-336/Parkvale Ave
   c.) NB - Station Ave
   d.) NB - S.R. 2049/Bellevue Ave
   e.) SB - S.R. 2047/Hulmeville Ave

10.) Bridge Replacements
   a.) S.R. 0413/Pine St over S.R. 0001
   b.) S.R. 2199/West Interchange Rd over S.R. 0001
   c.) S.R. 2197/Corn Crib Ln over S.R. 0001

11.) Bridge Rehabilitation
   a.) S.R. 0001 over S.R. 2008/Highland Ave

3.0 METHODOLOGY

This noise study has been completed using the methodology described in PennDOT Publication No. 24, Project Level Highway Traffic Noise Handbook, May 2019 and FHWA criteria as described in 23 CFR Part 772.

Property owners affected by the noise study were notified via letter of intent to enter their property to gather information. One long-term (24-hour) noise monitoring session was conducted in April 2021 to determine hours of peak noise at one central location within the study area. Short-term noise

monitoring locations were monitored in April and September of 2021. Each short-term monitoring session was conducted with simultaneous traffic counts and speed determinations along the corridor.

Noise monitoring was performed in conformance with FHWA-PD-96-046, Measurement of Highway-Related Noise. Ambient readings were conducted using Larson Davis LxT and 831 Noise Meters. Initial ambient monitoring consisted of performing a 24-hour noise monitoring at one central location, followed by short-term ambient readings taken at 31 sites. The duration of the short-term monitoring sessions were 20 minutes with simultaneous traffic counting performed for model validation.

The ambient monitoring was followed by preliminary 2050 Design Year TNM v2.5 noise modeling and abatement considerations for Section RC3.

3.1 Highway Noise Fundamentals

A discussion on Highway Noise Fundamentals is included because it helps define many of the terms and criteria utilized in this report.

The extent to which individuals are affected by noise sources is controlled by several factors, including:

- The duration and frequency of sound
- The distance between the sound source and the receptor
- The intervening natural or man-made barriers or structures
- The ambient environment

The level of highway traffic noise depends primarily upon the following:

- The volume of traffic
- The speed of traffic
- The number of trucks in the flow of traffic

Generally, traffic noise is increased by heavier traffic volumes, higher speeds, and greater numbers of trucks. Consequently, the FHWA has established the following vehicle categories to use in traffic noise analysis:

- Heavy-duty trucks, defined as vehicles having three or more axles
- Medium-duty trucks, defined as vehicles with two axles and six wheels
- Automobiles, defined as vehicles with two axles and four wheels
- Buses
- Motorcycles

Heavy-duty trucks typically produce more noise than medium-duty trucks traveling at the same speed. Medium-duty trucks, in turn, typically generate more noise than automobiles.

Traffic noise is measured and described according to FHWA guidelines, which allows the use of the hourly equivalent sound level [Leq (h)] as the primary descriptor for noise analysis. Leq (h) is defined as the equivalent steady state sound level, which in one hour contains the same acoustic energy as the time-varying sound level during the same one-hour period.

The unit of measure for the Leq is the "A-weighted" decibel [dB(A)]. The dB(A) scale de-emphasizes the very low and very high frequencies and emphasizes the middle frequencies, thereby closely approximating the frequency response of the human ear. **Table 1** provides examples of common outdoor noise levels and their respective noise level decibels. To place the noise levels into a context that some people can more easily relate to, **Table 1** also provides the equivalent common indoor noise levels.

Typically, noise level changes between 2 and 3 dB(A) are barely perceptible, while a change of 5 dB(A) is readily noticeable by most people. A 10 dB(A) increase is usually perceived as a doubling of loudness, and conversely, noise is perceived to be reduced by one-half when a sound level is reduced by 10 dB(A).

Table 1 Common Outdoor and Indoor Noise Levels[1]

Common Outdoor Noise Levels	Noise Level Decibels [dB(A)]	Common Indoor Noise Levels
	110	Rock Band
Jet Fly Over at 1,000 feet	100	Inside Subway Train (NY)
Gas Lawn Mower at 3 feet		
Diesel Truck at 50 feet	90	Food Blender at 3 feet
Noisy Urban Daytime	80	Garbage Disposal at 3 feet or Shouting at 3 feet
Gas Lawn Mower at 100 feet	70	Vacuum Cleaner at 10 feet
Commercial Area	60	Normal Speech at 3 feet
		Large Business Office
Quiet Urban Daytime	50	Dishwasher Next Room
Quiet Urban Nighttime	40	Small Theater, Large Conference Room (Background)
Quiet Suburban Nighttime	30	Library
Quiet Rural Nighttime	20	Bedroom at Night, Concert Hall (Background)
		Broadcast & Recording Studio
	10	Threshold of Hearing
	0	

1. Adapted from Guide on Evaluation and Attenuation of Traffic Noise, AASHTO-1974.

3.2 Noise Abatement Criteria

The determination of traffic noise impacts is based on the relationship between the 2019 Existing worst-case noise levels, 2050 design year predicted noise levels, and the established noise abatement criteria for the study area. The effects of noise are determined in accordance with the Federal Highway Administration guidelines as established by 23 CFR Part 772 and PennDOT Policies found in Publication 24. The Federal Noise Abatement Criteria (NAC) provided in **Table 2** are based on specific land uses and are used in determining areas that warrant noise abatement consideration.

Table 2 Hourly Weighted Sound Levels dB(A) For Various Land Use Categories

Land Use Activity Category	Exterior Leq(h)[1]	Description of Land Use 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[2]	67 (Exterior)	Residential
C[2]	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[2]	72 (Exterior)	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A, B or C.
F	--	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.

Source: PennDOT Publication No. 24 dated May 2019
1. Impact thresholds should not be used as design standards for noise abatement purposes.
2. Includes undeveloped lands permitted for this activity category
** PennDOT has chosen to use Leq(h) [not L10(h)] on all of its transportation improvement projects.*

The entirety of the study area evaluated in this report is Land Use Categories B and C. Based on field reconnaissance the identified active land uses found along the corridor study area and neighboring community are as follows:

Land Use Activity B

- Single-family residences
- Multi-family residences
- Apartments
- Woods School Campus Residential Program Housing

Land Use Activity C

- Neshaminy High School Athletic Fields
- Langhorne Presbyterian Church
- Langhorne/Bucks County Public Library
- Woods School Campus
- Our Lady of Grace Cemetery

No land use activities such as hotels, hospitals or lands on which serenity and quiet are of extraordinary significance were identified in the project area.

Per FHWA, an activity in Category B or C is considered to be "impacted" when traffic noise levels approach or exceed 67 dB(A), or when the predicted noise levels are substantially higher than the existing ambient noise levels. In defining the term "approaches," PennDOT has adopted 66 dB(A) as the impact threshold for Category B & C and uses a 10 dB(A) increase over existing noise levels to define a substantial increase.

This noise study involves proposed highway improvements including the removal of portions of the Frontage Road and the addition of interchanges at S.R. 0413 (Pine St.) and S.R. 2008 (Highland Ave.) as outlined in Section 2.2, making this a Type 1 noise analysis. A Type 1 study is performed when new highways are constructed, existing highways are expanded, or there is a significant change in the horizontal or vertical alignment of the highway.

4.0 EXISTING HIGHWAY NOISE ENVIRONMENT

4.1 Noise Study Area Descriptions

Noise Study Areas (NSAs) can be residential as well as non-residential. Residential NSAs include single-family residences, single-family attached residences (townhouses), and multi-family residences (condominiums and apartments) located in neighborhoods adjacent to the project corridor. Non-residential NSAs include recreation areas, playgrounds, schools, churches, a library, and a cemetery located adjacent to the project corridor.

During the Alternatives Analysis Phase Section RC3 screening analysis, seven NSAs were defined through the Section RC3 project corridor, however this detailed study split the areas into nine NSAs. **Figure 2** shows the locations of the nine NSAs.

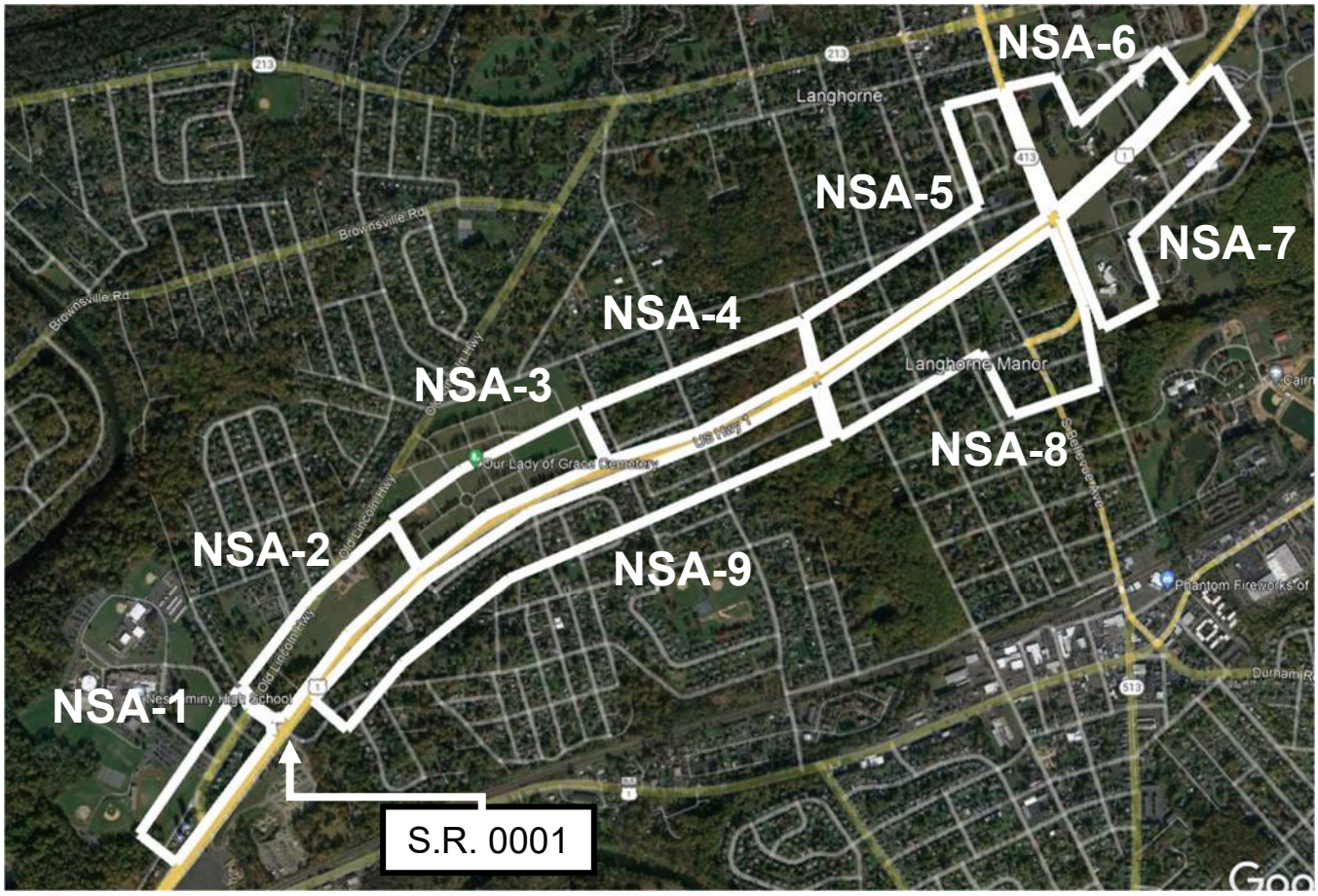


FIGURE 2 - NOISE STUDY AREA (NSA) LOCATIONS
S.R. 0001, Group 03S, Section RC3
Middletown Township, Langhorne Borough, and Langhorne Manor Borough
Bucks County, Pennsylvania
Source: GoogleEarth Imagery

Noise analysis locations throughout the study area are referred to as 'Receptors'. In this study, receptors have been labeled according to the following convention: '**M**' receptors were measured in the field with short-term (20-minute) monitoring sessions or long-term (24-hour) monitoring session, and '**R**' receptors were not measured but only modeled in TNM v2.5 along with the 'M' receptors for the existing worst-case, 2050 No-Build, and 2050 Build Conditions.

NSA 1 – (Southwestern Section represented by Receptors M1-1 through M1-3 and R1-1 through R1-11) consists of the residential areas and Neshaminy High School on the north side of S.R. 0001 bounded by the RC3 southern limit and Fairhill / Highland Avenue.

NSA 2 – (Southwestern Section represented by Receptors M2-1 and R2-1 through R2-4) consists of the residential area and undeveloped cemetery land on the north side of S.R. 0001 bounded by north of Highland Avenue and the active area of Our Lady of Grace Cemetery.

NSA 3 – (Central Section represented by Receptors M3-1 through M3-3 and 130' spaced gridded receptors R3-1 through R3-60) consists of the active area of the cemetery property on the north side of S.R. 0001 bounded by Old Lincoln Highway and the cemetery property lines.

NSA 4 – (Central Section represented by Receptors M4-1 through M4-2 and R4-1 through R4-19) consists of the residential area on the north side of S.R. 0001 bounded by Our Lady of Grace Cemetery, and W. Interchange Road.

NSA 5 – (Northeastern Section represented by Receptors M5-1 through M5-5 and R5-1 through R5-24) consists of the mixed-use area on the north side of S.R. 0001 bounded by West Interchange Road and S. Pine Street (S.R. 0413).

NSA 6 – (Northeastern Section represented by Receptors M6-1 and 130' spaced gridded receptors R6-1 through R6-64) consists of the Woods School Campus, Public Library, and Heckman Elementary School on the north side of S.R. 0001 bounded by S. Pine Street (S.R. 0413) and Flowers Avenue. Please note that some gridded receptors were removed from roadways and parking areas that are not used for frequent outdoor use.

NSA 7 – (Northeastern Section represented by Receptors M7-1 through M7-2 and 130' spaced gridded receptors R7-1 through R7-73, R7-90 and R7-91) consists of the Woods School Campus on the south side of S.R. 0001 bounded by S. Pine Street (S.R. 0413) and the northern project limits. Please note that some gridded receptors were removed from analysis in roadways and parking areas since they are not used for frequent outdoor use.

NSA 8 – (Northeastern Section represented by Receptors M8-1 through M8-5 and R8-1 through R8-27) consists of the residential area on the south side of S.R. 0001 bounded by S. Pine Street (S.R. 0413) and West Interchange Road.

NSA 9 – (Central Section represented by Receptors M9-1 through M9-10 and R9-1 through R9-68) consists of the residential and mixed-use area on the south side of S.R. 0001 bounded by West Interchange Road and Park Avenue.

4.2 Receptors

The short-term and long-term monitored locations were selected along the project corridor with an attempt to represent the entire community as a whole. Monitored receptors were placed at the ends and in the middle of noise study areas as well as in the first row and second row of houses in relation to S.R. 0001, where applicable. The Section RC3 long-term monitoring site (M3-3) and short-term sites (M1-1 through M9-10) are shown in **Maps 1 through 6** and are described in **Table 3**.

Table 3 Monitored Receptor Location Description

Receptor Number	Residence Address or Property Description	Land Use Type	Location
M1-1	Neshaminy High School	High School	Walking Path
M1-2	1948 W Old Lincoln Highway	Single-Family	Backyard
M1-3	Neshaminy High School	High School	Front Yard
M2-1	1830 Old Lincoln Highway	Single-Family	Side Yard
M3-1	Our Lady of Grace Cemetery	Cemetery	Cemetery
M3-2	Our Lady of Grace Cemetery	Cemetery	Cemetery
M3-3	Our Lady of Grace Cemetery	Cemetery	Cemetery
M4-1	882 Henry Ave	Single-Family	Front Yard
M4-2	891 Henry Ave	Single-Family	Side Yard
M5-1	303 Central Ave	Single-Family	Backyard
M5-2	500 Hulmeville Ave	Single-Family	Front Yard
M5-3	210 Central Ave	Single-Family	Front Yard
M5-4	406 Station Ave	Single-Family	Side Yard
M5-5	Langhorne Presbyterian Church	Church	Open Field
M6-1	Woods School Campus	School	Open Field
M7-1	Woods School Campus	School	Playground
M7-2	Woods School Housing	Multi-Family	Backyard
M8-1	509 Hulmeville Ave	Single-Family	Front Yard
M8-2	501 Hill Ave	Single-Family	Backyard
M8-3	106 W Highland Ave	Single-Family	Front Yard
M8-4	502 Station Ave	Single-Family	Front Yard
M8-5	148 E Highland Ave	Single-Family	Front Yard
M9-1	1701 Highland Ave	Single-Family	Backyard
M9-2	1648 Super Highway	Single-Family	Side Yard
M9-3	705 Timber Lane	Multi-Family	Front Yard
M9-4	1141 Jeffrey Lane	Single-Family	Side Yard

Table 3 Monitored Receptor Location Description			
Receptor Number	**Residence Address or Property Description**	**Land Use Type**	**Location**
M9-5	1154 Jeffrey Lane	Single-Family	Front Yard
M9-6	642 Fee Ave	Single-Family	Front Yard
M9-7	951 Jeffrey Lane	Single-Family	Backyard
M9-8	934 Jeffrey Lane	Single-Family	Front Yard
M9-9	734 North St	Single-Family	Side Yard
M9-10	814 North St	Single-Family	Side Yard

4.3 Noise Measurement Data

Highway noise measurements were performed in conformance with the U.S. Department of Transportation FHWA's Measurement of Highway-Related Noise (FHWA-PD-96-046 May 1996). Long-term (24-hour) and short-term (20-minute) noise measurements were conducted for this study.

S.R. 0001, Section RC3 field data corresponding to this section of the report can be found in:

- **Appendix A** – Noise Measurement Data
- **Appendix B** – Traffic Count Data

Field measurements of ambient noise levels for Section RC3 were performed in April, 2021 and then re-monitored in September, 2021 for use in validating the FHWA Traffic Noise Model. The noise measurements were conducted using Larson Davis LXT and Larson Davis 831 noise meters. Calibration certificates for each piece of equipment are included in **Appendix G**. Both long-term (24-hours) and short-term (20-minute) measurements were performed.

4.3a 24-Hour Noise Measurements

One long-term (24-hour) noise measurement was taken (M3-3) in the project area and the hourly equivalent sound levels, Leq(h), were calculated for each hour of the 24-hour noise measurements. The Leq(h) levels defined each 24-hour noise measurement site's peak noise hour and peak noise hour level. Peak noise hours may not occur at the peak traffic hour; instead, the peak hours may occur when traffic volumes are lower, but the truck mix or vehicle speeds are higher. **Table 4** provides a Summary of the peak noise level for the 24-hour noise measurement. A graph indicating hourly noise levels during the monitoring session is shown in **Appendix A**. [Note: military time, 1300 = 1:00 pm]

Table 4 24-Hour Noise Measurement Summary					
Receptor Number	**Residence Address or Property Description (No. Units Represented)**	**Land Use Type**	**Start Date & Time**	**Peak Hour**	**Peak Noise Hour Leq, dB(A)**
M3-3	Our Lady of Grace Cemetery	Cemetery	4/27/21, 7:10AM	0515 - 0615	70

4.3b Short-term Noise Measurements

Thirty-one short-term noise measurements (20-minute duration) were conducted within the nine NSAs along the project corridor. The 20-minute monitoring sessions were set up for one-minute intervals to provide the ability to isolate significant non-highway related noise (i.e., dog barking, horns, and airplanes) during the monitoring session. The 20-minute equivalent sound level, Leq[h] was calculated for each short-term noise measurement. **Table 5** summarizes the measured noise level for each of the short-term noise measurements. The level is rounded to the nearest whole decibel in accordance with PennDOT guidelines. **Appendix A** contains data collected in the field. **Maps 1 through 6** show receptor locations.

4.4 Existing Monitored Traffic Data

Short-term noise measurements (20-minute) were collected concurrently with classified traffic counts for each receptor monitored in April 2021 and September 2021. The 20-minute Traffic Monitoring Session (TMS) counts were divided into five vehicle classes: cars, large trucks, medium trucks, buses, and motorcycles. Speeds were collected using a radar gun and represent the average speed during each session. The traffic counts and speeds were then used in Traffic Noise Model (TNM) Version 2.5 validation as outlined in **Section 4.6** of this report. The Section RC3 traffic count data is presented in **Appendix B** along with average collected speed data.

The existing posted speed limit for S.R. 0001 mainline is 55 mph in both directions and 40 mph along the existing frontage road.

4.5 Monitored Conditions Results

The noise monitoring results from **Table 4 and Table 5** show that 11 of the 31 monitored receptors have noise levels that exceed the PennDOT Noise Abatement Criteria (NAC), as per **Section 3.2**.

Table 5 Section RC3 Short-Term Noise Measurement Summary

Receptor Number	Residence Address or Property Description	Land Use Type	Location	Date	Interval	Duration	Measured Level Leq, dB(A)[1]
NSA-1							
M1-1	Neshaminy High School	High School	Walking Path	9/13/2021	0820-0840	20-min	59
M1-2	1948 Old Lincoln Highway	Single Family	Backyard	9/13/2021	0820-0840	20-min	**72**
M1-3	Neshaminy High School	High School	Front	9/13/2021	0820-0840	20-min	60
NSA-2							
M2-1	1830 Old Lincoln Highway	Single Family	Side Yard	9/13/2021	0900-0920	20-min	64
NSA-3							
M3-1	Our Lady of Grace Cemetery	Cemetery	Cemetery	9/13/2021	1420-1440	20-min	63
M3-2	Our Lady of Grace Cemetery	Cemetery	Cemetery	9/13/2021	1420-1440	20-min	65
NSA-4							
M4-1	882 Henry Ave	Single Family	Front Yard	9/13/2021	0220-0240	20-min	59
M4-2	891 Henry Ave	Single Family	Side Yard	9/13/2021	1100-1120	20-min	58
NSA-5							
M5-1	303 Central Ave	Single Family	Backyard	9/13/2021	1340-1400	20-min	**71**
M5-2	500 Hulmeville Ave	Single Family	Front Yard	9/13/2021	1340-1400	20-min	64
M5-3	210 Central Ave	Single Family	Front Yard	9/13/2021	1340-1400	20-min	**66**
M5-4	406 Station Ave	Single Family	Side Yard	4/28/2021	1420-1440	20-min	**70**
M5-5	Langhorne Presbyterian Church	Church	Church	4/28/2021	1420-1440	20-min	58
NSA-6							
M6-1	Woods School Campus	School	Open Field	4/28/2021	1420-1440	20-min	60
NSA-7							
M7-1	Woods School Campus	School	Playground	4/28/2021	1420-1440	20-min	55
M7-2	Woods School Housing	Multi-Family	Backyard	4/28/2021	1420-1440	20-min	64
NSA-8							
M8-1	509 Hulmeville Ave	Single Family	Front Yard	9/13/2021	1140-1200	20-min	62
M8-2	501 Hill Ave	Single Family	Backyard	9/13/2021	1140-1200	20-min	**69**
M8-4	502 Station Ave	Single Family	Front Yard	9/13/2021	1140-1200	20-min	**68**
M8-3	106 W Highland Ave	Single Family	Front Yard	9/13/2021	1300-1320	20-min	55
M8-5	148 E Highland Ave	Single Family	Front Yard	9/13/2021	1300-1320	20-min	54

Table 5 Section RC3 Short-Term Noise Measurement Summary

Receptor Number	Residence Address or Property Description	Land Use Type	Location	Date	Interval	Duration	Measured Level Leq, dB(A)[1]
			NSA-9				
M9-1	1701 Highland Ave	Single Family	Backyard	9/13/2021	0900-0920	20-min	58
M9-2	1648 Super Highway	Single Family	Side Yard	9/13/2021	0900-0920	20-min	**74**
M9-3	705 Timber Lane	Multi- Family	Front Yard	9/13/2021	0940-1000	20-min	**68**
M9-4	1141 Jeffrey Lane	Single Family	Side Yard	9/13/2021	0940-1000	20-min	62
M9-5	1154 Jeffrey Lane	Single Family	Front Yard	9/13/2021	0940-1000	20-min	62
M9-6	642 Fee Ave	Single Family	Front Yard	9/13/2021	1020-1040	20-min	58
M9-7	951 Jeffrey Lane	Single Family	Backyard	9/13/2021	1020-1040	20-min	**70**
M9-8	934 Jeffrey Lane	Single Family	Front Yard	9/13/2021	1020-1040	20-min	58
M9-9	734 North St	Single Family	Side Yard	9/13/2021	1100-1120	20-min	**68**
M9-10	814 North St	Single Family	Side Yard	9/13/2021	1100-1120	20-min	**66**
				Total Number of Short-term Noise Measurements			**31**

LEGEND

Exceeds PennDOT NAC[2]

1. *All Noise Levels are shown as hourly equivalent sound levels (Leq[h]) with units in A-weighted decibels (dB[A]. Noise values are calculated to the tenth of a dB(A) and then rounded to the nearest whole decibel for presentation purposes in accordance with PennDOT guidelines.*
2. *Receptors where the existing (measured) noise levels approach or exceed 67 dB(A) for Land Use Category B and Category C. PennDOT has adopted "approach" to mean 66 dB(A) as the impact threshold for Category B & C.*

4.6 TNM v2.5 Model Validation

The TNM model validation verifies the calibration of the TNM model by evaluating the model's ability to reproduce the measured noise levels under specific measured traffic conditions. After the Noise Measurements and Traffic Counts were obtained, a TNM v2.5 Model was developed for the study area, inputting pertinent roadways, terrain, and structural elements thought to be needed for adequately characterizing the study area's noise environment. Each Noise Measurement Receptor was accurately represented in the model by a TNM Receptor. The model was then validated by testing it under the appropriate traffic conditions encountered during the corresponding traffic monitoring session. PennDOT considers a TNM Model to be properly validated when the Modeled Noise Levels are within 3.0 dB(A) of the Measured Noise Levels for the receptors. **Table 6** compares the field Measured Noise Levels to the Modeled Noise Levels from the TNM Runs.

Table 6 Validation Results

Receptor Number	Residence Address or Property Description	Measured Noise Level	Modeled Noise Level	Difference
M1-1	Neshaminy High School	58.9	60.9	2.0
M1-2	1948 Old Lincoln Highway	71.9	74.9	3.0
M1-3	Neshaminy High School	60.3	61.4	1.1
M2-1	1830 Old Lincoln Highway	63.8	62.5	-1.3
M3-1	Our Lady of Grace Cemetery	63.3	66.1	2.8
M3-2	Our Lady of Grace Cemetery	64.6	67.1	2.5
M4-1	882 Henry Ave	59.0	61.6	2.6
M4-2	891 Henry Ave	67.7	69.4	1.7
M5-1	303 Central Ave	71.4	72	0.6
M5-2	500 Hulmeville Ave	63.6	64.7	1.1
M5-3	210 Central Ave	65.5	68.1	2.6
M5-4	406 Station Ave	70.1	73.1	3.0
M5-5	Langhorne Presbyterian Church	58.0	55.1	-2.9
M6-1	Woods School Campus	59.7	61.4	1.7
M7-1	Woods School Campus	54.6	51.9	-2.7
M7-2	Woods School Housing	63.7	65.6	1.9
M8-1	509 Hulmeville Ave	62.2	63.8	1.6
M8-2	501 Hill Ave	69.4	71.1	1.7
M8-4	502 Station Ave	67.5	69.4	1.9
M8-3	106 W Highland Ave	55.1	52.8	-2.3
M8-5	148 E Highland Ave	54.0	52.7	-1.3
M9-1	1701 Highland Ave	58.0	60.5	2.5
M9-2	1648 Super Highway	74.4	74.9	0.5
M9-3	705 Timber Ln	67.6	70.5	2.9
M9-4	1141 Jeffrey Ln	62.1	63.4	1.3
M9-5	1154 Jeffrey Ln	62.3	62.5	0.2

Table 6 Validation Results

Receptor Number	Residence Address or Property Description	Measured Noise Level	Modeled Noise Level	Difference
M9-6	642 Fee Ave	57.8	60.8	3.0
M9-7	951 Jeffrey Ln	69.8	69.3	-0.5
M9-8	934 Jeffrey Ln	57.8	58.7	0.9
M9-9	734 North St	67.9	70.9	3.0
M9-10	814 North St	65.5	68.5	3.0

Thirty-one out of thirty-one receptor locations measured noise levels are within 3 dB(A) of the modeled TNM v2.5 noise levels and are considered validated. Validation results and TNM printouts are presented in **Appendix C**.

4.7 Determining Worst-Case Existing Conditions

After the noise model was validated, a 2019 existing worst-case noise model was used to predict worst-case existing noise levels within the project area. The witnessed traffic data was replaced in the model with Year 2019 Existing worst-case traffic data. The Year 2019 Existing Worst-Case traffic volume figures from the report are included in **Appendix D**.

Modeled receptors were added to the model to comprehensively represent each community.

The existing worst-case noise levels serve as a basis for the PennDOT "substantial increase" noise abatement criteria and are presented in **Table 7** where existing 2019 values are compared with future 2050 Build Condition predicted noise levels.

A total of 209 receptors along the Section RC3 project corridor have 2019 existing worst-case traffic noise levels that approach or exceed the Land Use Activity Category B or C noise abatement criteria (67 dB(A)). PennDOT has adopted "approach" to mean 66 dB(A) as the impact threshold for Category B & C.

4.8 Determining Equivalent Residential Units (ERU) Values

PennDOT has developed methodologies for the determination of the number of residential units to be used to represent multi-dwelling structures and activity sites used by more than one family or person. These methodologies focus on the development of Equivalent Residential Unit (ERU) values based on the relationship of a "person hours used per year" value for a specific activity use to the average "person hours used per year" value associated with an average single-family dwelling in Pennsylvania.

The ERU calculations were based off guidance from PennDOT Publication 24 *Appendix E – Methodologies for Determining Equivalent Residential Unit Values and Assessing Noise Barrier Reasonableness in Activity Category B, C, D, and E Areas*.

The Equivalent Residential Unit (ERU) value is a function of the "person-hours per year" of use of the site, expressed as a ratio to the "person-hours per year" of use by an average single-family dwelling in Pennsylvania. While the ERU value for a single-family residence is always one, ERU values for other sites will vary based on a variety of factors. The ERU values for impacted non-residential receptors along the corridor were assumed by following the guidance in PennDOT Pub. No. 24's Appendix E. The ERU value used for each receptor point is shown in **Tables 9 through 13**.

The ERU calculations for Neshaminy High School within NSA 1 were taken from discussions and correspondence with Neshaminy High School Representatives. Neshaminy High School has about 2,500 students in grades 9-12, and NSA 1 contains both sports fields and mixed-use green space. Two ERU calculation were completed using the playground and athletic facilities PennDOT example ERU calculations. The calculations each consider regular use of green space and event use (football games, graduation, etc) in the stadium. The green space outdoor usage was estimated as an average of 25% of the students (equal to 625 persons) use the area per day, for an average of 30 minutes each day, 30% of school days (60 days) a year. This value of 1 ERU is applied at M-1-1 for barrier analysis. The Stadium usage is estimated as an average of 1,400 people, for an average of 2.5 hours, 24 days a year. The 6 ERUs calculated for the Stadium is applied at R1-11 for barrier analysis. See ERU calculations spreadsheet in **Appendix E** and correspondence email chain in **Appendix J**.

The ERU calculations for Our Lady of Grace Catholic Cemetery within NSA 3 were taken from discussions and correspondence with caretakers and leaders of Our Lady of Grace Catholic Cemetery. The calculation used the estimates that 110 people/day use it for about 0.38 hours/day for 365 days/year. The total ERU was divided by the 60 representative grid points, and each receptor is given the value of 0.0190. See ERU calculations spreadsheet in **Appendix E** and correspondence email chain in **Appendix J**.

The ERU calculation for Langhorne Presbyterian Church within NSA 5 was taken from discussions and correspondence with Langhorne Presbyterian Church Representatives. NSA 5 contains picnic and mixed-use green space. The ERU calculation uses the picnic area PennDOT example ERU calculation. The calculation used the estimates that the site capacity is 200 people and is 12% occupied for 10 hours/day for 100 days/year. See ERU calculations spreadsheet in **Appendix E** and Langhorne Presbyterian correspondence email chain in **Appendix J**.

The ERU calculation for the Langhorne Branch of the Bucks County Library within NSA 6 were taken from discussions and correspondence with representatives from the Bucks County Library. The ERU calculation uses the picnic area PennDOT example ERU calculation. The calculation used the estimates that the site capacity is 200 people and is 5% occupied for 10 hours/day for 100 days/year. See ERU calculations spreadsheet in **Appendix E** and Bucks County Library correspondence email chain in **Appendix J**.

ERU calculations for the Woods School Campus were taken from discussions and correspondence with Woods School Representatives. NSA 5, 6, and 7 contain land owned by the Woods School. The area north of Langhorne Presbyterian Church is owned by Woods within NSA 5, and after discussions with Woods School Representatives this was determined to not be an area of frequent human use. NSAs 6 and 7

contain both residential use and mixed-use green space. Both NSAs were divided into two zones by Corn Crib Lane. The ERU calculation for each section used the total amount of students and staff in each respective zone estimating that they used their section for 5 hours a day for 270 days per year. This total ERU value was divided by the number of 130' gridded receptors representing the residences and green space in the respective zone, and that resulting value was attributed to each receptor. See ERU calculations spreadsheet in **Appendix E** and the Woods School correspondence summary in **Appendix J**. Please note that direct correspondence from Woods School cannot be included in Appendix J due to confidentiality statement.

5.0 FUTURE HIGHWAY TRAFFIC NOISE ANALYSIS

5.1 Introduction

Future worst-case noise levels are predicted using TNM V2.5 for the 2050 No-Build and 2050 Build Conditions. A validated TNM model of existing conditions was used as a base to create the TNM runs for predicting future conditions. The persons conducting the Traffic Noise Analysis are qualified as per PennDOT Pub. No. 24 and copies of Certificates of Training can be found in **Appendix H**.

5.2 Predicted Noise Levels

5.2a Predicted Traffic

The project's traffic engineering team and DVRPC provided traffic data for the noise analysis. **Appendix D** includes traffic fleet volumes and speeds for key S.R. 0001, Section RC3 roadways that were modeled in TNM for 2019 Existing Worst-case, 2050 No-Build, and 2050 Build Conditions.

5.2b Predicted Noise Level Results

The existing noise model was used as a base for the 2050 future no-build model, where the existing worst-case traffic was replaced with the no-build predicted traffic and speeds.

The proposed roadway alignments and corridor improvements were incorporated into the 2050 Build Condition model and were run to determine future noise levels and preliminary assessment of "warranted" receptors.

Table 7 compares the modeled 2050 Build Condition worst-case noise levels to the Existing Worst-Case and 2050 No-Build Conditions. 'Highlight' (white background) in the Predicted Noise Levels table indicates that receptors are impacted in the 2050 Build Condition with predicted noise levels at or above 66 dB(A) or with a substantial noise level increase (10 dB(A)) from existing and that a noise abatement investigation is warranted.

All noise levels are rounded to the nearest whole decibel. 2050 No-Build Noise Levels were found to decrease (maximum 1 dB(A)) or increase 2 dB(A) compared to the existing worst-case values at all receptors. 2050 Build Noise Levels were found to decrease (maximum 9 dB(A)) in some areas and increase (maximum 5 dB(A)) in others depending on the proposed roadway configuration, proposed traffic data, and the addition of solid roadway barriers along the roadway shoulder and median where there had previously only been guide rail.

The TNM files from the predicted noise level analysis are included in **Appendix E**.

Table 7 Predicted Noise Levels

Receptor Number[1]	Residence Address or Property Description	2019 Existing Worst-Case Traffic Noise Level (dB(A))	2050 No-Build Predicted Noise Level (dB(A))	Difference from Existing to 2050 No-Build	2050 Build Predicted Noise Level (dB(A))[2]	Difference from Existing to 2050 Build
NSA 1						
M1-1	Neshaminy High School	64	**66**	2	**67**	3
M1-2	1948 W Old Lincoln Highway	**75**	**76**	1	**76**	1
M1-3	Neshaminy High School	63	64	1	63	0
R1-1	2052 Old Lincoln Highway	**72**	**73**	1	**74**	2
R1-2	1980 Old Lincoln Highway	**72**	**73**	1	**74**	2
R1-3	1968 Old Lincoln Highway	**71**	**72**	1	**74**	3
R1-4	1958 Old Lincoln Highway	**72**	**72**	0	**75**	3
R1-5	1936 Old Lincoln Highway	**74**	**75**	1	**76**	2
R1-6	1924 Old Lincoln Highway	**66**	**67**	1	**70**	4
R1-7	1900 Old Lincoln Highway	**72**	**72**	0	**73**	1
R1-8	1903 Old Lincoln Highway	65	65	0	65	0
R1-9	Neshaminy High School	63	63	0	64	1
R1-10	Neshaminy High School	59	60	1	61	2
R1-11	Neshaminy High School	62	63	1	63	1
NSA 2						
M2-1	1830 Old Lincoln Highway	**67**	**67**	0	**69**	2
R2-1	1812 Old Lincoln Highway	**67**	**68**	1	**69**	2
R2-2	1830 Old Lincoln Highway	65	65	0	**66**	1
R2-3	697 Fairhill Ave	63	63	0	64	1
R2-4	1801 Old Lincoln Highway	65	65	0	**66**	1
NSA 3						
M3-1	Our Lady of Grace Cemetery	**70**	**70**	0	**68**	-2
M3-2	Our Lady of Grace Cemetery	**71**	**71**	0	**68**	-3
M3-3	Our Lady of Grace Cemetery	**68**	**68**	0	**66**	-2
R3-1	Our Lady of Grace Cemetery	**76**	**76**	0	**76**	0
R3-2	Our Lady of Grace Cemetery	**77**	**76**	-1	**76**	-1
R3-3	Our Lady of Grace Cemetery	**77**	**77**	0	**76**	-1

Table 7 Predicted Noise Levels

Receptor Number[1]	Residence Address or Property Description	2019 Existing Worst-Case Traffic Noise Level (dB(A))	2050 No-Build Predicted Noise Level (dB(A))	Difference from Existing to 2050 No-Build	2050 Build Predicted Noise Level (dB(A))[2]	Difference from Existing to 2050 Build
R3-4	Our Lady of Grace Cemetery	**77**	**76**	-1	**76**	-1
R3-5	Our Lady of Grace Cemetery	**76**	**76**	0	**75**	-1
R3-6	Our Lady of Grace Cemetery	**76**	**76**	0	**74**	-2
R3-7	Our Lady of Grace Cemetery	**76**	**75**	-1	**72**	-4
R3-8	Our Lady of Grace Cemetery	**76**	**76**	0	**72**	-4
R3-9	Our Lady of Grace Cemetery	**76**	**76**	0	**72**	-4
R3-10	Our Lady of Grace Cemetery	**76**	**76**	0	**72**	-4
R3-11	Our Lady of Grace Cemetery	**76**	**76**	0	**72**	-4
R3-12	Our Lady of Grace Cemetery	**77**	**76**	-1	**73**	-4
R3-13	Our Lady of Grace Cemetery	**76**	**76**	0	**73**	-3
R3-14	Our Lady of Grace Cemetery	**76**	**76**	0	**72**	-4
R3-15	Our Lady of Grace Cemetery	**75**	**75**	0	**72**	-3
R3-16	Our Lady of Grace Cemetery	**69**	**69**	0	**66**	-3
R3-17	Our Lady of Grace Cemetery	**69**	**69**	0	**67**	-2
R3-18	Our Lady of Grace Cemetery	**69**	**69**	0	**67**	-2
R3-19	Our Lady of Grace Cemetery	**70**	**69**	-1	**67**	-3
R3-20	Our Lady of Grace Cemetery	**69**	**69**	0	**67**	-2
R3-21	Our Lady of Grace Cemetery	**69**	**69**	0	**67**	-2
R3-22	Our Lady of Grace Cemetery	**69**	**69**	0	**67**	-2
R3-23	Our Lady of Grace Cemetery	**70**	**69**	-1	**67**	-3
R3-24	Our Lady of Grace Cemetery	**70**	**69**	-1	**67**	-3
R3-25	Our Lady of Grace Cemetery	**70**	**70**	0	**68**	-2
R3-26	Our Lady of Grace Cemetery	**70**	**70**	0	**68**	-2
R3-27	Our Lady of Grace Cemetery	**70**	**70**	0	**69**	-1
R3-28	Our Lady of Grace Cemetery	**70**	**70**	0	**69**	-1
R3-29	Our Lady of Grace Cemetery	**70**	**70**	0	**69**	-1
R3-30	Our Lady of Grace Cemetery	**70**	**70**	0	**69**	-1
R3-31	Our Lady of Grace Cemetery	**67**	**67**	0	65	-2
R3-32	Our Lady of Grace Cemetery	**67**	**67**	0	65	-2
R3-33	Our Lady of Grace Cemetery	**67**	**67**	0	65	-2
R3-34	Our Lady of Grace Cemetery	**67**	**67**	0	65	-2
R3-35	Our Lady of Grace Cemetery	**67**	**67**	0	65	-2
R3-36	Our Lady of Grace Cemetery	**67**	**67**	0	64	-3
R3-37	Our Lady of Grace Cemetery	**66**	**66**	0	63	-3
R3-38	Our Lady of Grace Cemetery	**66**	**66**	0	63	-3
R3-39	Our Lady of Grace Cemetery	**66**	**66**	0	63	-3
R3-40	Our Lady of Grace Cemetery	**66**	**66**	0	63	-3

Table 7 Predicted Noise Levels

Receptor Number[1]	Residence Address or Property Description	2019 Existing Worst-Case Traffic Noise Level (dB(A))	2050 No-Build Predicted Noise Level (dB(A))	Difference from Existing to 2050 No-Build	2050 Build Predicted Noise Level (dB(A))[2]	Difference from Existing to 2050 Build
R3-41	Our Lady of Grace Cemetery	**66**	**66**	0	63	-3
R3-42	Our Lady of Grace Cemetery	**66**	**66**	0	63	-3
R3-43	Our Lady of Grace Cemetery	**66**	**66**	0	63	-3
R3-44	Our Lady of Grace Cemetery	**66**	**66**	0	63	-3
R3-45	Our Lady of Grace Cemetery	**66**	**66**	0	63	-3
R3-46	Our Lady of Grace Cemetery	63	63	0	61	-2
R3-47	Our Lady of Grace Cemetery	63	63	0	61	-2
R3-48	Our Lady of Grace Cemetery	63	63	0	61	-2
R3-49	Our Lady of Grace Cemetery	64	63	-1	61	-3
R3-50	Our Lady of Grace Cemetery	63	63	0	61	-2
R3-51	Our Lady of Grace Cemetery	63	63	0	61	-2
R3-52	Our Lady of Grace Cemetery	63	63	0	61	-2
R3-53	Our Lady of Grace Cemetery	63	63	0	61	-2
R3-54	Our Lady of Grace Cemetery	64	64	0	61	-3
R3-55	Our Lady of Grace Cemetery	64	64	0	61	-3
R3-56	Our Lady of Grace Cemetery	64	64	0	62	-2
R3-57	Our Lady of Grace Cemetery	64	64	0	62	-2
R3-58	Our Lady of Grace Cemetery	64	64	0	62	-2
R3-59	Our Lady of Grace Cemetery	64	64	0	62	-2
R3-60	Our Lady of Grace Cemetery	64	64	0	62	-2
NSA 4						
M4-1	882 Henry Ave	**67**	**67**	0	65	-2
M4-2	891 Henry Ave	**73**	**72**	-1	**70**	-3
R4-1	570 Parkvale Ave	**75**	**75**	0	**72**	-3
R4-1	871 Henry Ave	**74**	**73**	-1	**71**	-3
R4-2	841 Henry Ave	**74**	**74**	0	**72**	-2
R4-3	821 Henry Ave	**75**	**74**	-1	**72**	-3
R4-4	811 Henry Ave	**75**	**75**	0	**73**	-2
R4-5	565 Hulmeville Rd	**73**	**73**	0	**72**	-1
R4-6	555 Hulmeville Rd	**68**	**68**	0	**67**	-1
R4-7	545 Hulmeville Rd	**67**	**67**	0	65	-2
R4-8	812 Henry Ave	**68**	**68**	0	**67**	-1
R4-9	836 Henry Ave	**67**	**66**	-1	**66**	-1
R4-10	864 Henry Ave	**67**	**67**	0	65	-2
R4-11	547 Henry Ave	**68**	**68**	0	**66**	-2
R4-12	554 Parkvale Ave	**70**	**70**	0	**67**	-3
R4-13	546 Parkvale Ave	**68**	**67**	-1	65	-3

Table 7 Predicted Noise Levels

Receptor Number[1]	Residence Address or Property Description	2019 Existing Worst-Case Traffic Noise Level (dB(A))	2050 No-Build Predicted Noise Level (dB(A))	Difference from Existing to 2050 No-Build	2050 Build Predicted Noise Level (dB(A))[2]	Difference from Existing to 2050 Build
R4-14	534 Parkvale Ave	65	65	0	63	-2
R4-15	519 Parkvale Ave	63	63	0	61	-2
R4-16	520 Hulmeville Rd	61	60	-1	59	-2
R4-17	528 Hulmeville Rd	65	65	0	64	-1
R4-18	533 Hulmeville Rd	65	65	0	64	-1
R4-19	882 Henry Ave	**67**	**67**	0	65	-2
NSA 5						
M5-1	303 Central Ave	**74**	**74**	0	**74**	0
M5-2	500 Hulmeville Ave	**67**	**67**	0	**66**	-1
M5-3	210 Central Ave	**71**	**71**	0	**69**	-2
M5-4	406 Station Ave	**72**	**73**	1	**71**	-1
M5-5	Langhorne Presbyterian Church	56	56	0	58	2
R5-1	502 Hulmeville Ave	**72**	**72**	0	**71**	-1
R5-2	503 Hulmeville Ave	**74**	**74**	0	**73**	-1
R5-3	501 Hulmeville Ave	**70**	**70**	0	**69**	-1
R5-4	208 Central Ave	**71**	**71**	0	**69**	-2
R5-5	406 Station Ave	**75**	**75**	0	**74**	-1
R5-6	407 Station Ave	**70**	**71**	1	**68**	-2
R5-7	403 Station Ave	**68**	**69**	1	**66**	-2
R5-8	Langhorne Presbyterian Church	**73**	**73**	0	**73**	0
R5-9	110 W Gillam Ave	64	65	1	63	-1
R5-10	401 Station Ave	62	63	1	61	-1
R5-11	404 Station Ave	65	**66**	1	63	-2
R5-12	406 Hill Ave	**68**	**68**	0	**67**	-1
R5-13	304 Central Ave	**67**	**68**	1	**66**	-1
R5-14	407 Hulmeville Ave	64	64	0	62	-2
R5-15	408 Hulmeville Ave	61	61	0	60	-1
R5-16	404 Hill Ave	61	61	0	59	-2
R5-17	407 Hill Ave	63	63	0	61	-2
R5-18	401 Hill Ave	60	61	1	59	-1
R5-19	205 W Gillam Ave	61	62	1	60	-1
R5-20	402 Station Ave	61	62	1	59	-2
R5-21	Langhorne Presbyterian Church	59	59	0	62	3
R5-22	361 S Bellevue Ave	62	62	0	63	1
R5-23	362 S Bellevue Ave	63	63	0	61	-2
R5-24	363 S Bellevue Ave	54	54	0	55	1
NSA 6						

Table 7 Predicted Noise Levels

Receptor Number[1]	Residence Address or Property Description	2019 Existing Worst-Case Traffic Noise Level (dB(A))	2050 No-Build Predicted Noise Level (dB(A))	Difference from Existing to 2050 No-Build	2050 Build Predicted Noise Level (dB(A))[2]	Difference from Existing to 2050 Build
M6-1	Woods School Campus	62	62	0	64	2
R6-1	Woods School Campus	**74**	**74**	0	**-**	-
R6-2	Woods School Campus	**74**	**74**	0	**-**	-
R6-3	Woods School Campus	**74**	**74**	0	**-**	-
R6-4	Woods School Campus	**74**	**74**	0	**-**	-
R6-5	Woods School Campus	**77**	**76**	-1	**77**	0
R6-6	Woods School Campus	**76**	**76**	0	**76**	0
R6-7	Woods School Campus	**75**	**75**	0	**76**	1
R6-8	Woods School Campus	**74**	**74**	0	**76**	2
R6-9	Woods School Campus	**74**	**75**	1	**77**	3
R6-10	Woods School Campus	**75**	**75**	0	**77**	2
R6-11	Woods School Campus	**67**	**67**	0	**68**	1
R6-12	Woods School Campus	**67**	**67**	0	**68**	1
R6-13	Woods School Campus	**67**	**67**	0	**69**	2
R6-14	Woods School Campus	**67**	**67**	0	**69**	2
R6-15	Woods School Campus	**67**	**67**	0	**69**	2
R6-16	Woods School Campus	**67**	**67**	0	**69**	2
R6-17	Woods School Campus	**67**	**67**	0	**70**	3
R6-18	Woods School Campus	**66**	**66**	0	**70**	4
R6-19	Woods School Campus	**67**	**67**	0	**69**	2
R6-20	Woods School Campus	**67**	**67**	0	**69**	2
R6-21	Woods School Campus	**66**	**66**	0	**68**	2
R6-22	Woods School Campus	**66**	**66**	0	**68**	2
R6-23	Woods School Campus	**67**	**67**	0	-	-
R6-24	Woods School Campus	**67**	**67**	0	-	-
R6-25	Woods School Campus	**67**	**67**	0	-	-
R6-26	Woods School Campus	63	63	0	-	-
R6-27	Woods School Campus	63	63	0	-	-
R6-28	Woods School Campus	62	62	0	**66**	4
R6-29	Woods School Campus	52	52	0	54	2
R6-30	Woods School Campus	62	62	0	65	3
R6-31	Woods School Campus	62	62	0	**66**	4
R6-32	Woods School Campus	61	61	0	**66**	5
R6-33	Woods School Campus	62	62	0	**66**	4
R6-34	Woods School Campus	63	62	-1	**66**	3
R6-35	Woods School Campus	63	63	0	**66**	3
R6-36	Woods School Campus	61	61	0	64	3

Table 7 Predicted Noise Levels

Receptor Number[1]	Residence Address or Property Description	2019 Existing Worst-Case Traffic Noise Level (dB(A))	2050 No-Build Predicted Noise Level (dB(A))	Difference from Existing to 2050 No-Build	2050 Build Predicted Noise Level (dB(A))[2]	Difference from Existing to 2050 Build
R6-37	Woods School Campus	61	61	0	63	2
R6-38	Woods School Campus	60	60	0	61	1
R6-39	Woods School Campus	58	58	0	60	2
R6-40	Woods School Campus	55	55	0	57	2
R6-41	Woods School Campus	57	56	-1	60	3
R6-42	Woods School Campus	59	59	0	63	4
R6-43	Woods School Campus	59	59	0	63	4
R6-44	Woods School Campus	59	59	0	62	3
R6-45	Woods School Campus	57	57	0	59	2
R6-46	Woods School Campus	59	59	0	63	4
R6-47	Woods School Campus	60	60	0	65	5
R6-48	Woods School Campus	63	63	0	**67**	4
R6-49	Woods School Campus	60	60	0	62	2
R6-50	Woods School Campus	58	58	0	61	3
R6-61	Woods School Campus	49	49	0	51	2
R6-62	Woods School Campus	57	57	0	60	3
R6-63	Woods School Campus	61	61	0	61	0
R6-64	Bucks Co. Public Library	55	55	0	57	2
NSA 7						
M7-1	Woods School Campus	52	52	0	55	3
M7-2	Woods School Campus	**70**	**70**	0	**71**	1
R7-1	Woods School Campus	**75**	**74**	-1	**77**	2
R7-2	Woods School Campus	**75**	**75**	0	**77**	2
R7-3	Woods School Campus	**76**	**75**	-1	**78**	2
R7-4	Woods School Campus	**76**	**75**	-1	**78**	2
R7-5	Woods School Campus	**74**	**75**	1	**77**	3
R7-6	Woods School Campus	**74**	**75**	1	**77**	3
R7-7	Woods School Campus	**74**	**75**	1	**76**	2
R7-8	Woods School Campus	**73**	**74**	1	**75**	2
R7-9	Woods School Campus	**70**	**70**	0	**70**	0
R7-10	Woods School Campus	**74**	**74**	0	**76**	2
R7-11	Woods School Campus	**75**	**74**	-1	**76**	1
R7-12	Woods School Campus	**75**	**74**	-1	**76**	1
R7-13	Woods School Campus	**74**	**74**	0	**75**	1
R7-14	Woods School Campus	**72**	**72**	0	**72**	0
R7-15	Woods School Campus	**72**	**72**	0	**73**	1
R7-24	Woods School Campus	**66**	**66**	0	**67**	1

Table 7 Predicted Noise Levels

Receptor Number[1]	Residence Address or Property Description	2019 Existing Worst-Case Traffic Noise Level (dB(A))	2050 No-Build Predicted Noise Level (dB(A))	Difference from Existing to 2050 No-Build	2050 Build Predicted Noise Level (dB(A))[2]	Difference from Existing to 2050 Build
R7-25	Woods School Campus	65	65	0	**66**	1
R7-26	Woods School Campus	**69**	**68**	-1	**69**	0
R7-27	Woods School Campus	**68**	**68**	0	**70**	2
R7-28	Woods School Campus	**68**	**68**	0	**69**	1
R7-29	Woods School Campus	**68**	**67**	-1	**68**	0
R7-30	Woods School Campus	**66**	**66**	0	**67**	1
R7-31	Woods School Campus	**66**	**66**	0	**67**	1
R7-32	Woods School Campus	65	65	0	**67**	2
R7-33	Woods School Campus	64	65	1	**67**	3
R7-34	Woods School Campus	64	65	1	**67**	3
R7-35	Woods School Campus	65	**66**	1	**69**	4
R7-36	Woods School Campus	**66**	**66**	0	**70**	4
R7-37	Woods School Campus	**66**	**66**	0	**70**	4
R7-38	Woods School Campus	61	61	0	65	4
R7-39	Woods School Campus	61	61	0	65	4
R7-40	Woods School Campus	61	61	0	64	3
R7-41	Woods School Campus	59	60	1	63	4
R7-42	Woods School Campus	61	61	0	62	1
R7-43	Woods School Campus	60	59	-1	61	1
R7-44	Woods School Campus	63	63	0	64	1
R7-45	Woods School Campus	65	65	0	**66**	1
R7-46	Woods School Campus	63	63	0	64	1
R7-47	Woods School Campus	57	56	-1	58	1
R7-49	Woods School Campus	57	57	0	58	1
R7-50	Woods School Campus	60	60	0	60	0
R7-51	Woods School Campus	59	59	0	60	1
R7-52	Woods School Campus	55	55	0	56	1
R7-53	Woods School Campus	58	58	0	59	1
R7-54	Woods School Campus	57	56	-1	59	2
R7-55	Woods School Campus	58	58	0	59	1
R7-56	Woods School Campus	58	58	0	59	1
R7-57	Woods School Campus	57	58	1	59	2
R7-58	Woods School Campus	57	57	0	60	3
R7-59	Woods School Campus	57	57	0	60	3
R7-60	Woods School Campus	55	55	0	60	5
R7-61	Woods School Campus	56	56	0	60	4
R7-62	Woods School Campus	54	55	1	58	4

Table 7 Predicted Noise Levels

Receptor Number[1]	Residence Address or Property Description	2019 Existing Worst-Case Traffic Noise Level (dB(A))	2050 No-Build Predicted Noise Level (dB(A))	Difference from Existing to 2050 No-Build	2050 Build Predicted Noise Level (dB(A))[2]	Difference from Existing to 2050 Build
R7-63	Woods School Campus	55	56	1	58	3
R7-64	Woods School Campus	55	55	0	56	1
R7-65	Woods School Campus	54	54	0	57	3
R7-66	Woods School Campus	56	56	0	58	2
R7-67	Woods School Campus	55	55	0	57	2
R7-68	Woods School Campus	52	52	0	55	3
R7-69	Woods School Campus	57	57	0	58	1
R7-70	Woods School Campus	56	56	0	57	1
R7-71	Woods School Campus	56	55	-1	56	0
R7-72	Woods School Campus	55	55	0	56	1
R7-73	Woods School Campus	53	53	0	54	1
R7-90	Woods School Campus	54	55	1	58	4
R7-91	Woods School Campus	56	56	0	59	3
NSA 8						
M8-1	509 Hulmeville Ave	**66**	**66**	0	64	-2
M8-2	501 Hill Ave	**74**	**75**	1	**74**	0
M8-3	106 W Highland Ave	60	61	1	51	-9[3]
M8-4	502 Station Ave	**72**	**73**	1	**71**	-1
M8-5	148 E Highland Ave	57	58	1	59	2
R8-1	504 S Bellevue Ave	**72**	**72**	0	**72**	0
R8-2	506 Hulmeville Ave	**74**	**73**	-1	**71**	-3
R8-3	505 Hulmeville Ave	**73**	**73**	0	**71**	-2
R8-4	502 Hill Ave	**74**	**74**	0	**72**	-2
R8-5	501 Station Ave	**74**	**75**	1	**72**	-2
R8-6	500 S Bellevue Ave	**72**	**73**	1	**72**	0
R8-7	50 Central Ave	**69**	**70**	1	**68**	-1
R8-8	507 S Bellevue Ave	**69**	**69**	0	**67**	-2
R8-9	503 Station Ave	**66**	**67**	1	65	-1
R8-10	502 Station Ave	**68**	**68**	0	**66**	-2
R8-11	503 Hill Ave	**66**	**66**	0	64	-2
R8-12	504 Hill Ave	**68**	**68**	0	**66**	-2
R8-13	507 Hulmeville Ave	**67**	**67**	0	**66**	-1
R8-14	510 Hulmeville Ave	64	64	0	62	-2
R8-15	514 Hulmeville Ave	63	63	0	60	-3
R8-16	304 W Highland Ave	63	63	0	61	-2
R8-17	505 Hill Ave	63	64	1	61	-2
R8-18	505 Station Ave	**66**	**67**	1	63	-3

Table 7 Predicted Noise Levels

Receptor Number[1]	Residence Address or Property Description	2019 Existing Worst-Case Traffic Noise Level (dB(A))	2050 No-Build Predicted Noise Level (dB(A))	Difference from Existing to 2050 No-Build	2050 Build Predicted Noise Level (dB(A))[2]	Difference from Existing to 2050 Build
R8-19	506 S Bellevue Ave	59	60	1	62	3
R8-20	515 S Bellevue Ave	57	57	0	59	2
R8-21	525 S Bellevue Ave	**66**	**67**	1	57	-9
R8-22	112 E Highland Ave	63	64	1	63	0
R8-23	613 S Bellevue Ave	64	65	1	64	0
R8-24	154 E Highland Ave	60	61	1	62	2
R8-25	166 E Highland Ave	65	65	0	65	0
R8-26	619 S Bellevue Ave	65	**66**	1	62	-3
R8-27	600 S Bellevue Ave	**69**	**69**	0	**66**	-3
NSA 9						
M9-1	1701 Highland Ave	64	65	1	62	-2
M9-2	1648 Super Highway	**77**	**77**	0	**75**	-2
M9-3	705 Timber Lane	**73**	**73**	0	**70**	-3
M9-4	1141 Jeffrey Lane	**72**	**71**	-1	**71**	-1
M9-5	1154 Jeffrey Lane	64	64	0	63	-1
M9-6	642 Fee Ave	65	65	0	64	-1
M9-7	951 Jeffrey Lane	**75**	**75**	0	**75**	0
M9-8	934 Jeffrey Lane	64	63	-1	63	-1
M9-9	734 North St	**74**	**74**	0	**73**	-1
M9-10	814 North St	**72**	**71**	-1	**71**	-1
R9-1	904 Buchanan Dr	**66**	**66**	0	65	-1
R9-2	1735 Highland Ave	65	**66**	1	65	0
R9-3	1749 Highland Ave	**70**	**70**	0	**69**	-1
R9-4	1757 Highland Ave	**71**	**72**	1	**71**	0
R9-5	1718 Super Highway	**74**	**74**	0	**74**	0
R9-6	1648 Super Highway	**70**	**70**	0	**68**	-2
R9-7	1628 Super Highway	**74**	**74**	0	**72**	-2
R9-8	1612 Super Highway	**73**	**73**	0	**71**	-2
R9-9	1554 Super Highway	**74**	**74**	0	**72**	-2
R9-10	1538 Super Highway	**75**	**75**	0	**72**	-3
R9-11	1641 Highland Ave	63	63	0	61	-2
R9-12	700 Timber Ln	**74**	**73**	-1	**71**	-3
R9-13	712 Timber Ln	**69**	**69**	0	**67**	-2
R9-14	720 Timber Ln	**66**	**66**	0	63	-3
R9-15	724 Timber Ln	63	63	0	61	-2
R9-16	735 Timber Ln	65	65	0	63	-2
R9-17	711 Timber Ln	**68**	**68**	0	65	-3

Table 7 Predicted Noise Levels

Receptor Number[1]	Residence Address or Property Description	2019 Existing Worst-Case Traffic Noise Level (dB(A))	2050 No-Build Predicted Noise Level (dB(A))	Difference from Existing to 2050 No-Build	2050 Build Predicted Noise Level (dB(A))[2]	Difference from Existing to 2050 Build
R9-18	706 Fox Ct	**74**	**74**	0	**72**	-2
R9-19	1257 Jeffrey Ln	**75**	**75**	0	**75**	0
R9-20	1239 Jeffrey Ln	**75**	**75**	0	**75**	0
R9-21	1203 Jeffrey Ln	**75**	**75**	0	**75**	0
R9-22	1195 Jeffrey Ln	**75**	**75**	0	**75**	0
R9-23	1175 Jeffrey Ln	**75**	**75**	0	**75**	0
R9-24	1153 Jeffrey Ln	**75**	**75**	0	**75**	0
R9-25	111 Jeffrey Ln	**75**	**75**	0	**75**	0
R9-26	616 Fee Ave	**75**	**75**	0	**75**	0
R9-27	1025 Jeffrey Ln	**76**	**76**	0	**76**	0
R9-28	1015 Jeffrey Ln	**76**	**75**	-1	**76**	0
R9-29	997 Jeffrey Ln	**76**	**75**	-1	**76**	0
R9-30	979 Jeffrey Ln	**75**	**75**	0	**75**	0
R9-31	959 Jeffrey Ln	**76**	**75**	-1	**76**	0
R9-32	935 Jeffrey Ln	**75**	**75**	0	**75**	0
R9-33	927 Jeffrey Ln	**70**	**70**	0	**70**	0
R9-34	958 Jeffrey Ln	64	63	-1	63	-1
R9-35	643 Avenue F	64	64	0	63	-1
R9-36	651 Fee Ave	65	64	-1	64	-1
R9-37	1024 Jeffrey Ln	**66**	**66**	0	65	-1
R9-38	1132 Jeffrey Ln	56	56	0	57	1
R9-39	1164 Jeffrey Ln	56	56	0	56	0
R9-40	1176 Jeffrey Ln	56	56	0	56	0
R9-41	1198 Jeffrey Ln	64	64	0	63	-1
R9-42	1224 Jeffrey Ln	64	64	0	63	-1
R9-43	1234 Jeffrey Ln	64	64	0	63	-1
R9-44	1254 Jeffrey Ln	**66**	**66**	0	65	-1
R9-45	710 Fox Ct	**70**	**69**	-1	**68**	-2
R9-46	718 Fox Ct	**68**	**68**	0	**66**	-2
R9-47	726 Fox Ct	64	64	0	62	-2
R9-48	658 Fee Ave	63	62	-1	61	-2
R9-49	651 Fee Ave	62	61	-1	60	-2
R9-50	655 Avenue F	60	59	-1	59	-1
R9-51	904 Jeffrey Ln	59	59	0	59	0
R9-52	919 Jeffrey Ln	**67**	**67**	0	**66**	-1
R9-53	624 Parkvale Ave	**74**	**73**	-1	**74**	0
R9-54	61 Parkvale Ave	**74**	**74**	0	**74**	0

Table 7 Predicted Noise Levels

Receptor Number[1]	Residence Address or Property Description	2019 Existing Worst-Case Traffic Noise Level (dB(A))	2050 No-Build Predicted Noise Level (dB(A))	Difference from Existing to 2050 No-Build	2050 Build Predicted Noise Level (dB(A))[2]	Difference from Existing to 2050 Build
R9-55	760 North St	**73**	**72**	-1	**73**	0
R9-56	752 North St	**72**	**72**	0	**72**	0
R9-57	724 North St	**74**	**74**	0	**72**	-2
R9-58	628 Hulmeville Rd	**72**	**71**	-1	**70**	-2
R9-59	629 Hulmeville Rd	**71**	**71**	0	**70**	-1
R9-60	2 W Highland Ave	**67**	**67**	0	65	-2
R9-61	729 Olive St	64	64	0	62	-2
R9-62	749 Olive St	**66**	65	-1	65	-1
R9-63	645 Parkvale Ave	**67**	**67**	0	**66**	-1
R9-64	633 Parkvale Ave	**68**	**68**	0	**67**	-1
R9-65	630 Parkvale Ave	**67**	**67**	0	**66**	-1
R9-66	657 Parkvale Ave	63	63	0	62	-1
R9-67	750 Olive St	62	62	0	61	-1
R9-68	648 Hulmeville Rd	64	64	0	63	-1

LEGEND

	2050 Build Condition Warrant[4]

1. *A Receptor Number beginning with "M" represents a short or long term measured location and a Receptor Number beginning with "R"" represents a modeled receptor only.*
2. *Some receptors are not included in Build Condition due to proposed roadway configuration and/or displacements.*
3. *Major differences from Build noise levels to Existing & No-Build noise levels in NSA 8 are due to differences in provided non-mainline roadway traffic data and will be revisited during the Final Design Noise Analysis.*
4. *Warrants are receptors that warrant the investigation of noise abatement. This occurs where the predicted noise levels meet any of the following criteria:*
   - *2050 Build Predicted Highway Traffic Noise levels approach or exceed 67 dB(A) for Land Use Category B and C. PennDOT has adopted "approach" to mean 66 dB(A) as the impact threshold for Category B & C.*
   - *2050 Build Predicted Highway Traffic Noise substantially exceed (by 10 dB(A) or more) the existing Highway Traffic Noise.*

6.0 HIGHWAY TRAFFIC NOISE ABATEMENT ALTERNATIVES

6.1 Impact Analysis and Noise Abatement Warrants

PennDOT defines traffic noise impacts if the noise levels approach or exceed the defined Noise Abatement Criteria (NAC) for the appropriate Land Use Activity Category. For a Type I analysis, a noise study area warrants consideration of noise abatement if one of the following criteria is met:

- Predicted Design Year Highway Traffic Noise levels approach or exceed the NAC criteria in **Table 1**, or
- Predicted Design Year Highway Traffic Noise levels are predicted to substantially increase by 10 dB(A) or more over existing levels.

A total of 187 receptors along the Section RC3 project corridor have worst-case traffic noise levels that approach or exceed the Land Use Activity Category B or C noise abatement criteria (67 dB(A)) for the 2050 Build Condition. PennDOT has adopted "approach" to mean 66 dB(A) as the impact threshold for Category B & C. Please see **Tables 9-15** for ERUs assigned to each receptor. The results are detailed and distributed as follows:

NSA 1 – (Southwestern Section represented by Receptors M1-1 through M1-3 and R1-1 through R1-11) consists of the residential areas and Neshaminy High School on the north side of S.R. 0001 bounded by the RC3 southern limit and Fairhill / Highland Avenue. There are nine receptors where the predicted future 2050 Build Condition levels are at or above 66 dB(A). Predicted levels range from 61 dB(A) to 76 dB(A), with a maximum increase of 4 dB(A) from the existing worst-case condition. Abatement alternatives were evaluated in this area along S.R. 0001 Southbound. **Map 1** shows the locations of both measured and modeled receptors.

NSA 2 – (Southwestern Section represented by Receptors M2-1 and R2-1 through R2-4) consists of the residential area and undeveloped cemetery land on the north side of S.R. 0001 bounded by north of Highland Avenue and the active area of Our Lady of Grace Cemetery. There are four receptors where the predicted future 2050 Build Condition levels are at or above 66 dB(A). Predicted levels range from 64 dB(A) to 69 dB(A), with a maximum increase of 2 dB(A) from the existing worst-case condition. Abatement alternatives were evaluated in this area along S.R. 0001 Southbound. **Maps 1 and 2** show the locations of both measured and modeled receptors within the NSA boundary.

NSA 3 – (Central Section represented by Receptors M3-1 through M3-3 and 130' spaced gridded receptors R3-1 through R3-60) consists of the active area of the cemetery property on the north side of S.R. 0001 bounded by Old Lincoln Highway and the cemetery property lines. There are 33 receptors where the predicted future 2050 Build Condition levels are at or above 66 dB(A). Predicted levels range from 61 dB(A) to 76 dB(A), with no increases from the existing worst-case condition. Abatement alternatives were evaluated in this area along S.R. 0001 Southbound. **Maps 2 and 3** show the locations of both measured and modeled receptors within the NSA boundary.

NSA 4 – (Central Section represented by Receptors M4-1 through M4-2 and R4-1 through R4-19) consists of the residential area on the north side of S.R. 0001 bounded by the cemetery and W. Interchange Road. There are twelve receptors where the predicted future 2050 Build Condition levels are at or above 66 dB(A). Predicted levels range from 59 dB(A) to 73 dB(A), with no increases from the existing worst-case condition. Abatement alternatives were evaluated in this area along S.R. 0001 Southbound. **Map 3** shows the locations of both measured and modeled receptors.

NSA 5 – (Northeastern Section represented by Receptors M5-1 through M5-5 and R5-1 through R5-24) consists of the mixed-use area on the north side of S.R. 0001 bounded by W. Interchange Road and S. Pine Street. There are fourteen receptors where the predicted future 2050 Build Condition level is at or above 66 dB(A). Predicted levels range from 55 dB(A) to 74 dB(A), with a maximum increase of 3 dB(A) from the existing worst-case condition. Abatement alternatives were evaluated in this area along S.R. 0001 Southbound. **Maps 4 and 6** show the locations of both measured and modeled receptors within the NSA boundary.

NSA 6 – (Northeastern Section represented by 130' spaced gridded Receptors M6-1 and R6-1 through R6-64) consists of the Woods School and Public Library on the north side of S.R. 0001 bounded by S. Pine Street and Flowers Avenue. Please note that some gridded receptors were removed from areas that are not used for frequent outdoor use or are displaced in the Build Condition, so some receptor numbers might skip. There are 25 receptors where the predicted future 2050 Build Condition level is at or above 66 dB(A). Predicted levels range from 51 dB(A) to 77 dB(A), with a maximum increase of 5 dB(A) from the existing worst-case condition. Abatement alternatives were evaluated in this area along S.R. 0001 Southbound. **Map 6** shows the locations of both measured and modeled receptors.

NSA 7 – (Northeastern Section represented by Receptors M7-1 through M7-2 and 130' spaced gridded R7-1 through R7-73 and R9-90 through R9-91) consists of the Woods School on the south side of S.R. 0001 bounded by S.R. 0413 Pine Street and the northern project limits. Please note that some gridded receptors were removed from areas that are not used for frequent outdoor use or are displaced in the Build Condition, so some receptor numbers might skip. There are 31 receptors where the predicted future 2050 Build Condition level is at or above 66 dB(A). Predicted levels range from 54 dB(A) to 78 dB(A), with a maximum increase of 5 dB(A) from the existing worst-case condition. Abatement alternatives were evaluated in this area along S.R. 0001 Northbound. **Maps 5 and 6** show the locations of both measured and modeled receptors within the NSA boundary.

NSA 8 – (Northeastern Section represented by Receptors M8-1 through M8-5 and R8-1 through R8-27) consists of the residential area on the south side of S.R. 0001 bounded by S.R. 0413 Pine Street and West Interchange Road. There are 14 receptors where the predicted future 2050 Build Condition level is at or above 66 dB(A). Predicted levels range from 51 dB(A) to 74 dB(A), with a maximum increase of 3 dB(A) from the existing worst-case condition. Abatement alternatives were evaluated in this area along S.R. 0001 Northbound. Note that the major (9 dB(A)) differences from 2050 Build noise levels to 2019 Existing & 2050 No-Build noise levels are due to differences in provided roadway traffic data for non-mainline roadways. This will be revisited during the Final Design Noise Analysis. **Maps 4 and 5** show the locations of both measured and modeled receptors within the NSA boundary.

NSA 9 – (Central Section represented by Receptors M9-1 through M9-10 and R9-1 through R9-68) consists of the residential and mixed-use area on the south side of S.R. 0001 bounded by West Interchange Road and Park Ave. There are 45 receptors where the predicted future 2050 Build Condition level is at or above 66 dB(A). Predicted levels range from 56 dB(A) to 76 dB(A), with a maximum increase of 1 dB(A) from the existing worst-case condition. Abatement alternatives were evaluated in this area along S.R. 0001 Northbound. **Maps 1 through 3** show the locations of both measured and modeled receptors within the NSA boundary.

6.2 Abatement Considerations

After determining areas where abatement is warranted for the Section RC3 2050 Build Condition, several sound barrier designs were investigated for feasibility and reasonableness by studying the existing topography, proposed roadway alignment and impacted residence locations. Due to right-of-way constraints and proximity of structures, earth berms were not feasible and sound barriers/noise walls were considered the only feasible form of noise abatement for this project.

Noise abatement is warranted for the 2050 Build Condition and sound barrier options were evaluated at the following locations along S.R. 0001, Section RC3:

- NSA 1-2 Barrier – NSAs 1 and 2, located along SB S.R. 0001 from north of Fairhill / Highland Ave to Old Lincoln Highway/S.R. 0001 interchange
- NSA 3-4 Barrier– NSAs 3 and 4, located along SB S.R. 0001 from south of West Interchange Road overpass to the southern limits of the active part of the Our Lady of Grace Cemetery
- NSA 5 Barrier – NSA 5, located along SB S.R. 0001 from S.R. 0413/Pine Street Interchange to West Interchange Road overpass
- NSA 6 Barrier – NSA 6, located along SB S.R. 0001 from northern project limit to S.R. 0413/Pine Street Interchange
- NSA 7 Barrier – NSA 7, located along NB S.R. 0001 from S.R. 0413/Pine Street Interchange to northern project limit
- NSA 8 Barrier – NSA 8, located along NB S.R. 0001 from West Interchange Road overpass to S.R. 0413/Pine Street Interchange
- NSA 9 Barrier – NSA 9, located along NB S.R. 0001 from S.R. 2008/Highland Avenue Interchange to West Interchange Road overpass

Noise barrier alignments were set based on the existing topography, proposed roadway alignment, proposed contours, proposed drainage, proposed structures, and impacted property limits to provide the most cost-effective layout. Preliminary analysis panel spacing was set at 100 feet. The exact alignment and location of the warranted, feasible, and reasonable barriers will be determined by coordinating with the roadway and structural design team during the final design process. When optimizing the height of the noise barriers, PennDOT noise barrier abatement design goals, as outlined in PennDOT Pub. No. 24 (dated May 2019), were used as well as consideration of the feasibility and reasonableness criteria.

PennDOT is committed to the construction of warranted, feasible, and reasonable highway traffic noise abatement measures at the noise-impacted locations identified in **Table 7** contingent upon: 2050 Build Condition TNM modeling results; analysis and determination of the feasibility and reasonableness of highway traffic noise abatement measures methodology and criteria; community input regarding desires, types, heights, and locations as well as aesthetic considerations; and safety and engineering aspects as related to the roadway user and the adjacent property owner.

6.2a Noise Barrier Abatement Goal Compliance

According to PennDOT Pub. No. 24, the following tiered noise barrier abatement goals should be used to govern the optimized barrier design:

- Reduce future Highway Traffic Noise 7 dB(A) or greater for at least one benefited receptor.
- It is desirable, while conforming to the Maximum Square Footage of Abatement Per Benefited Receptor value of 2,000 (MaxSF/BR) criteria, to reduce by 7 db(A) or greater for additional impacted receptor sites, if justified by a "point of diminishing returns" evaluation. (The MaxSF/BR criterion replaces the previously used "Cost per Benefited Receptor".)
- While conforming to the MaxSF/BR criteria, it is desirable to provide additional exterior insertion loss above the 7 dB(A) minimum if justified by a "point of diminishing returns".
- If possible, reduce future exterior noise levels to the low 60-decible range (60-63) for Category B and C receptors and the upper 60-decible range (65-68) for Category E receptors.
- If possible, reduce future Highway Traffic Noise levels back to existing levels.

6.2b Feasibility Criteria

To meet the PennDOT feasibility requirements for the S.R. 0001, Section RC3 Frontage Road Project seven acoustical and engineering parameters need to be considered. Each of the seven parameters is stated in the form of a question that can be answered with "yes" or "no". In order for a noise barrier to be "feasible", there needs to be a "yes" answer to all seven questions. The seven feasibility parameters are listed below.

1. Can a Highway Traffic Noise reduction of at least 5 dB(A) be achieved at the majority of the impacted Receptor Units (i.e. 50% or greater)?
2. Can the noise barrier be designed and physically constructed at the proposed location?
3. Can the noise barrier be constructed without causing a safety problem?
4. Can the noise barrier be constructed without restricting access to vehicular or pedestrian travel?
5. Can the noise barrier be constructed in a manner that allows for required maintenance & operations?

6. Can the noise barrier be constructed in a manner that allows utilities to adequately function?
7. Can the noise barrier be constructed in a manner that allows drainage features to adequately function?

6.2c Reasonableness Criteria

To determine if a noise barrier is reasonable, criteria such as square footage of abatement per benefited receptor, desires of the property owners, maintainability, and land use conformity are considered. The reasonableness criteria are listed below. A benefited receptor is a receptor receiving 5 dB(A) or more in noise reduction.

1. Do at least 50% of benefited receptor unit owners and renters desire the noise barrier?
2. Is the Square Footage Per Benefited Receptor Evaluation equal to or less than 2,000 SF/BR?
3. Does at least one benefited receptor receive a 7-dB(A) or greater noise reduction?
4. Does the barrier provide an insertion loss of at least 7 dB(A) for more than 1 receptor while still conforming to the Max SF/BR value of 2,000 and a "point of diminishing returns" evaluation?
5. Does the barrier reduce future exterior levels to the low 60-decible range for Category B & C receptors and the upper 60-decible range for Category E receptors?
6. Does the barrier reduce design year noise levels back to existing levels?

6.2d Parallel Barrier Considerations

Due to the potential for parallel noise barriers for abatement purposes special analysis needs to be considered to account for the multiple reflections of the noise, from side to side across the roadway, between the parallel barriers. The reverberation tends to increase noise levels at nearby receptors. This increase in noise due to the reverberation may partially offset the noise reduction due to the proposed noise barrier that blocks the lines-of-sight. As a result, the intervening barrier does not provide as much noise reduction as it would without the parallel barrier scenario.

TNM's regular sound-level computations can predict the sound-level reduction due to a single intervening noise barrier but cannot take multiple reflections into account. Therefore, TNM cannot directly predict the "reverberation" effect (parallel-barrier degradation) due to parallel barriers. TNM does have a separate module that does predict parallel-barrier degradation in two dimensions as outlined in the TNM Technical Manual. Within the Parallel Barrier Analysis module users enter the vertical-plane cross-section geometry and assign values of Noise Reduction Coefficient (NRC) to each surface. NRCs range from 0.0 for purely reflective to 0.05 for concrete to 0.30 for grass with a maximum value of 0.95 for absorptive surfaces.

As part of the S.R. 0001 Section RC3 Noise Screening Study, a preliminary Parallel Barrier Analysis was performed for one cross-section along the corridor around Station 191+00 with and without absorptive treatments (NRC = 0.70) for illustration purposes. See ***Table 8*** for a summary of the

increase in Leq at Station 191+00 with a comparison between the fully reflective parallel barrier scenario and the absorptive parallel barrier scenario.

Table 8 - Parallel Barrier Example (Station 191+00)

Analysis Location	Approximate Distance from Frontage Road	Reflective Parallel Scenario Increase in Leq (dB(A))	Absorptive Parallel Scenario Increase in Leq (dB(A))
Row 1 SB (NSA1)	50 feet	3.4	0.0
Row 2 SB (NSA1)	150 feet	5.0	0.0
Row 3 SB (NSA1)	250 feet	5.8	0.0
Row 4 SB (NSA1)	450 feet	6.7	0.0
Row 5 SB (NSA1)	650 feet	6.5	0.0
Row 1 NB (NSA9)	65 feet	4.8	0.5
Row 2 NB (NSA9)	265 feet	7.7	0.8
Row 3 NB (NSA9)	465 feet	7.4	0.1
Row 4 NB (NSA9)	665 feet	5.8	0.0

The TNM User's Guide suggests using these Leq increases as adjustment factors in the main part of TNM for the receptors affected and moving forward with barrier optimization using the adjusted noise levels. The TNM Short Course Workbook does not recommend using the parallel barrier Leq increases as adjustment factors but instead as a design module, where you can:

- Analyze the effects of sound absorbing materials on all or part of one or both of the barrier faces (by changing the NRC's in the Parallel Cross Section input dialog box); or
- Analyze tilting the walls outward by adjusting the horizontal values for the wall tops.

PennDOT Pub. No. 24 Section 4.4 provides guidance for parallel barrier techniques, absorptive treatments, and using adjustment factors from the TNM Parallel Barrier Module. Future discussions and coordination are needed with PennDOT District 6-0, PennDOT Central Office EPDD, and FHWA to determine the preferred parallel barrier approach and absorptive treatment considerations for next steps. Final determinations on any absorptive barrier surface treatments will be made during the Final Design Phase.

6.3 Design Discussion Overview

The barriers were analyzed at constant heights, measured from the groundline/gutterline, of 8, 10, 14, 16, 18, and 20 feet and then using the results of the constant height analysis, optimized to determine the most cost-effective barrier while meeting the PennDOT sound barrier abatement goals. The Line-of-Sight (LOS) TNM function was also utilized to break the sight line between receivers and trucks on S.R. 0001 where reasonable. **Table ES.1** (found in the Executive Summary) summarizes the preliminary noise barrier results outlined below (including **Tables 9-15**), and **Appendix F** details the noise barrier optimizations.

The analysis results detailed in **Section 6.4, 6.5, 6.6, 6.7, 6.8, 6.9, and 6.10** show that all seven optimized barriers were found to be warranted, feasible, and reasonable using PennDOT criteria.

Note that both recommended and non-recommended sound barriers may change between these environmental document preliminary findings and final design as a result of changes in the project design. Any new "planned, designed or programmed" noise sensitive areas (i.e., residence, school, church, hospital, library, etc.) along the S.R. 0001, Sec. RC3 project corridor will only be analyzed if the building permit is issued prior to National Environmental Policy Act (NEPA) clearance.

6.4 NSA 1-2 Barrier Design

NSAs 1 and 2 contain 27 Equivalent Residential Units (ERUs). The barrier was laid out to protect impacted receptors M1-1, M1-2, R1-1 through R1-7, M2-1, R2-1, R2-2, and R2-4. NSA 1-2 barrier analysis area contains houses, apartments, and Neshaminy High School on the SB side of S.R. 0001, as shown on **Map 1**. The preliminary sound barrier alignment is set along the edge of shoulder.

The preliminary optimized barrier is 1,780 feet long, ranges in height from 13 feet to 18 feet, and has an average height of 16.1 feet, measured from ground/gutterline. The total area from TNM v2.5 for the optimized barrier is 28,649 SF. A maximum of 12 dB(A) noise level reduction (Insertion Loss) can be achieved at the impacted receptors with 74% having a 5 dB(A) reduction or greater; therefore, meeting the feasibility criteria in this area.

There are 13 Benefited Receptors representing 15 ERUs with Insertion Loss greater than 5 dB(A). Because the Area per Benefited Receptor for the optimized barrier is 1,910 SF/BR, the 2,000 SF/BR maximum reasonableness criteria is met. The reasonableness criteria to reduce design year exterior noise levels by at least 7 dB(A) for at least one benefited receptor is also met. The preliminary assumption is that at least 50% of the impacted and benefited receptor units desire the noise barrier. **Therefore, the NSA 1-2 Preliminary Barrier is feasible and reasonable.**

Table 9 shows the 2050 Build Predicted Noise Levels, with and without a barrier, the insertion losses attained, and the barrier design data for various constant height barriers and the optimized barrier that were analyzed. **Appendix I** contains the draft version of the Warranted, Feasible, and Reasonable Worksheet for NSA 1-2.

TABLE 9	SR 0001, Group 03S, Section RC3 NSA 1-2 Sound Barrier Analysis																			
Modeled Receptor Number	TNM No Barrier Calculated	Difference (Build - Existing)	# of Residences/ ERU	Noise Barrier Height & Insertion Loss																
				8 ft Constant Height		10 ft Constant Height		12 ft Constant Height		14 ft Constant Height		16 ft Constant Height		18 ft Constant Height		20 ft Constant Height		opt1 Optimized Height 13'-18' (avg. 16.10')	
				Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss
M1-1	67	3	1	65	2	65	2	65	2	65	2	65	2	64	3	64	3	64	3
M1-2	76	1	1	75	1	73	3	71	5	70	6	66	10	65	11	64	12	65	11
M1-3	63	0	0	61	3	60	3	60	3	59	5	58	5	58	5	58	5	58	5
R1-1	74	2	1	72	2	71	3	70	4	70	5	67	7	65	9	63	11	65	9
R1-2	74	2	1	72	2	71	3	70	4	69	5	66	8	65	10	63	11	65	9
R1-3	74	3	1	71	3	70	4	69	5	69	5	65	9	64	10	63	11	64	10
R1-4	75	3	1	72	3	71	4	70	5	69	6	65	10	64	11	63	12	64	11
R1-5	76	2	1	72	4	71	5	70	6	67	9	65	11	64	12	63	13	64	12
R1-6	70	4	1	67	3	65	5	63	7	61	9	61	9	60	10	60	11	60	10
R1-7	73	1	4	67	6	64	9	63	10	63	11	62	11	62	11	61	12	62	11
R1-8	65	0	1	62	3	62	3	61	4	60	5	60	5	60	5	60	5	60	5
R1-9	64	1	0	62	2	62	2	62	2	61	3	61	3	61	3	61	3	61	3
R1-10	61	2	0	60	2	59	2	59	2	59	2	59	2	58	3	58	3	59	2
R1-11	63	1	6	62	2	61	2	61	2	61	2	61	2	61	2	61	3	61	2
M2-1	69	2	1	65	4	64	5	64	5	64	5	64	5	64	5	64	5	64	5
R2-1	69	2	1	64	5	62	7	61	8	60	9	60	9	59	10	59	10	60	9
R2-2	66	1	1	63	3	62	5	61	5	61	5	61	5	61	5	61	6	61	5
R2-3	64	1	1	62	2	62	2	61	3	61	3	61	3	61	3	61	3	61	3
R2-4	66	1	4	66	1	65	1	65	1	65	1	65	1	65	1	65	1	65	1
Barrier Length (Feet)				1780		1780		1780		1780		1780		1780		1780		1780	
Area (square feet), from TNM				14239		17798		21358		24918		28477		32037		35597		28649	
Total # Receptor units receiving at least 5 dBA insertion loss				5		9		12		15		15		15		15		15	
Area/ # of 5dBA Benefited Receptors				2848		1978		1780		1661		1898		2136		2373		1910	
Exterior Noise levels reduced by at least 7 DBA for 1 benefitted Receptor?				NO		YES		YES		YES		YES		YES		YES		YES	

Notes:
1. A Receptor Number beginning with "M" represents a field measured location and a Receptor Number beginning with "R" represents a modeled receptor only.
2. Impacted receptors (highlighted) are those that warrant the investigation of noise abatement. This occurs where the predicted noise levels meet any of the following criteria:
Predicted Highway Traffic Noise levels approach or exceed NAC or Predicted Highway Traffic Noise substantially exceed (by 10 dB(A) or more) the existing Highway Traffic Noise levels.
4. Noise values, comparisons, and insertion losses are calculated to the tenth of dB(A) and then rounded for presentation purposes.
5. Square footage indicated is based upon its length and its height from the finished ground elevation at the base of the barrier to its top elevation (acoustical profile line).

6.5 NSA 3-4 Barrier Design

NSA 3-4 Barrier is designed for NSAs 3 and 4, containing 29 Equivalent Residential Units (ERUs.) The NSA 3-4 Barrier was laid out to protect impacted receptors M3-1 through M3-3, R3-1 through R3-30, M4-2, R4-1 through R4-7, R4-9, R4-10, R4-12, and R4-13. The NSAs contain single and multi-family residences, Our Lady of Grace Cemetery, and mixed-use areas on the SB side of S.R. 0001, as shown on **Maps 2 and 3**. The preliminary sound barrier alignment is set along the edge of shoulder.

The preliminary optimized barrier is 3,816 feet long and is 10-14 feet tall, measured from ground/gutterline. The total area from TNM v2.5 for the optimized barrier is 46,657 SF. A maximum of 11 dB(A) noise level reduction (Insertion Loss) can be achieved at the impacted receptors with 99% having a 5 dB(A) reduction or greater; therefore, meeting the feasibility criteria in this area.

There are 47 Benefited Receptors representing 26.49 ERUs with Insertion Loss of 5 dB(A) or greater. Because the Area per Benefited Receptor for the optimized barrier is 1,762 SF/BR, the 2,000 SF/BR maximum reasonableness criteria is met. The reasonableness criteria to reduce design year exterior noise levels by at least 7 dB(A) for at least one benefited receptor is also met. The preliminary assumption is that at least 50% of the impacted and benefited receptor units desire the noise barrier. **Therefore, the NSA 3-4 Preliminary Barrier is feasible and reasonable.**

Table 10 shows the 2050 Build Predicted Noise Levels, with and without a barrier, the insertion losses attained, and the barrier design data for various constant height barriers and the optimized barrier that were analyzed. **Appendix I** contains the draft version of the Warranted, Feasible, and Reasonable Worksheet for the NSA 3-4 Barrier.

TABLE 10	SR 0001, Group 03S, Section RC3 NSA 3-4 Sound Barrier Analysis																	
Modeled Receptor Number	TNM No Barrier Calculated	Difference (Build - Existing)	# of Residences/ ERU	Noise Barrier Height & Insertion Loss														
				8 ft Constant Height		10 ft Constant Height		12 ft Constant Height		14 ft Constant Height		16 ft Constant Height		18 ft Constant Height		20 ft Constant Height		opt1 Optimized Height 10'-14' (avg. 12.23')	
				Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss
M3-1	68	-2	0	66	2	64	4	61	7	60	8	59	9	58	10	58	10	62	6
M3-2	68	-3	0	66	2	64	4	62	6	61	7	60	8	59	9	59	10	62	6
M3-3	66	-2	0	64	2	64	3	62	4	60	6	59	7	58	8	58	8	63	3
R3-1	76	0	0.02	70	6	68	8	66	11	65	11	64	12	63	13	63	13	66	10
R3-2	76	-1	0.02	70	6	66	10	65	11	64	12	63	13	62	14	61	15	65	11
R3-3	76	-1	0.02	70	6	67	10	65	11	64	12	63	13	62	14	62	15	66	10
R3-4	76	-1	0.02	71	5	68	8	65	11	64	12	63	13	63	13	62	14	66	10
R3-5	75	-1	0.02	70	5	68	7	65	10	64	11	63	12	62	13	61	14	66	9
R3-6	74	-2	0.02	70	4	68	6	65	9	64	10	63	11	62	12	61	13	66	9
R3-7	72	-4	0.02	69	3	65	7	64	8	63	9	62	10	61	11	61	11	64	8
R3-8	72	-4	0.02	69	3	65	7	64	8	63	9	62	10	61	11	61	11	65	8
R3-9	72	-4	0.02	68	4	65	7	64	8	63	9	62	10	61	11	61	11	64	8
R3-10	72	-4	0.02	68	4	65	7	64	8	63	9	62	10	61	11	61	11	64	8
R3-11	72	-4	0.02	68	4	65	7	64	8	63	9	62	10	62	11	61	11	64	8
R3-12	73	-4	0.02	69	5	65	8	64	9	63	10	62	11	62	11	61	12	65	8
R3-13	73	-3	0.02	68	5	65	8	64	9	63	10	62	11	62	11	61	12	65	9
R3-14	72	-4	0.02	68	4	65	7	64	8	63	9	62	10	61	11	61	11	64	8
R3-15	72	-3	0.02	68	4	65	7	64	8	63	9	62	10	61	11	61	11	63	9
R3-16	66	-3	0.02	65	1	63	3	60	6	59	7	58	8	58	8	57	9	60	6
R3-17	67	-2	0.02	65	2	63	4	60	7	59	8	58	9	58	9	57	10	61	6
R3-18	67	-2	0.02	65	2	63	4	61	6	60	8	59	8	58	9	58	10	61	6
R3-19	67	-3	0.02	65	2	63	4	61	7	59	8	58	9	58	9	57	10	61	6
R3-20	67	-2	0.02	65	2	64	3	61	6	59	8	59	9	58	9	57	10	61	6
R3-21	67	-2	0.02	65	2	64	3	61	7	59	8	58	9	58	9	57	10	61	6
R3-22	67	-2	0.02	65	2	64	3	61	6	59	8	59	9	58	9	57	10	61	6
R3-23	67	-3	0.02	65	2	64	3	61	6	60	8	59	8	58	9	58	10	63	5
R3-24	67	-3	0.02	65	2	64	3	61	6	60	7	59	8	58	9	58	9	63	4
R3-25	68	-2	0.02	66	2	65	3	62	6	60	8	59	9	59	9	58	10	64	4
R3-26	68	-2	0.02	66	2	66	3	63	5	61	7	60	8	59	9	59	9	65	4
R3-27	69	-1	0.02	66	3	66	3	63	6	61	8	60	9	60	9	60	10	65	4
R3-28	69	-1	0.02	66	3	66	3	63	6	61	8	61	9	60	9	60	9	65	4
R3-29	69	-1	0.02	66	3	65	4	63	6	61	8	61	8	60	9	60	9	65	5
R3-30	69	-1	0.02	66	3	66	3	64	5	62	7	61	8	61	8	61	8	65	4

TABLE 10	SR 0001, Group 03S, Section RC3 NSA 3-4 Sound Barrier Analysis																	
Modeled Receptor Number	TNM No Barrier Calculated	Difference (Build - Existing)	# of Residences/ ERU	Noise Barrier Height & Insertion Loss														
				8 ft Constant Height		10 ft Constant Height		12 ft Constant Height		14 ft Constant Height		16 ft Constant Height		18 ft Constant Height		20 ft Constant Height		opt1 Optimized Height 10'-14' (avg. 12.23')	
				Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss
R3-31	65	-2	0.02	63	2	63	2	62	4	60	5	59	6	59	6	59	6	63	2
R3-32	65	-2	0.02	63	2	63	2	61	4	59	6	58	7	58	7	58	7	62	3
R3-33	65	-2	0.02	63	2	63	2	61	4	59	6	58	7	58	7	57	8	63	3
R3-34	65	-2	0.02	63	2	63	2	61	4	59	6	58	7	57	8	57	8	62	3
R3-35	65	-2	0.02	63	2	63	2	61	4	59	7	58	7	57	8	57	8	62	3
R3-36	64	-3	0.02	63	1	62	2	60	4	58	6	57	7	57	7	57	7	62	2
R3-37	63	-3	0.02	62	1	62	1	59	4	58	5	57	6	56	7	56	7	61	3
R3-38	63	-3	0.02	63	1	61	2	59	4	57	6	57	6	56	7	56	7	60	3
R3-39	63	-3	0.02	62	1	61	2	58	5	57	6	56	7	56	7	55	8	60	3
R3-40	63	-3	0.02	62	1	61	2	58	5	57	6	56	7	56	8	55	8	60	3
R3-41	63	-3	0.02	62	1	61	2	58	5	57	6	56	7	55	8	55	8	60	3
R3-42	63	-3	0.02	62	1	61	2	58	5	57	6	56	7	55	8	55	8	59	4
R3-43	63	-3	0.02	62	1	61	2	58	5	57	6	56	7	55	8	55	8	59	4
R3-44	63	-3	0.02	62	1	61	2	58	5	57	6	56	7	55	8	55	8	59	4
R3-45	63	-3	0.02	62	1	61	2	58	5	57	7	56	7	55	8	55	8	58	5
R3-46	61	-2	0.02	60	1	59	2	56	5	55	7	54	7	53	8	53	8	56	5
R3-47	61	-2	0.02	60	1	59	2	56	5	55	6	54	7	54	7	53	8	57	4
R3-48	61	-2	0.02	60	1	59	2	56	5	55	6	54	7	53	8	53	8	57	4
R3-49	61	-3	0.02	60	1	59	2	56	5	55	6	54	7	54	7	53	8	57	4
R3-50	61	-2	0.02	60	1	59	2	56	5	55	6	54	7	54	7	54	8	58	3
R3-51	61	-2	0.02	60	1	59	2	56	5	55	6	55	7	54	7	54	7	58	3
R3-52	61	-2	0.02	60	1	59	2	57	4	55	6	55	6	54	7	54	7	58	3
R3-53	61	-2	0.02	60	1	60	1	57	4	56	5	55	6	54	7	54	7	58	3
R3-54	61	-3	0.02	60	1	60	1	57	4	56	5	55	6	55	7	54	7	59	2
R3-55	61	-3	0.02	60	1	60	1	58	3	56	5	55	6	55	6	55	6	59	2
R3-56	62	-2	0.02	60	2	60	2	58	4	56	6	56	6	55	7	55	7	60	2
R3-57	62	-2	0.02	61	2	60	2	59	3	57	5	56	6	56	7	55	7	60	2
R3-58	62	-2	0.02	61	1	60	2	59	3	57	5	56	6	56	6	56	6	60	2
R3-59	62	-2	0.02	61	1	60	2	60	2	57	5	57	5	56	6	56	6	60	2
R3-60	62	-2	0.02	61	1	61	1	61	2	58	4	58	4	58	5	57	5	61	1
M4-1	65	-2	1	63	2	62	3	59	6	58	7	57	8	57	8	57	9	58	7
M4-2	70	-3	1	67	3	65	5	63	7	62	8	61	9	60	10	60	10	62	8

TABLE 10	SR 0001, Group 03S, Section RC3 NSA 3-4 Sound Barrier Analysis																	
Modeled Receptor Number	TNM No Barrier Calculated	Difference (Build - Existing)	# of Residences/ ERU	Noise Barrier Height & Insertion Loss														
				8 ft Constant Height		10 ft Constant Height		12 ft Constant Height		14 ft Constant Height		16 ft Constant Height		18 ft Constant Height		20 ft Constant Height		opt1 Optimized Height 10'-14' (avg. 12.23')	
				Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss
R4-1	72	-3	1	68	4	65	7	64	8	63	10	62	10	61	11	60	12	63	9
R4-2	71	-3	2	69	2	67	4	64	7	63	9	62	10	61	10	60	11	63	9
R4-3	72	-2	2	69	3	68	4	64	8	63	9	62	10	61	11	61	11	63	9
R4-4	72	-3	2	69	3	68	4	65	8	63	9	62	10	61	11	61	11	63	9
R4-5	73	-2	1	70	3	68	5	65	8	64	10	63	11	62	11	61	12	64	10
R4-6	72	-1	1	68	4	68	4	65	7	62	10	61	11	60	12	59	13	62	10
R4-7	67	-1	1	65	3	64	3	64	3	62	6	61	7	60	7	60	7	62	5
R4-8	65	-2	1	64	2	63	2	63	2	61	4	60	5	59	6	59	6	61	4
R4-9	67	-1	1	64	3	64	3	64	3	60	7	59	8	59	8	58	9	60	7
R4-10	66	-1	2	64	2	64	3	63	3	59	7	58	8	58	9	57	9	59	7
R4-11	65	-2	2	63	2	63	2	62	3	59	6	58	7	57	8	57	8	59	6
R4-12	66	-2	1	64	2	63	3	60	6	59	7	58	8	58	8	58	9	59	7
R4-13	67	-3	1	66	2	63	4	61	6	60	7	59	8	58	9	58	9	60	7
R4-14	65	-3	1	64	1	62	3	59	6	58	7	57	8	57	8	56	9	59	7
R4-15	63	-2	2	62	1	61	3	57	6	56	7	55	8	55	8	54	9	57	6
R4-16	61	-2	2	60	1	59	2	56	5	55	6	55	6	54	7	54	7	56	5
R4-17	59	-2	1	57	2	57	2	55	4	52	7	51	8	50	9	50	9	52	7
R4-18	64	-1	1	62	2	61	3	61	3	59	5	58	6	57	7	57	7	59	5
R4-19	64	-1	1	62	2	62	2	62	3	61	3	59	5	59	5	58	6	61	3
Barrier Length (Feet)				3816		3816		3816		3816		3816		3816		3816		3816	
Area (square feet), from TNM				30529		38161		45794		53426		61058		68690		76323		46657	
Total # Receptor units receiving at least 5 dBA insertion loss				0.13		3.28		18.80		27.10		29.10		29.12		29.12		26.49	
Area/ # of 5dBA Benefited Receptors				233224		11633		2435		1971		2098		2359		2621		1762	
Exterior Noise levels reduced by at least 7 DBA for 1 benefitted Receptor?				NO		YES		YES		YES		YES		YES		YES		YES	

Notes:

1. A Receptor Number beginning with "M" represents a field measured location and a Receptor Number beginning with "R" represents a modeled receptor only.
2. Impacted receptors (highlighted) are those that warrant the investigation of noise abatement. This occurs where the predicted noise levels meet any of the following criteria:
Predicted Highway Traffic Noise levels approach or exceed NAC or Predicted Highway Traffic Noise substantially exceed (by 10 dB(A) or more) the existing Highway Traffic Noise levels.
4. Noise values, comparisons, and insertion losses are calculated to the tenth of dB(A) and then rounded for presentation purposes.
5. Square footage indicated is based upon its length and its height from the finished ground elevation at the base of the barrier to its top elevation (acoustical profile line).

6.6 NSA 5 Barrier Design

NSA 5 contains 27 Equivalent Residential Units (ERUs). The NSA 5 Barrier was laid out to protect impacted receptors M5-1 through M5-4, R5-1 through R5-8, R5-12, and R5-13. Receptors R5-22 through R5-24 represent a portion of the Woods School property that was confirmed to not be in use. The rest of NSA 5 contains single and multi-family residences on the SB side of S.R. 0001, as shown on **Maps 4 and 6**. The preliminary sound barrier alignment is set along the edge of shoulder.

The preliminary optimized barrier is 2,730 feet long and is 9 to 14 feet tall, averaging 13.12 feet, measured from ground/gutterline. The total area from TNM v2.5 for the optimized barrier is 34,717 SF. A maximum of 11 dB(A) noise level reduction (Insertion Loss) can be achieved at the impacted receptors with 100% having a 5 dB(A) reduction or greater; therefore, meeting the feasibility criteria in this area.

There are 24 Benefited Receptors representing 25 ERUs with Insertion Loss greater than 5 dB(A). Because the Area per Benefited Receptor for the optimized barrier is 1,389 SF/BR, the 2,000 SF/BR maximum reasonableness criteria is met. The reasonableness criteria to reduce design year exterior noise levels by at least 7 dB(A) for at least one benefited receptor is also met. The preliminary assumption is that at least 50% of the impacted and benefited receptor units desire the noise barrier. **Therefore, the NSA 5 Preliminary Barrier is feasible and reasonable.**

Table 11 shows the 2050 Build Predicted Noise Levels, with and without a barrier, the insertion losses attained, and the barrier design data for various constant height barriers and the optimized barrier that were analyzed. **Appendix I** contains the draft version of the Warranted, Feasible, and Reasonable Worksheet for the NSA 5 Barrier.

TABLE 11	SR 0001, Group 03S, Section RC3 NSA5 Sound Barrier Analysis																	
Modeled Receptor Number	TNM No Barrier Calculated	Difference (Build - Existing)	# of Residences/ ERU	Noise Barrier Height & Insertion Loss														
				8 ft Constant Height		10 ft Constant Height		12 ft Constant Height		14 ft Constant Height		16 ft Constant Height		18 ft Constant Height		20 ft Constant Height		opt1 Optimized Height 9'-14' (13.12 Avg)	
				Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss
M5-1	74	0	1	69	5	67	7	64	10	63	11	62	12	61	13	60	14	63	11
M5-2	66	-1	1	63	3	63	3	60	6	59	7	59	7	58	8	58	8	60	6
M5-3	69	-2	1	65	4	65	4	62	8	60	9	59	10	58	11	57	12	61	9
M5-4	71	-1	0	67	4	67	5	63	8	61	10	60	11	59	12	59	12	62	9
M5-5	58	2	0	58	0	58	0	58	0	57	1	57	1	57	1	57	1	58	0
R5-1	71	-1	1	68	4	66	5	64	7	63	8	63	8	62	9	62	9	64	7
R5-2	73	-1	1	69	4	68	5	64	9	63	10	62	11	61	12	61	12	64	9
R5-3	69	-1	1	66	3	66	4	62	7	60	9	59	10	58	11	58	12	61	8
R5-4	69	-2	2	66	3	65	4	63	6	60	9	59	10	58	11	58	12	61	8
R5-5	74	-1	1	69	5	68	6	64	10	63	11	62	12	61	13	61	13	64	10
R5-6	68	-2	1	66	2	65	3	61	7	60	9	58	10	57	11	57	11	60	8
R5-7	66	-2	1	64	2	64	2	60	6	59	7	58	8	57	9	57	9	60	6
R5-8	73	0	1	69	4	68	5	65	8	64	9	64	10	63	10	63	11	65	8
R5-9	63	-1	1	61	2	61	2	58	5	57	6	56	7	56	8	55	8	58	5
R5-10	61	-1	1	59	2	59	2	57	4	56	5	55	6	54	7	54	7	56	5
R5-11	63	-2	1	61	2	61	2	60	4	57	7	55	8	55	9	54	9	57	6
R5-12	67	-1	1	63	4	63	4	60	7	58	9	57	10	56	11	55	12	59	9
R5-13	66	-1	1	63	3	62	4	59	7	58	9	56	10	55	11	55	12	58	8
R5-14	62	-2	2	60	2	60	2	58	4	56	6	55	7	54	8	54	9	56	6
R5-15	60	-1	1	58	2	58	2	56	4	55	5	54	6	54	6	54	6	55	5
R5-16	59	-2	1	57	2	57	2	56	3	53	6	52	7	51	8	51	8	54	5
R5-17	61	-2	1	58	3	58	3	58	4	54	7	53	8	52	9	51	10	55	6
R5-18	59	-1	1	57	2	57	2	57	3	53	6	52	7	51	8	51	8	54	5
R5-19	60	-1	1	58	2	58	3	57	3	54	6	53	7	52	8	51	9	55	5
R5-20	59	-2	1	57	2	57	2	56	3	54	6	53	6	52	7	52	7	54	5
R5-21	62	3	1	62	0	62	0	62	0	62	0	62	0	62	0	62	1	62	0
R5-22	63	1	0	63	0	63	0	63	0	63	0	63	0	63	0	63	0	63	0

TABLE 11	SR 0001, Group 03S, Section RC3 NSA5 Sound Barrier Analysis																			
Modeled Receptor Number	TNM No Barrier Calculated	Difference (Build - Existing)	# of Residences/ ERU	Noise Barrier Height & Insertion Loss																
				8 ft Constant Height		10 ft Constant Height		12 ft Constant Height		14 ft Constant Height		16 ft Constant Height		18 ft Constant Height		20 ft Constant Height		opt1 Optimized Height 9'-14' (13.12 Avg)	
				Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	
R5-23	61	-2	0	61	0	61	0	61	0	61	0	61	0	61	0	61	0	61	0	
R5-24	56	1	0	56	0	56	0	56	0	56	1	55	1	55	1	55	1	56	0	
Barrier Length (Feet)				2730		2730		2730		2730		2730		2730		2730		2730		
Area (square feet), from TNM				21843		27304		32765		38226		43686		49147		54608		34717		
Total # Receptor units receiving at least 5 dBA insertion loss				2		5		15		25		25		25		25		25		
Area/ # of 5dBA Benefited Receptors				10922		5461		2184		1529		1747		1966		2184		1389		
Exterior Noise levels reduced by at least 7 DBA for 1 benefitted Receptor?				NO		YES		YES		YES		YES		YES		YES		YES		

Notes:

1. A Receptor Number beginning with "M" represents a field measured location and a Receptor Number beginning with "R" represents a modeled receptor only.
2. Impacted receptors (highlighted) are those that warrant the investigation of noise abatement. This occurs where the predicted noise levels meet any of the following criteria:

Predicted Highway Traffic Noise levels approach or exceed NAC or Predicted Highway Traffic Noise substantially exceed (by 10 dB(A) or more) the existing Highway Traffic Noise levels.

4. Noise values, comparisons, and insertion losses are calculated to the tenth of dB(A) and then rounded for presentation purposes.
5. Square footage indicated is based upon its length and its height from the finished ground elevation at the base of the barrier to its top elevation (acoustical profile line).

6.7 NSA 6 Barrier Design

NSA 6 contains 36.9 Equivalent Residential Units (ERUs) as explained in **Section 4.8** and calculated in **Appendix E**. Receptors were laid out in a 130' spaced grid within the outdoor spaces used in project limits of Woods Campus. The NSA 6 Barrier was laid out to protect impacted receptors R6-5 through R6-28, and R6-31 through R6-35. NSA 6 contains the Woods School Campus on the SB side of S.R. 0001, as shown on **Maps 5 and 6**. The preliminary sound barrier alignment is set along the edge of shoulder.

The preliminary optimized barriers are a total of 1,732 feet long, 869' south of Corn Crib Lane and 863' north of Corn Crib Lane. The barriers are 14-16 feet tall, averaging about 15.8 feet measured from ground/gutterline. The total area from TNM v2.5 for the optimized barriers is 27,417 SF. A maximum of 14 dB(A) noise level reduction (Insertion Loss) can be achieved at the impacted receptor units with 86% having a 5 dB(A) reduction or greater; therefore, meeting the feasibility criteria in this area.

There are 25 Benefited Receptors representing 21.89 ERUs with Insertion Loss greater than 5 dB(A). Because the Area per Benefited Receptor for the optimized barrier is 1,253 SF/BR, the 2,000 SF/BR maximum reasonableness criteria is met. The reasonableness criteria to reduce design year exterior noise levels by at least 7 dB(A) for at least one benefited receptor is also met. The preliminary assumption is that at least 50% of the impacted and benefited receptor units desire the noise barrier. **Therefore, the NSA 6 Preliminary Barrier is feasible and reasonable.**

Table 12 shows the 2050 Build Predicted Noise Levels, with and without a barrier, the insertion losses attained, and the barrier design data for various constant height barriers and the optimized barrier that were analyzed. **Appendix I** contains the draft version of the Warranted, Feasible, and Reasonable Worksheet for the NSA 6 Barrier.

TABLE 12	SR 0001, Group 03S, Section RC3 NSA 6 Sound Barrier Analysis																	
Modeled Receptor Number	TNM No Barrier Calculated	Difference (Build - Existing)	# of Residences/ ERU	Noise Barrier Height & Insertion Loss														
				8 ft Constant Height		10 ft Constant Height		12 ft Constant Height		14 ft Constant Height		16 ft Constant Height		18 ft Constant Height		20 ft Constant Height		opt2 Optimized Height 14'-16' (Ave. 15.8')	
				Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss
R6-5	77	0	0.497	73	4	72	5	71	6	71	6	70	7	70	7	70	7	70	7
R6-6	76	0	0.497	72	4	71	5	67	9	66	10	65	11	65	12	64	12	65	11
R6-7	76	1	0.497	71	5	69	7	66	10	65	11	64	12	63	13	63	14	64	12
R6-8	76	2	0.497	73	3	72	4	71	5	71	5	71	5	70	6	70	6	71	5
R6-9	77	3	0.497	76	1	76	1	76	1	76	1	76	1	76	1	76	1	76	1
R6-10	77	2	0.497	76	1	76	1	76	1	76	1	76	1	76	1	76	1	76	1
R6-11	68	1	0.497	68	0	68	0	68	0	68	0	68	0	68	0	68	0	68	0
R6-12	68	1	0.497	68	0	68	0	68	0	68	0	68	0	68	0	68	0	68	0
R6-13	69	2	0.497	67	2	67	2	67	2	66	3	66	3	66	3	66	3	66	3
R6-14	69	2	0.497	67	2	66	3	65	4	64	5	64	5	63	6	63	6	64	5
R6-15	69	2	0.497	66	3	66	3	63	6	62	7	61	8	60	9	60	9	61	8
R6-16	69	2	0.497	66	3	66	3	65	4	63	6	62	7	62	8	61	8	62	7
R6-18	70	4	1.225	67	3	67	3	66	5	65	5	65	6	64	6	64	6	65	6
R6-19	69	2	1.225	67	3	66	3	64	5	63	6	62	7	62	7	61	8	62	7
R6-20	69	2	1.225	66	3	66	4	63	6	62	8	61	8	60	9	59	10	61	8
R6-21	68	2	1.225	66	2	65	3	63	6	61	7	60	8	60	9	59	9	60	8
R6-22	68	2	1.225	64	4	63	6	61	7	60	8	59	9	58	10	58	10	59	9
R6-28	66	4	1.225	64	2	62	4	61	5	60	6	59	7	59	7	58	8	60	7
R6-29	54	2	1.225	54	0	54	1	53	1	53	1	52	2	52	2	51	3	52	2
R6-30	65	3	1.225	63	2	62	3	61	4	59	6	58	7	58	7	57	8	58	7
R6-31	66	4	1.225	63	3	62	4	61	6	59	7	59	7	58	8	58	8	59	7
R6-32	66	5	1.225	63	3	63	3	61	5	60	6	60	6	60	6	59	7	60	6
R6-33	66	4	0.497	63	3	63	3	62	4	60	7	59	7	58	8	58	8	59	7
R6-34	66	3	0.497	63	3	63	4	62	4	60	6	59	7	59	7	58	8	59	7
R6-35	66	3	0.497	63	3	63	3	62	4	61	5	60	6	60	6	59	7	60	6
R6-36	64	3	0.497	64	0	64	1	63	1	63	1	63	1	63	1	63	1	63	1
R6-37	64	2	0.497	64	0	64	0	64	0	64	0	64	1	63	1	63	1	64	1
R6-38	61	1	0.497	61	0	61	0	61	0	61	0	61	0	61	1	61	1	61	0
R6-39	60	2	0.497	60	0	60	0	60	0	60	0	60	0	60	0	60	1	60	0
R6-40	57	2	0.497	55	2	55	2	55	2	54	3	52	5	52	6	51	6	52	5
R6-41	60	3	0.497	58	2	57	3	57	3	55	5	54	6	54	6	53	7	54	6
R6-42	63	4	1.225	60	3	60	3	60	4	58	5	57	6	57	6	57	6	57	6

TABLE 12	SR 0001, Group 03S, Section RC3 NSA 6 Sound Barrier Analysis																	
Modeled Receptor Number	TNM No Barrier Calculated	Difference (Build - Existing)	# of Residences/ ERU	Noise Barrier Height & Insertion Loss														
				8 ft Constant Height		10 ft Constant Height		12 ft Constant Height		14 ft Constant Height		16 ft Constant Height		18 ft Constant Height		20 ft Constant Height		opt2 Optimized Height 14'-16' (Ave. 15.8')	
				Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss
R6-43	63	4	1.225	60	3	60	3	60	3	58	5	57	6	57	7	56	7	57	6
R6-44	62	3	1.225	60	2	59	3	59	3	57	5	57	5	56	6	56	6	57	5
R6-45	59	2	1.225	59	0	59	0	58	1	58	2	57	2	57	2	57	2	57	2
R6-46	63	4	1.225	62	1	61	2	61	3	60	3	60	3	60	3	60	4	60	3
R6-47	65	5	1.225	64	1	64	1	64	1	64	1	64	1	64	1	64	1	64	1
R6-49	62	2	1.225	62	0	62	0	62	0	62	0	62	1	62	1	62	1	62	0
R6-50	61	3	1.225	60	1	60	1	60	2	59	2	59	2	59	2	59	2	59	2
R6-51	61	3	1.225	59	2	58	3	58	3	57	5	56	5	56	5	55	6	56	5
R6-62	60	3	1.225	59	1	59	1	59	1	58	2	58	2	58	2	58	2	58	2
R6-63	61	0	1.225	61	0	61	0	61	0	61	0	61	0	61	0	61	0	61	0
R6-64	58	2	0	58	0	57	0	57	0	57	0	57	1	57	1	57	1	57	1
Barrier Length (Feet)				1732		1732		1732		1732		1732		1732		1732		1732	
Area (square feet), from TNM				13858		17323		20788		24252		27717		31181		34646		27417	
Total # Receptor units receiving at least 5 dBA insertion loss				0.497		2.716		12.285		21.392		21.889		21.889		21.889		21.889	
Area/ # of 5dBA Benefited Receptors				27883		6378		1692		1134		1266		1425		1583		1253	
Exterior Noise levels reduced by at least 7 DBA for 1 benefitted Receptor?				NO		YES		YES		YES		YES		YES		YES		YES	

Notes:

1. A Receptor Number beginning with "M" represents a field measured location and a Receptor Number beginning with "R" represents a modeled receptor only.
2. Impacted receptors (highlighted) are those that warrant the investigation of noise abatement. This occurs where the predicted noise levels meet any of the following criteria:

Predicted Highway Traffic Noise levels approach or exceed NAC or Predicted Highway Traffic Noise substantially exceed (by 10 dB(A) or more) the existing Highway Traffic Noise levels.

4. Noise values, comparisons, and insertion losses are calculated to the tenth of dB(A) and then rounded for presentation purposes.
5. Square footage indicated is based upon its length and its height from the finished ground elevation at the base of the barrier to its top elevation (acoustical profile line).

6.8 NSA 7 Barrier Design

NSA 7 contains 36.27 Equivalent Residential Units (ERUs) as calculated in **Appendix E**. Receptors were laid out in a 130' spaced grid within the outdoor spaces used in the project limits of Woods Campus. The NSA 7 Barrier was laid out to protect impacted receptors R7-1 through R7-37, and R7-45. NSA 7 contains the Woods School Campus on the NB side of S.R. 0001, as shown on **Map 5 and 6**. The preliminary sound barrier alignment is set along the edge of shoulder.

The preliminary optimized barriers are split by Corn Crib Lane. The total barrier length is 2,331 feet long, 1,301 feet south of Corn Crib Lane and 1,030 feet north of Corn Crib Lane and 16 feet tall, measured from ground/gutterline. The total area from TNM v2.5 for the optimized barrier is 37,300 SF. A maximum of 14 dB(A) noise level reduction (Insertion Loss) can be achieved at the impacted receptors with 100% having a 5 dB(A) reduction or greater; therefore, meeting the feasibility criteria in this area.

There are 40 Benefited Receptors representing 25.09 ERUs with Insertion Loss greater than 5 dB(A). Because the Area per Benefited Receptor for the optimized barrier is 1,487 SF/BR, the 2,000 SF/BR maximum reasonableness criteria is met. The reasonableness criteria to reduce design year exterior noise levels by at least 7 dB(A) for at least one benefited receptor is also met. The preliminary assumption is that at least 50% of the impacted and benefited receptor units desire the noise barrier. **Therefore, the NSA 7 Preliminary Barrier is feasible and reasonable.**

Table 13 shows the 2050 Build Predicted Noise Levels, with and without a barrier, the insertion losses attained, and the barrier design data for various constant height barriers and the optimized barrier that were analyzed. **Appendix I** contains the draft version of the Warranted, Feasible, and Reasonable Worksheet for NSA 7 Barrier.

TABLE 13	SR 0001, Group 03S, Section RC3 NSA 7 Sound Barrier Analysis																	
Modeled Receptor Number	TNM No Barrier Calculated	Difference (Build - Existing)	# of Residences/ ERU	Noise Barrier Height & Insertion Loss														
				8 ft Constant Height		10 ft Constant Height		12 ft Constant Height		14 ft Constant Height		16 ft Constant Height		18 ft Constant Height		20 ft Constant Height		opt1 Optimized Height 16'	
				Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss
R7-1	77	2	0.713	68	9	67	10	65	12	65	13	63	14	63	15	62	15	63	14
R7-2	77	2	0.713	68	9	66	11	65	12	65	12	64	13	63	14	62	15	64	13
R7-3	78	2	0.713	70	8	67	11	66	12	65	13	64	14	63	15	62	16	64	14
R7-4	78	2	0.713	72	6	69	9	67	11	66	12	64	14	63	15	62	16	64	14
R7-5	77	3	0.713	73	4	71	6	67	10	66	11	65	12	64	13	63	14	65	12
R7-6	77	3	0.713	74	4	72	5	68	9	67	10	65	12	64	13	63	14	65	12
R7-7	76	2	0.713	72	4	71	5	67	9	66	10	65	11	64	12	63	13	65	11
R7-8	75	2	0.713	71	4	71	4	67	8	65	10	64	11	63	12	62	13	64	11
R7-11	76	1	0.557	70	6	68	8	65	11	64	12	63	13	62	14	61	15	63	13
R7-12	76	1	0.557	69	7	66	10	64	12	63	13	62	14	62	14	61	15	62	14
R7-13	75	1	0.557	66	9	64	11	63	12	62	13	62	13	61	14	61	15	62	13
R7-14	72	0	0.557	65	8	63	9	63	9	62	10	61	11	61	11	60	12	61	11
R7-15	73	1	0.557	65	8	64	9	63	10	63	10	62	11	62	11	61	12	62	11
R7-24	67	1	0.557	65	2	64	3	63	4	63	5	62	5	62	5	62	5	62	5
R7-25	66	1	0.557	63	3	61	5	61	6	60	6	60	6	60	7	59	7	60	6
R7-26	69	0	0.557	65	4	63	6	62	7	61	8	61	8	61	9	60	9	61	8
R7-27	70	2	0.557	66	4	64	6	62	8	61	9	61	9	60	10	60	10	61	9
R7-28	69	1	0.557	66	3	66	3	63	6	62	7	61	8	60	9	60	9	61	8
R7-29	68	0	0.557	66	2	66	3	64	4	62	6	61	7	60	8	60	9	61	7
R7-30	67	1	0.557	65	2	64	3	63	4	61	6	60	7	59	8	59	8	60	7
R7-33	67	3	0.713	66	1	66	1	63	4	61	6	60	7	59	8	58	9	60	7
R7-34	67	3	0.713	66	1	66	2	62	5	61	6	60	7	59	8	58	9	60	7
R7-35	69	4	0.713	66	3	65	4	62	7	61	8	60	9	60	9	59	10	60	9
R7-36	70	4	0.713	66	4	65	5	62	8	62	8	61	9	60	10	60	10	61	9
R7-37	70	4	0.713	66	4	64	6	63	7	62	8	62	8	61	9	61	9	62	8
R7-38	65	4	0.713	63	2	62	3	60	5	60	5	60	5	59	6	59	6	60	5
R7-39	65	4	0.713	63	2	62	3	60	5	59	6	59	6	59	7	58	7	59	6
R7-40	64	3	0.713	63	1	62	2	59	5	59	5	58	6	58	7	57	7	58	6
R7-41	63	4	0.713	62	2	61	2	59	4	59	4	58	5	58	5	58	5	58	5
R7-43	61	1	0.557	60	1	60	1	59	2	57	4	56	5	56	5	56	5	56	5
R7-44	64	1	0.557	62	2	62	2	61	4	59	5	59	5	58	6	58	6	59	5
R7-45	66	1	0.557	63	3	62	4	61	6	60	6	59	7	59	7	59	7	59	7
R7-46	64	1	0.557	62	2	60	4	59	6	58	6	57	7	57	7	57	7	57	7

TABLE 13	SR 0001, Group 03S, Section RC3 NSA 7 Sound Barrier Analysis																	
Modeled Receptor Number	TNM No Barrier Calculated	Difference (Build - Existing)	# of Residences/ ERU	Noise Barrier Height & Insertion Loss														
				8 ft Constant Height		10 ft Constant Height		12 ft Constant Height		14 ft Constant Height		16 ft Constant Height		18 ft Constant Height		20 ft Constant Height		opt1 Optimized Height 16'	
				Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss
R7-47	58	1	0.557	56	2	55	3	53	5	52	6	51	7	51	8	50	8	51	7
R7-49	58	1	0.557	56	2	54	4	52	6	51	7	51	7	50	8	50	8	51	7
R7-50	60	0	0.557	59	1	57	3	55	5	53	7	53	8	52	8	52	8	53	8
R7-51	60	1	0.557	58	2	58	2	56	4	55	5	55	5	55	6	54	6	55	5
R7-52	56	1	0.557	55	1	55	1	54	2	53	3	53	3	52	4	52	4	53	3
R7-53	59	1	0.557	60	-1	59	0	58	1	58	1	57	2	57	2	57	2	57	2
R7-54	59	2	0.557	56	3	56	3	54	5	53	6	53	6	52	7	52	7	53	6
R7-55	59	1	0.557	58	1	58	1	57	2	56	3	55	4	55	4	55	4	55	4
R7-58	60	3	0.713	59	1	58	2	57	3	56	4	56	4	55	5	55	5	56	4
R7-59	60	3	0.713	60	1	59	1	57	3	57	4	56	4	56	4	55	5	56	4
R7-60	60	5	0.713	60	0	60	0	60	0	60	0	60	0	60	0	60	0	60	0
R7-61	60	4	0.713	60	0	60	0	59	1	59	1	59	1	59	1	59	1	59	1
R7-62	58	4	0.713	58	0	58	0	57	1	57	1	57	1	57	1	57	1	57	1
R7-63	58	3	0.713	58	0	57	1	56	2	56	2	56	3	55	3	55	3	56	3
R7-65	57	3	0.713	56	1	55	2	55	2	54	3	54	3	53	4	53	4	54	3
R7-66	58	2	0.713	56	2	56	2	55	3	54	4	54	5	53	5	53	5	54	5
R7-67	57	2	0.713	56	1	56	1	55	2	54	3	54	3	53	4	53	4	54	3
R7-68	55	3	0.713	55	0	55	1	54	1	54	1	53	2	53	2	53	2	53	2
R7-69	58	1	0.557	57	1	57	1	56	2	55	3	55	3	54	4	54	4	55	3
R7-70	57	1	0.557	56	1	56	1	55	2	54	3	53	4	52	5	52	5	53	4
R7-72	56	1	0.557	55	1	54	2	52	4	52	4	51	5	51	5	51	5	51	5
R7-73	54	1	0.557	55	-1	54	0	53	1	52	2	52	2	52	2	52	3	52	2

TABLE 13	SR 0001, Group 03S, Section RC3 NSA 7 Sound Barrier Analysis																			
Modeled Receptor Number	TNM No Barrier Calculated	Difference (Build - Existing)	# of Residences/ ERU	Noise Barrier Height & Insertion Loss															
				8 ft Constant Height		10 ft Constant Height		12 ft Constant Height		14 ft Constant Height		16 ft Constant Height		18 ft Constant Height		20 ft Constant Height		opt1 Optimized Height 16'	
				Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss
R7-90	58	4	0.713	57	1	57	1	57	1	57	2	56	2	56	2	56	2	56	2
R7-91	59	3	0.713	59	0	59	0	59	0	59	0	58	1	58	1	58	1	58	1
Barrier Length (Feet)				2331		2331		2331		2331		2331		2331		2331		2331	
Area (square feet), from TNM				18650		23313		27975		32638		37300		41963		46626		37300	
Total # Receptor units receiving at least 5 dBA insertion loss				5.637		10.873		19.05		22.548		25.088		26.358		27.071		25.088	
Area/ # of 5dBA Benefited Receptors				3308		2144		1469		1447		1487		1592		1722		1487	
Exterior Noise levels reduced by at least 7 DBA for 1 benefitted Receptor?				YES		YES		YES		YES		YES		YES		YES		YES	

Notes:
1. A Receptor Number beginning with "M" represents a field measured location and a Receptor Number beginning with "R" represents a modeled receptor only.
2. Impacted receptors (highlighted) are those that warrant the investigation of noise abatement. This occurs where the predicted noise levels meet any of the following criteria:
Predicted Highway Traffic Noise levels approach or exceed NAC or Predicted Highway Traffic Noise substantially exceed (by 10 dB(A) or more) the existing Highway Traffic Noise levels.
4. Noise values, comparisons, and insertion losses are calculated to the tenth of dB(A) and then rounded for presentation purposes.
5. Square footage indicated is based upon its length and its height from the finished ground elevation at the base of the barrier to its top elevation (acoustical profile line).

6.9 NSA 8 Barrier Design

NSA 8 contains 38 Equivalent Residential Units (ERUs.) The NSA 8 Barrier was laid out to protect the receptors M8-2, M8-4, R8-1 through R8-8, R8-10, R8-12, R8-13, and R8-27. NSAs 8 contains single and multi-family houses and mixed-use areas on the NB side of S.R. 0001, as shown on **Map 4 and 5**. The preliminary sound barrier alignment is set along the edge of shoulder.

The preliminary optimized barrier is 2,364 feet long, ranges in height from 11 feet to 14 feet, and has an average height of 13.74 feet. The total area from TNM v2.5 for the optimized barrier is 32,469 SF. A maximum of 12 dB(A) noise level reduction (Insertion Loss) can be achieved at the impacted receptors with 100% having a 5 dB(A) reduction or greater; therefore, meeting the feasibility criteria in this area.

There are 21 Benefited Receptors representing 25 ERUs with Insertion Loss greater than 5 dB(A). Because the Area per Benefited Receptor for the optimized barrier is 1,299 SF/BR, the 2,000 SF/BR maximum reasonableness criteria is met. The reasonableness criteria to reduce design year exterior noise levels by at least 7 dB(A) for at least one benefited receptor is also met. The preliminary assumption is that at least 50% of the impacted and benefited receptor units desire the noise barrier. **Therefore, the NSA 8 Preliminary Barrier is feasible and reasonable.**

Table 14 shows the 2050 Build Predicted Noise Levels, with and without a barrier, the insertion losses attained, and the barrier design data for various constant height barriers and the optimized barrier that were analyzed. Please note that negative insertion losses were due to differences in provided non-mainline roadway traffic data and will be revisited during the Final Design Noise Analysis. **Appendix I** contains the draft version of the Warranted, Feasible, and Reasonable Worksheet for this barrier.

TABLE 14 **SR 0001, Group 03S, Section RC3 NSA8 Sound Barrier Analysis**

Modeled Receptor Number	TNM No Barrier Calculated	Difference (Build - Existing)	# of Residences/ ERU	Noise Barrier Height & Insertion Loss															
				8 ft Constant Height		10 ft Constant Height		12 ft Constant Height		14 ft Constant Height		16 ft Constant Height		18 ft Constant Height		20 ft Constant Height		opt1 Optimized Height 11'-14' (Ave. 13.74')	
				Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss
M8-1	64	-2	1	62	2	61	3	58	6	58	7	57	7	56	8	56	8	58	7
M8-2	74	0	1	68	6	65	9	63	11	62	12	61	13	60	14	59	15	62	12
M8-3	51	-9	1	51	0	51	0	51	0	51	0	51	0	51	0	51	0	51	0
M8-4	71	-1	1	67	4	67	4	63	8	61	10	60	11	59	12	59	12	61	10
M8-5	59	2	1	59	0	59	0	59	0	59	0	59	0	59	0	59	0	59	0
R8-1	72	0	1	68	4	67	5	64	8	64	8	63	9	63	9	63	9	64	8
R8-2	71	-3	1	68	3	66	5	63	9	61	10	60	11	60	11	59	12	61	10
R8-3	71	-2	1	68	3	67	4	63	8	62	9	61	10	60	11	59	12	62	9
R8-4	72	-2	1	69	3	67	5	64	8	63	9	62	10	61	11	60	12	63	9
R8-5	72	-2	2	69	3	65	7	64	8	63	9	62	10	61	11	60	12	63	9
R8-6	72	0	1	68	4	67	5	64	8	63	9	63	9	62	10	62	10	64	9
R8-7	68	-1	1	66	3	64	4	61	7	60	9	59	10	58	10	57	11	60	8
R8-8	67	-2	1	64	3	64	4	61	6	59	9	58	10	57	11	56	11	59	9
R8-9	65	-1	1	62	3	62	3	58	7	56	9	55	10	54	11	53	12	56	9
R8-10	66	-2	1	63	3	63	3	61	5	58	8	57	9	56	10	55	11	58	8
R8-11	64	-2	2	62	2	62	2	60	4	58	6	57	7	56	8	56	8	58	6
R8-12	66	-2	1	64	2	63	3	60	6	58	8	57	9	57	9	56	10	58	8
R8-13	66	-1	1	64	2	64	3	63	3	61	5	61	5	60	6	60	6	61	5
R8-14	62	-2	1	61	1	61	1	61	1	59	3	59	3	59	3	59	3	60	2
R8-15	60	-3	2	59	1	59	1	56	5	54	6	53	7	53	7	52	8	54	6
R8-16	61	-2	1	59	2	59	2	57	4	54	7	53	8	52	9	52	9	54	7
R8-17	61	-2	1	59	2	59	2	58	3	55	6	54	7	53	8	52	9	55	6
R8-18	63	-3	2	62	1	62	1	58	5	57	6	56	7	55	8	54	9	57	6
R8-19	62	3	2	62	0	62	0	61	1	61	1	61	1	61	1	61	1	61	1
R8-20	59	2	2	60	-1	59	0	59	0	59	0	59	1	58	1	58	1	59	0
R8-21	57	-9	1	56	1	56	1	56	1	55	2	55	2	54	3	54	3	55	2
R8-22	63	0	1	63	0	63	0	63	0	63	0	63	0	63	0	63	0	63	0
R8-23	64	0	1	64	0	64	0	64	0	64	0	64	0	64	0	64	0	64	0

TABLE 14	SR 0001, Group 03S, Section RC3 NSA8 Sound Barrier Analysis																			
Modeled Receptor Number	TNM No Barrier Calculated	Difference (Build - Existing)	# of Residences/ ERU	Noise Barrier Height & Insertion Loss																
				8 ft Constant Height		10 ft Constant Height		12 ft Constant Height		14 ft Constant Height		16 ft Constant Height		18 ft Constant Height		20 ft Constant Height		opt1 Optimized Height 11'-14' (Ave. 13.74')	
				Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss
R8-24	62	2	1	62	0	62	0	62	0	62	0	62	0	62	0	62	0	62	0
R8-25	65	0	1	65	0	65	0	65	0	65	0	65	0	65	0	65	1	65	0
R8-26	62	-3	1	62	0	62	0	62	0	62	0	62	0	62	1	62	1	62	0
R8-27	66	-3	1	64	2	63	3	59	7	58	8	57	9	56	10	56	11	58	8
Barrier Length (Feet)				2364		2364		2364		2364		2364		2364		2364		2364	
Area (square feet), from TNM				18910		23637		28365		33092		37820		42547		47275		32469	
Total # Receptor units receiving at least 5 dBA insertion loss				1		7		20		25		25		25		25		25	
Area/ # of 5dBA Benefited Receptors				18910		3377		1418		1324		1513		1702		1891		1299	
Exterior Noise levels reduced by at least 7 DBA for 1 benefitted Receptor?				NO		YES		YES		YES		YES		YES		YES		YES	

Notes:
1. A Receptor Number beginning with "M" represents a field measured location and a Receptor Number beginning with "R" represents a modeled receptor only.
2. Impacted receptors (highlighted) are those that warrant the investigation of noise abatement. This occurs where the predicted noise levels meet any of the following criteria:
Predicted Highway Traffic Noise levels equal or exceed NAC or Predicted Highway Traffic Noise substantially exceed (by 10 dB(A) or more) the existing Highway Traffic Noise levels.
4. Noise values, comparisons, and insertion losses are calculated to the tenth of dB(A) and then rounded for presentation purposes.
5. Square footage indicated is based upon its length and its height from the finished ground elevation at the base of the barrier to its top elevation (acoustical profile line).
6. Negative insertion losses were due to differences in provided non-mainline roadway traffic data and will be revisited during the Final Design Noise Analysis.

6.10 NSA 9 Barrier Design

NSA 9 contains 132 Equivalent Residential Units (ERUs.) The NSA 9 Barrier was laid out to protect the impacted receptors M9-2 through M9-4, M9-7, M9-9, M9-10, R9-3 through R9-10, R9-12, R9-13, R9-18 through R9-33, R9-45, R9-46, R9-52 through R9-59, and R9-63 through R9-65. NSA 9 contains single and multi-family houses and mixed-use areas on the NB side of S.R. 0001, as shown on **Maps 1 through 3**. The preliminary sound barrier alignment is set along the edge of shoulder.

The preliminary optimized barrier is 4,968 feet long, ranges in height from 14 feet to 15 feet, and has an average height of 14.23 feet. The total area from TNM v2.5 for the optimized barrier is 70,704 SF. A maximum of 13 dB(A) noise level reduction (Insertion Loss) can be achieved for the receptors with 93% of impacted receptors having a 5 dB(A) reduction or greater; therefore, meeting the feasibility criteria in this area.

There are 70 Benefited Receptors representing 120 ERUs with Insertion Loss greater than 5 dB(A). Because the Area per Benefited Receptor for the optimized barrier is 589 SF/BR, the 2,000 SF/BR maximum reasonableness criteria is met. The reasonableness criteria to reduce design year exterior noise levels by at least 7 dB(A) for at least one benefited receptor is also met. The preliminary assumption is that at least 50% of the impacted and benefited receptor units desire the noise barrier. **Therefore, the NSA 9 Preliminary Barrier is feasible and reasonable.**

Table 15 shows the 2050 Build Predicted Noise Levels, with and without a barrier, the insertion losses attained, and the barrier design data for various constant height barriers and the optimized barrier that were analyzed. **Appendix I** contains the draft version of the Warranted, Feasible, and Reasonable Worksheet for this barrier.

TABLE 15	SR 0001, Group 03S, Section RC3 NSA9 Sound Barrier Analysis																		
Modeled Receptor Number	TNM No Barrier Calculated	Difference (Build - Existing)	# of Residences/ ERU	Noise Barrier Height & Insertion Loss															
				8 ft Constant Height		10 ft Constant Height		12 ft Constant Height		14 ft Constant Height		16 ft Constant Height		18 ft Constant Height		20 ft Constant Height		opt1 Optimized Height 14'-15' (Ave. 14.23')	
				Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss
M9-1	62	-2	2	62	0	62	1	60	2	59	3	59	3	59	3	59	3	59	3
M9-2	75	-2	1	71	4	68	7	67	8	66	9	66	9	65	10	65	10	66	9
M9-3	70	-3	4	68	2	67	3	63	7	62	8	61	9	60	10	59	11	62	8
M9-4	71	-1	1	67	4	66	5	63	8	61	10	60	11	59	12	58	13	61	10
M9-5	63	-1	1	62	1	61	2	60	3	58	5	57	6	56	7	55	8	58	6
M9-6	64	-1	1	62	2	62	2	60	4	58	6	57	7	56	8	56	9	58	6
M9-7	75	0	1	70	5	68	7	65	10	63	12	62	13	61	14	61	14	63	12
M9-8	63	-1	1	61	2	61	3	58	5	57	7	55	8	55	8	54	9	57	7
M9-9	73	-1	1	69	4	67	7	64	9	63	11	61	12	60	13	60	14	63	11
M9-10	71	-1	1	67	4	66	5	63	8	62	9	61	10	61	10	60	11	62	9
R9-1	65	-1	1	64	1	64	1	64	1	64	1	64	1	64	1	64	1	64	1
R9-2	65	0	3	64	1	64	1	63	2	63	2	63	2	63	2	63	2	63	2
R9-3	69	-1	2	68	1	68	1	68	1	68	1	68	1	68	1	68	1	68	1
R9-4	71	0	1	70	1	70	1	70	1	70	1	70	1	70	1	70	1	70	1
R9-5	74	0	1	73	2	72	2	72	2	72	2	72	2	72	2	72	2	72	2
R9-6	68	-2	1	67	1	67	1	66	2	66	2	66	3	65	3	65	3	66	2
R9-7	72	-2	1	69	3	68	4	65	7	64	8	63	9	63	9	62	10	64	8
R9-8	71	-2	1	68	3	68	3	64	7	63	8	62	9	61	10	61	10	63	8
R9-9	72	-2	1	69	3	68	4	64	8	63	9	62	10	61	11	61	11	63	9
R9-10	72	-3	2	69	3	66	6	64	8	63	9	62	10	62	11	61	11	63	9
R9-11	61	-2	1	60	1	60	1	57	4	56	5	55	6	55	6	55	6	56	5
R9-12	71	-3	4	69	2	67	4	64	7	63	9	61	10	61	10	60	11	62	9
R9-13	67	-2	4	65	2	65	2	61	6	60	7	59	8	58	9	58	10	60	7
R9-14	63	-3	4	62	1	61	2	58	5	57	6	56	7	55	8	55	8	57	7
R9-15	61	-2	4	60	1	59	2	57	4	55	6	55	6	54	7	54	7	55	6
R9-16	63	-2	4	61	2	61	2	59	4	56	7	55	8	54	9	54	9	56	7
R9-17	65	-3	4	64	1	63	2	60	6	58	7	57	8	56	9	55	10	58	7
R9-18	72	-2	1	69	3	68	4	64	8	63	9	61	11	61	12	60	12	62	10
R9-19	75	0	2	70	5	69	6	65	10	64	11	63	12	62	13	61	14	63	12
R9-20	75	0	2	70	5	69	6	65	10	64	12	62	13	61	14	61	14	63	12
R9-21	75	0	2	70	5	69	6	65	10	64	11	62	13	62	14	61	14	63	12
R9-22	75	0	2	70	5	69	7	65	10	64	12	62	13	61	14	61	14	63	12
R9-23	75	0	2	70	5	68	7	65	10	63	12	62	13	61	14	61	14	63	12
R9-24	75	0	2	70	5	68	7	65	10	63	12	62	13	61	14	61	14	63	12
R9-25	75	0	1	70	5	68	7	64	11	63	12	62	13	61	14	61	14	63	12
R9-26	75	0	1	70	5	67	8	64	11	63	12	62	13	61	14	61	15	63	12
R9-27	76	0	1	70	6	68	9	65	11	63	13	62	14	61	15	61	15	63	13

TABLE 15	SR 0001, Group 03S, Section RC3 NSA9 Sound Barrier Analysis																		
Modeled Receptor Number	TNM No Barrier Calculated	Difference (Build - Existing)	# of Residences/ ERU	Noise Barrier Height & Insertion Loss															
				8 ft Constant Height		10 ft Constant Height		12 ft Constant Height		14 ft Constant Height		16 ft Constant Height		18 ft Constant Height		20 ft Constant Height		opt1 Optimized Height 14'-15' (Ave. 14.23')	
				Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss
R9-28	76	0	2	70	7	67	9	64	12	63	13	62	14	61	15	61	15	63	13
R9-29	76	0	2	69	7	66	10	64	12	63	13	62	14	61	15	61	15	63	13
R9-30	75	0	2	70	5	67	8	64	11	63	12	62	13	61	14	61	14	63	12
R9-31	76	0	1	70	6	68	8	65	11	64	13	62	14	62	14	61	15	63	13
R9-32	75	0	2	70	5	69	6	65	10	64	11	62	13	62	13	61	14	64	11
R9-33	70	0	1	66	4	66	4	62	8	60	10	59	11	58	12	58	12	60	10
R9-34	63	-1	2	62	2	61	2	60	3	58	5	57	7	55	8	55	8	58	5
R9-35	63	-1	2	62	1	61	2	60	3	58	5	57	7	56	8	55	8	58	5
R9-36	64	-1	1	62	2	61	3	59	5	57	7	56	8	56	8	55	9	57	7
R9-37	65	-1	1	63	2	62	3	59	6	58	7	57	8	56	9	55	10	58	7
R9-38	57	1	2	57	0	56	1	53	5	51	6	50	7	50	7	49	8	51	6
R9-39	56	0	1	56	0	56	1	53	3	51	5	50	6	50	6	49	7	51	5
R9-40	56	0	2	57	-1	56	0	53	3	52	5	51	5	50	6	49	7	51	5
R9-41	63	-1	2	62	1	61	2	61	2	59	4	57	6	56	7	56	8	58	5
R9-42	63	-1	1	62	1	61	2	61	2	59	4	57	6	56	7	55	8	58	5
R9-43	63	-1	2	62	1	61	2	61	2	59	4	57	6	56	7	55	8	58	5
R9-44	65	-1	1	63	2	62	3	62	3	59	6	58	7	57	8	57	9	58	7
R9-45	68	-2	1	65	3	65	3	63	5	60	8	58	10	57	11	57	11	59	9
R9-46	66	-2	1	64	2	64	2	64	3	59	8	57	9	56	10	56	10	58	8
R9-47	62	-2	1	61	1	60	2	60	2	55	7	54	8	53	9	53	9	55	7
R9-48	61	-2	1	59	2	59	2	56	5	55	6	54	7	53	8	53	8	55	6
R9-49	60	-2	2	58	2	58	2	55	5	53	7	53	8	52	8	52	9	53	7
R9-50	59	-1	1	57	2	57	2	53	6	52	7	52	8	51	8	50	9	52	7
R9-51	59	0	2	57	2	57	2	55	4	52	7	51	8	51	9	50	9	52	7
R9-52	66	-1	1	63	3	63	3	61	5	58	8	57	9	56	10	55	11	58	8
R9-53	74	0	1	69	5	68	6	64	10	63	11	62	12	61	13	60	14	63	11
R9-54	74	0	1	69	5	68	6	64	10	63	11	62	12	61	13	60	14	63	11
R9-55	73	0	2	68	5	66	7	63	10	62	11	61	12	61	12	60	13	62	11
R9-56	72	0	1	68	5	66	6	63	9	62	10	61	11	60	12	59	13	62	10
R9-57	72	-2	2	69	3	67	6	64	8	63	9	62	10	61	11	60	12	63	9
R9-58	70	-2	1	68	2	66	4	64	6	63	7	62	8	62	8	61	9	63	7
R9-59	70	-1	1	67	3	66	4	64	6	63	7	63	8	62	8	62	8	63	7

TABLE 15	SR 0001, Group 03S, Section RC3 NSA9 Sound Barrier Analysis																	
Modeled Receptor Number	TNM No Barrier Calculated	Difference (Build - Existing)	# of Residences/ ERU	Noise Barrier Height & Insertion Loss														
				8 ft Constant Height		10 ft Constant Height		12 ft Constant Height		14 ft Constant Height		16 ft Constant Height		18 ft Constant Height		20 ft Constant Height		opt1 Optimized Height 14'-15' (Ave. 14.23')	
				Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss	Leq	Insertion Loss
R9-60	65	-2	1	63	2	63	2	62	3	61	4	61	4	61	4	61	5	61	4
R9-61	62	-2	2	60	2	59	3	57	5	56	6	56	6	56	6	55	7	56	6
R9-62	65	-1	2	63	3	62	3	59	6	59	6	58	7	58	7	58	8	59	6
R9-63	66	-1	3	63	3	63	3	60	6	59	7	58	8	57	9	57	9	59	7
R9-64	67	-1	1	64	3	64	3	61	6	59	8	58	9	57	10	56	11	59	8
R9-65	66	-1	1	64	3	63	3	61	5	59	7	57	9	56	10	56	10	59	7
R9-66	62	-1	3	60	2	60	2	58	4	56	6	56	6	55	7	55	7	56	6
R9-67	61	-1	2	59	2	59	2	57	4	56	5	56	5	56	5	56	6	56	5
R9-68	63	-1	2	61	2	60	3	58	5	57	6	57	6	57	6	56	7	57	6
Barrier Length (Feet)				4968		4968		4968		4968		4968		4968		4968		4968	
Area (square feet), from TNM				39744		49680		59616		69552		79488		89424		99360		70704	
Total # Receptor units receiving at least 5 dBA insertion loss				30		38		87		115		120		120		121		120	
Area/ # of 5dBA Benefited Receptors				1325		1307		685		605		662		745		821		589	
Exterior Noise levels reduced by at least 7 DBA for 1 benefitted Receptor?				YES		YES		YES		YES		YES		YES		YES		YES	

Notes:

1. A Receptor Number beginning with "M" represents a field measured location and a Receptor Number beginning with "R" represents a modeled receptor only.
2. Impacted receptors (highlighted) are those that warrant the investigation of noise abatement. This occurs where the predicted noise levels meet any of the following criteria:

Predicted Highway Traffic Noise levels approach or exceed NAC or Predicted Highway Traffic Noise substantially exceed (by 10 dB(A) or more) the existing Highway Traffic Noise levels.

4. Noise values, comparisons, and insertion losses are calculated to the tenth of dB(A) and then rounded for presentation purposes.
5. Square footage indicated is based upon its length and its height from the finished ground elevation at the base of the barrier to its top elevation (acoustical profile line).

7.0 CONSTRUCTION NOISE

During the S.R. 0001, Group 03S, Section RC3 Mainline construction improvements the residences in neighborhoods closest to the construction area will likely be temporarily impacted by construction noise as a result of the project. To minimize the impact to the residential community, all proposed construction will comply with applicable Federal, State, and Local noise control regulations, as well as the Occupational Safety and Health Act of 1970. Where practicable, construction activity should be confined to time periods that will create a minimum amount of disturbance to the community.

The Contractor will follow PUB 408 and local ordinances regarding construction noise.

8.0 PUBLIC INVOLVEMENT

Every effort to involve the local officials and affected communities was made throughout the design process. PennDOT Publication No. 295 Public Involvement Handbook was used as a guide for the public involvement process. A project website has been established to promote the entire S.R. 0001, Group 03S project to the public. The project is being called the US-1 Improvement Project and the website is https://www.us1bucks.com/. The website has been updated throughout the Alternative Analysis Phase and Preliminary Engineering design process and will be updated during the Final Design and Construction phases of the project.

Traffic noise levels are an existing concern for the residences in this area due to some comments by public officials in the area. A Public Officials Meeting was held on May 14, 2013 at State Senator Tomlinson's Langhorne Office to discuss the S.R. 0001, Section RC3 project. A question was raised by Mr. Al Sutter, Senator Tomlinson's District Director, about the potential for noise barriers along the corridor showing that there is public interest related to noise in the adjacent communities.

Public involvement efforts continued for the Section RC3 Alternatives Analysis part of the project through a Public Design Alternative Presentation for U.S. 1 Section RC3 dating June 7, 2021.

This presentation can be viewed by navigating to the web location shown below:
https://www.us1bucks.com/2021/06/07/u-s-1-section-rc3-public-design-alternative-presentation/

A Virtual Public Officials Meeting was held on November 22, 2021 and meeting minutes are included in **Appendix J**.

The exact location, abatement type, aesthetic treatment, and right-of-way requirements will be determined and documented in the Final Design Highway Noise Analysis report for the S.R. 0001, Group 03S, Section RC3 project. Future public meetings will discuss the results of the Preliminary Technical Noise Report and qualified personnel will be on hand for noise related questions from the public.

8.1 Coordination with Property Owners

In addition, the design team has begun coordinating with specific property owners along the corridor, addressing concerns and answering questions about the noise related topics as needed.

Woods Services was contacted February of 2022 regarding land use and residential areas for ERU calculations. Our Lady of Grace Cemetery, Langhorne Presbyterian, Neshaminy High School, and Bucks County Library Langhorne Branch were contacted in August of 2022 regarding land use for ERU calculations. See **Appendix J** for all correspondence.

During the Final Design Phase community voting for all warranted, feasible, and reasonable barriers will be conducted using the procedures outlined in PennDOT Publication No. 24, Section 6.4.

8.2 Undeveloped Land Analysis

Within the project limits there is an undeveloped open field owned by Our Lady of Grace Cemetery along S.R. 0001 Southbound with in NSA 2 and two undeveloped wooded parcels at the northern ends of NSA 4 and NSA 9. As per PennDOT Publication #24, to minimize future traffic noise impacts on currently undeveloped lands of Type I projects, PennDOT shall inform local officials of the predicted future design year noise levels. Preliminary results indicate that the estimated distance for the 71 dB(A) and 66 dB(A) noise contours are approximately 65’ and 130’ respectively from the edge of pavement.

9.0 FUTURE STUDIES AND COORDINATION

Further detailed study including potential barriers will be completed as part of the Final Design Phase to satisfy FHWA criteria. Additionally, further coordination with PennDOT and the affected adjacent communities will be completed during this phase. A preliminary list of items to be included during the Final Design Phase is included below.

- Final Design Undeveloped Lands Analysis
- Final Design detailed barrier design and optimization
- Parallel Barrier Analysis and Absorptive Treatment Considerations (coordinate with PennDOT)
    - Coordination early in the Final Design Phase is needed with PennDOT District 6-0, PennDOT Central Office EPDD, and FHWA to determine the preferred parallel barrier approach and absorptive treatment considerations
- Renderings and Graphics to present proposed noise barrier options and layout
- Noise Specific Community Meetings and Voting on acceptance, color, and texture/pattern
- Final Design Technical Noise Report

10.0 REFERENCES

A. Title 23, United States Code of Federal Regulations, Part 772, (23 CFR) entitled Procedures for Abatement of Highway Traffic Noise and Construction Noise. National Archives and Records Administration – April 1, 1995

B. Highway Traffic Noise Analysis and Abatement, Policy and Guidance. USDOT, FHWA – June 1995.

C. Pennsylvania Department of Transportation Project Level Highway Traffic Noise Handbook. Revised Publication No. 24 – May 2019.

D. US 1 Widening and Reconstruction Traffic Study Technical Memorandum. Delaware Valley Regional Planning Commission - August 2008.

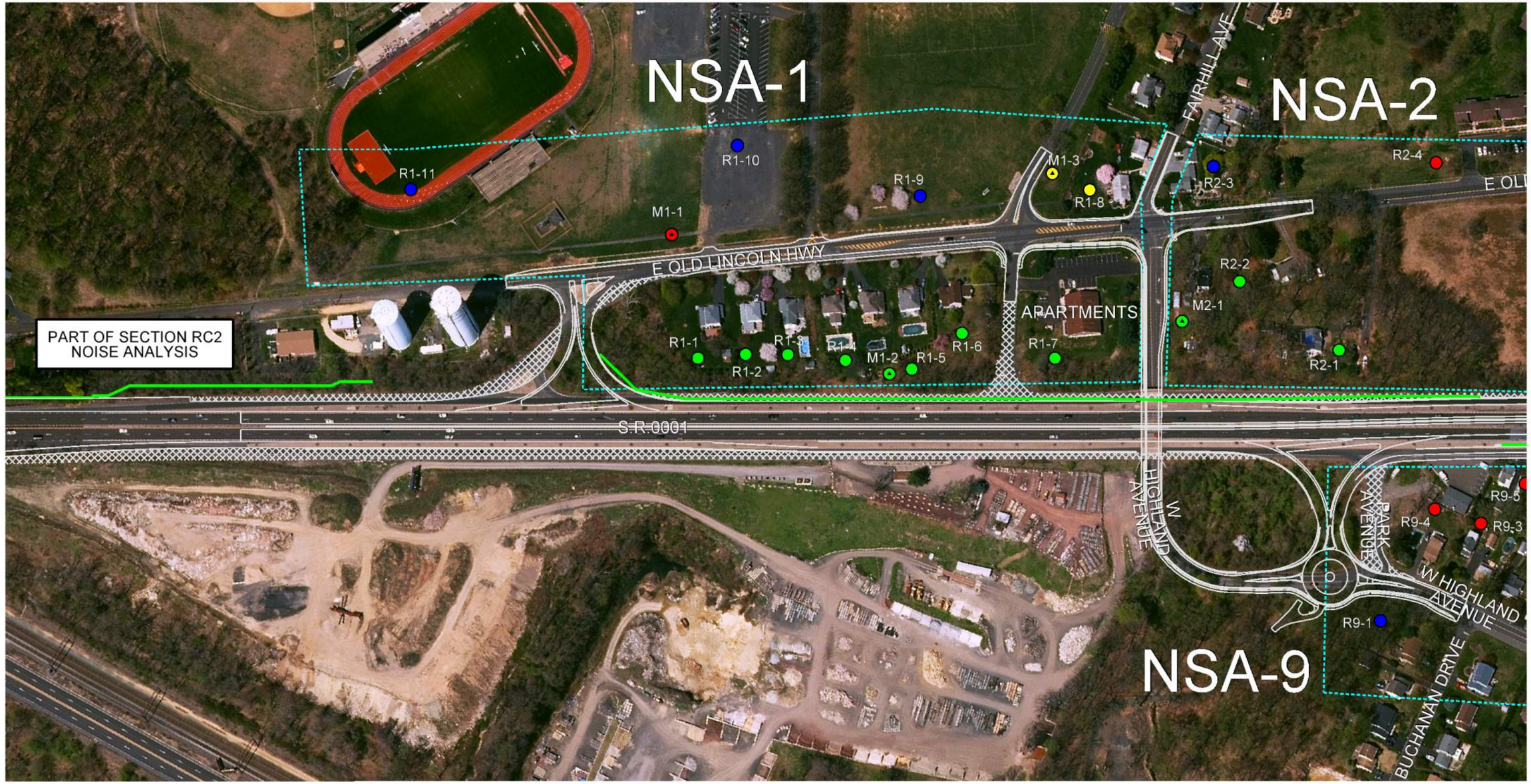
E. S.R. 0001 Group 03S Section RC3 Noise Screening Analysis. Johnson, Mirmiran & Thompson – October 2013

F. S.R. 0001 Group 03S Section RC3 Noise Screening Analysis Update. Susquehanna Civil – March 2020

G. U.S. 1 Frontage Road Improvement Project TNM 2.5 model Validation Results Memo. Susquehanna Civil – October 11, 2021.

H. Traffic Analysis Memo. Johnson, Mirmiran & Thompson – March 2020

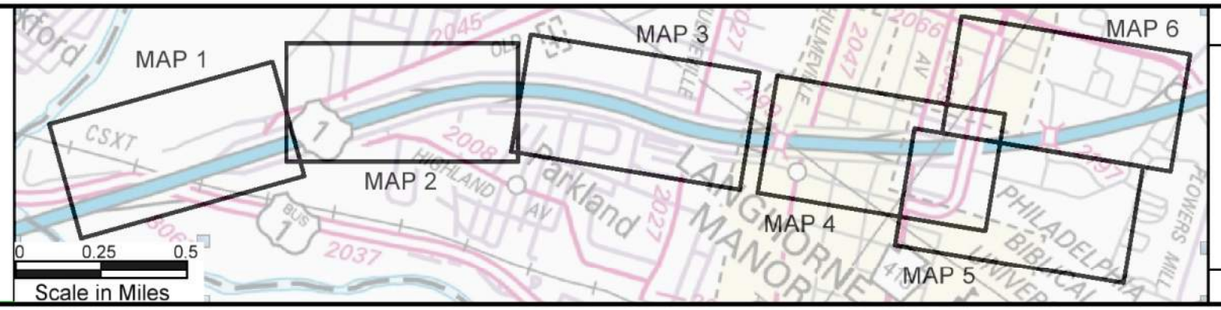
I. S.R. 0001 Section RC3 Interchange Study; Alternatives Analysis Report. Johnson, Mirmiran & Thompson – July 2021



Legend

- NSA-1 — Noise Study Area
- Proposed Roadway
- 24 Hour Noise Measurement Site
- Short Term Noise Measurement Site
- Impacted, Benefitted
- Impacted, Not Benefitted
- Not Impacted, Benefitted
- Not Impacted, Not Benefitted
- Potential Acquisition/ Zero ERU Value
- Barrier Feasible, Not Reasonable
- Barrier Not Feasible
- Barrier Feasible and Reasonable

0 100 200
Scale in Feet



OCTOBER 2022 — Bucks County

The Pennsylvania
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S.R. 0001, Group 03S, Section RC3
Reconstruction Project

PennDOT District 6-0

Preliminary Noise Analysis

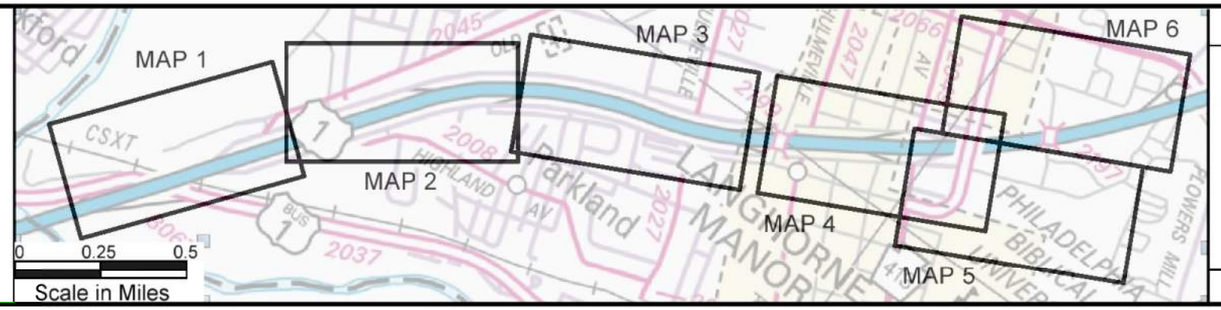
Map No. 1

\\fileserver\SCI-NET101\Projects\20007(SR1)\ENVIRONMENTAL\RC3\Noise\CADD\RC3 Noise\1 Barrier Map (NSA 1,2,&9).dgn
10/20/2022

Legend

- NSA-1 Noise Study Area
- Proposed Roadway
- 24 Hour Noise Measurement Site
- Short Term Noise Measurement Site
- Impacted, Benefitted
- Impacted, Not Benefitted
- Not Impacted, Benefitted
- Not Impacted, Not Benefitted
- Potential Acquisition/ Zero ERU Value
- Barrier Feasible, Not Reasonable
- Barrier Not Feasible
- Barrier Feasible and Reasonable

0 100 200
Scale in Feet



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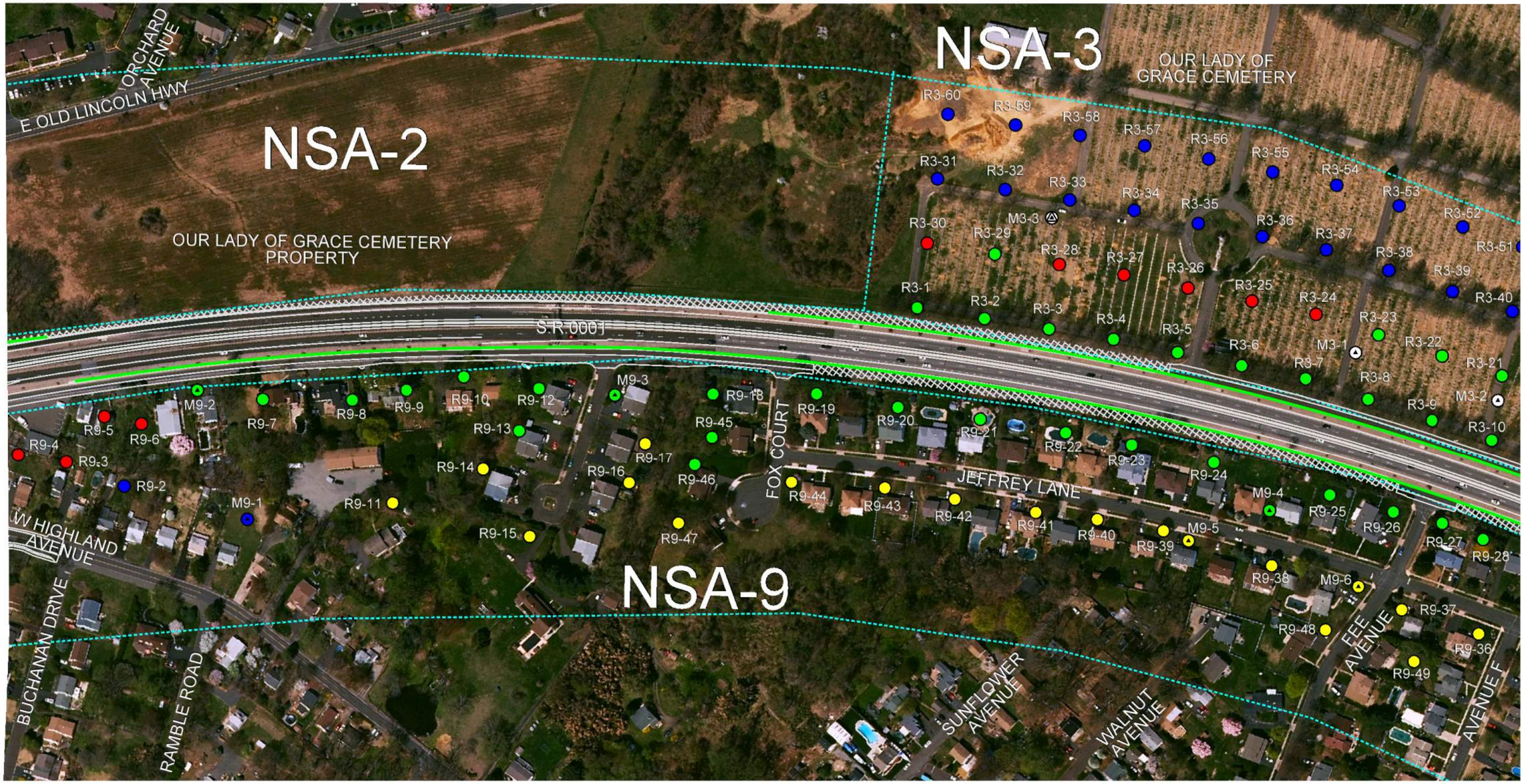
Reconstruction Project

PennDOT District 6-0

Preliminary Noise Analysis

Map No. 3

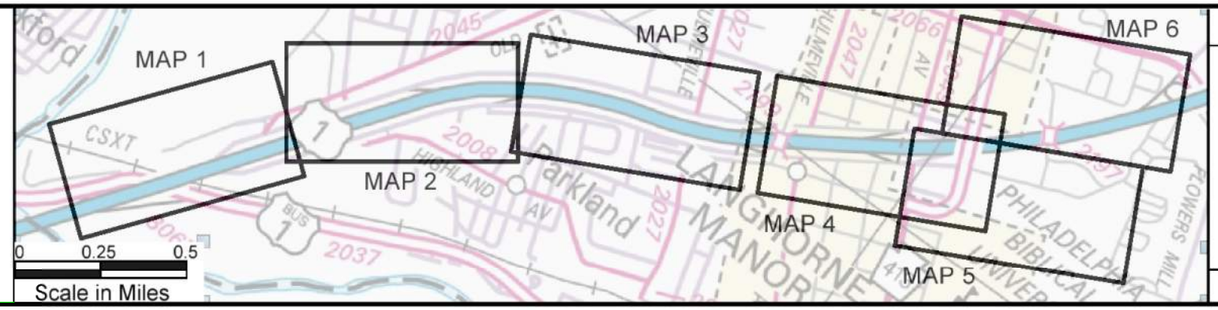
\\fileserver\SCI-NET\01\Projects\20007(SR1)\ENVIRONMENTAL\RC3\Noise\CADD\RC3 Noise\3 Barrier Map (NSA 3,4,&9).dgn
10/20/2022



Legend

NSA-1	Noise Study Area
	Proposed Roadway
	24 Hour Noise Measurement Site
	Short Term Noise Measurement Site
	Impacted, Benefitted
	Impacted, Not Benefitted
	Not Impacted, Benefitted
	Not Impacted, Not Benefitted
	Potential Acquisition/ Zero ERU Value
	Barrier Feasible, Not Reasonable
	Barrier Not Feasible
	Barrier Feasible and Reasonable

0 100 200
Scale in Feet



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Reconstruction Project

PennDOT District 6-0

Preliminary Noise Analysis

Map No. 2

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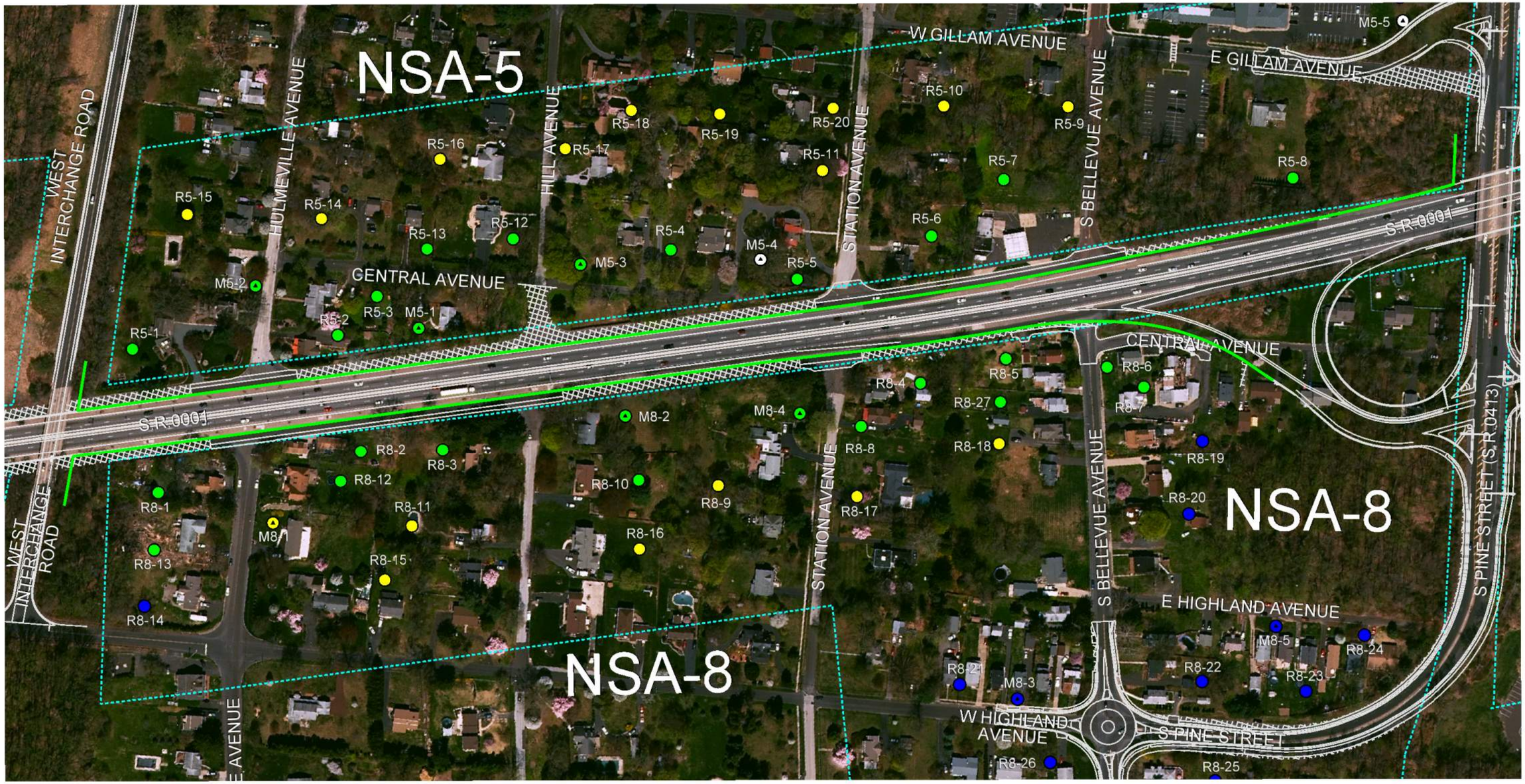
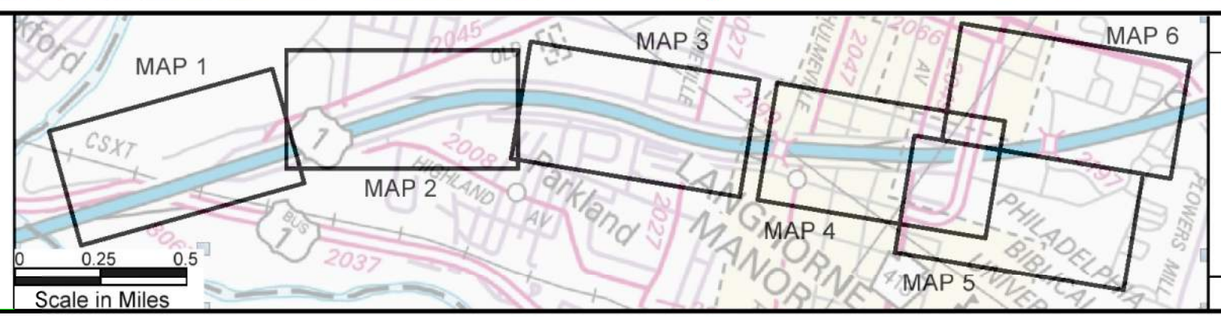
10/20/2022



Legend

NSA-1	Noise Study Area
	Proposed Roadway
	24 Hour Noise Measurement Site
	Short Term Noise Measurement Site
	Impacted, Benefitted
	Impacted, Not Benefitted
	Not Impacted, Benefitted
	Not Impacted, Not Benefitted
	Potential Acquisition/ Zero ERU Value
	Barrier Feasible, Not Reasonable
	Barrier Not Feasible
	Barrier Feasible and Reasonable

0 100 200
Scale in Feet



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Reconstruction Project

PennDOT District 6-0

Preliminary Noise Analysis

Map No. 4

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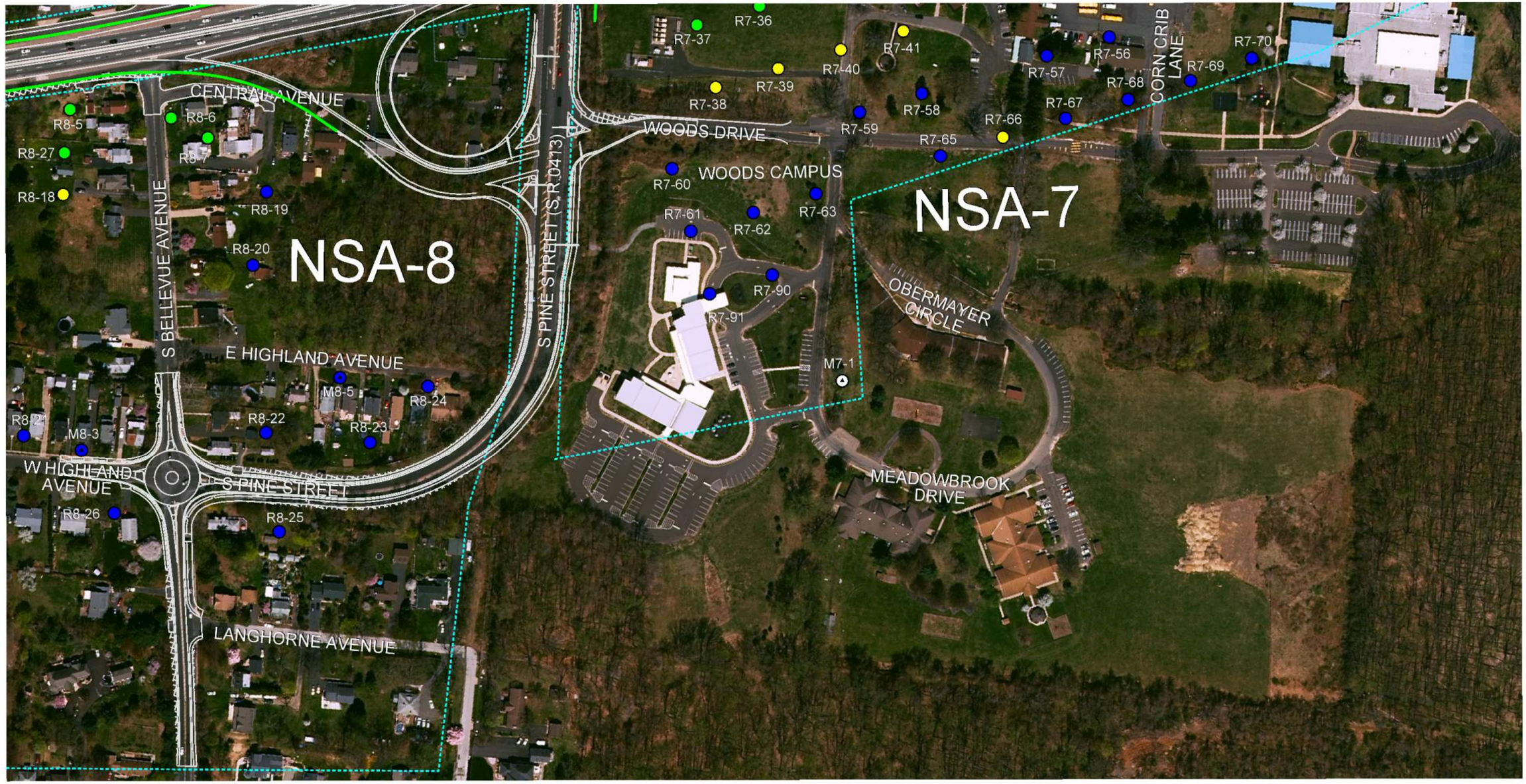
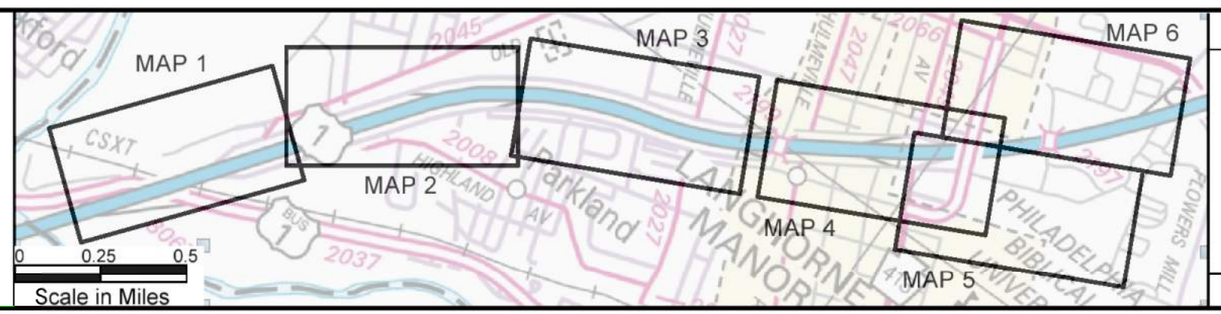
10/20/2022



Legend

- NSA-1 Noise Study Area
- Proposed Roadway
- 24 Hour Noise Measurement Site
- Short Term Noise Measurement Site
- Impacted, Benefitted
- Impacted, Not Benefitted
- Not Impacted, Benefitted
- Not Impacted, Not Benefitted
- Potential Acquisition/ Zero ERU Value
- Barrier Feasible, Not Reasonable
- Barrier Not Feasible
- Barrier Feasible and Reasonable

0 100 200
Scale in Feet



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The Pennsylvania
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Reconstruction Project

PennDOT District 6-0

Preliminary Noise Analysis

Map No. 5

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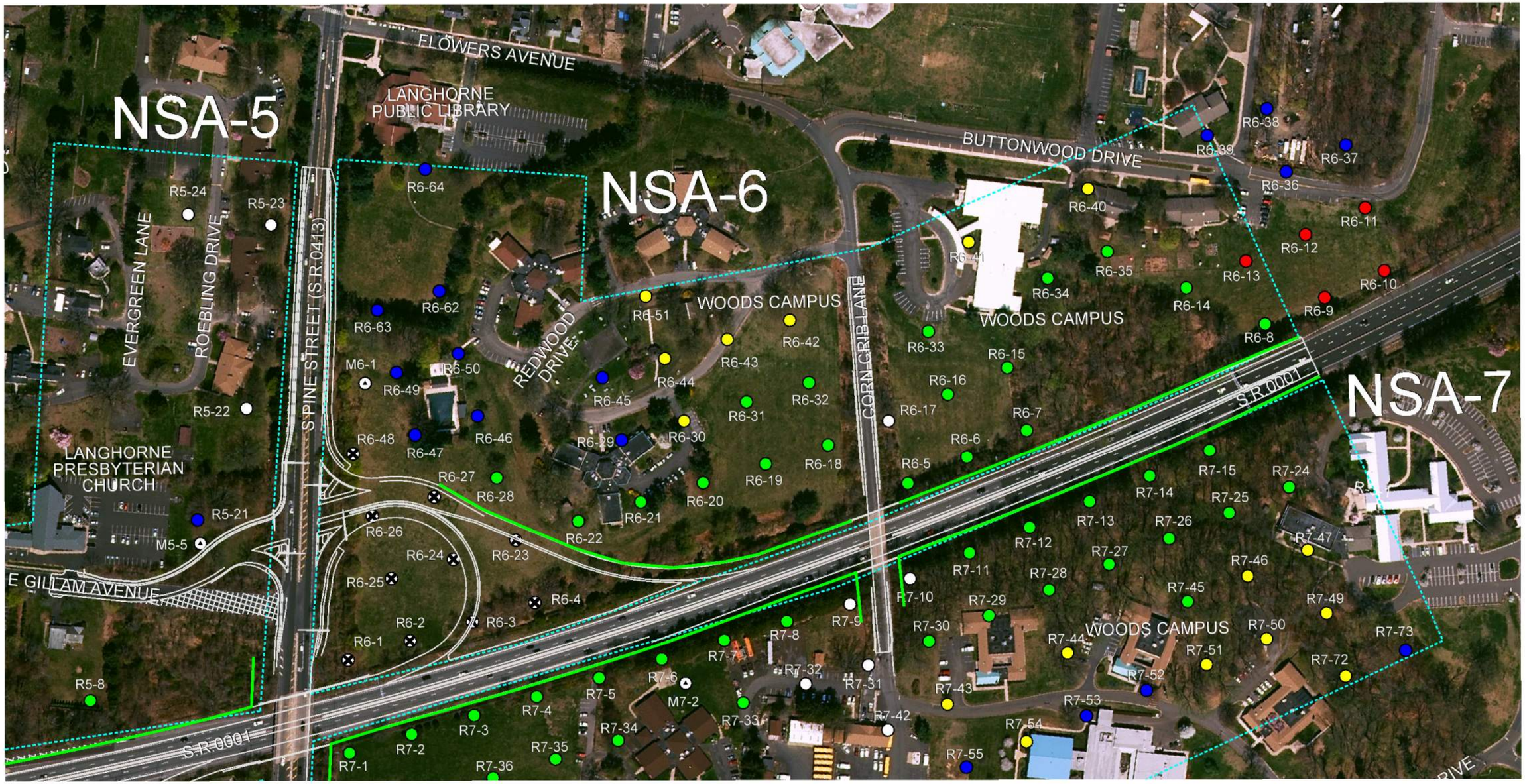
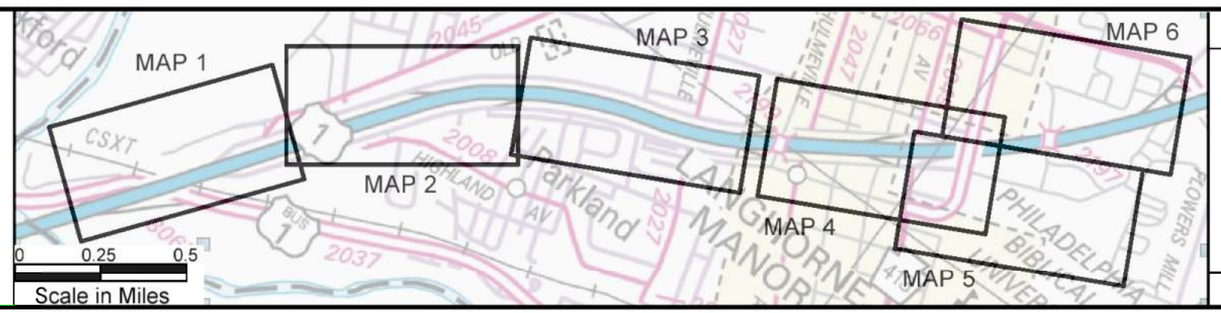
10/20/2022



Legend

NSA-1	Noise Study Area
	Proposed Roadway
	24 Hour Noise Measurement Site
	Short Term Noise Measurement Site
	Impacted, Benefitted
	Impacted, Not Benefitted
	Not Impacted, Benefitted
	Not Impacted, Not Benefitted
	Potential Acquisition/ Zero ERU Value
	Barrier Feasible, Not Reasonable
	Barrier Not Feasible
	Barrier Feasible and Reasonable

0 100 200
Scale in Feet



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Preliminary Noise Analysis

Map No. 6

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10/20/2022