Kimley»Horn

September 15, 2021

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Subject: ***N Quincy Street Temporary Bus Facility Noise Analysis***
Arlington, Virginia

Executive Summary

The purpose of this technical memorandum is to summarize the evaluated noise levels associated with the on-site operations at the N Quincy Street property for the proposed temporary bus facility in Arlington, Virginia. Kimley-Horn staff conducted noise measurements at the N Quincy Street property to document the existing noise levels and conducted noise measurements at an active Arlington Transit (ART) bus facility at 2629 Shirlington Road. The N Quincy Street property site is approximately 3 miles southwest of the District of Columbia, approximately 0.5 mile north of downtown Arlington, and immediately south of the Custis Memorial Parkway (I-66). The site is on County-owned land that has four existing buildings with parking lots throughout the site. The site is bordered by I-66 to the north, residences and a school to the east, residences to the south, and a school to the west. The location of the proposed site is shown in **Figure 1**.

Analysis Findings

- *Although Arlington County noise requirements do not apply at the proposed temporary bus facility, the potential noise impact of on-site operations was analyzed. Predicted noise levels were found to be similar to existing ambient noise levels. However, there may be periods of time where on-site operations are more noticeable. After discussion with the County, a 6-foot fence with a noise abatement attachment was analyzed. Noise abatement of 6 feet in the form of Acoustifence may be installed as an attachment to the proposed chain fencing for temporary noise reduction and line of sight benefits.*

Project Description

The N Quincy Street property will be a temporary Arlington Transit (ART) bus parking facility while the bus facility at 2629 Shirlington Road is under construction. The Shirlington Road bus facility currently accommodates 41 buses, and 29 of those buses will be temporarily relocated to the N Quincy Street property. The N Quincy Street property is bordered by N Quincy Street to the west, Custis Memorial Parkway (I-66) to the north, 14th Street to the south and N Lincoln Street to the east. The property has four existing buildings with parking throughout the site. Buses will be parked in the western parking lot near the entrance off N Quincy Street as well as in the parking lot between Buildings 2 and 3 in the middle of the site. Buses, guests, and employees will all access the site via the N Quincy Street entrance.

Operations at the site are anticipated to occur from 4:00 am to 12:00 am on weekdays with no Saturday or Sunday morning rollouts. There will be limited bus movements on Sundays from 3:00 pm to 12:00 am in preparation for Monday's service. During the week, the majority of the bus movement on-site will occur between 5:00 am to 2:00 pm. Throughout the remainder of the day, intermittent buses will arrive to and depart from the parking facility. For modeling purposes, the speed limit on the site was assumed to be 15 miles per hour (mph) for employee/guest vehicles and 10 mph for buses.

Figure 1: Site Location and Vicinity

Characteristics of Noise

Noise is generally defined as unwanted sound. It is emitted from many natural and man-made sources. Sound pressure levels are usually measured and expressed in decibels (dB). The decibel scale is logarithmic and expresses the ratio of the sound pressure unit being measured to a standard reference level. Most sounds occurring in the environment do not consist of a single frequency, but rather a broad band of differing frequencies. The intensities of each frequency add together to generate sound. Because the human ear does not respond to all frequencies equally, the method commonly used to quantify environmental noise consists of evaluating all the frequencies of a sound according to a weighting system. It has been found that the A-weighted decibel [dB(A)] filter on a sound level meter, which includes circuits to differentially measure selected audible frequencies, best approximates the frequency response of the human ear.

The degree of disturbance from exposure to unwanted sound – noise – depends upon three factors:

1. The amount, nature, and duration of the intruding noise
2. The relationship between the intruding noise and the existing sound environment; and
3. The situation in which the disturbing noise is heard

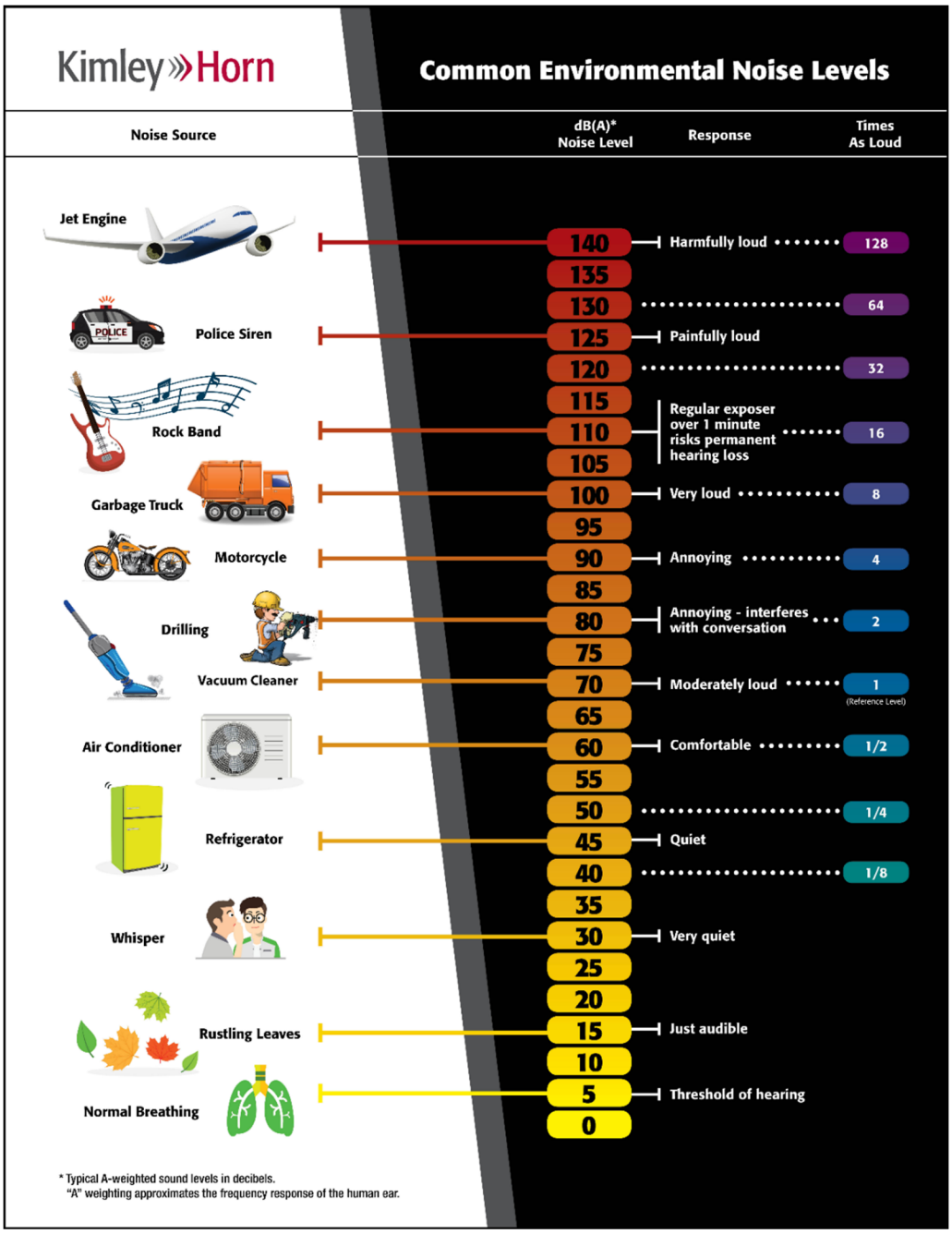
In considering the first of these factors, it is important to note that individuals have varying sensitivity to noise. Loud noises bother some people more than other people, and some individuals become increasingly upset if an unwanted noise persists. The time patterns and durations of noise(s) also affect perception as to whether or not it is offensive. For example, noises that occur during nighttime (sleeping) hours are typically considered to be more offensive than the same noises in the daytime.

With regard to the second factor, individuals tend to judge the annoyance of an unwanted noise in terms of its relationship to noise from other sources (background noise). A car horn blowing at night when background noise levels are low would generally be more objectionable than one blowing in the afternoon when background noise levels are typically higher. The response to noise stimulus is analogous to the response to turning on an interior light. During the daytime an illuminated bulb simply adds to the ambient light, but when eyes are conditioned to the dark of night, a suddenly illuminated bulb can be temporarily blinding.

The third factor – situational noise – is related to the interference of noise with activities of individuals. In a 60 dB(A) environment such as is commonly found in a large business office, normal conversation would be possible, while sleep might be difficult. Loud noises may easily interrupt activities that require a quiet setting for greater mental concentration or rest; however, the same loud noises may not interrupt activities requiring less mental focus or tranquility.

As shown in **Figure 2**, most individuals are exposed to fairly high noise levels from many sources on a regular basis. To perceive sounds of greatly varying pressure levels, human hearing has a non-linear sensitivity to sound pressure exposure. Doubling the sound pressure results in a three decibel change in the noise level; however, variations of three decibels [3 dB(A)] or less are commonly considered “barely perceptible” to normal human hearing. A five decibel [5 dB(A)] change is more readily noticeable. A ten-fold increase in the sound pressure level correlates to a 10 decibel [10 dB(A)] noise level increase; however, it is judged by most people as only sounding “twice as loud”.

Figure 2: Common Noise Levels



Over time, individuals tend to accept the noises that intrude into their lives on a regular basis. However, exposure to prolonged and/or extremely loud noise(s) can prevent use of exterior and interior spaces and has been theorized to pose health risks.

Noise Regulations and Goals

The N Quincy Street property is in Arlington, Virginia. The Arlington County Code, Chapter 15 states:

Noise from sources other than motor vehicles, unless exempt pursuant to §§ 15-5.F. or 15-15, shall not exceed the noise limits set forth in Table 1 below for each of the zoning districts indicated during the time of day indicated. The maximum permissible noise shall be that associated with the zoning district classification of the property that receives the noise…Motor vehicle noise sources are subject to the noise limits set forth in Table 2 below.

According to §15-15, the noise control ordinance "shall not apply to operations at County facilities or engaged in by County employees or County contractors…or by an entity under contract with the County." Therefore, the noise regulations in the Arlington County Code do not apply to the N Quincy Street property.

Table 1: Maximum Permissible Noise Levels from Stationary Sources

Zoning District	Time of Day	Continuous Noise (dBA)	Impulsive Noise (dBA)	Frequency (Hz)	dBA component
CM, M-1 & M-2 P-S	All	70	120	31.5 63 125 250 500 1,000 2,000 4,000 8,000	85 84 79 74 68 62 57 53 50
R-5, R-6, R-8, R-10, R-20, R2-7, R-15-30T, R-10T, RA 14-26, RA8-18, RA6-15, RA7-16 S-3A & S-D	Daytime	60	95	31.5 63 125 250 500 2,000 4,000 8,000	75 74 69 64 58 47 43 40
R-5, R-6, R-8, R-10, R-20, R2-7, R-15-30T, R-10T, RA 14-26, RA8-18, RA6-15, RA7-16 S-3A & S-D	Nighttime	55	90	31.5 63 125 250 500 2,000 4,000 8,000	70 69 64 59 53 42 38 35

Table 2: Maximum Permissible Noise From Motor Vehicles

Class of Source Vehicle	Up to 35 miles per hour	35 miles per hour & above
Motorcycle	80 dBA	84 dBA
Total GVW < 10,000 lbs.	70 dBA	79 dBA
Total GVW > 1,000 lbs.	86 dBA	90 dBA

The N Quincy Street property is within a Light Industrial District (M-1) and the residences to the south are within a Restricted Two-Family Dwelling District (R-5). Therefore, this analysis assumed a noise goal of 60 dB(A) in the daytime (7:00 am to 9:00 pm weekdays and 10:00 am to 9:00 pm weekends) and 55 dB(A) in the nighttime (9:00 pm to 7:00 am weekdays and 9:00 pm to 10:00 am weekends) at the residences south of the site.

Existing Conditions

To document existing noise levels on-site, long-term (24-hour) noise measurements were taken at the N Quincy Street property. Additional long-term noise measurements were also conducted at the existing Shirlington Road bus facility to establish a baseline value for ART bus operations. Detailed information about the noise measurements is contained in the following sections.

Shirlington Road Bus Facility Noise Measurements

Kimley-Horn staff conducted noise monitoring from July 13, 2021 to July 14, 2021, to document the bus activity at the Shirlington Road Bus Facility. Noise measurement locations are shown in **Figure 3**. Two Type 1 precision integrating sound level meters using the A-weighting scale were used. Data collected by the noise meters included time, average noise level (L_{eq}), maximum noise level (L_{max}), and instantaneous peak noise level (L_{pk}) for each interval. Photographs of the noise measurement setups are shown in **Table 3**.

Table 3: Long-Term Noise Measurement Setup Pictures at Shirlington Road Bus Facility

Shirlington Road Bus Facility Noise Meters	
LT1: Facing West	**LT2: Facing West**
	

Figure 3: Shirlington Road Bus Facility Noise Measurement Locations

The results of the Shirlington Road bus facility noise measurements are shown in Table 4 and detailed hourly measurement data is included in Table 5. The predominant sources of noise in the vicinity of the development are the traffic noise along Henry G. Shirley Memorial Hwy (I-395), approximately 50 feet east of the eastern noise measurement location, and local roads such as S Shirlington Road. Other sources of noise also include ambient environmental noise, which includes wind, birds chirping, insects, household appliances, lawn mowers, etc.

Table 4: Shirlington Road Bus Facility Noise Measurements Summary

Setup	Location Description	Measurement Time	24-hr L_{eq} Noise Level [dB(A]	Average Daytime L_{eq} Noise Level [dB(A]	Average Nighttime L_{eq} Noise Level [dB(A]
LT 1	East of the center of the site along the access drive and parking	10:00 AM (7/13) to 10:00 AM (7/14)	68.9	69.1	68.5
LT 2	At the entrance of the site	10:00 AM (7/13) to 10:00 AM (7/14)	67.1	67.9	65.3

Table 5: Shirlington Road Bus Facility Hourly Noise Measurement Summary

Hour	Leq	
	LT1	LT2
10:00 – 11:00 AM	69.1	69.1
11:00 – 12:00 PM	70.3	66.1
12:00 – 1:00 PM	70.5	68.8
1:00 – 2:00 PM	70.1	67.9
2:00 – 3:00 PM	70.0	67.4
3:00 – 4:00 PM	70.2	68.0
4:00 – 5:00 PM	69.7	65.8
5:00 – 6:00 PM	68.9	65.2
6:00 – 7:00 PM	70.0	66.1
7:00 – 8:00 PM	68.9	66.4
8:00 – 9:00 PM	69.2	67.1
9:00 - 10:00 PM	69.3	65.6
10:00 – 11:00 PM	67.6	64.3
11:00 – 12:00 PM	65.6	63.9
12:00 – 1:00 AM	64.0	59.5
1:00 – 2:00 AM	61.4	58.6
2:00 – 3:00 AM	60.4	58.1
3:00 – 4:00 AM	65.5	68.7
4:00 – 5:00 AM	70.8	71.4
5:00 – 6:00 AM	70.5	69.5
6:00 – 7:00 AM	71.0	67.5
7:00 – 8:00 AM	69.0	66.1
8:00 - 9:00 AM	68.4	68.4
9:00 – 10:00 AM	67.5	67.5
24-hr Average	68.9	67.1
Daytime Average	69.1	67.9
Nighttime Average	68.5	65.3

N Quincy Street Property Noise Measurements

Kimley-Horn staff conducted noise monitoring from July 14, 2021 to July 15, 2021, to document existing noise at the N Quincy Street property. Noise measurement locations are shown in **Figure 4**. Two Type 1 precision integrating sound level meters using the A-weighting scale were used. Data collected by the noise meters included time, average noise level (L_{eq}), maximum noise level (L_{max}), and instantaneous peak noise level (L_{pk}) for each interval. Photos of the noise measurement setups are shown in **Table 6**.

Table 6: Long-Term Noise Measurement Setup Pictures at N Quincy Street Property

N Quincy Street Property Noise Meters	
LT1: Facing West	**LT2: Facing East**
	

Figure 4: N Quincy Street Property Noise Measurement Locations

The results of the N Quincy Street property noise measurements are shown in **Table 7** and detailed hourly measurement data is included in **Table 8**. The predominant sources of noise in the vicinity of the site are the traffic noise along I-66, located approximately 250 feet north of the noise measurement locations, and local roads such as N Quincy Street and 14th Street. Other sources of noise also include ambient environmental noise, which includes wind, birds chirping, dogs barking, insects, household appliances, lawn mowers, etc.

Table 7: Noise Measurements Summary

Setup	Location Description	Measurement Time	24-hr L_{eq} Noise Level [dB(A]	Average Daytime L_{eq} Noise Level [dB(A]	Average Nighttime L_{eq} Noise Level [dB(A]
LT 1	In the southwest area of the site bordering the residential homes adjacent to the parking lot	11:00 AM (7/14) to 11:00 AM (7/15)	52.6	53.3	51.4
LT 2	In the southeast area of the site bordering the residential homes at the top of the hill	11:00 AM (7/14) to 11:00 AM (7/15)	54.1	54.7	52.8

Table 8: N Quincy Street Property Hourly Noise Measurement Summary

	Leq	
Hour	LT1	LT2
11:00 – 12:00 PM	53.8	55.2
12:00 – 1:00 PM	53.7	55.3
1:00 – 2:00 PM	54.8	55.8
2:00 – 3:00 PM	53.4	55.5
3:00 – 4:00 PM	53.5	55.2
4:00 – 5:00 PM	53.4	55.3
5:00 – 6:00 PM	53.7	55.2
6:00 – 7:00 PM	53.3	54.7
7:00 – 8:00 PM	52.1	54.1
8:00 – 9:00 PM	53.6	54.5
9:00 - 10:00 PM	50.8	52.3
10:00 – 11:00 PM	50.2	51.6
11:00 – 12:00 PM	49.4	50.4
12:00 – 1:00 AM	47.0	48.0
1:00 – 2:00 AM	45.9	46.5
2:00 – 3:00 AM	44.4	45.5
3:00 – 4:00 AM	45.7	46.6
4:00 – 5:00 AM	48.7	50.5
5:00 – 6:00 AM	52.3	53.2
6:00 – 7:00 AM	52.9	55.1
7:00 – 8:00 AM	54.1	55.8
8:00 - 9:00 AM	55.0	56.4
9:00 – 10:00 AM	55.8	56.7
10:00 – 11:00 AM	54.4	55.6
24-hr Average	52.6	54.1
Daytime Average	53.3	54.7
Nighttime Average	51.4	52.8

Although the noise measurements show that the active bus facility Leq was up to 17 dB(A) higher than the measurements from the N Quincy Street property, the Shirlington Road bus facility is closer in elevation to I-395 than the N Quincy Street property is to I-66. Also, the Shirlington Road bus

facility is located near industrial and commercial land uses which contribute to the measured noise levels.

Noise Analysis

Noise levels from the proposed facility were evaluated using SoundPLAN. This program computes predicted noise levels at noise-sensitive areas through a series of adjustments to reference sound levels. SoundPLAN also accounts for topography, groundcover type, and intervening structures. Sound levels generated from bus movements are anticipated to be the dominant source of noise from the proposed site. Additional sound will be generated from cars operating on-site.

It should be noted that noise from surrounding roadways was not included in this analysis, although I-66 and N Quincy Street are anticipated to contribute to the ambient noise environment throughout the entire day.

Operations at the site are anticipated to occur from 4:00 am to 12:00 am on weekdays with no Saturday or Sunday morning rollouts. There will be limited bus movements on Sundays from 3:00 pm to 12:00 am in preparation for Monday's service. During the week, the majority of the bus movement on-site will occur between 5:00 am to 2:00 pm. Throughout the remainder of the day, intermittent buses will arrive to and depart from the parking facility. As a result, it is anticipated the facility may be a noticeable generator of noise during peak bus activity times, specifically in the early morning.

Site Activity

Noise from bus and employee vehicle movements on the proposed site were modeled in SoundPLAN. Most of the bus and employee/guest vehicles accessing the site are anticipated to occur during normal daytime hours; however, some peak bus activity and employee/guest trips will also occur during nighttime hours (e.g., between the hours of 9:00 pm to 7:00 am). To account for the worst-case noise scenario from bus operations and employee/guest vehicular movement at the site, a total of 16 bus trips were modeled as line sources of noise at 10 mph and as area sources of noise within the designated parking areas. Once on-site, buses will travel along the southern drive aisle to the designated parking area on the eastern façade of the middle building, or drive around the building on the northern drive aisle to wrap around to the parking area on the western façade of the middle building. Employee/guests vehicles will travel along the drive aisle to the POV parking area, south of the middle building. This represents the worst-case traffic conditions based on provided traffic data.

A second scenario, representing typical activity throughout the day, was also modeled. For this scenario, a total of 10 bus trips were modeled as line sources of noise at 10 mph and as area sources of noise within the designated parking areas. All other bus movement assumptions remained the same.

Results

Utilizing the input data described above, SoundPLAN was used to calculate noise levels at the noise-sensitive land uses surrounding the N Quincy Street property. It should be noted that predicted noise levels are conservative estimates since it was assumed that all equipment and operational activity at

the proposed site would occur in a constant, simultaneous manner. However, it is anticipated that these noise sources would occur intermittently throughout the day and night.

The SoundPLAN-predicted maximum noise levels at the nearest noise-sensitive land uses south of the site are anticipated to range between 50 dB(A) and 56 dB(A). The anticipated worst-case operational noise contours are shown in **Figure 5**. Operational noise contours for the rest of the day are shown in **Figure 6**.

Noise Abatement Measures

Passive noise abatement measures are effective because they absorb sound energy, extend the source-to-receptor sound transmission path, or both. Sound absorption is a function of abatement medium (e.g. earth berms absorb more sound energy than noise walls of the same height because earth berms are more massive). The source-to-receptor path is extended by placement of an obstacle, such as an earth berm or concrete wall, that sufficiently blocks the transmission of sound waves that travel from the source to the receptor.

Sound barriers are primarily constructed as earth berms or solid-mass walls adjacent to sources of noise that are in proximity to noise-sensitive land use(s). To be effective, a sound barrier must be long enough and tall enough to shield potentially impacted areas. Generally, the noise barrier length must be eight times the distance from the barrier to the receptor. For example, if a receptor is 200 feet from the noise source, an effective barrier would be approximately 1,600 feet long – with the noise-sensitive land use in the horizontal center.

After discussion with Arlington County, it was determined that the bus parking areas will have a chain fence south of the bus parking. Kimley-Horn identified a noise abatement product, Acoustifence, that attaches to fences and is designed to reduce noise impacts. Since operational site noise levels are predicted to increase at the closest residences south of the N Quincy Street property, noise abatement was analyzed to reduce the predicted noise levels from the site. **Appendix A** provides various photos of Acoustifence installations.

A 6-foot-tall noise abatement measure between the bus parking area and the residences to the south was determined to reduce the anticipated on-site operational noise by approximately 0.5 dB(A) to 1 dB(A) at the residences to the south of the site. The anticipated worst case noise contours with the analyzed Acoustifence are shown in **Figure 7**. The anticipated daytime noise contours with the analyzed Acoustifence are shown in **Figure 8**. With the proposed noise abatement, noise levels are predicted to be less than the noise goal of 55 dB(A) during nighttime hours at the closest noise-sensitive properties.

Conclusions

The N Quincy Street property is generally located south of the Custis Memorial Parkway (I-66), and east of N Quincy Street in Arlington, VA. Kimley-Horn staff conducted noise measurements at the N Quincy property to document existing noise levels and at an active bus facility on Shirlington Road to document bus activity.

Although Arlington County noise requirements do not apply at the proposed temporary bus facility, the potential noise impact of on-site operations was analyzed. Predicted noise levels were found to be similar to existing ambient noise levels. Modeling and analyzing the worst-case operational scenario at the proposed site determined that noise levels will generally be consistent with the noise goal of 55 dB(A) during nighttime hours at the closest noise-sensitive uses. After discussion with the County, a 6' fence with Acoustifence noise abatement was analyzed. The predicted noise levels for the adjacent properties without the noise abatement are shown in **Figure 9** and the predicted noise levels for the adjacent properties with the noise abatement are shown in **Figure 10**. A comparison of the measured noise levels and the predicted noise levels with abatement are shown in **Figure 11.** The County may choose to install the analyzed noise abatement for temporary noise reduction and line of sight benefits.

Figure 5: Worst-Case (5:00am-6:00am) Operational Noise Contours

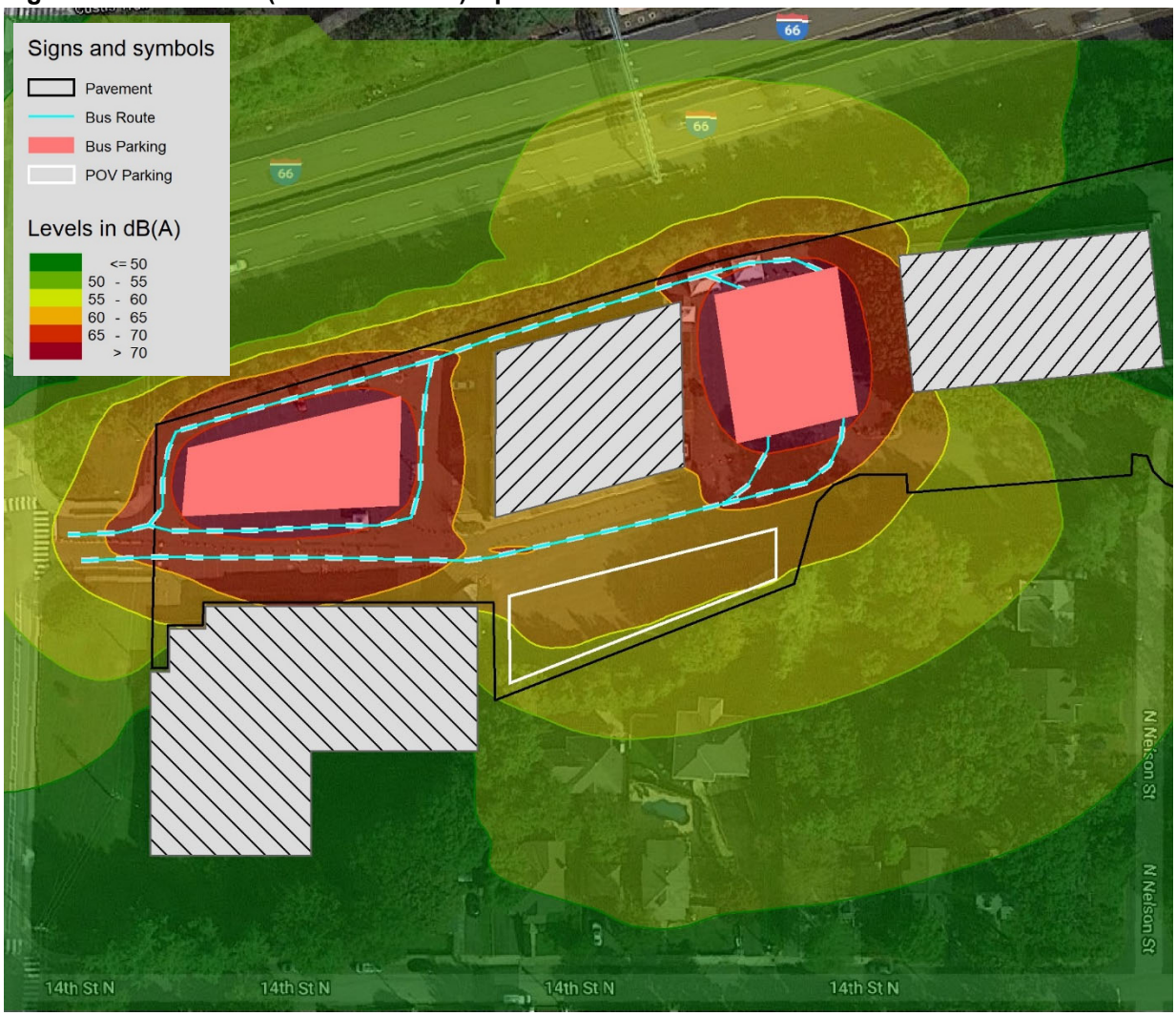


Figure 6: Worst-Case (5:00am-6:00am) Operational Noise Contours with 6' Fence

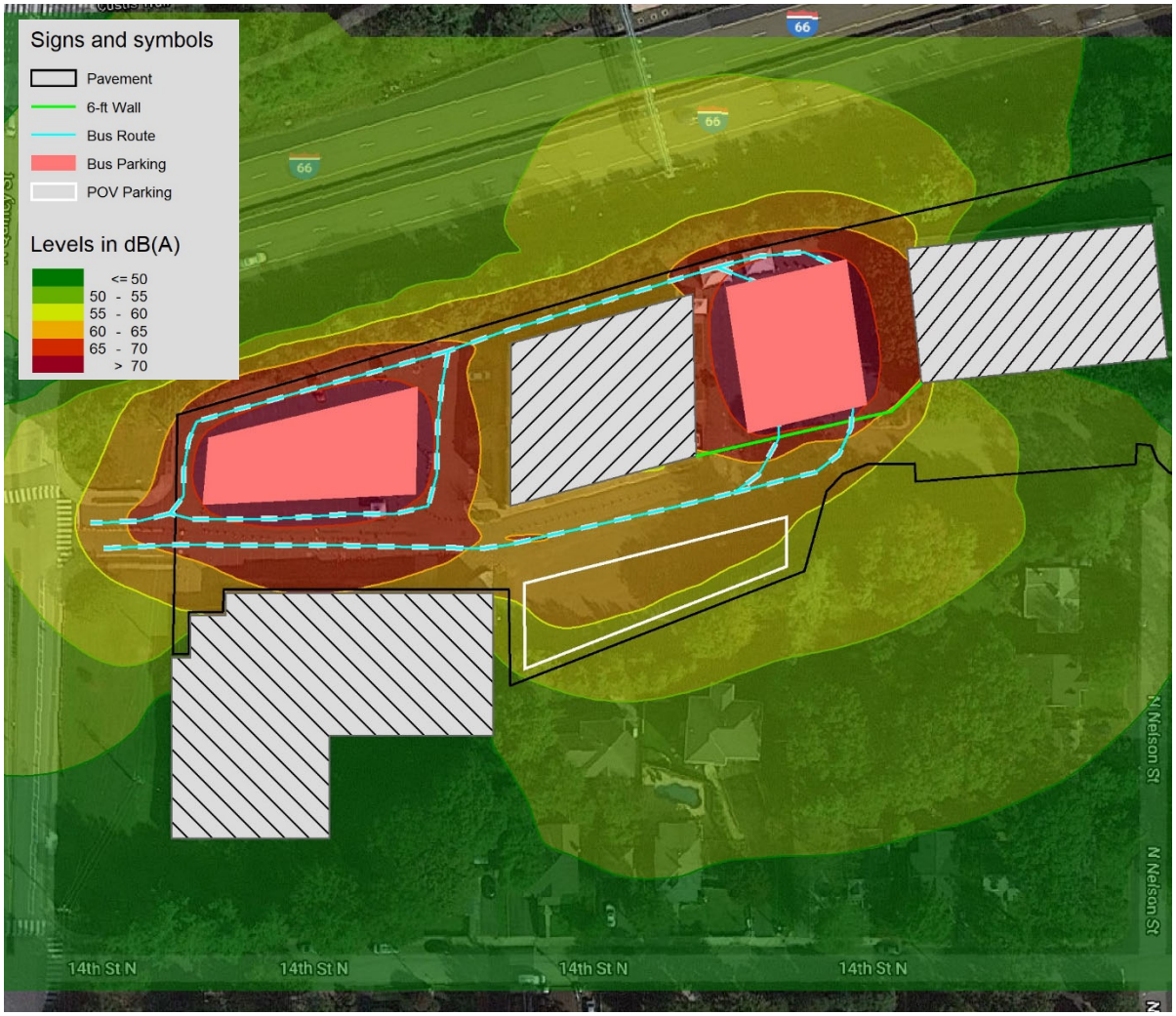


Figure 7: Daytime Operational Noise Contours

Figure 8: Daytime Operational Noise Contours with 6' Fence

Figure 9: Predicted (Daytime/Worst Case) Noise Levels at Adjacent Properties

Figure 10: Predicted (Daytime/Worst Case) Noise Levels at Adjacent Properties with Abatement

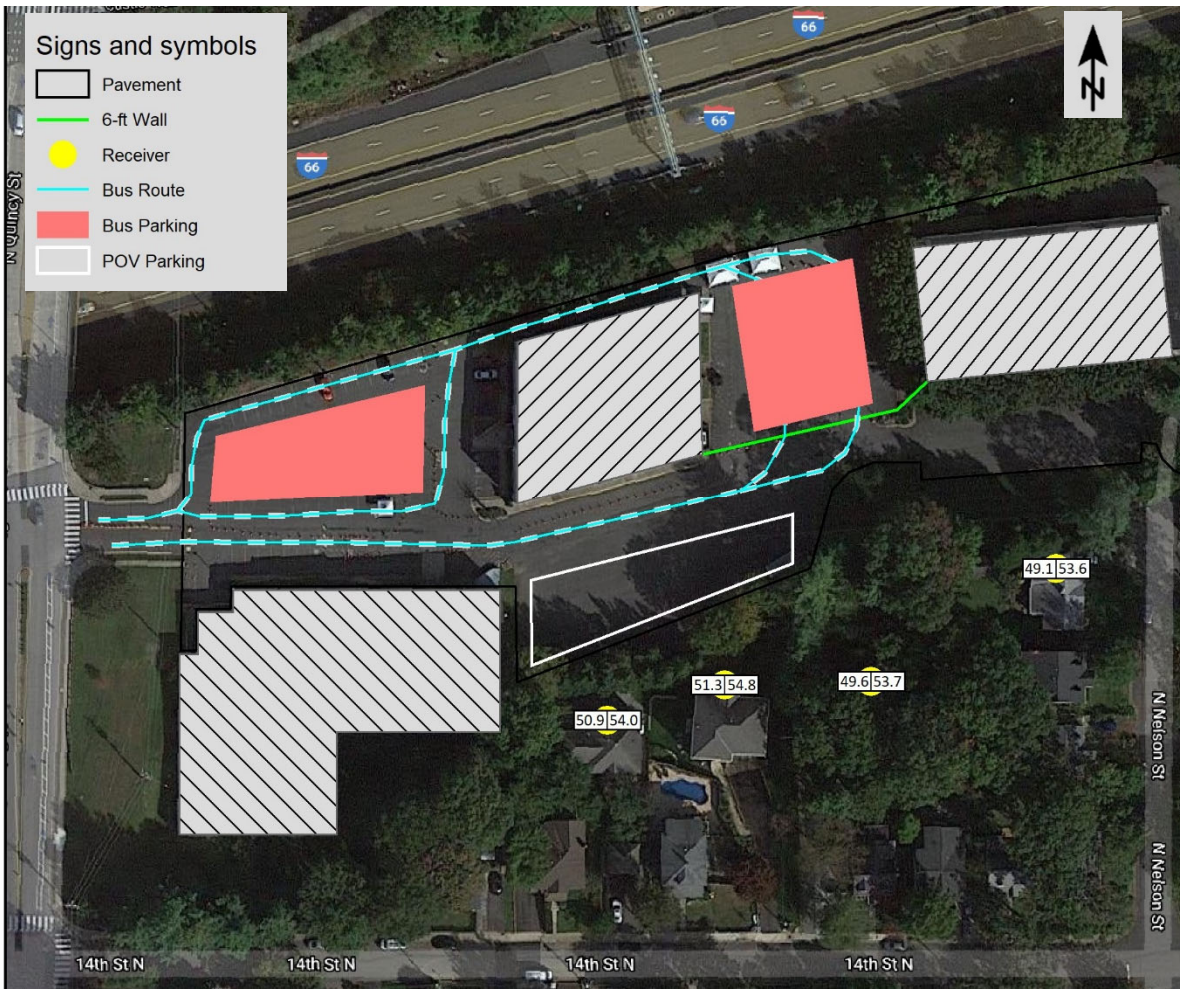


Figure 11: Measured Noise Levels (Average Daytime/5-6am) and Predicted (Daytime/Worst Case) Noise Levels with Abatement

Appendix A – Acoustifence Example Installations

Images from https://www.acoustiblok.com/acoustiblok-soundproofing-product-lines/acoustifence-noise-reducing-fences/ product examples.